GRAVELLY FORD WATER DISTRICT GROUNDWATER SUSTAINABILITY PLAN

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SECTION 1 - INTRODUCTION

1.1 - Purpose of the Groundwater Sustainability Plan (GSP or Plan) (Reg. § 354)(354.2)

It is the intent of this Gravelly Ford Groundwater District Sustainability Plan to provide to the California Department of Water Resources the information essential to permit department staff to review and approve the Plan. This Section includes not only Plan preparer contact information but brief, critical, Plan reference data and sustainability objectives, goals, and monitoring procedures. It concludes by describing proposed Plan evaluation reporting, analysis, effectiveness and any essential, State-approved, modifications during the twenty-year implementation process.

1.1.1 - EXECUTIVE SUMMARY (REG. § 354.4) (A)

This Plan is for the Gravelly Ford Groundwater Sustainability Area, one of seven components of the Madera Subbasin. It encompasses approximately 8,500 acres; its boundaries are coterminous with those of the Gravelly Ford Water District (District). Grape vineyards, nut tree groves, and on-farm rural residences are the only land uses in the Area. The District has from the beginning bee'n a conjunctive use operation with the import of surface water for both recharge and irrigation. The management of this operation has been to utilize the maximum amount of available surface waters prior to using groundwater for the production of crops. This is represented in the overall water balance for the District, and with the implementation of the proposed projects to monitor subsidence and pumping volumes it will continue to provide the data that supports the District as being sustainable. The operational management of water from the beginning of the District's operation has been in conformance with the proposed guidelines by SGMA to provide for a balanced area. This has been achieved through the maximum use of surface water imports to either irrigate crops or to place in the recharge of the aquifer prior to the use of groundwater.

The Area has had, because of its location and conjunctive use of surface water supplies and groundwater, minimal State GSP-defined undesirable results. Although groundwater levels and groundwater storage have declined, the position of the District is that pumping from surrounding lands represent the majority of the current conditions within the district boundary. The impact of pumping in areas adjacent to the district boundary has led to land subsidence in the Area, but due to the import of surface water within the boundary of the district this has been less than most parts of the Subbasin.

To achieve the Plan's goal of full compliance with groundwater sustainability within twenty years, the Area (the District) has already instituted projects and management actions implementing the Plan. They include additional monitoring and measurement of groundwater levels and groundwater water quality, of surface water flows, and of land subsidence; additional surface waters capture and irrigation/recharge, and full cooperation with a State well discharge metering program. The total cost of the projects and management actions over the 20-year plan implementation period is estimated to exceed $788,000 (see Section 1.3.4).

1.1.2 - References and Technical Studies (b)

The technical study which serves as the basic data source for consideration of this GSP is the Hydrologic Conceptual Model and Groundwater Conditions for the Gravelly Ford Water District GSP prepared by Kenneth D. Schmidt and Associates and appended hereto as Appendix B. That report references, in its text, numerous sources for its data and analysis. Other technical references are contained in this GSP text. Additional information has been used in the development of the report from the studies completed by the Consultant team for the Joint Madera Subbasin GSP.

References listed below where utilized as guidelines for the GSP document format to assure ease of review by the Department of Water Resources staff and other interested-parties:

- The Groundwater Sustainability Plan (GSP) Emergency Regulations Guide, July 2016, California Department of Water Resources;
- The Groundwater Sustainability Plan (GSP) Annotated Outline, December 2016, California Department of Water Resources;
- The Preparation Checklist for GSP Submittal, December 2016, California Department of Water Resources; and
- The datasets, interactive maps and best management practice documents described in the Department of Water Resources Technical Assistance bulletin, August 2017.

1.2 - Sustainability Goal

A sustainability goal is an overarching target that guides the description of undesirable results for the six sustainability indicators: groundwater levels, water storage, water quality, seawater intrusion, subsidence, and surface water and groundwater depletion. In support of the sustainability goals, a GSP must prepare a description of which undesirable results apply to the Madera subbasin within the jurisdiction of Gravelly Ford Water District and what the undesirable results are for each of the applicable sustainability indicators. This includes potential effects of undesirable results on the beneficial uses and users of groundwater, land uses and property interests.

The sustainability goal for this Subbasin is to minimize the listed undesirable results throughout the Subbasin by providing a Gravelly Ford GSP water supply that supports current cultivated acreage in the Plan area by developing an expanded surface water irrigation and recharge program, and groundwater monitoring and land elevation measurement program. The greatest challenge facing the Madera Subbasin is overdraft that has historically occurred throughout the Subbasin area. Once fully implemented, farmers of the Gravelly Ford GSS should be able to continue at their present level of farming and related GSA undesirable results should be eliminated with attendant benefit to the entire Subbasin.

The ability to operate the GFWD service area within the sustainable yield for this area is dependent on the continued inflow of surface waters from the two (2) primary sources of the San Joaquin River and Cottonwood Creek. The historical imported surface water to the GFWD service area has shown the area to be in balance a majority of the years over the last 25 years used for the water balance analysis.

This continued balance of imported surface flows will be maintained through the use of the distribution system of canals and the recharge basin to achieve the recharge goals, along with the continued practice of conjunctive use throughout the lands of the District to utilize surface water when available prior to pumping groundwater.

1.3 - Agency Information (Reg. § 354.6)

1.3.1 - Organization and Management Structure of the Groundwater Sustainability Agency (GSA or Agency) (a)(b)

The Gravelly Ford Water District was formed in 1961 as a special district local agency as defined in section 10721 of the Water Code. The District has a 5-member board of directors elected by landowners in the District and a District Manager. The Board determines the policies and procedures to operate the District and the Manager implements those policies and procedures.

1.3.2 - Contact Information (a)(c)

Don Roberts, General Manager
18811 Road 27
Madera, CA 93638
(559) 474-1000
Donroberts717@gmail.com

1.3.3 - Legal Authority of the GSA (d)

Attached in Appendix A are the following documents:

- Notice of GFWD intent to Serve as Groundwater Sustainability Agency, and resolution; and
- Notification of Intent to Develop Groundwater Sustainability Plan, and resolution

1.3.4 - Estimated Cost of Implementing the GSP and the GSA's Approach to Meet Costs (e)

The costs of Plan implementation are estimated to be:

A. Initial Measuring and Surveying

These costs, which have been formalized in a consultant agreement with hydrological and engineering consultants, are estimated to be:

1.	Water well, land elevation surveying, mapping; initial water level measurements; establishment of subsidence benchmarks; mapping	$29,500
2.	Well sampling and testing; recordation	$4,000
3.	Establishment of percolation/recharge test program	$4,500
	Total	$38,000

B. Scheduled Testing, Measurement, Facilities Improvement and Maintenance Recordation and Reporting

1.	Annual subsidence, surveying and mapping	$3,000 per year x 20 years: $60,000
2.	Water level measurements, recordation, mapping	$1,500 per year x 20 years: $30,000
3.	Well sampling and testing	$2,000 per year x 20 years: $40,000
4.	Percolation/recharge metering, testing, recordation	$3,000 per year x 20 years = $60,000
5.	Recharge basin improvements, maintenance (contractual services)	$25,000 per year x 20 years = $500,000
6.	Annual and five-year evaluation and reporting, recommendations	$3,000 per year x 15 years + $8,000 during years 5, 10, 15 and 20: $3,000 x 15 + 8,000 x 4, $45,000 + $32,000 = $67,000
	Total	$757,000
	Total costs, initial and <u>operational</u>	$788,000

*Estimated in 2019 dollars; no correction for inflation-related cost increases

1.4 - GSP Organization (b)

1.4.1 - Description of GSP organization

The Board of the District presides over the GSP along with support from the Consulting Engineering Firm of Quad Knopf and the legal counsel for the District of Campagne & Campagne. The District provided a final draft of this report to the public through their web site and distributed copies to local agencies for review within the Madera basin.

1.4.2 - Checklist for GSP Submittal

The District's consultants used the "Preparation Checklist for GSP Submittal" by the California Department of Water Resources, Sustainable groundwater Management Program to assess the document.

SECTION 2 - PLAN AREA AND BASIN SETTING (REG. § 354.8)

2.1 - Description of the Plan Area (Reg. § 354.8) (b)

The District encompasses approximately 8,500 acres, of which approximately 7,500 acres are irrigated agriculture. The area of the proposed GSA coincides with the District boundaries in the southwest portion of the Madera Subbasin. The District's GSA is one of the 7 GSAs to be formed for the Subbasin. The District and its facilities are shown on Figure 2-1.

The other GSA agencies that make up the Madera Subbasin are listed below:

Madera County GSA

Madera Irrigation District GSA

City of Madera GSA

Madera Water District GSA

Root Creek Water District GSA

New Stone Water District GSA

The area, which is almost exclusively comprised of intensive agriculture, has rural domestic wells for land owners. These wells serve the farm residences scattered throughout the area. There are not any municipal wells or public water systems within the District boundaries.

The density of wells per square mile is approximately 1.7.

2.1.1 - SUMMARY OF JURISDICTIONAL AREAS AND OTHER FEATURES (REG. § 354.8 B)

- The following figures depict the boundary of the GFWD (Figure 2-1), location of GFWD in the Madera Subbasin (Figure 2-2), the location of Agricultural Wells within he GFWD boundary (Figure 2-3), direction of groundwater outflows (Figure 2-4) and watersheds within Madera County (Figure 2-5).

- Map(s) (Reg. § 354.8 a):

  - areas covered by an Alternative: the GSP area does not provide for an alternative due to its small size. (1)

  - Jurisdictional boundaries of federal or State land: There are no known Federal or State boundaries within the GFWD boundary. (3)

  - Existing land use designations the complete area of the GFWD GSP boundary is General Agriculture under the current Madera County General Plan. (4)

  - Density of wells per square mile is approximately 1.7. (5)

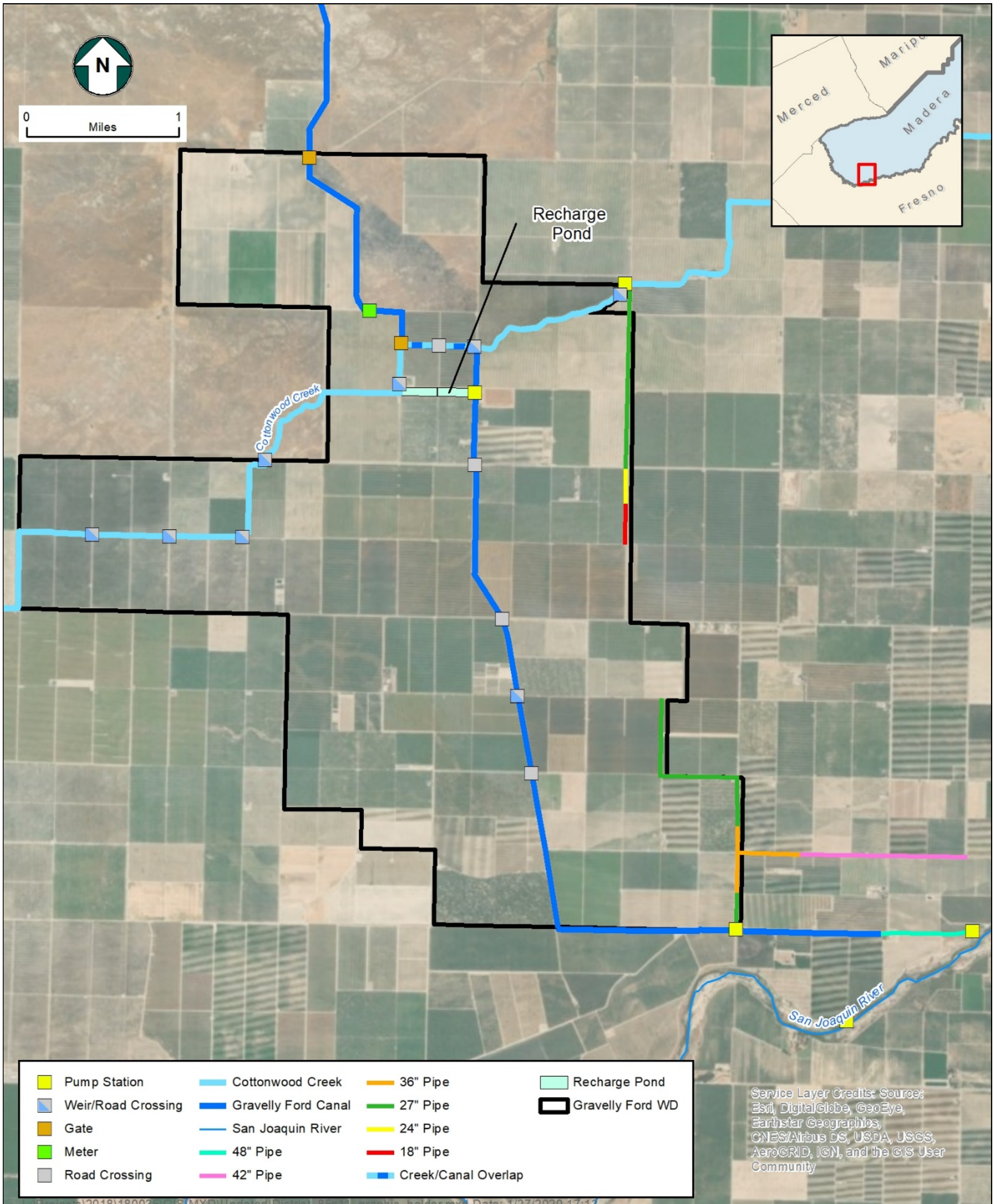


Figure 2-1
Gravelly Ford Water District/GSP Area (a)(1)

(Reg. § 354.8)

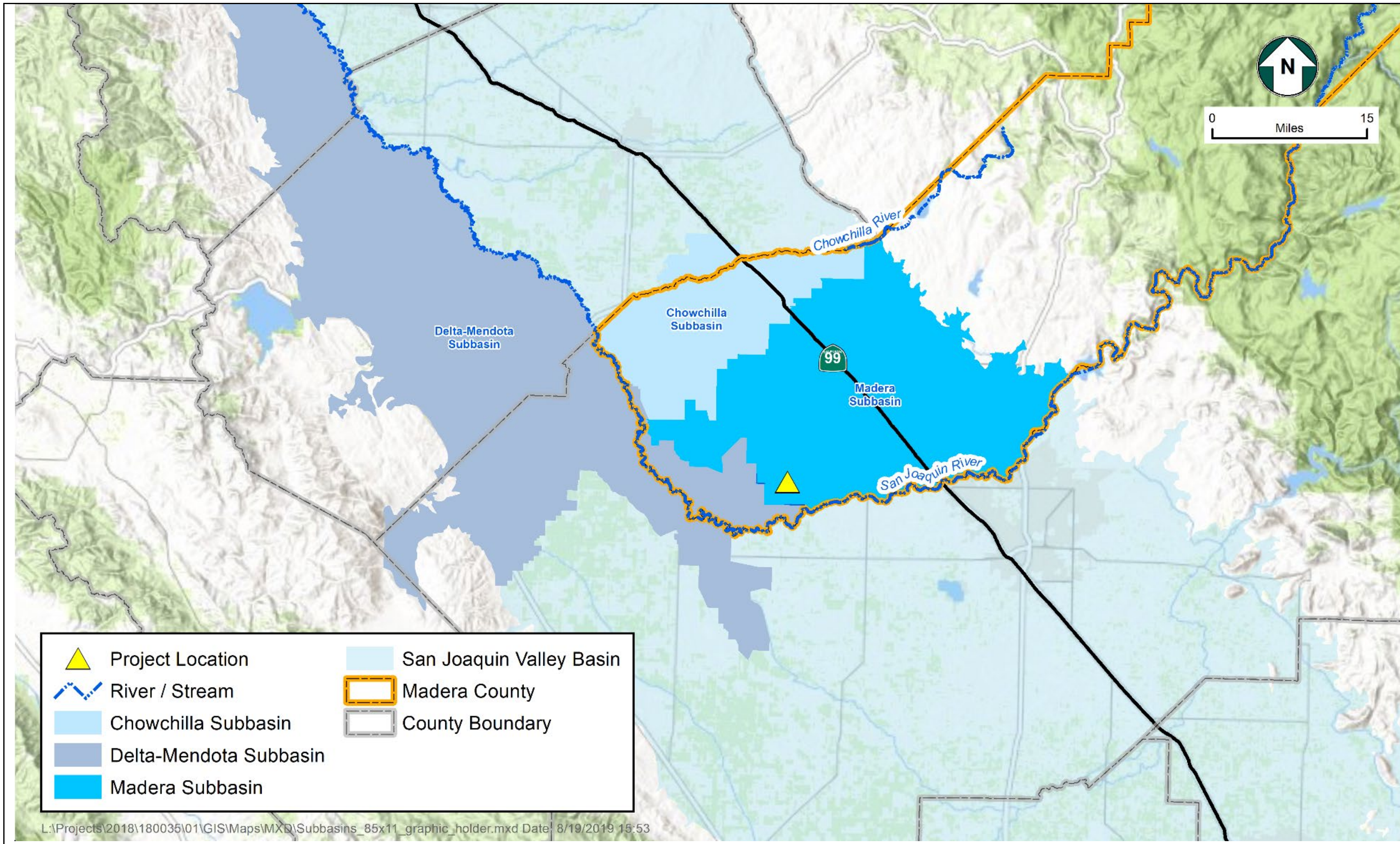


Figure 2-2
Basin and Subbasins (a)(1)(3)

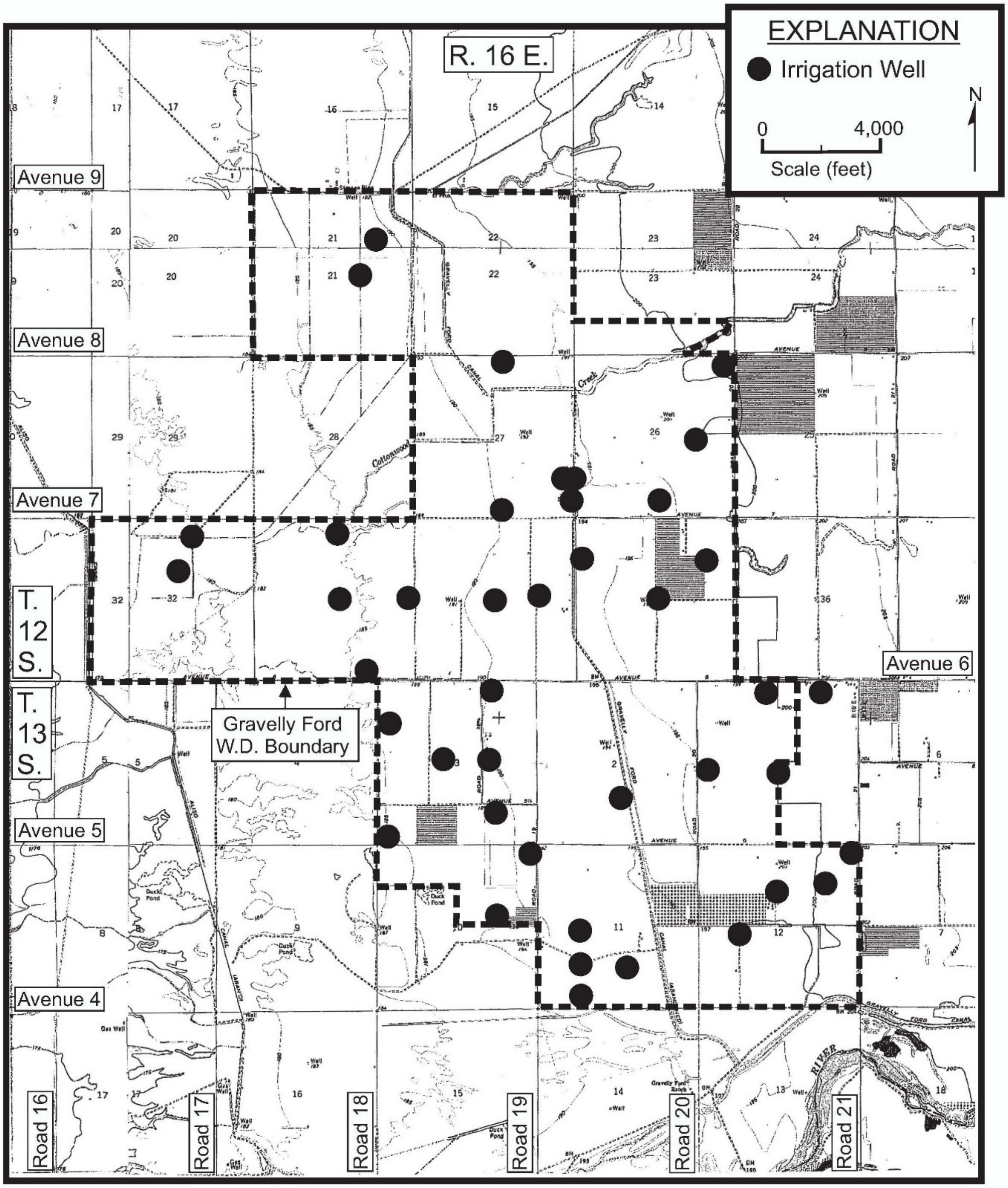


Figure 2-3
In-District Wells (5)

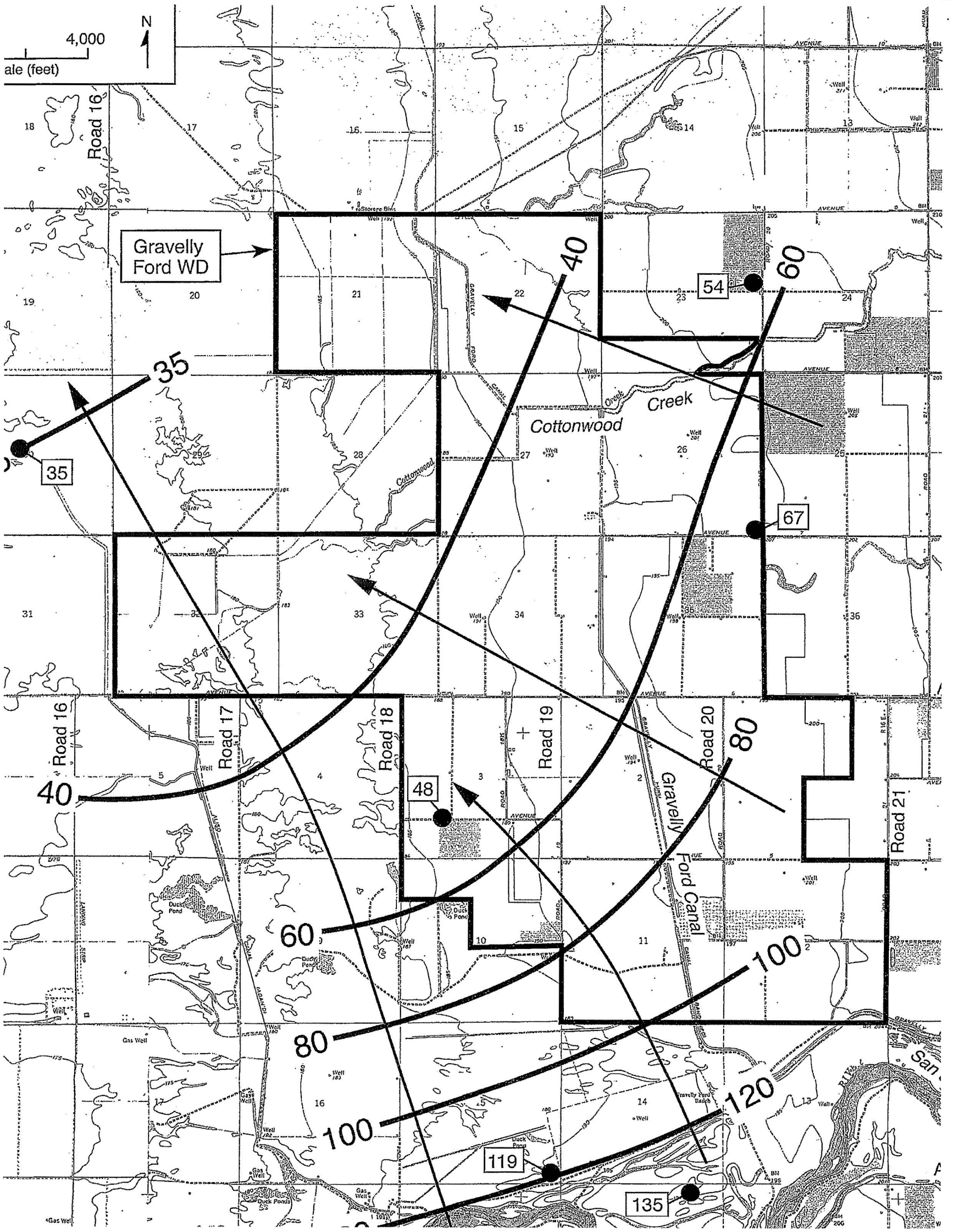


Figure 2-4
Direction of Groundwater Flow

(Reg. § 354.8)

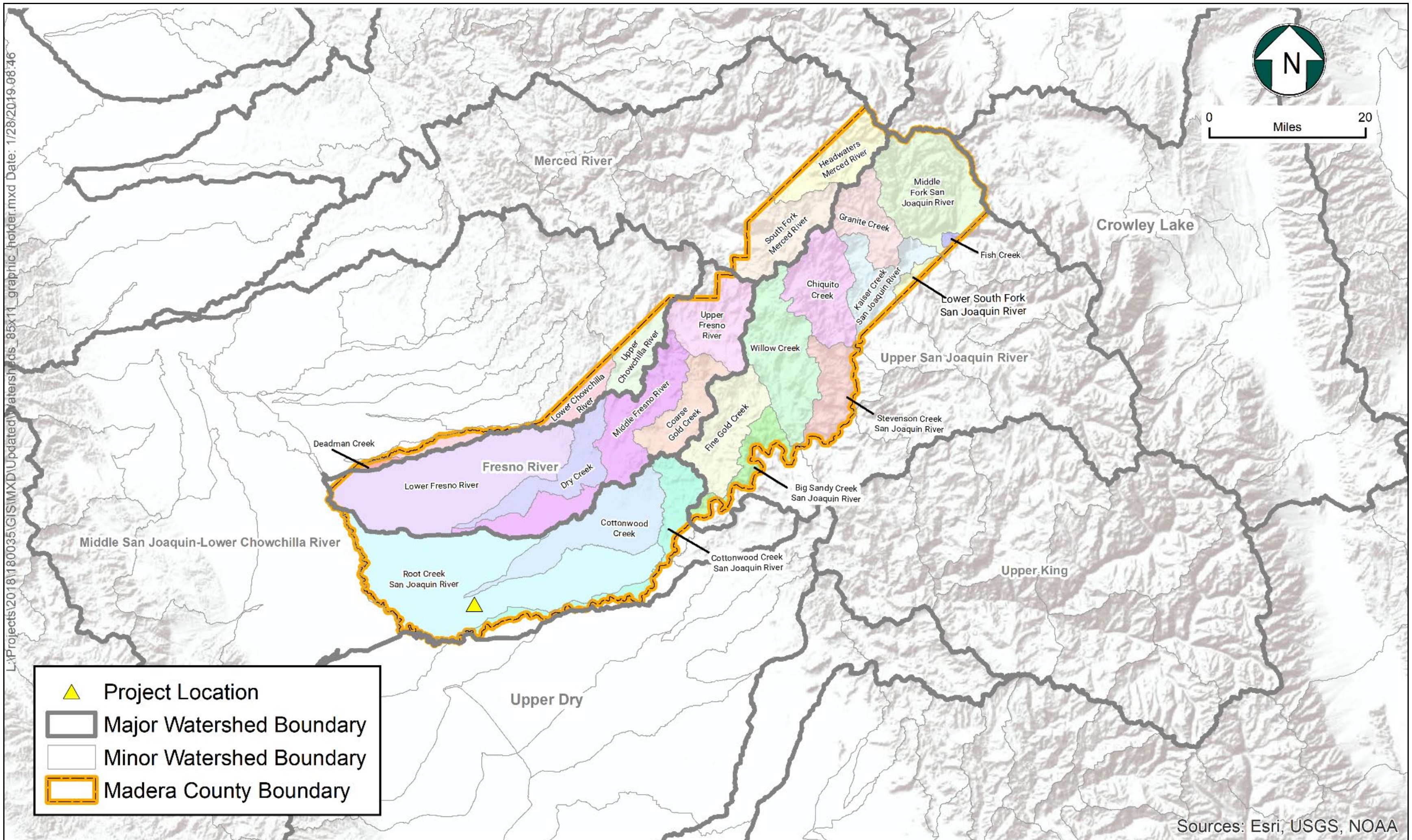


Figure 2-5
Watersheds (2)

2.1.2 - Water Resources Monitoring and Management Programs (Reg. § 354.8 c, d, e)

EXISTING AND PROPOSED WATER RESOURCE MONITORING AND MANAGEMENT PROGRAMS (c)

The District has instituted a comprehensive monitoring program which will quantify the conditions of the groundwater GFWD GSA area. The purposes for the monitoring program are to assess the long-term conditions of the GFWD GSA area through ongoing and routine measurements and to provide a basis for continuing evaluation and effective modification of programs to affect sustainability goals.

The existing monitoring program for GSP-related data in or directly affecting the District's GSP has included:

- Water-level elevations in deep wells in the District in Spring of 2015;
- Long-term water hydrographs for five wells in or near the District, accessed from the Department of Water Resources website;
- Pump tests for multiple irrigation wells in the District, including specific capacities ;
- Land subsidence data in and near the District between December 2011 and June 2016, from the San Joaquin River Restoration Project;
- Water-level measurements, for shallow monitor wells, from the San Joaquin River Restoration Project; and
- Weather and hourly recorded precipitation measurements, at Station 045233 located at Avenue 12 ¼ just west of Road 38.

The water resource monitoring program which has already been instituted and will be continued by the District includes:

- Static water level measurements, twice per year, of 24 representative wells in the District;
- Water sampling annually for irrigation suitability, during each summer pumping season, for each of these wells (electrical conductivity, SAR and pH, irrigation suitability analysis includes these three);
- Five new subsidence monitoring stations within District boundaries, surveyed once per year (in July and December); and

- Additional emphasis upon accurate metering and data recordation of surface water deliveries.

- Percolation tests at potential recharge facilities.

Newly installed water management programs include:

- The data collection, collation and recordation program described above.

- Refurbishing and maintenance of existing open-ditch and storage pond facilities to increase percolation capabilities of available excess wet-year surface water supplies, supplementing irrigation usage of such supplies.

- Installation of water measurement meters on all wells within the District to be used on agricultural lands, reporting annual pumping volumes. Through the adoption of Resolution 2019-04 reserves the right for the District to require all new wells within the District to have a flow meter installed with a totalizer and annual reporting of usage to the District.

The data collected from the well measurement levels and the volume pumped annually will be used to adjust the water balance for the GSA boundary. This information will also be placed against the volume of surface water inflow and recharge volume to determine the net change in the water system storage for the area. This will provide guidance on the volumes of extraction and surface water inflow for the coming year to maintain a balance in the storage and not have any undesirable outcomes.

The ability to maintain the necessary mix of groundwater and surface water flows will be dependent on the type of water year and the additional available water storage in the system to allow minimal overdraft during Below Normal, Dry or Critically Dry years to provide the required application volume of water per farmed acre. If need be a reduction of allowed extraction will be determined by the GFWD Board to provide no exceedance of a measurable objective of the groundwater depth and therefore to avoid the exceedance of a minimum threshold so there are no undesirable results for the operational year.

CURRENT MONITORING LIMITATIONS AND HOW TO ADAPT (d)

The District is a member of the Madera Subbasin Formation Committee and the Madera Groundwater Authority. The agencies in these organizations include the Madera Irrigation District, City of Madera, County of Madera, and local water agencies including Gravelly Ford Water District, Root Creek Water District, and Madera Water District.

The GSP proposes the continuation and strengthening of these relations and the sharing with such agencies of the data obtained by the expansion of District monitoring activities. Those items of most interest will be the annual pumping volumes, depth readings of the static water levels during the spring and fall of each year and surface water volumes recharged each year to the benefit of the subbasin.

CONJUNCTIVE USE PROGRAMS (e)

The District has, since the District was formed in 1961, utilized conjunctive use programs to manage water supplies and to improve groundwater conditions. Prior to the formation of the District this area was managed with similar programs for recharge of water supplies to improve groundwater conditions in the area.

The data program and the GSP-incorporated improved water-percolation capabilities of existing open-ditch and pond-storage facilities will be of major benefit in achieving sustainability goals. Both of those facilities have been evaluated for percolation rates and with the availability of surface water the deficit amount within the GSP area can easily be recharged each year or higher volumes during wet years to maintain the usage within the District for a balanced subbasin area.

2.1.3 - LAND USE ELEMENTS OR TOPIC CATEGORIES OF APPLICABLE GENERAL PLANS (REG. § 354.8 F) (I)

The lands within the boundary of the District are all designated Agricultural in the Madera General Plan. The land use designation for the parcels within the boundary of the District's GSA is Agricultural (A) as per their current General Plan for the County of Madera. The District landowners currently have no plans to change the crop pattern or to drill new wells. The replacement of old wells to maintain the same level of service to a parcel within the District will have a result of zero change to the current basin usage volumes. The implementation of the GSP as proposed would have no effect on the land use plans within the District as long as those land use patterns do not change from their current use.

The land surrounding the District boundary is also designated as Agricultural lands. Presently there is a similar crop pattern outside the District boundary. Should the crop patterns change to a higher demand crop the additional demand to the groundwater pool in the area could cause the groundwater levels to lower if additional surface water is not recharged in the area.

Plan Description (2 thru 5)

As a result of GFWD's operations over the past 57 years there has been minimal lowering of water levels and minimal land subsidence. The District plans to continue present levels of farming operations though a reliance on Bureau Class 2 water and other surface water supplies. Groundwater usage will be measured yearly and every five years for a compression to GSP goals. Water availability is dependent on the type of water year. During periods of extended dry or below normal waters years the extraction volume from the groundwater by the existing wells within the boundary of the GFWD GSA maybe may require reduction to maintain groundwater levels above the minimum threshold. This will be determined by the Board of the GFWD based on previous years addition to the system storage volume in the area of the GFWD. Surface water inflows and recharge volumes will be used along with the trend of the groundwater levels to make the recommendation for the allowable extraction volume per acre for the operational year be considered at that time.

The extraction volume set by the Board of the GFWD will allow the landowner in the District to determine their water budget for the growing season and adjust their practices to work within that allotment of water from the district surface and groundwater volumes. The landowner can work to supplement their water needs through outside water sources during a year when available water from the GFWD resources is limited by the availability from GFWD.

The District will expand its groundwater recharge program to allow the capture of more wet year water supplies. The District will also seek water supplies from outside the basin, when available, to further increase surface water irrigation usage and direct recharge.

The continued balance of the basin area for the District is dependent on no additional outside influence that would deplete or lower the groundwater availability in the current wells utilized for agricultural production. GFWD is not a regulatory agency that has the ability to review and approve the transition of current lands adjacent to the GFWD boundary. The County of Madera has that authority to regulate the change in the current zoning from agriculture to another land use that would result in the extraction of groundwater adjacent to the boundary of GFWD. The land use change that results in additional or dependence on groundwater for that use should be regulated by Madera County and will need to be a part of the coordinated GSP for the basin to limit or restrict new land uses that are dependent on groundwater extraction adjacent to the GFWD boundary. The increase of such land uses will directly influence the sustainability of the groundwater related to the GFWD use area and those impacts may limit extraction in the future through no fault of the operational management of the area by the GFWD. The GFWD Board adopted Resolution 2019-04 to have Madera County provide any new land use change applications to GFWD for comment prior to approval during the application process in the County Planning Department.

2.1.4 - Additional GSP Elements (Reg. § 354.8 g)

A.) Control of saline water intrusion: The relationship of the lands within the District boundary and the potential impact from a saline source are far removed, therefore no measures are being suggested to control saline water intrusion.

B.) Wellhead Protection: The existing agricultural and residential wells within the District will be reviewed for compliance with State and Madera County Environmental Health Department standards on the sanitary seal, that a check valve or air gap is provided and that the air vent screen is correctly installed.

C.) Migration of contaminated groundwater: Currently there is no contaminated groundwater within the District. Going forward the District will educate customers using groundwater wells on the operational procedures to prevent a contamination.

D.) Well abandonment and well destruction program: The District will have the landowner follow the guidelines and requirements of the Madera County Department of Environmental Health for well abandonment and well destruction.

E.) Replenishment of groundwater extractions: The District has been providing the import of surface water to the district area since the formation of the District. Surface water has been made available to recharge through the earthen canals and recharge basin.

F.) Conjunctive use and underground storage: The District has provided surface water into the district boundary over the past 25 plus years to allow for use of both surface water and groundwater to the crop production lands. This has also provided increased storage of groundwater during wet water years, as shown in table 2-1.

G.) Well construction policies: The District will follow the policies provided by the State and the County of Madera. The District will look for the County of Madera Environmental Health Department to coordinate all new well and replacement well applications within the boundary of the GFWD with the District for review and approval. The District will utilize the water budget and operational goals of the GSP to determine if the well application will have negative impacts on the overall operational goals of the area. The GFWD Board has adopted Resolution 2019-04 to reserve the right to approve the location of new wells being drilled in the District.

H.) Efficient water management practices: The District will continue to provide surface water when available throughout the growing season to offset the groundwater pumping and to recharge to the subbasin to achieve a rolling balance of the subbasin in the District boundary.

I.) Relationship with State and Federal agencies: The District has a strong relationship with both State and Federal agencies for the ability to coordinate surface water deliveries.

J.) Impacts on groundwater dependent ecosystems: There are not any known areas of ecosystems being dependent on groundwater within the boundary of the District.

2.1.5 - NOTICE AND COMMUNICATION (REG. § 354.10)

Notice and Communication

BENEFICIAL USES (A)

The predominant existing, and planned, beneficial use of groundwater and surface water in the GSP area is irrigated crop production. A small amount of groundwater is pumped for domestic use. The monthly Board meeting provides an opportunity for input by the public and customers, along with review of this planning document.

COMMENTS REGARDING PLAN (C)

The District welcomes any and all constructive comments regarding the GSP which will enable an increase in its effectiveness in reaching its groundwater goals and objectives. Comments received on the draft GSP are in Section 7, Appendix E

List of Public Meetings (b):

GFWD meets the third Monday of each month and for the last two years the GSP report has been on the agenda for comment by the public and in August of 2019 the draft report was placed on the District's web page.

COMMUNICATION PLAN (D)

All comments should be directed to the Gravelly Ford Water District (GFWD) General Manager, Don Roberts. The Board of Directors for the GFWD will be presented with comments or requests to provide direction to staff on how those items will be addressed within the framework of the GSP. District (GSP) representatives will be pleased to continue to attend and participate in Plan-pertinent meetings of Madera Subbasin water agencies.

2.2 - Basin Setting (Reg. § 354.12)

2.2.1 - HYDROGEOLOGIC CONCEPTUAL MODEL (REG. § 354.14)

This section was principally prepared by Kenneth D. Schmidt and Associates (KDSA) and the full report and exhibits are attached in Appendix B. Supplemental information was added as data became available through the evaluation of the GSP subsequent to the completion of the report prepared by KDSA. The area of the District has a relatively flat topography.

Surficial Characteristics

SURFICIAL GEOLOGY

There are Quaternary fan deposits in the southern portion of the GSA, while the northern portion features Quaternary basin deposits.

TOPSOIL'S

The U.S. Soil Conservation Service report on soils in the Madera area shows four soil classifications in the GSA (Ulrich & Stromberg, 1962). Topsoils in the majority of the GSA were mapped as the Dinuba-El Peco association. North of Avenue 6, some topsoils are of the Fresno-El Peco association. Both of these soils have hardpan development. Trevor-Chino association soils are present in only a small area, south of Avenue 7 and east of Road 16. These soils don't have a hardpan but contain more clay in the subsoil. Between Avenues 4 and 5, soils of the Hanford-Tujunga association are present. These soils are coarse-grained and the most permeable of the topsoil's in the GSA.

RECHARGE AREAS

The distribution system for the District is primarily open earth canals along with a 17 acre recharge basin (Figure 2-1). These features provide the opportunity for recharge during the season when surface water flows are released into this system and during the winter months when Storm water flows can be captured or diverted into this system.

SURFACE WATER BODIES

The San Joaquin River is the major stream in the area and is located near the southeast corner of the GSA. Cottonwood Creek drains a considerable area in the foothills and enters the GSA from the northeast. The Chowchilla Canal Bypass is a major flood control channel that passes from the south to north several miles west of the east edge of the District (Figure 2-1).

SURFACE WATER SOURCE/DELIVERY

The source of the majority of the surface water imported into the District is San Joaquin River flows released from Friant Dam. The surface water is pumped from the river into the District's system. The other source is from Cottonwood Creek when foothill runoff flows can be diverted into the system.

2.2.2 - CURRENT AND HISTORICAL GROUNDWATER CONDITIONS (REG. § 354.16)

- Groundwater elevation data is limited for the area (see Figure 9 of the Ken Schmidt & Associates report in Appendix B). Groundwater levels are also represented in Figures 2-6 and 2-7 for the Spring of 2016. This information will be updated through the project to measure the 24 existing agricultural wells within the GFWD district and provided in the report update in the next five years.

- Estimate of groundwater storage from the Ken Schmidt & Associates report in Appendix B on page 21 is 15,000 acre-feet. This figure will be updated through the monitoring program to be implemented by the GFWD in conjunction with the groundwater level measurements. This collected information will be used to update the report and adjust the measurable outcomes in the five-year update of the report.

- Seawater intrusion conditions. The area of the District is not located where there is a potential for seawater intrusion.

- Groundwater quality issues. The present groundwater supply is suitable for irrigation of most crops, with some need for treatment to lower the pH and/or sodium adsorption ratio (SAR) if required by the drop type. Overall the water quality is good with no known constituents of exceedance.

Historic Surface Water Usage and Water Balance

Table 2-1 shows GFWD's historical surface water deliveries for a period from 1989 thru 2014.

Table 2-1
Surface Water Deliveries

Surface Water Deliveries (Acre Feet)					
Water Year	Diversion from San Joaquin River (Bureu Class 2)	Diversions from MID Conveyance System	Diversions from Cottonwood Creek via MID	Diversions from Cottonwood Creek (Natural Flow)	Total (Inflow)
1989 (C)	-	65	0	72	137
1990 (C)	-	0	0	0	0
1991 (C)	2,225	247	0	0	2,472
1992 (C)	-	424	0	0	424
1993 (W)	10,999	4,247	6,610	5,195	27,051
1994 (C)	11,754	1,588	340	294	13,976
1995 (W)	10,796	4,120	6,274	7,305	28,495
1996 (W)	12,569	4,126	6,106	3,999	26,800
1997 (W)	11,871	3,429	4,850	2,398	22,548
1998 (W)	9,969	2,809	3,999	9,078	25,855
1999 (AN)	7,174	1,850	3,197	5,287	17,508
2000 (AN)	8,864	2,102	3,189	3,635	17,790
2001 (D)	3,707	872	1,308	841	6,728
2002 (D)	5,732	1,338	1,000	721	8,791
2003 (BN)	7,509	1,367	1,386	1,374	11,636
2004 (D)	11,472	1,517	2,340	89	15,418
2005 (W)	9,562	1,281	2,736	1,611	15,190
2006 (W)	9,730	1,921	3,560	1,211	16,422
2007 (C)	7,940	1,183	1,202	291	10,616
2008 (C)	7,854	949	545	0	9,348
2009 (BN)	2,556	373	0	0	2,929
2010 (AN)	5,965	31	53	1,117	7,166
2011 (W)	6,302	2,876	3,604	3,475	16,257
2012 (D)	823	442	126	82	1,473
2013 (C)	-	0	0	0	0
2014 (C)	-	0	0	0	0
2015 (C)	-	0	0	0	0
Total (AF)	165,373	39,157	52,425	48,075	305,030
Average (AF/yr)	6,361	1,506	2,016	1,849	11,732

The San Joaquin River Restoration program now being implemented will increase surface water presence in the river channel near the District's southeast border and will thus commensurately increase groundwater recharge to the GSP area, supplementing existing recharge areas and surface water transport canals (see Figures 2-1 and 2-2).

Water Balance (overdraft)

Water balance has been calculated (Appendix B) using the specific yield for the unconfined groundwater and the long-term average water-level change over a hydrologic base period. Using an area of 8,500 acres, specific yield of 0.12, and average water-level decline of 0.9 foot per year, the overdraft in the GSA is about 900 acre-feet per year. This average water decline was influenced by the pumping from wells outside the boundary of the District and this figure would be close to the range of 0.2 to 0.5 foot per year based on the "in" District pumping since the District's area represents only a fraction of the overall Madera Subbasin and the extraction of groundwater in areas without the influence of surface water flows.

David's Engineering, as part of studies of the Madera Subbasin, has made water balance estimates for the Gravelly Ford GSA. They estimated recharge to average about 16,000 acre-feet per year for 1989-2014, and the average groundwater pumpage to be about 16,700 acre-feet per year. This leaves a negative water balance of 700 acre-feet per year. However their water balance did not include groundwater flows.

Because the GSA is in a subsiding area, an additional source of water has been compaction from the Corcoran Clay and underlying clay layers. Assuming that the average compaction during 1989-2014 was about 0.08 foot per year (half of the subsidence between 2011 and 2016), the amount of water expelled from the clays would be about 2.2 feet times 8,500 acres, or about 700 acre-feet per year. This has reduced the net imbalance to about zero (0) acre-feet per year, in good agreement with the value determined from the David's Engineering estimate and the water-level change-specific yield estimate, recognizing that totally successful implementation of subsidence goals would, with no other changes, make the estimated overdraft zero (0) acre feet per year. The water balance by David's Engineering for the Gravelly Ford WD is shown to be a negative 386 acre-feet due to surface water outflows. The water balance below for the GFWD boundary area provides for an imbalance of 378 acre-feet (Table 2-2). Table 2-3 is the water balance provided by David's Engineering that shows an imbalance of 386 acre-feet. Both represent the average over the period from 1989 to 2014.

Historical Water Budget – the historical water budget is shown in Table 2-6 for the average flows and ET conditions over the period from 1989 to 2014.

Current Water Budget – the current water budget has followed the similar numbers provide in Table 2-6 with increased inflow of surface waters to adjust for the current ET of the crop pattern and adjustment to provide additional surface flows for a balanced water budget.

Future Water Budget – the future water budget will be similar to Table 2-6 with adjustments from the data collected and applied to the determined volume of inflow surface water to provide a balanced water budget, maintain the system storage volume and stay within the limits of the projected groundwater levels and not reduce water quality. This is to be achieved through the increase of import surface water to the District for recharge, by the increased flows in the San Joaquin River from the Restoration project to increase the average groundwater storage volumes. The overall projected increased of additional import surface water is estimated at 1,600 acre-feet annually.

Table 2-2
Water Balance

Gravelly Ford Water District

Surface Water Balance June 2019

Notes:

Total Acres	8,380	acres (total in GSA area)
Average Irrigated Acres	7,501	acres (including idle)
Average current ETAW	2.16	
Target ETAW	2.16	af/ac/yr
Consumptive Use Target	16,200	
Rural Residential Consumptive Use	100	acre-feet/yr
Total Consumptive Use	16,300	acre-feet/yr

Sources:

Water Sources (average 1989-2014)		
Native Groundwater @ 0.5 af/ac	4,190	af/yr (for "total acres")
San Joaquin River (Class 2)	6,361	af/yr
Diversion from MID (6.2)	1,506	af/yr
Diversion from Cottonwood Creek - MID	2,016	af/yr
Diversion from Cottonwood Creek natural flow	1,849	af/yr
Total Avg Historic Supplies	15,922	af/yr
2015 Consumptive Use	16,300	af/yr
Estimated Imbalance	**378**	**af/yr**

Table 2-3
David's Engineering Water Balance

Inflow/Outflow	Quantification Method	Typical Volume (AF)*	Estimated Confidence Interval (percent)	**Confidence Interval Source**
SW Inflows Total	Measurement	16,072	5%	Professional Judgement.
Boundary Watercourse Seepage Inflow	Calculation	0	25%	Professional Judgement.
Precipitation	Calculation	7,196	20%	Professional Judgement.
ET	Measurement	19,591	5%	Professional Judgement.
SW Outflows Total	Calculation	4,062	5%	Professional Judgement.
Net Recharge from SWS	Closure	-386	-500%	Calculation**

*1989-2014 average

**Because the Net Recharge from SWS is close to zero, the calculation results in a large confidence interval indicating that the value could be greater than zero.

Subsurface Geologic Conditions

REGIONAL GEOLOGIC AND STRUCTURAL SETTING

The GSA is within the San Joaquin Valley, which is a topographic and structural trough, bounded on the east by the Sierra Nevada and on the west by the folded and faulted Coast Ranges. Both mountain ranges have contributed to marine and continental deposits in the Valley. In the west-central portion of the Valley, more than 1,200 feet of sediments are present. Alluvial deposits comprise the upper and lower aquifers, where are represented by Corcoran Clay. These inter-layered deposits dip slightly to the south-southwest.

SUBBASIN BOUNDARIES

Figure 2-1 shows the boundaries of the San Joaquin Valley Basin and GSA-pertinent Subbasins. The Madera Subbasin boundaries include the San Joaquin River on the south end. The remaining boundaries are political boundaries, including the Madera Irrigation District service area to the north and east of the Gravelly Ford Water District. The entire Subbasin lies within Madera County.

DEFINABLE BOTTOM OF THE BASIN

Figure 4 in the KDSA report (Appendix B) shows the definable bottom of the basin. Historically, the U.S. Geological Survey has used an electrical conductivity of about 3,000 micromhos per centimeter at 25 degrees Celsius to delineate the regional base of the fresh groundwater in the San Joaquin Valley. The base of the fresh groundwater can be called the "bottom of the basin." However, another factor to consider is the depth where the deposits become fine-grained. As part of this evaluation, electric logs for deep holes were obtained from the California Division of Oil, Gas, and Geothermic Resources. A review of these logs indicated depths to the "bottom of the basin" ranging from about 800 to 1,100 feet. The bottom of the basin is generally the shallowest beneath the southwest part of the GSA and deepest beneath the north-east and east parts of the GSA.

FORMATION NAMES

Mitten, Leblanc, and Bertoldi (1970) divided the unconsolidated deposits in the Madera area into the younger alluvium (normally less than about 50 feet thick), the Quaternary older alluvium (less than 1,000 feet thick), and the Tertiary-Quaternary continental deposits (about 1,000 to 2,200 feet thick). The Corcoran Clay is a regional defining clay bed. This clay divides the groundwater into an upper aquifer and lower aquifer. Water producing deposits in the GSA are generally termed the Sierra sands, as they were derived from the Sierra Nevada.

CONFINING BEDS

The confining bed that is important beneath the GSA is the E-Clay or Corcoran Clay. The top of this clay is shallowest (about 300 feet deep) in the north part of the GSA and is deepest (about 380 feet deep) near the south edge of the GSA. The depth to the top of the Corcoran Clay essentially defines the base of the upper aquifer. The Corcoran Clay generally thickens to the southwest beneath the GSA.

PRINCIPAL AQUIFERS

Based on subsurface geologic cross sections and water well drillers' logs and completion reports, the lower part of the upper aquifer and the upper part of the lower aquifer comprise the principal strata tapped by irrigation wells in most of the District. Because of relatively shallow water levels near the San Joaquin River some wells in this part of the GSA tap only the upper aquifer.

(Reg. § 354.8)

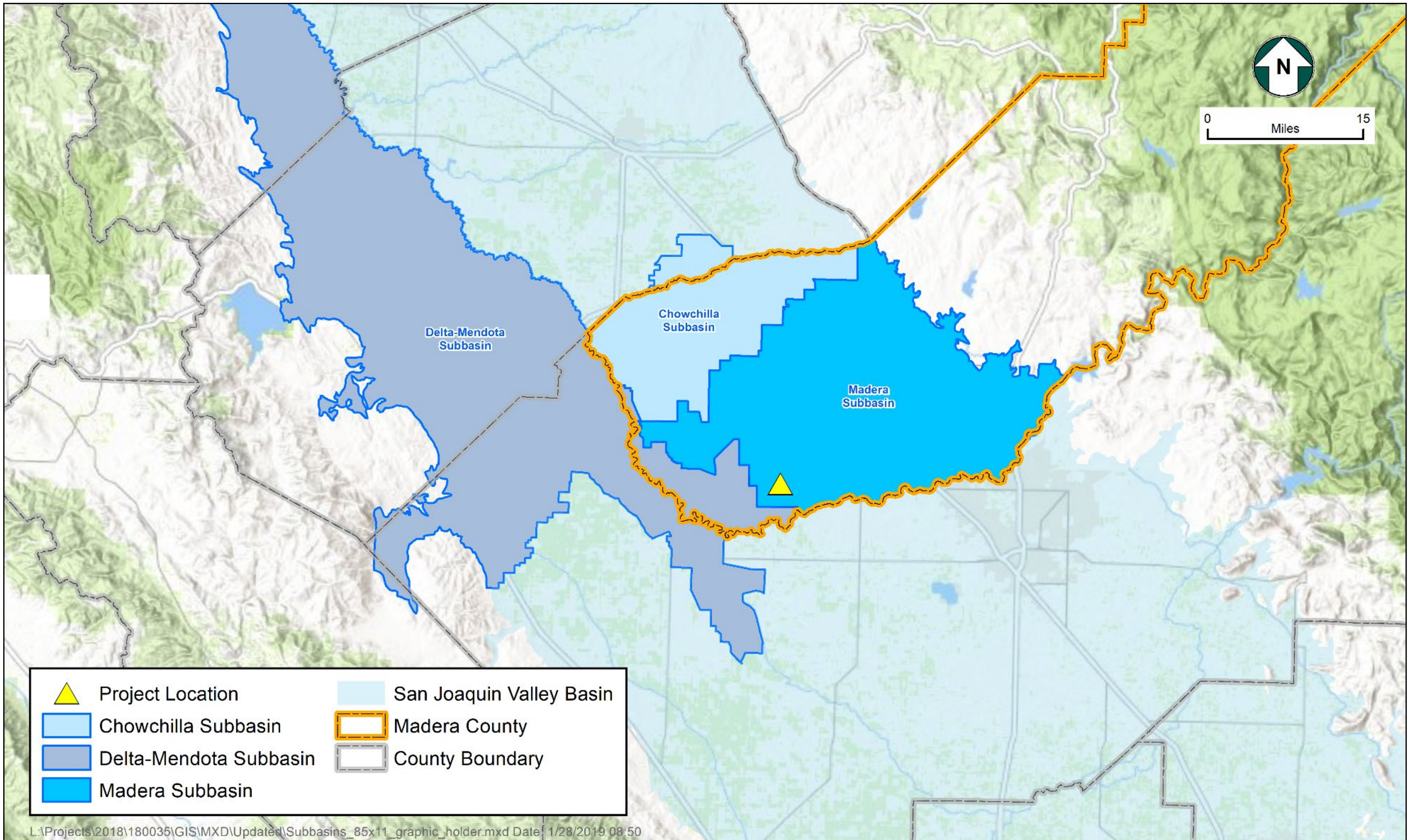


Figure 2-6
Basin and Subbasins

SUBSURFACE GEOLOGIC CROSS SECTIONS

KDSA has developed three subsurface geologic cross sections for and near the GSA. Cross section A-A' generally extends from the northwest to the southeast, perpendicular to the inferred dip of the alluvial deposits. In contrast, Cross Sections B-B' and C-C' extend from the southwest to the northeast, generally perpendicular to Cross Section A-A', and along the inferred dip of the deposits. These cross sections are shown as Figures 12, 13, and 14 in Appendix B.

Groundwater Conditions

GROUNDWATER USE AND WELL DATA

Primary Uses of Each Aquifer

Within the GSA, the primary uses of the upper and lower aquifers are for irrigation. Some water is also used for domestic use.

Depths of Supply Wells

Driller's logs and well completion reports indicate that depths of most active irrigation wells in the GSA range from about 350 feet to 600 feet. Only a small percentage of these wells exclusively tap the upper aquifer. Almost all of the remaining irrigation wells are composite wells, tapping strata both above and below the Corcoran Clay.

WATER LEVELS

This water-level discussion focuses on measurements primarily from irrigation wells, many of which are composite wells tapping both the upper and lower aquifers. Because of the lack of wells in and near the GSA that solely tap the lower aquifer, it is not possible to prepare a water-level map for the lower aquifer. However, limited data based on measurements for a few wells in nearby areas indicate a southwesterly direction of groundwater flow in the lower aquifer.

Water Level Elevations and Direction of Groundwater Flow

Water-level elevations in Spring 2015 ranged from more than 110 feet above mean sea level near the southeast corner of the GSA to about 30 feet in the north part of the GSA. Groundwater flowed away from the San Joaquin River, to the northwest or north.

Water Level Fluctuations

Long-term water-level hydrographs from the DWR website were accessed for five wells in or near the GFWD. The water level in Well T12S/R16E-23H1 fell from about 20 feet deep in 1938 to about 60 feet deep in 1954. Spring water levels fell an average of about 0.8 foot per year since 1960. Well T12/R16E-26H1 water levels fell an average of 1.0 foot per year between 1950 and 1980. The average water level decline after 1980 has been about 1.2 feet per year. Both wells 26H1 and 26H1 are composite wells, tapping both aquifers. Water level data for Well T12S/R16E-26R1 is available from 1949 onward. Spring water levels in this well have fallen at an average rate of 0.4 foot per year since 1960. Well T12S/R16E-31G has had reported spring water levels falling from 50 feet deep in 1987 to about 105 feet deep in 2009, or an average loss of about 2.5 feet per year. Water levels fell significantly during the 2013-2016 drought. Well T13S/R16E-3L1 has had reported spring levels falling from 35 feet in 1960 to 92 feet in 2011, or an average loss of about 1.1 feet per year. Overall, the average water-level decline in recent decades for these wells was about 0.9 foot per year. Hydrographs for Well T12S/R16E-23H1 and Well T13S/R16E-3L1 are shown in Figure 10 of Appendix B.

GROUNDWATER OVERDRAFT

The groundwater gradient has been calculated (Appendix B) using the specific yield for the unconfined groundwater and the long-term average water-level change over a hydrologic base period. Using an area of 8,500 acres, specific yield of 0.12, and average water-decline of 0.9 foot per year, the overdraft in unconfined aquifer for the GSA is about 900 acre-feet per year.

Because the GSA is in a subsiding area, an additional source of water has been compaction from the Corcoran Clay and underlying clay layers. Assuming that the average compaction during 1989-2014 was about 0.08 foot per year (half of the subsidence between 2011 and 2016), the amount of water expelled from the clays would be about 2.2 feet times 8,500 acres, or about 700 acre-feet per year. After taking into consideration the other factors that influence the available water in the boundary of GFWD; precipitation, evapotranspiration, infiltration of precipitation, infiltration of surface water, boundary surface outflows the average change in surface water supply storage was 12 acre-feet. This provides for the GFWD service boundary to be in the positive of 12 acre-feet during a Wet year and a low of a negative 172 acre-feet during a Below Normal water year.

David's Engineering, as part of studies of the Madera Subbasin, has made water balance estimates for the Gravelly Ford GSA. They estimated inflow and recharge to average about 16,072 acre-feet per year for 1989-2014, and the average groundwater extraction to be about 15,753 acre-feet per year. This leaves a negative water balance of 319 acre-feet per year. However, their water budget did not include inflows from groundwater and therefore is incomplete.

The difference between the water balance complete for the Coordinated GSP for the Madera Sub Basin and the one for the GFWD boundary relates to the Evapotranspiration (ET) value used in the calculations; The Coordinated GSP used the ET value for the 2015 year, were the GFWD used the average ET for the review period of water years.

SOURCES OF RECHARGE

Figure 11 in Appendix B shows recharge groundwater transport facilities in the GSA. Water-level maps indicate that seepage from the open channels and existing recharge basin have been an important source of recharge to the groundwater in the GSA. Historically, there has also been recharge from flows in Cottonwood Creek. Seepage from conveyance facilities has also been an important source of recharge. (The District's Secara Pond serves as a percolation recharge site; it has a capacity of 50-acre feet of storage. A pilot test was completed in 2019 providing a recharge rate of 13 to 15 acre-feet per day, the test was operated for 30 days)

Source of Discharge

Groundwater discharge in the GSA primarily results from well pumpage and secondarily from groundwater outflow to the northwest. Figures 2-2 and 2-3 show in-District groundwater wells and the direction of the groundwater outflow.

Aquifer Characteristics

Pump tests area available for dozens of irrigation wells in the GSA. Pumping rates for most such wells range from about 800 to 2,300 gpm. Specific capacities of most wells range from about 25 to 70 gpm per foot. For wells tapping both aquifers, specific capacities can be multiplied by a factor of 1,750 to estimate aquifer transmissivity. Based on the range of specific capacities, transmissivities would be expected to range from about 45,000 to 120,000 gpd per foot. Transmissivity has been determined at some wells, and values range from about 60,000 to 120,000 gpd per foot. The best values of specific yield for the upper aquifer are derived from soil texture descriptions and specific yield estimates commonly used by the U.S. Geological Survey. For the GSA, a specific yield of 12 percent is reasonable, based on a review of the subsurface geologic cross sections presented in this report. For the groundwater confined below the Corcoran Clay, a storage coefficient of 0.001 to 0.0001 is considered reasonable.

Change in Storage

Based on an estimated average water-level decline of 0.9 foot per year in recent decades in the GSA, and using an average specific yield of 0.12, the unconfined groundwater overdraft beneath the 8,500-acre GSA has averaged about 900 acre-feet per year. Figure 13 in Appendix B shows annual changes in unconfined groundwater storage for strata tapped by irrigation wells in the District. About 700 acre-feet of storage has been lost due to collapse of unconfined layers in the upper aquifers. This totals to 1,600 acre-feet of additional surface flow into the District for a balance in the system storage. The San Joaquin River Restoration project is estimated to provide this amount or more since there is a 10 miles of river frontage along the District boundary that will provide influence on the groundwater levels. The monitoring of the existing groundwater levels in the 24 Agricultural wells within the District will be used to quantify this amount of influence from the review flows and it will be monitored over the first five (5) years and results provided in the 2025 update to this report.

San Joaquin River Hydrologic Region

This region is approximately 15,200 square miles and is located between the Sacramento River Hydrologic Region to the north, and the Tulare Lake Hydrologic Region to the south (DWR 2013b). The watershed is bordered on the east by the Sierra Nevada and on the west by the Coast Range mountains. The San Joaquin River begins in the high Sierra Nevada's and has historically flowed approximately 100 miles to the west then turned north for 260 miles, where it joined the Sacramento River to form the Delta. By 1951 and the completion of the Central Valley project, San Joaquin River flows were captured at Friant Dam and diverted into two (2) canals. The Madera-Chowchilla canal flows to the North and the Friant-Kern canal flows to the South. These canals service the eastern side of the San Joaquin valley from Madera county to Kern County through 30 contracts with cities and irrigation districts. The portion of the river between Friant Dam and Sack Dam (approximately 85 miles) routinely dries out during much of the year; however, the Restoration Program will increase or create additional river water flows above Gravelly Ford and adjacent to the southeast boundary of the GSA. Continuous flows return for the final 60-miles of river, from Lander Avenue to the Delta and are comprised of ephemeral flows from the Coast Range, freshwater flows from the Sierra Nevada, and agricultural drainage. Main tributary rivers of the San Joaquin River include the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced to the east, and during flood flows from the Friant Canal, the Chowchilla Bypass, and Fresno Rivers to the southeast.

MADERA SUBBASIN

The Madera Subbasin is identified as Basin 5-22.06 by DWR in Bulletin 118. The Subbasin covers an area of 614 square miles and is located entirely within Madera County. It is bounded on the south by the San Joaquin River, on the west by the eastern line of the Columbia Canal Service Area, on the north by the south line of the Chowchilla Subbasin, and on the east by the crystalline basement bedrock of the Sierra Nevada foothills. The Madera-Chowchilla canal delivers water to this area for irrigation. Groundwater recharge is primarily from deep percolation of applied irrigation water. The Madera Subbasin has been determined to be in critical overdraft.

DELTA-MENDOTA SUBBASIN

The Delta-Mendota Subbasin is identified as Basin 5-22.07 by DWR. The Subbasin covers an area of 1,170 square miles. It lies largely in Fresno County along with portions of Madera, Stanislaus, and Merced counties. It is bounded on the west by the Coast Range mountains, on the north by the Stanislaus/San Joaquin county line, and on the east generally by the San Joaquin River. The southern boundary is irregular and bordered by portions of the western Kings Subbasin and the Westside Subbasin. DWR Bulletin 118 states that groundwater levels within the Delta-Mendota Subbasin have been relatively stable. Groundwater recharge is primarily from deep percolation of applied irrigation water.

Watersheds

Major rivers in the Region include the San Joaquin, Fresno, and Chowchilla. The Region is home to several reservoirs which provide both irrigation water and flood protection to the Valley area. The major watersheds are shown in Figure 2-7.

Eastman Lake, operated by the US Army Corps of Engineers, is in the foothills on the Chowchilla River. Bass Lake, operated by Pacific Gas & Electric, is impounded by Crane Valley Dam, located in the foothills on Willow Creek, which flows into the San Joaquin River above Millerton Lake. Millerton Lake, behind Friant Dam, operated by the United States Bureau of Reclamation, is on the San Joaquin River in the foothills at the eastern edge of the Valley. Mammoth Pool and Dam 6 Lake are located along the San Joaquin River above Millerton Lake and are operated by Southern California Edison.

The Eastside Bypass and the Chowchilla Bypass are the backbone of the flood control conveyance facilities in this part of the Valley, providing additional flow capacity above and beyond that available in the San Joaquin River channel below Friant Dam. Madera Irrigation District and Chowchilla Water District have extensive irrigation canal systems supplied with water primarily from the San Joaquin, Chowchilla and Fresno Rivers.

A portion of the Merced River watershed lies within the Region, although it drains into the Merced IRWM planning area to the north. The Merced River joins the San Joaquin River in Merced County, north of the Region boundary.

(Reg. § 354.8)

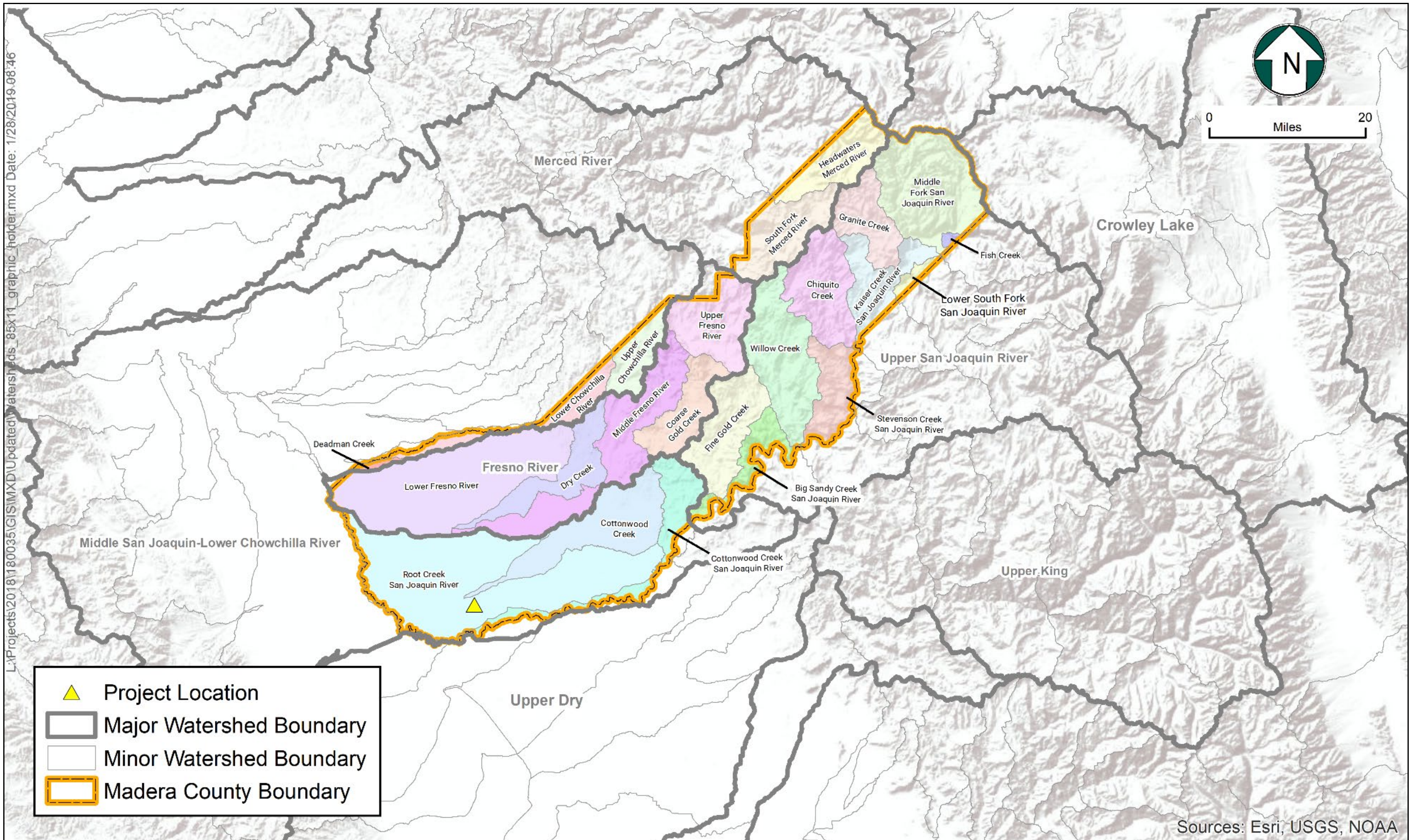


Figure 2-7
Watersheds

Land Subsidence

Land subsidence occurs when groundwater levels in confined aquifers decline due to excessive withdrawals of water. This results in compaction of fine-grained sediments (clays) above and within the aquifer system as water is removed from pores between the grains of the sediments. Over time, as more water is removed from the area; the ground level sinks. Land subsidence can lead to reduced conveyance capacity in canals and damage to structures such as canals, levees, buildings, and wells. Subsidence can also cause flooding by creating low spots or reducing gradients in natural channels.

Within parts of Madera County, land subsidence is of concern. The area of the most significant subsidence is in the north western portion of the county. As shown in Figure 2-5 this area of the County in 2017 had subsidence ranging from 3 up to 15 inches. These areas with significant subsidence are in both the Chowchilla and Madera Subbasins.

Groundwater Sustainability Agencies in the Chowchilla GSA and the Madera GSA have been formed and they are preparing Groundwater Sustainability Plans (GSPs) which will be completed in 2020. These plans will address land subsidence as a priority issue.

CAUSE OF LOCAL LAND SUBSIDENCE

Land subsidence in the Valley portion of the Region is caused by pumping groundwater from the deeper confined aquifer that is separated from the shallower unconfined aquifer by the Corcoran Clay. The Corcoran Clay is the aquitard prevalent throughout the western half of the San Joaquin Valley area. The area of greatest land subsidence in the Region coincides with the area underlain by the Corcoran Clay in western Madera County particularly along the Eastside Bypass when there has been a large amount of pumpage from the lower aquifer.

HISTORY OF LAND SUBSIDENCE IN AREA

Land subsidence in the Region is of historic and ongoing significance. Between 1926 and 1972, subsidence resulted in between 1.0 and 4.0 feet of ground surface elevation drop within the western half of the Valley portion of the Madera Subbasin.

The majority of subsidence has occurred since 1940, when large turbine pumps came into widespread use for pumping water from the lower confined aquifer. Availability of surface water from the California Aqueduct after the early 1960's resulted in decreased groundwater demand, stabilization of groundwater levels, and a reduced rate of subsidence. Drought conditions during 1976-1977 and 1987-1992 restricted surface water deliveries, resulting in increased demand for groundwater supply and increased subsidence rates. Drought and regulatory reductions in surface water deliveries (especially the San Joaquin River Restoration) from 2007 through 2014 have brought about large withdrawals of water from the confined aquifer to meet local water demand when there has been a large amount of pumpage from the lower aquifer.

(Reg. § 354.8)

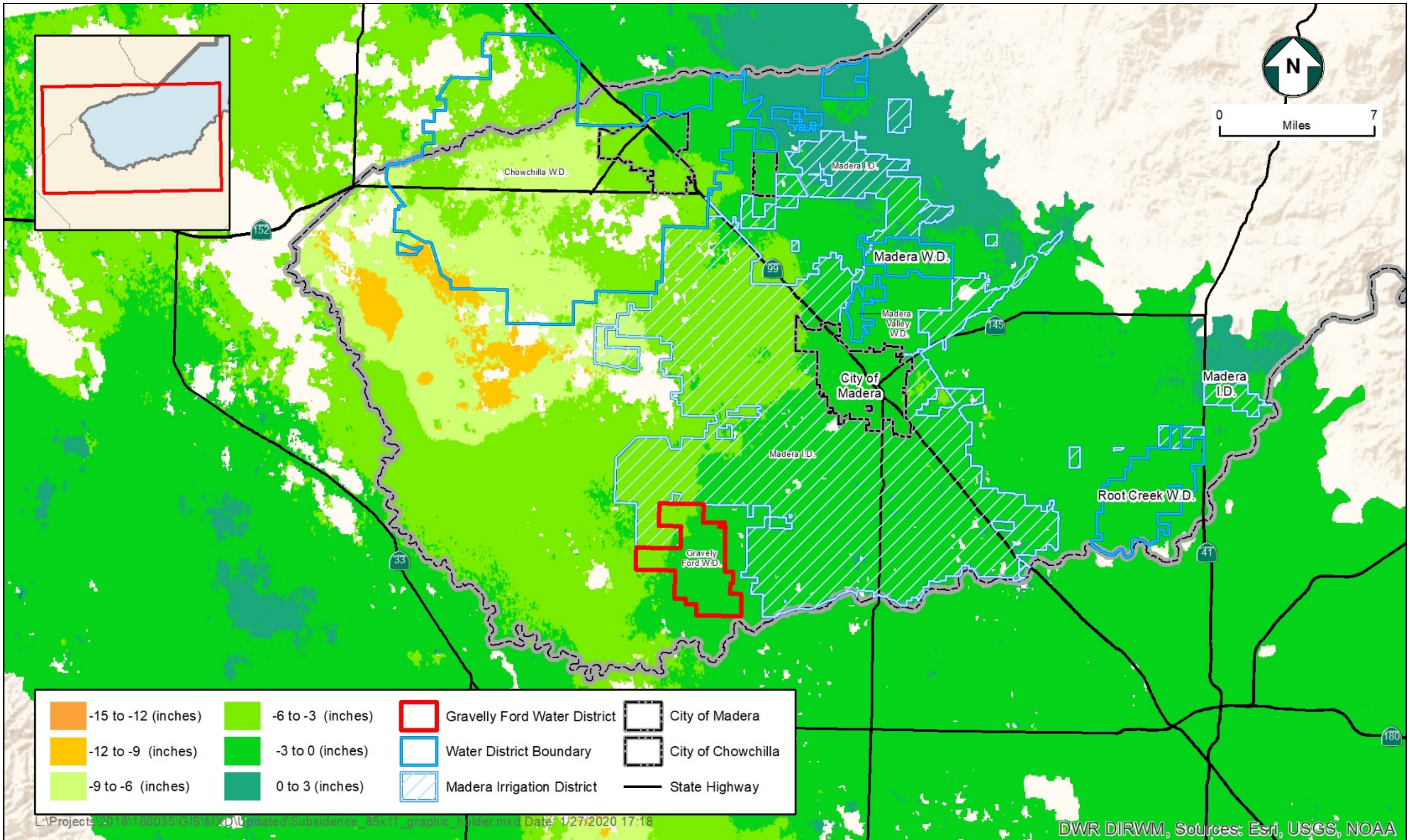


Figure 2-8
Land Subsidence

Period of 3/2016 to 3/2017

Source: NASA/JPL Vertical Displacement

LOSS OF STORAGE DUE TO SUBSIDENCE

The primary cause of land subsidence in the Valley has been the compaction of fine-grained silt and clay sediments associated with the lower aquifer following extensive long-term withdrawal of groundwater in excess of recharge. This subsidence, due to compaction of fine-grained sediments, began in some areas in the 1930s. As groundwater levels declined severely in the late 1960s, fine-grained sediments lost water from pore spaces and became compacted from the weight of the overlying soil. When pumpage decreased, and water levels were allowed to recover, compaction rates slowed significantly.

Increased groundwater pumping during the 1976-77 drought increased the rate of subsidence, some of which even resulted from compaction of coarse-grained sediments. When groundwater levels recovered in 1978 following the end of the drought years, the compacted coarse-grained sediments regained some of their original volume when the former or near former pore pressure was attained and the land surface rebounded. However, the fine-grained sediments remained compacted and will never recover.

The fine-grained portions of the aquifer are not typically considered maximal water producing portions. The minimal amount of storage loss in the coarser grained sediments, in the unconfined aquifer, is for the most part recoverable and is not considered a permanent loss.

RECENT LAND SUBSIDENCE IMPACTS

Groundwater pumping that results in renewed compaction and land subsidence in the Valley could cause serious operational, maintenance, and construction-design problems for the California Aqueduct, the San Luis & Delta-Mendota canals, and other water-delivery and flood- control canals in the San Joaquin Valley. Subsidence has reduced the flow capacity of several canals that deliver irrigation water to farmers and transport floodwater out of the valley. Several canals managed by the San Luis & Delta-Mendota Water Authority (SLDMWA) and the Central California Irrigation District (CCID) have had reduced freeboard and structural damages that have already required millions of dollars of repairs, and more repairs are expected in the future (Sneed, et al. 2013). These instances of land subsidence are not in the Region but are adjacent to the westerly portions of the area near the San Joaquin River and indicate that subsidence is occurring in a broad area of the central part of the San Joaquin Valley. Within the Region, subsidence near the San Joaquin River and its flood control structures may cause flooding of Highway 152 and a local elementary school. It may also threaten valuable farmland and dairies while possibly jeopardizing the San Joaquin River Restoration Program.

Recent work by the USGS, USBR, DWR and KDSA indicates that the greatest amount of subsidence in the Region is in the area of the East Side Bypass. This is referred to as the Red-Top Area, which is located in the west-northwest portion of the Region near the axis of the Valley where the majority of the historic land subsidence has been documented. The maximum subsidence near the Eastside Bypass has been approximately nine (9) feet.

Water Quality Problem Areas

Communities in the Central Valley rely on surface and groundwater for many beneficial uses including agriculture and drinking water supplies. However, elevated salt and nitrate concentrations in portions of the Central Valley groundwater impair or threaten to impair the region's water and soil quality which, in turn, adversely affects agricultural productivity and/or drinking water supplies.

The salinity and nitrate problems in the Central Valley are complex, multi-faceted and present a daunting challenge for the Central Valley Regional Water Quality Control Board (Central Valley Water Board or Board) to confront. To assist in the Board's long-term planning efforts, a broad group of agriculture, cities, industry, and regulatory agencies joined together in 2006 to form the Central Valley Salinity Alternatives for Long-Term Sustainability Initiative (CV-SALTS). The CV-SALTS Executive Committee is a decision-making body with 30 voting members. In addition, dischargers participating in CV-SALTS formed the non-profit Central Valley Salinity Coalition (CVSC) to manage and fund the effort and have entered into a Memorandum of Agreement with the State Water Board and the Central Valley Water Board to formalize their commitment. Goals adopted by CV-SALTS include:

- Sustain the Valley's lifestyle;
- Support regional economic growth;
- Retain a world-class agricultural economy;
- Maintain a reliable, high-quality water supply; and
- Protect and enhance the environment.

CV-SALTS was tasked with developing a Salt and Nitrate Management Plan (SNMP) for the entirety of the Central Valley Regional Water Quality Control Board's jurisdictional area. The SNMP was also developed to meet requirements set forth in the State Recycled Water Policy, adopted in 2009 by the State Water Resources Control Board. The Recycled Water Policy provides statewide direction regarding the appropriate criteria to be used when issuing permits for recycled water projects. In addition, the Recycled Water Policy articulates the Board's policy that every groundwater basin/subbasin in California needs to have a consistent salt/nutrient management plan (i.e., SNMP). To ensure that such plans are developed in a timely manner, the Recycled Water Policy establishes criteria and timelines for their development.

CV-SALTS participants, including the Central Valley Water Board, have worked together to develop this SNMP to address salinity and nitrate concerns in the Central Valley Region in a comprehensive, consistent, and sustainable manner, both environmentally and economically. CV-SALTS participants are also committed to evaluating, promoting, and initiating options to provide safe drinking water to communities already impacted by salt and nitrates. To this end, this Central Valley SNMP builds on a range of water quality management policies and implementation programs already in existence, proposes additional policies and tools needed to provide the Central Valley Water Board with flexibility in addressing legacy and ongoing loading of salt and nitrate in the diverse region, and presents a comprehensive regulatory and programmatic approach for the sustainable management of salt and nitrate.

CENTRAL VALLEY SALT AND NITRATE MANAGEMENT PLAN

The Central Valley Water Board has flexibility in addressing the legacy and ongoing loading of salt and nitrate in the Region and presenting a comprehensive regulatory and programmatic approach for the sustainable management of salt and nitrate.

Combined, the development of the SNMP and the proposed corresponding Basin Plan amendments will establish a revised regulatory framework and provide the flexibility necessary to make salt and nitrate management decisions at the appropriate temporal, geographic and/or management scales. The SNMP will be reviewed and revised as needed to support state and regional policies, regulations, and/or new technical information developed during SNMP implementation and establishes criteria and timelines for their development.

GFWD GSA will request the testing information from the domestic wells within the GSA boundary under the Irrigated Lands Regulatory Program on a voluntary basis to assess the water quality of the GSA area. This matter will be left to the County of Madera Environmental Health Department.

Groundwater Levels

Groundwater levels are one of the most critical issues for future water planning. The Madera Subbasin has been designated as in critical overdraft. Groundwater Sustainability Agencies (GSA) have been formed and are working together to develop Groundwater Sustainability Plans (GSP) to improve the declining groundwater levels. The level of overdraft varies between the GSAs as some have imported water supplies and some areas rely entirely on groundwater.

Groundwater levels in most parts of the Sub-basin have been in decline, and without changes this trend will continue. The Department of Water Resources is requiring that all basins in critical overdraft meet sustainability goals by 2040. To achieve this goal, water supplies need to be increased or there needs to be a reduction in demand. One way to reduce demand is to take farmland out of production. Alternatively, implementation of water resources conservation measures will also reduce demand.

The following Figures, 2-9, Groundwater Level Elevations and 2-10, Depth to Groundwater, show contours for Spring 2016 water level measurements.

(Reg. § 354.8)

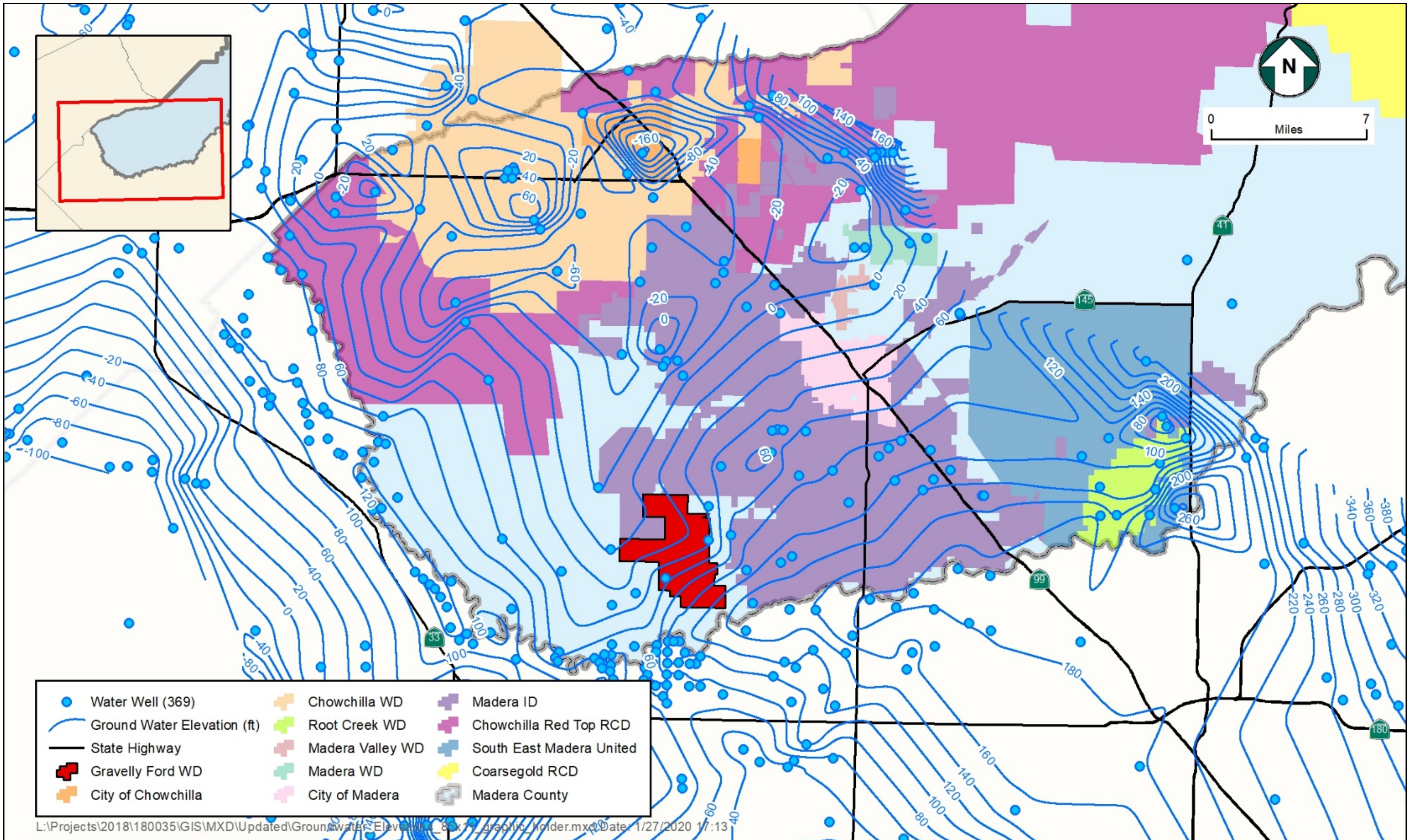


Figure 2-9
Groundwater Levels Elevations

Unconfined Aquifer

(Reg. § 354.8)

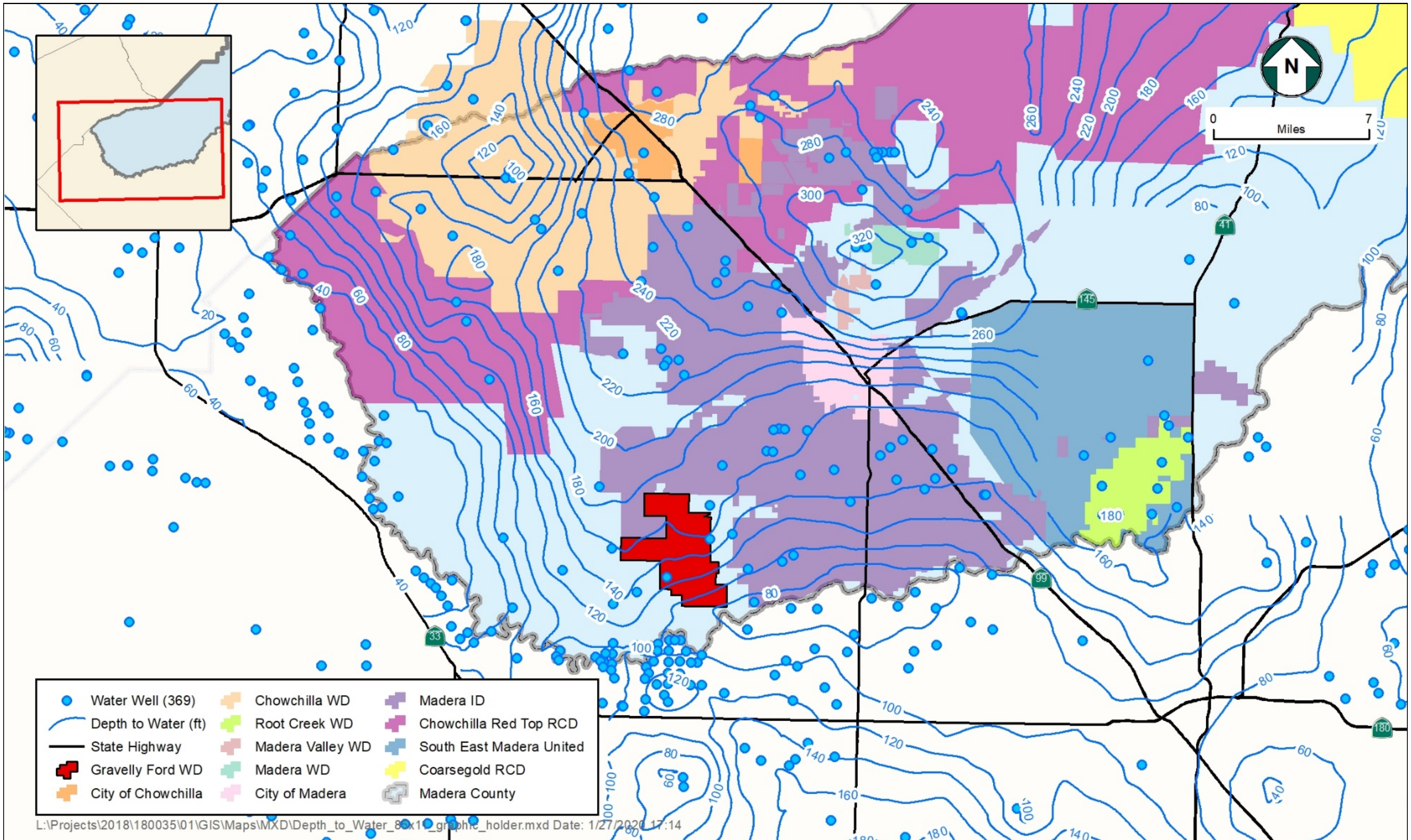


Figure 2-10
Depth to Groundwater

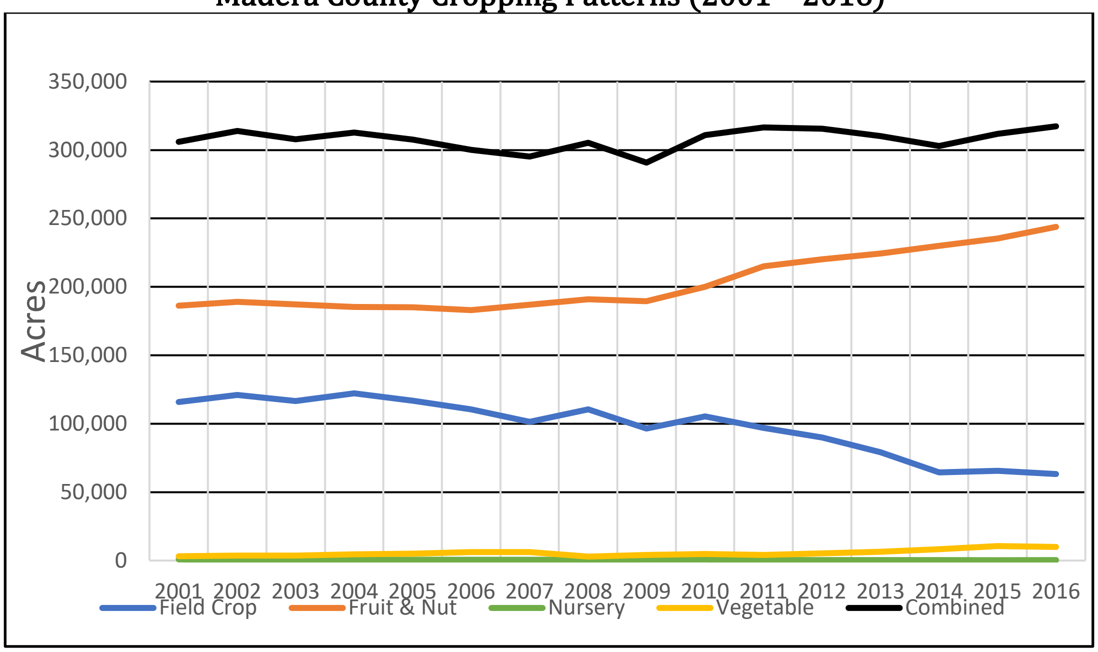
Agricultural Water Demands

The water demands for the Madera Subbasin area have remained relatively constant over the past 15 years. The amount of applied water to agricultural land has been averaging 1,030,000 AF per year. During this same 15-year period the total of irrigated acreage remained constant. According to the Madera County Agricultural Commissioner's office, there has been a shift from field crops to permanent crops consisting primarily of fruit and nuts in the past few years. Table 2-4 lists Madera County's top 10 crops in 2017 and Table 2-5 shows the change from field crops to fruits and nuts over past 16 years.

Table 2-4
Madera County Crop Information (2017)

Commodity	2017 Rank	2017 Dollar Value	2016 Rank
Almonds, Nuts & Hulls	1	$ 723,518,000.00	1
Milk	2	$ 306,228,000.00	2
Grapes	3	$ 291,971,000.00	3
Pistachios	4	$ 194,260,000.00	4
Cattle & Calves	5	$ 63,176,000.00	5
Pollination	6	$ 54,795,000.00	6
Replacement Heifers	7	$ 35,500,000.00	7
Nursery Stock	8	$ 29,382,000.00	8
Tomatoes, Fresh, & Processed	9	$ 29,035,000.00	9
Poultry	10	$ 24,259,000.00	*

Table 2-5
Madera County Cropping Patterns (2001 – 2016)



2.2.3 - Water Budget Information (Reg. § 354.18)

- The GFWD is small in size and is managed as one area with no sub areas within the boundary of the District. The GFWD has taken an approach to monitor all available wells in the boundary of the District, record and measure all inflows of surface water to the District and monitor and record all recharge volumes. All this data that represents the input and output of the water system will be used along with the crop ET, precipitation and groundwater flows to analyze the available water in storage each year to determine the operational management of the resources.

The approach to balance the groundwater and surface water resources has been the historical operation of the District and will be going forward based on this plan. The import surface waters in Table 2-1 to the GFWD GSA area and the projected native flows to the groundwater storage from both Cottonwood Creek and the San Joaquin River provide excess storage volume above the crop demand for the GFWD GSA area. The areas outside of the GFWD GSA boundary have the potential to cause negative impacts to the areas groundwater storage volume as they do not control the extraction rate to be balanced with the surface import volumes.

The historical period from 1989 – 2014 has shown that the operational management of the District through the import of surface water, and conjunctive use has provided for a balanced or sustainable area in the majority of those years. The import of additional surface waters and the influence of the San Joaquin River Restoration project will be quantified to further document those improvements to the groundwater levels in the area of the District.

Definitions and assumptions for the historical, current, and projected water budgets are provided below. The Historical, Current and Projected Water Budget are all shown in Table 2-6, with a summation of the change in storage. It should be noted that the historical groundwater storage was not in overdraft for the GFWD area and the projected Water Budget for the next 20 years has been shown as a balance with no reduction to the overall groundwater storage.

2.2.3.1 Historical Water Budget

The historical water budget is intended to evaluate availability and reliability of past surface water supply deliveries, aquifer response to water supply, and demand trends relative to water year type. The historical period of 1989 – 2014 was the data years used to determine the historical water budget. During this period there have been dry and drought years, along with normal and above normal water years. The 25-year period provides for a reasonable balance of wet and dry years. Table 2-6 provides a summary of the Historical Water Budget. Table 2-7 provides the Historical Groundwater Budget as presented by the Ken Schmidt and Associates. Both Tables show a historical reduction in storage of approximately 1,700 acre feet.

GFWD record data information was used along with data from "Appendix 2.F.e Surface Water System Water Budget: Gravelly Ford Water District GSA", prepared as part of the Groundwater Sustainability Plan Madera Subbasin(Appendix E).

2.2.3.2 Current Water Budget

The current water budget is reflective of the historical water budget, as the crop pattern and irrigation demands have changed little over the last several years. The GFWD GSA area has the same reaction to the crop water demands as it has in the past, through the banking of waters during normal or above normal water years. Monitoring groundwater levels within the GFWD GSA area to balance the surface and groundwater usage. Table 2-6 provides a summary of the Current Water Budget, based on an Average water year.

2.2.3.3 Projected Water Budget

The projected water budget is intended to assess the conditions of the GFWD GSA area and those impacts from the adjacent Madera Subbasin area, based on the projected conditions for surface water supply, groundwater storage, and agricultural crop demand. The GFWD does not see any proposed change in the crop pattern or acreage within the GFWD GSA area. The proposed inflow from the San Joaquin River Restoration Project and additional recharge volumes stand to improve the groundwater levels within the GFWD GSA area, barring increases by the area directly adjacent to GFWD. See Table 2-6 for Projected Water Budget.

The various factors involved, and the three water years described above have been summarized in Table 2-6.

Sustainable Yield:

The projection of the GFWD GSA area is that it will maintain the same acreage in production and with the same or similar crop pattern going forward over the next 50 years. The increased import of surface water into the GFWD GSA area to offsite groundwater outflows and reduce groundwater pumping will provided for a sustainable yield of the GFWD GSA Area of approximately 14,400 Acre feet per year (average).

Table 2-6
Total Water Budget

Component	Historic Condition Water Budget	Current Condition Water Budget	Sustainable Condition Water Budget
Hydrologic Period	WY 1989 - 2014	WY 2014	WY 2020 - 2040
Inflows			
Surface Water	12,200	-	13,800
Native Flows	1,900	-	6,000
Contract Water Class 2	6,600	-	6,000
MID Diversions	1,600	-	-
CVP supply by Cottonwood Cr.	2,100	-	1,800
Precipitation *	7,200	2,500	7,200
Groundwater Extraction - Ag	15,800	21,800	14,000
Subsurface Inflow	500	-	-
Groundwater Extraction - Residential	100	100	100
Outside Water Purchases			1,200
San Joaquin River Seepage			1,200
Total Inflows	35,800	24,400	37,500
Outflows			
Evapotranspiration **	18,100	18,000	18,000
Infiltration of Precipitation Loss *	2,700	700	2,700
Infiltration of Surface Water Loss *	6,200	200	6,200
Infiltration of Applied Water Loss *	6,400	5,300	6,400
Subsurface Outflow *	4,100	300	4,100
Total Outflows	37,500	24,600	37,500
Change in Storage	(1,700)	(200)	-

Notes:
* Values for Historic/Current From Appendix 2.F. Tables f the Report Titled "Ground Sustainability Plan Madera Subbasin".
**ET Value based on total GSA Area of 8,380 acres and 2.16 af/ac/yr

Table 2-7
Historical Groundwater Budget

Component	Historic Condition Budget AF/yr
RECHARGE	
Deep Percolation of Precipitation	500
Canal Seepage	6,200
Deep Percolation of Irrigation Water	6,400
Groundwater Inflow	5,200
Subtotal:	18,300
DISCHARGE	
Pumpage	15,900
Groundwater Outflow	4,100
Subtotal:	20,000
Net Deficient (Decrease in Storage)	(1,700)

2.2.4 - Management Areas (Reg. § 354.20)

No management area(s) have been developed or proposed for the GFWD GSA area, due to the size and uniformity of the GSA area.

SECTION 3 - SUSTAINABLE MANAGEMENT CRITERIA (REG. § 354.22)

A sustainability goal is an overarching target that guides the description of undesirable results for the six sustainability indicators: groundwater levels, water storage, water quality, seawater intrusion, subsidence, and surface water and groundwater depletion. In support of the sustainability goals, a GSP must prepare a description of which undesirable results apply to the Madera subbasin within the jurisdiction of Gravelly Ford Water District (GFWD) and what the undesirable results are for each of the applicable sustainability indicators. This includes potential effects of undesirable results on the beneficial uses and users of groundwater, land uses and property interests.

3.1 - Sustainability Goal (Reg. § 354.24)

The sustainability goal for this Subbasin is to minimize the listed undesirable results throughout the Subbasin by providing a Gravelly Ford GSP water supply that supports current cultivated acreage in the Plan area by developing an expanded surface water irrigation and recharge program, and groundwater monitoring and land elevation measurement program. The water balance shown in Table 2-2, along with the projection of the depth to groundwater trend lines shown in Figures 3-1 & 3-2 established the sustainable goals for the GFWD service area. The recently obtained results from the infiltration testing of the open canals and recharge basin of the District provide the ability for a continued and measured recharge of the groundwater storage for the service area. This increased monitoring of the inflows and recharge of surface waters, along with the measurement program of the wells within the district will provide for a close monitoring of the groundwater levels and how they are affected by the surface water inflow and extraction during each year. The greatest challenge facing the Madera Subbasin is overdraft that has historically occurred throughout the Subbasin area. Once fully implemented, farmers of the Gravelly Ford GSS should be able to continue at their present level of farming and related GSA undesirable results should be eliminated with attendant benefit to the entire Subbasin.

The ability to operate the GFWD service area within the sustainable yield for this area is dependent on the continued inflow of surface waters from the two (2) primary sources of the San Joaquin River and Cottonwood Creek. The historical imported surface water to the GFWD service area has shown the area to be in balance a majority of the years over the last 25 years used for the water balance analysis.

This continued balance of imported surface flows will be maintained through the use of the distribution system of canals and the recharge basin to achieve the recharge goals, along with the continued practice of conjunctive use throughout the lands of the District to utilize surface water when available prior to pumping groundwater.

The sustainability goal for the GFWD GSA area is to:

Maintain sustainable groundwater management for the long term (average) through the increase of surface water recharge and/or reduce groundwater pumping, while avoiding undesirable results.

3.2 - Measurable Objectives (Reg. § 354.30)

A measurable objective is a quantifiable goal for the maintenance or improvement of specified groundwater conditions that have been included in an adopted GSP to achieve the sustainability goal.

A summary follows of the pertinent potential undesirable results potentially affecting the District's GSP area and their minimum thresholds and objectives by the completion of the twenty-year GSP implementation period:

1. Chronic Lowering of Groundwater Levels

   A stabilization of such levels, subject to climate influences, at their current levels. See Figures 3-1 & 3-2 for the trend of the groundwater levels and the limits for activation of reaching an undesirable result. The measurable objective is approximately a depth of 165 feet to groundwater with a Minimum threshold of approximately a depth of 220 feet to groundwater. The historical variation of the depth to groundwater was used to establish the upper and lower limits of the trend line as shown on Figures 3-1 & 3-2. These upper and lower limits represent the margin of safety for this measurable objective. The indicated levels along the trend line will be used to gauge the operational measures taken in the five years prior to the five year update of the report. Should there be significant differential of the level in relationship to the trend line level then the operational management of the water system will be adjusted to provide for compliance with the trend line at the next five year report update and continue on with this approach through to the 20 year mark from report adoption.

2. Reduction of Groundwater Storage

   Like, and related, to chronic lowering of groundwater levels, stabilization of current groundwater capacity. To achieve this objective the measurement and increase utilization of the recharge basin will become part of the operational management program for each water year and a determined minimum amount of recharge volume will be established for each year based on the previous year's inflows and outflows. Similar to above, end of the year data for the operation of the lands within the boundary of the GFWD GSA will be evaluated and adjustments will be made as to the established surface water volume to recharge, so the system storage volume maintains within balance year over year. This approach will continue and be updated each five-year period through the projected 20-year period.

Part of this analysis from the collected data will be to determine the amount of water banked during those years when additional surface water is imported to the District. The predominant approach in the area is to look at the Total Recharge volume and reduce it by between 5 to 10% as water that is not recoverable or left behind, reduce it again by the volume pumped and the remainder is added to the system storage. The hydrology of the area is such that the recharge water would not move more than one (1) mile to the northwest from the recharge site. This will be confirmed through the monitoring of the groundwater levels in the 24 existing agricultural wells that are part of the monitoring program for this plan and for the District.

3. Degraded Groundwater Quality

   Maintenance of the current crop irrigation quality of groundwater.

4. Land Subsidence

   No increase in land subsidence in the GSP area

5. Depletions of Interconnected Surface Water and Groundwater

   Utilization for irrigation and groundwater recharge of the maximum available surface water each year.

Figures 3-1 & 3-2 provide the trend of the groundwater depth and have lines that represent the Average, High, Low projected out to 2050. This will represent the minimums or threshold. Additional import of surface water during normal or wet years will be utilized to increase storage for use during lower surface water years.

3.3 - Minimum Thresholds (Reg. § 354.28)

The following sections and discussion set forth minimum thresholds for the five pertinent sustainability indicators. These thresholds discussed below are based on minimum groundwater elevations that would prevent undesirable results. When groundwater characteristics drop below and remain below the minimum threshold for any of the sustainability indicators, the GSP area and the subbasin would experience an undesirable result.

3.4 - Undesirable Results (Reg. § 354.26)

Under the Sustainable Groundwater Management Act (SGMA), undesirable results occur when the effects caused by groundwater conditions cause significant and unreasonable impacts to any of the six sustainability indicators. These sustainability indicators are further defined as:

- Chronic lowering of groundwater levels;
- Reduction of groundwater storage;

- Degraded water quality, including the migration of contaminant plumes that impair water supplies;
- Land subsidence that substantially interferes with surface land uses;
- Sea water intrusion; and
- Depletions of interconnected surface water and groundwater.

The definition of what constitutes a significant and unreasonable impact for each sustainability indicator must be defined for this GSA and for the Subbasin. Each of the sustainability indicators is discussed below, in the context of undesirable results. GFWD has been operating in a balanced condition from its beginning as a Water District and prior to that when farmed by individual property owners. The annual conjunctive use operational standard has provided for the balanced use of surface and groundwater during most years of dry, normal and wet years. Those severely dry years represent the periods when limited surface water is available for import and the subbasin was in an unbalanced condition. This condition across the Madera Subbasin resulted in impacts to the GFWD service area as it did to the whole Madera Subbasin.

3.4.1 - Chronic Lowering of Groundwater Levels

The most applicable of these undesirable results to the Madera subbasin is the chronic lowering of groundwater levels. The continued lowering of groundwater levels threatens farmers' ability to maintain their agricultural operation to a degree sufficient to provide the state and nation with reasonably priced crops. The current agricultural activity within the Madera Subbasin is a valuable contributor to the local economy, as displayed in Table 2-1. To maintain long term vitality of the agricultural industry, groundwater supply levels should be sustainably managed and monitored to allow for maximum yield without jeopardizing the integrity of the aquifers for future use.

The primary cause to much of the Subbasin that would lead to the lowering of groundwater levels is groundwater production compared to recharge within the District and outside the District boundary. Groundwater production from the Subbasin may result in significant and unreasonable lowering of groundwater levels if the groundwater levels were lowered to an elevation below which they could not recover during a multi-year period of above-average precipitation. Adequate recharge during wet or above normal years will be an important operational management goal to maintain groundwater levels above minimum thresholds.

For this component of the Subbasin, the Gravelly Ford GSP area, the definition of sustainability indicators is the same as that appropriate to the Subbasin. See Figures 3-1 & 3-2 for the trend of the groundwater levels in the past and projected into the future years of the basin operation. The water level trend from these two (2) wells places the measurable objective of groundwater levels at a depth of 165 feet starting in 2040, with a minimum threshold of approximately 220 feet for the depth of groundwater starting in 2040.

The over extraction and reduced inflow of surface waters to the area would be the most likely combination that would lead to exceedance of a threshold and thus resulting in an undesirable result. This would be the definition of the undesirable result used to set minimum thresholds for groundwater levels.

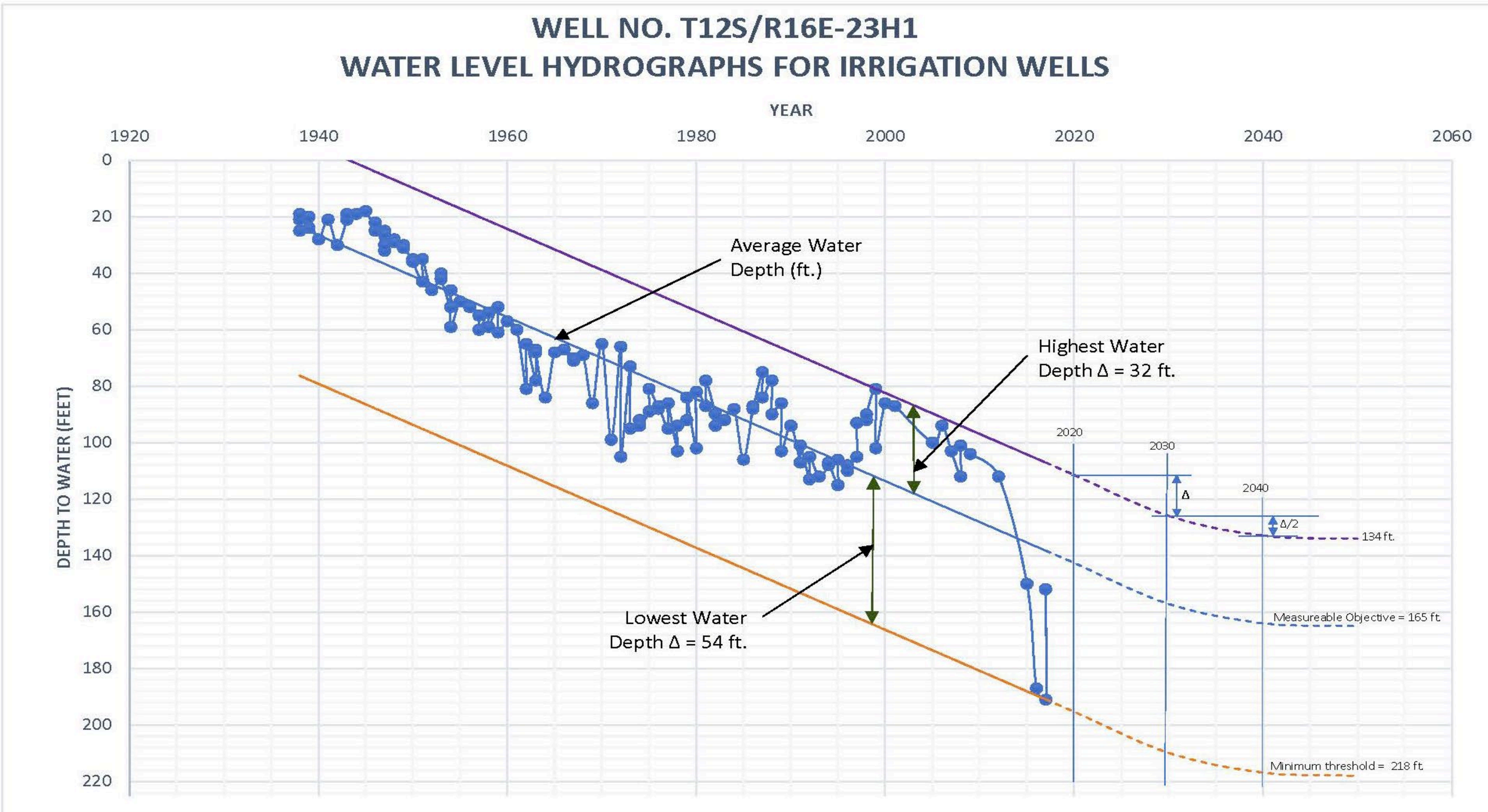


Figure 3-1
Water Level Hydrographs

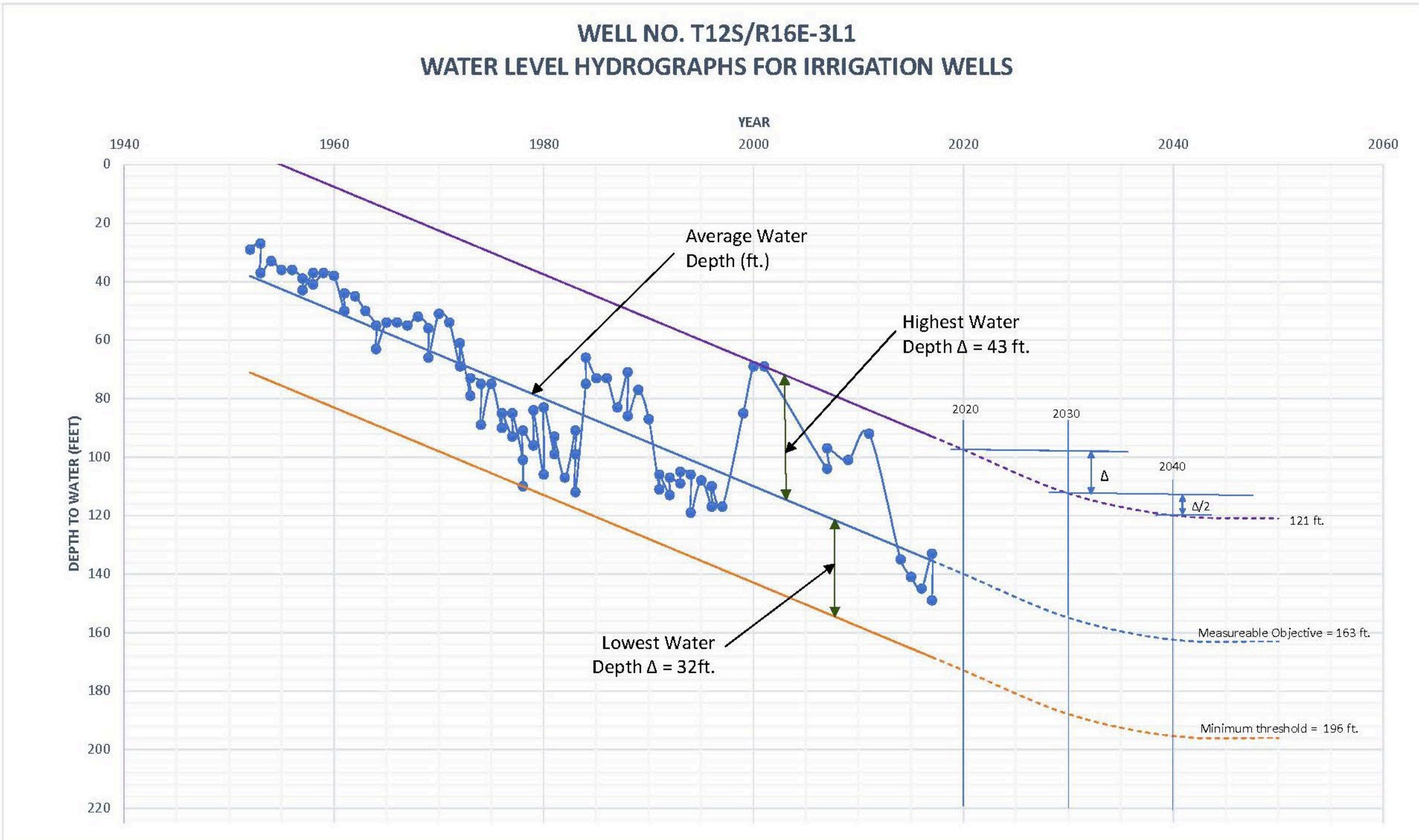


Figure 3-2
Water Level Hydrographs

3.4.2 - REDUCTION OF GROUNDWATER STORAGE

Sustainable groundwater management of the Madera Subbasin will mitigate or minimize the undesirable result of reduction in groundwater storage. Reduction of groundwater storage in the Madera Subbasin has the potential to impact the uses and users of groundwater in the Subbasin by limiting the volume of groundwater available for agricultural, municipal, industrial and domestic use, thus affecting all users of groundwater in the Subbasin.

The primary cause of groundwater conditions in the Subbasin that would lead to reduction in groundwater storage is groundwater production. Groundwater production from the Subbasin may result in a significant and unreasonable reduction of groundwater in storage if the volume of water produced from the Subbasin exceeds the volume of fresh water recharging the Subbasin over a cycle of drought and recovery. Changes in groundwater storage can be tracked using groundwater elevations and would become significant and unreasonable if groundwater levels are lowered to an elevation below which they could not recover during a multi-year period of above average precipitation, thus causing a long-term irrecoverable decline in groundwater storage. Another potential action that would reduce the groundwater storage would be the transfer of groundwater from the GFWD boundary to another parcel. This would remove the water volume from the District's boundary and reduce the available beneficial resource for the District's service area. The Board of Directors has agreed to not allow the transfer of groundwater out of the District's boundary. The Board of the GFWD adopted Resolution 2019-03 to address this issue.

For this component of the Subbasin, the Gravelly Ford GSP area, the definition of sustainability indicators is the same as that appropriate to the Subbasin.

Based on an average water-level decline of 0.9 foot per year as per the report by KDSA in recent decades in the District (GSA) and using an average specific yield of 0.12 foot per year, the unconfined groundwater overdraft potential beneath the 8,400-acre GSA has averaged about 900 acre-feet per year based on the KDSA analysis. There has been an additional reduction in the storage of 700 acre-feet per year due to the collapse of the clay layers.

3.4.3 - DEGRADED WATER QUALITY

Overall, the chemical quality of the groundwater in the Subbasin and in this GSA is suitable for irrigation of most crops. Some of the groundwater in the Subbasin requires treatment to lower the pH and/or sodium adsorption ratio.

Total Dissolved Solids (TDS)

Degradation of groundwater quality has the potential to impact the beneficial uses and users of agricultural irrigation in the groundwater in the GSP area, and in the Subbasin by: (1) limiting the volume of groundwater available for agricultural, municipal, industrial and domestic use, or (2) requiring construction of treatment facilities to remove the constituents of concern.

For this GSP area, total dissolved solids (TDS) concentrations range from about 160 mg/l to 500mg/l. The lowest TDS concentrations are generally in shallow groundwater near the San Joaquin River. Some of the higher TDS concentrations are in shallow groundwater beneath irrigated areas more than several miles from the river. The shallow groundwater tends to have higher hardness concentrations.

3.4.4 - LAND SUBSIDENCE

Land subsidence in and near the GSA has been measured as part of the San Joaquin River Restoration Project between December 2011 and June 2016. One station is located north of the San Joaquin River about 1.5 miles upstream of the eastern boundary of the GSA. The land subsidence at this station averaged 0.15 foot per year between December 2011 and June 2016. Another station was located near the western border of the GSA and Avenue 7. The land subsidence at this station averaged 0.18 foot per year between June 2012 and June 2016. This land subsidence is attributed primarily to pumping from the lower aquifer, primarily east of the Chowchilla Bypass in Madera County and south of the San Joaquin River in Fresno County.

The District's board has put forward a project to establish the current ground elevation at the 24 wells within the District and monitor the subsidence going forward on an annual basis.

The data from this monitoring program will be evaluated and presented in the 2025 update to adjust any operational management of the area should the results make an adjustment necessary to avoid any impacts to measurable objectives or minimum thresholds related to land subsidence. Should the collected data show an increase in the downward trend of the subsidence greater than the numbers listed above the District will install three (3) monitoring wells from the southeast to the northwest across the District area to measure the water levels below the Corcoran Clay layer. This will allow the Hydrogeologist to determine the nature of the subsidence, namely whether it comes from the pumpage within the area of the District or as has been stated previously that the area adjacent to the District has resulted in the majority of the subsidence due to those areas not having the imported surface water flows, which primarily results in those areas pulling water from below the Corcoran clay layer which is the primary cause of subsidence.

3.4.5 - SEA WATER INTRUSION

Sea water intrusion compromises the quality of groundwater and reduces the usability for agricultural and municipal operations. The GSA is not near any coastline and has not been reported to contain any chemical concentrations indicative of saltwater intrusion. Sea water intrusion is not a foreseeable impact arising from the production of groundwater in the Subbasin or in this GSA.

3.4.6 - Depletions of Interconnected Surface Water and Groundwater

Numerous shallow wells were installed for reclamation along the San Joaquin River as part of the River Restoration Program. Water-level measurements at these wells will be used to inform and devise management practices that address the interconnection of surface water and groundwater.

In general, river flows have always been present in the area east of Gravelly Ford. A review of these measurements for the area farther west indicated that during periods of no flow in the river, the shallow groundwater levels have been below the river channel along the river west of Gravelly Ford. When the river is flowing, there has been a direct connection between the surface water and groundwater levels.

3.5 - Monitoring Network (Reg. § 354.32)

3.5.1 - Description of Monitoring Network (Reg. § 354.34)

The GFWD Board of Directors acted in December 2018 to initiate a monitoring plan for groundwater levels, water quality, and ground level subsidence. These three (3) components along with the measured volume of surface water imports to the District will be used to develop the short term, seasonal and long-term trends in the groundwater levels and system storage volume. The ongoing review of this data will be used for the operational management of the District on an annual basis (year to year water years) and to make adjustments based on a long term or seasonal trend. Those adjustments will be referenced back to the GSP to relate the operational management directives to achieve the goals of the plan. This approach is being taken by the GFWD to avoid the exceedance of any minimum threshold and therefore not have any undesirable results.

Network for Monitoring Groundwater Levels and Groundwater Quality

Static water levels of 24 wells are being measured twice per year (normally in January and August). The wells were selected based on drillers' log and completion reports and location. Historically, the monitoring of water levels has been conducted by Madera Irrigation District in the area of GFWD. This program has experienced some data gaps in recent years so the GFWD, in 2018, enacted their own program to expand and improve monitoring. This information has and will continue to be provided for the calibration of the GSA groundwater model being developed for the Basin. The historical data of the wells in the District will be matched with future measurements from other wells in the Madera County GSA to compare with the record readings. The wells currently being monitored are:

Well T12S/R16E-23H1, located near Avenue 7 and Road 20, about 0.75 mile south of Cottonwood Creek.

Well T12S/R16E-26R1, located near Avenue 7 and Road 20, about 1.25 miles south of Cottonwood Creek.

Well T12S/R16E-31G, located near Avenue 6-1/2 and Road 15-1/2, about 2 miles northeast of the Chowchilla Bypass.

Well T13S/R16E-3L1, located near Avenue 5-1/2 and Road 18-1/2.

Annual water sampling of about 24 wells is beginning in 2019. Samples will be taken during the summer pumping season. Electrical conductivity, pH, and the water temperature will be measured in the field. The samples will be preserved, and hand-delivered, or shipped by overnight delivery, to a California certified laboratory for irrigation suitability parameters.

The lowering of the groundwater levels has been and will continue to be influenced by the volume of import surface water to the area and the uncontrolled extraction by those lands outside to the GFWD boundary, which presently the District has no control over. The basin wide GSP should address the extraction rate from those wells outside to the District boundary. Figure 2-4 shows the hydraulic gradient across the District.

Network for Monitoring Surface Water

Surface water deliveries from all sources are currently metered; such metering, and recording thereof, is and will be improved and continued. The metering locations will be evaluated for the correct installation and meters will be calibrated every two years.

The GFWD currently maintains four monitoring stations. Flow meters are present for Gravelly Ford Canal, at the San Joaquin River and South Line at MID Lat 6.2 (Gravelly Ford Water District, 2012). A weir is located at Cottonwood Creek near Road 20 Surface Water.

The GFWD has historically shown that import volumes of surface water have resulted in a long-term trend of a balanced storage. This along with the conjunctive use approach has resulted in a balanced water budget for the long term in the District.

Network For Monitoring Precipitation

The National Weather Service currently operates Weather Station 045233, located at Avenue 12 ¼ just west of Road 38; precipitation is recorded hourly. All data from this Station is available to the District and posted on the Station's website.

Network For Monitoring Subsidence

Land subsidence in and near the GSA was measured as part of the San Joaquin River Restoration Project between December 2011 and June 2016. One station was located north of the San Joaquin River approximately 1.5 miles upstream of the eastern boundary of the GSA. Another station was located near the west edge of the GSA and Avenue 7. A third subsidence monitoring station is located at Sack Dam on the San Joaquin River (see Figure 3-3).

The subsidence monitoring program will be expanded by the District in 2019 to include five stations within the District boundaries each year.

Groundwater Extraction Data

If the State requires metering of agricultural irrigation wells in the GSP area, monthly data therefrom will be collated annually by GSA (the District).

Percolation Testing

To be conducted by District staff in 2019 at locations selected by the staff and the GSP consultant and repeated thereafter under a consultant-prepared plan which will guide improvements in transport and storage facilities to improve percolation rates.

Current Monitoring Schedules

The monitoring schedule described in this Section is already in effect.

Proposed Monitoring Schedule After GSP Adoption

The current monitoring schedule will be continued during the GSP implementation, revised only to DWR-approved schedule increases or additions during the 5-year update for the Plan, the first will be with the 2025 update.

Groundwater levels: The measurement of groundwater well levels will be taken twice a year in months of January and October.

Groundwater Quality: Water samples will also be taken once a year during the month of October. Other water quality reporting completed for other programs by growers will be requested by the GFWD GSA to increase the reporting level.

Surface Water: The metered inflows to the GFWD will be recorded and reported, the native flows in both Cottonwood Creek and the San Joaquin River will be monitored and the influence toward the GFWD GSA area will be calculated for reporting.

Precipitation: Data from Weather Station 045233 will be downloaded and recorded for reporting.

Subsidence: The 24 existing wells will be measured annually for any elevation change and the results reported.

Groundwater Extraction: Groundwater pumping volumes will be requested by the District for the tabulation of reporting in the five-year updates to the Plan.

Percolation: The GFWD has the ability to measure the flow into the existing recharge basin and determine the percolation rate of that facility. Any changes in the current rate will be updated in the annual reporting. When conditions allow percolation rates will also be determined through measured flow and impoundment of a volume of water in the distribution facilities for the GFWD.

The first scheduled report is due in April of 2020, GFWD is working toward having the base line of the monitoring items in place for this report.

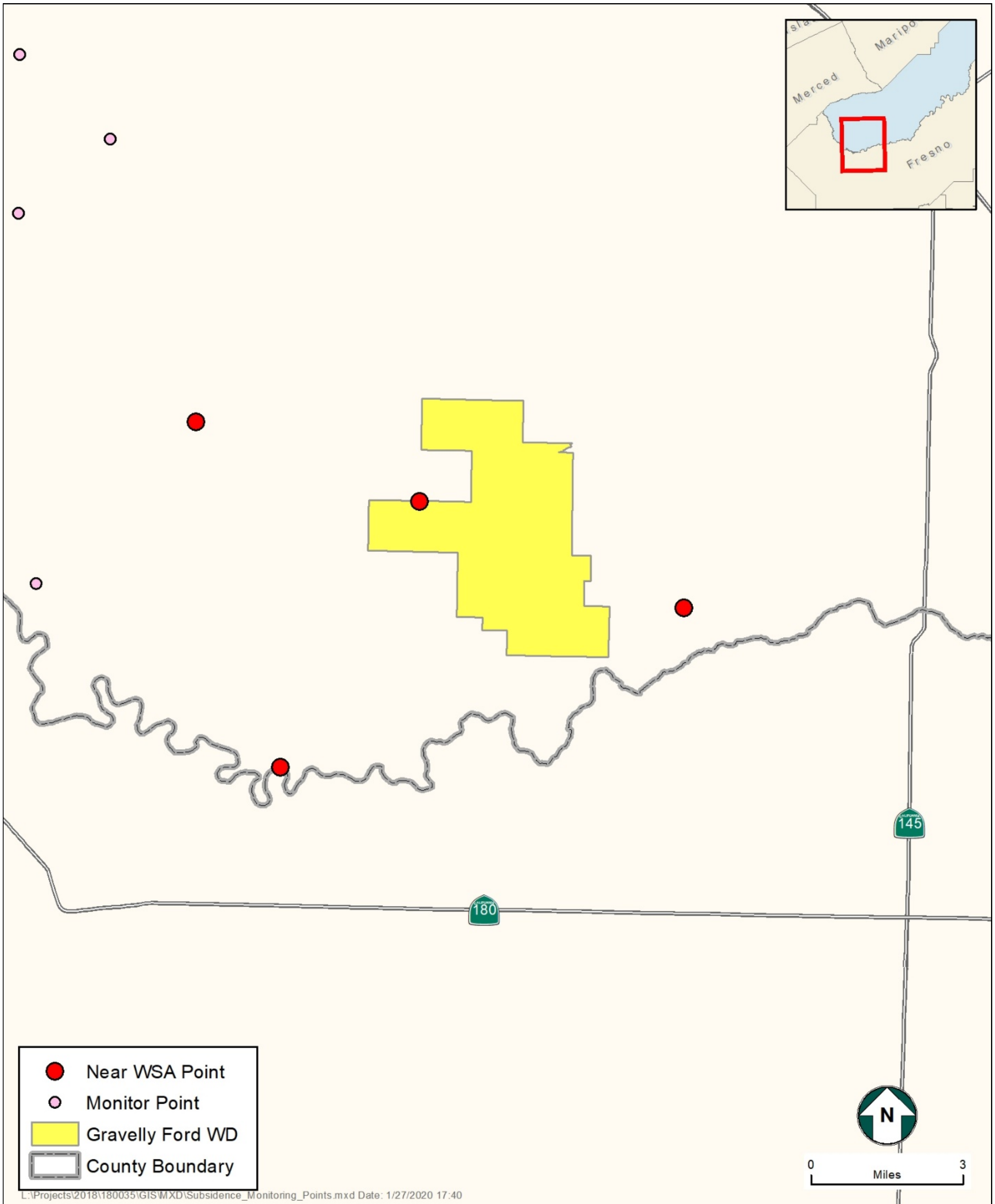


Figure 3-3
Subsidence Monitoring Sites

3.5.2 - Monitoring Protocols for Data Collection and Monitoring (Reg. § 352.2)

Protocols for collecting groundwater level measurements and water quality samples, as well as downloading transducers and logging the borehole of newly drilled wells, are included in the Monitoring Protocols BMP produced by DWR (DWR, December 2016). The GFGSA will ensure future data collection is conducted according to the relevant protocols.

Well water depths will be consistently measured from an established reference point on each well head, the reference point will be surveyed by a licensed land surveyor and a base map will be produced to correlate to the well location with each well having its own number. This refence point will also be used to measure the subsidence for each well within the District. All survey work will be completed in accordance with current ALTA survey standards. Water sampling will be completed, and handling protocol will be followed from sampling taken to delivery to the certified lab for testing of the water sample.

3.5.3 - Representative Monitoring (Reg. § 354.36)

Due to the size of the District no management areas or divisions within the District boundary is necessary. The data being measured and to be analyzed by the GSA each year is representative of the whole area. The District has decided to measure all wells in the District for groundwater levels twice each year. This data along with the volume of imported water compared to the ET for the growing year will be used to provide guidance on the coming year operational management indicators as to the projected volume of water to import and the allowable extraction volume from the groundwater. This will provide the status of and any changes in the GSA area's sustainability conditions.

3.5.4 - Assessment and Improvement of Monitoring Network (Reg. § 354.38)

Any changes deemed essential or desirable during the GSP implementation period will be recommended by the GSA to DWR in the annual report approval sought, and approved changes implemented. The proposed data gathering that is already in place or is in the process will provide adequate data for the oversight of the service area of the District. The proposed frequency of groundwater measurement levels at twice a year is the normal as proposed under GSA guidelines, if this appears to not provide sufficient data, then additional measurements will be taken during the year to provide additional data input. The data collection will be reviewed annually, and adjustments made according to fill any data gaps.

Reporting Monitoring Data to the Department (Reg. § 354.40)

Complete information regarding monitoring data, and GSA evaluation thereof, will be included in the GSA's annual report to DWR, in full accord with existing or modified State legislation and regulations, as well as being made available to other GSA's in the Subbasin.

It is noted that a secondary, but, equally important, objective of the GSP monitoring program is to assist such GSA's with their successful GSP implementation.

SECTION 4 - PROJECTS AND MANAGEMENT ACTIONS TO ACHIEVE SUSTAINABILITY GOAL (REG. § 354.42)

With the goal of long-term sustainability for the Madera Sub-basin, this section lists potential and ongoing projects and management actions that, as implemented, will assist in counteracting undesirable results.

The continued balance of the water budget for the District will be dependent on the volume of import surface water to the district, influence of the flows in the San Joaquin River and storm flows through Cottonwood Creek. The monitoring of the groundwater levels will be the measurable objective that will be the benefit from the measured and monitored volume of import surface water. The ability to provide this infiltration to benefit the system storage is a measurable objective of the GSP.

Since these facilities already exist in the District there is no need for implementation or public notice for the installation of the facilities.

The use of the existing canals and the recharge basin will provide mitigation for overdraft of the groundwater. The operational management of the District will be as it has been in the past to provide import surface water for conjunctive use and recharge to limit the extraction of the groundwater each year for crop production. No permitting or regulatory process is foreseen for the continuation of the current practices that benefit the groundwater storage volume. As stated above the facilities to provide the benefit of recharge are already in place and have been used in the past for the balance of the service area.

The import water is provided through contracts with the Bureau of Reclamation, a State Water Rights Permit for Cottonwood Creek and surplus water from Madera Irrigation District or other providers connected to the system and the volume varies each year dependent on the type of water year. The GFWD receives these waters through their contract agreement with Bureau of Reclamation for Class 2 water (14,000 Acre-feet) is 1-07-20-W0242D, Contract # 19-WC-20-5334 for Unreleased restoration Flows (URF) water which is a specific contract number each water year and the Water rights on Cottonwood Creek under Permit number 016060 for 5,000 acre-feet.

Projects (Reg. § 354.44)

4.1 - Recharge Program

GFWD has been importing and recharging water since the inception of the District in 1961. The program has provided a reliable supply for District operations. From 1961 until the drought period starting in 2014, groundwater levels declined approximately 30 feet. Looking at the period from 1989-2014, average GFGSA surface and groundwater supplies compared to 2015 consumptive use yielded a 378 Acre-feet per year groundwater usage imbalance with no adjustment for annual rainfall. To offset this, the District will expand its surface water irrigation and recharge usage.

The GSA's recharge program will increase percolation in the District's recharge basin(s), and make improvements to the District's San Joaquin River turnouts and to Cottonwood Creek facilities. There will also be improvements to canal control structures that will increase recharge capabilities, and increased metering of deliveries. The District's surface recharge-related facilities are shown on Figure 4-1. The existing recharge basin will be calibrated for current percolation rates and future increased flows to the basin will be scheduled to offset the shortfall in the area of the District. The existing open earth canals used for the distribution of surface water will be used in off season periods to facilitate the recharge of storm water flows and percolation during season will be monitored and calculated for the total recharge volume during that year. When available during wet years the District will provide increased surface water flows for flood irrigation of lands in the District. This also will increase the volume of recharge to the area and provide carryover storage volumes.

The recent percolation testing of the GFWD facilities (open canals & recharge basin) confirms the ability to provide additional groundwater storage volume to the GFWD GSA area through increased surface water imports or an increase in native flows in either Cottonwood Creek or the San Joaquin River.. The open canal system had on average a percolation rate of 24.1 acre-feet per day and the existing recharge basin rate was 13 to 15-acre feet per day. The use of the recharge basin alone at the lower infiltration rate would require approximately 29 days to achieve the additional volume to storage for a balanced water budget based on the 25 year period reviewed (1989-2014).

Recharge from the surface flows into the District is compared to the Pumpage rate based on applied water and irrigation efficiency which will determine the change in storage for each water year. Based on the averages for the period between 1989 and 2014 and an irrigated acreage of 7,500 acres:

Average ET (2.16 acre-feet/acre) x 7,500 acres = 16,200 Acre-feet

Average Surface water = 11,700 Acre-feet

Irrigation efficiency of 80%

16,200/0.80 = 20,250 acre-feet of applied water

20250 – 11700 = 8,550 acre-feet say 8,600 acre-feet pumpage

Change in Storage:

The subsidence determined by KDSA report has 900 acre-feet in the unconfined aquifer and 700 ac. ft. from land subsidence for a total of 1,600 acre-feet. This would bring the average sustainable pumping yield per year to 7,000 acre-feet, Sustainable Yield. Leaving the 1,600 acre-feet per year of additional surface water recharge to be applied to the District area. The San Joaquin River Restoration project is estimated to provide this amount in 2020 and the monitoring of the groundwater levels through the existing wells in the District will be used to quantify this in the 2025 report update, adjustments will be made at this time to maintain balance in the system storage.

4.2 - Agricultural Well Metering

State-mandated irrigation water well metering program will be a future option of the District Board to consider as a requirement to have all new wells in the District Boundary registered with the District. The District has all available information on the existing wells in the GFWD GSA area.

4.3 - Increased Measurement, Sampling and Monitoring

As an essential program, the increased water level measurements, groundwater sampling and testing for maintenance of irrigation water monitoring, land level measurement and surface water metering has been initiated and will be continued. The data being obtained and collated will be of major value in evaluating and improving, on at least a five-year basis, the other programs essential to GSA groundwater maintenance.

The wells will be surveyed and the establishment of the base line elevation will be recorded. Control survey will continue each year to determine the subsidence within the area of the District's wells.

4.4 - San Joaquin River Restoration Program

The San Joaquin River Restoration Program is the direct result of the San Joaquin River Restoration Settlement reached in September 2006 by the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council (NRDC), and the Friant Water Users Authority (FWUA). The Settlement received Federal court approval in October 2006 (San Joaquin River Restoration Program, n.d.). The District neither supported nor opposed the Program.

The stated Settlement goal which would benefit the GSA area is:

- Restoration – To restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.

"Water Management – To reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement."

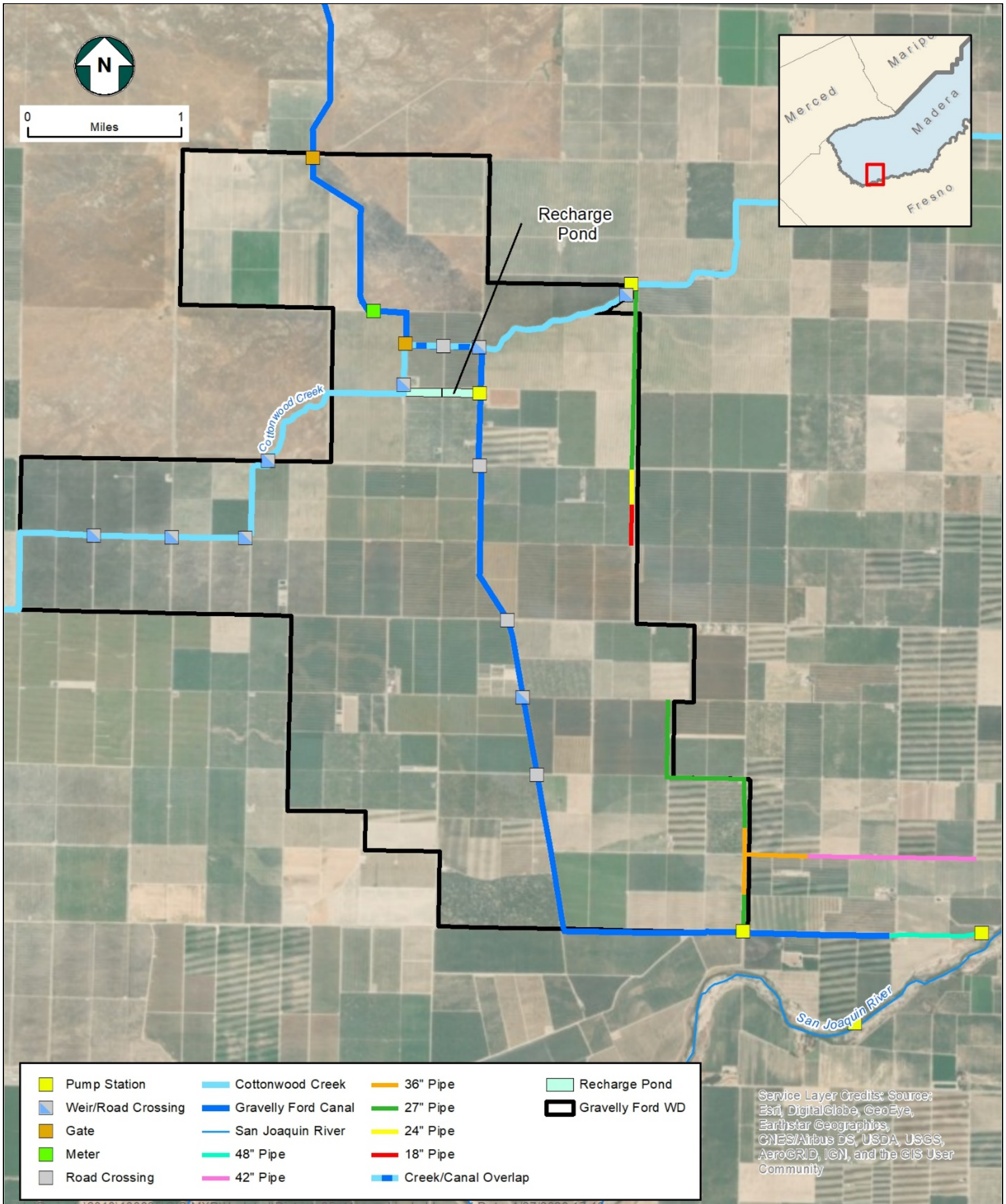


Figure 4-1
Recharge Facilities

SECTION 5 - PLAN IMPLEMENTATION

5.1 - Estimate of GSP Implementation Costs (Reg. § 354.6)

5.2 - Schedule for Implementation

5.3 - Annual Reporting

5.3.1 - GENERAL INFORMATION

The GSA (the District) will annually and timely file the DWR-required annual reports and looks forward to periodic DWR review and comments thereon to assist in meeting GSP goals. The estimated cost for the implementation of the GSP is $788,000.

5.3.2 - REPORT CONTENTS

GSA annual reports will contain, but not be limited to, the following, and appropriate additional, information as pertinent to evaluation of GSA progress in achieving sustainability goals.

Tables for Groundwater elevations at springtime

Groundwater level elevation contour maps

Hydrographs

Tables of Available groundwater pumpage data or estimates

Surface water supply deliveries

Total water use

Changes in groundwater storage

5.4 - Periodic Evaluations

- *GSA's process for required periodic evaluations*

SGMA requires that GSPs be evaluated regarding their progress towards meeting the approved sustainability goals at least every five years, and to provide a written assessment to DWR. This shall also include an evaluation if the GSP is amended. The five-year report will update information related to sustainability and changes in those indicators. The reporting of current groundwater levels, system storage and interim milestones will be compared to measurable objectives for the GFWD GSA area. Groundwater levels, groundwater quality and subsidence will be referenced at this point and related to the minimum thresholds for each of these objectives.

SECTION 6 - REFERENCES (REG. § 354.4)

DWR. (December 2016). *Best Management Practices for the Sustainable Management of Groundwater: Monitoring Protocols, Standards, and Sites.* .

Gravelly Ford Water District. (2012). *2009 Water Management Plan.*

San Joaquin River Restoration Program. (n.d.). *Background and History*. Retrieved from San Joaquin River Restoration Program: http://www.restoresjr.net/about/background-and-history/

Ulrich, R., & Stromberg, L. K. (1962). *Soil Survey, Madera area, California.* US Soil Conservation Service .

Appendix 2.F.e Surface Water System Water Budget: Gravelly Ford Water District GSA, Groundwater Sustainability Plan, Madera Subbasin (Janaury 2020)

APPENDIX A

NOTICES OF INTENT AND RESOLUTIONS

GRAVELLY FORD WATER DISTRICT

18811 Road 27 · Madera, CA 93638 (559) 474 ·1000 Fax: (559) 673 · 1086

July 7, 2016

Via Email & U.S. Mail

Mr. Mark Nordberg, GSA Project Manager
Senior Engineering Geologist
California Department of Water Resources
901 P Street, Room 213-B
P.O. Box 942836
Sacramento, CA 94236
Mark.Nordberg@water.ca.gov

Mr. Dane Mathis
Sup. Engineering Geologist
3374 East Shields Avenue
Fresno, CA 93726
Dane.Mathis@water.ca.gov

Mr. Mike McKenzie
Senior Engineering Geologist
3374 East Shields Avenue
Fresno, CA 93726
Charles.McKenzie@water.ca.gov

RE: Notice of the Gravelly Ford Water District's Intent to Serve as Groundwater Sustainability Agency for a Portion of the Madera Subbasin

To Whom it May Concern,

This letter constitutes notice to the Department of Water Resources (DWR) of Gravelly Ford Water District's (GFWD or District) intent to undertake sustainable groundwater management in a portion of the Madera Subbasin (Basin) as a Groundwater Sustainability Agency (GSA) pursuant to the Sustainability Groundwater Management Act (SGMA). GFWD is a public agency, established by the State Legislature as a Special Act District, and is eligible to serve as a GSA. This notice of intent is timely filed within 30 days of the date GFWD's Board of Directors (Board) approved its June 8, 2016 resolution electing to serve as a GSA.

This notice also includes all information requires to be submitted pursuant to Section 10723.8(a) of the Water Code. This notice encloses a map depicting GFWD's proposed GSA management area. (Water Code, § 10723.8, subd. (a)(1).) GFWD's proposed management area follows the boundary of the District and land owned by the District. The District's resolution electing to form a GSA is also enclosed.[1] (Id., subd. (a)(2).) Also attached to the resolution is the "Proof of Publication" for public noticing. No new bylaws, ordinances, or other new authorities were adopted in connection with this resolution to serve as a GSA. (Id., subd. (a)(3).)

Pursuant to Section 10723.8(a)(4) of the Water Code, the following is a list of "interested parties developed pursuant to [Water Code] Section 10723.2 and an explanation of how their interests will be considered in the development and operation of the groundwater sustainability agency and the development and implementation of the [District's] sustainability plan."

Specifically, Section 10723.2 of the Water Code requires a GSA to "consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing GSPs," including the following interests:

(a) Holders of overlying groundwater rights, including:
(1) Agricultural users.

- The Gravelly Ford Water District encompasses approximately 8,300 acres, of which, approximately 8,000 acres are agriculture. As GFWD is a conjunctive use District, most of agricultural users in the District are also groundwater users. GFWD has preexisting relationships with these landowners.

(2) Domestic Well owners.

- Most rural domestic well owners are also agricultural landowners and will be considered by the District.

(b) Municipal well operators.

- There are no municipal wells within the GFWD boundary.

(c) Public water systems.

- There are no Public Water Systems within the GFWD boundary.
-

1 The District did not adopt any new bylaws, ordinances, or new authorities that are applicable to this notice.

(d) Local land use planning agencies.

- County of Madera. The County of Madera and GFWD are members of the Madera *Subbasin GSA Formation Committee and the Madera Groundwater* Authority and will coordinate and cooperate through those processes.

(e) Environmental users of groundwater.

- Not applicable.

(f) Surface water users, if there is a hydrologic connection between surface and groundwater bodies.

- Not applicable. Within GFWD's boundary, the only surface water users are supplied by GFWD and described above.

(g) The federal government, including, but not limited to, the military and managers of federal lands.

- There are no federal lands within the District.

(h) California Native American Tribes.

- There are no lands of California Native American Tribes within the District.

(i) Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems.

- Madera County is considered by DWR as a county with a countywide median household income of less than 80%, GFWD is located entirely within Madera County. There are no Disadvantaged Communities within or adjacent to the Gravelly Ford Water District. The District will coordinate with the County of Madera on any areas that in the future may be considered Disadvantaged Communities within or adjacent to the District. The County of Madera and GFWD are both members of the Madera Subbasin GSA Formation Committee and the Madera Groundwater Authority.

(j) Entities listed in Section 10927 that are monitoring

- GFWD is a member of the Madera Subbasin GSA Formation Committee and the Madera Groundwater Authority. The agencies in these organizations include the Madera Irrigation District, City of Madera, County of Madera, and local water agencies including Gravelly Ford Water District, Root Creek Water District, Madera

Water District, and Aliso Water District. Agencies from the Chowchilla Subbasin and Delta Mendota Subbasin also participate including Columbia Canal Company, Chowchilla Water District, and the City of Chowchilla.

Interested parties will have several opportunities, both formally and informally, to provide input to GFWD throughout the process of developing, operating, and implementing the GSA including, but not limited to, public comment periods required by SGMA, opportunities for public comment during the GFWD's regular and special board meetings, and at other times to be determined and noticed pursuant to Water Code section 10727.8(a)).

If you should have any further questions, please feel free to contact me at 559-474-1000.

Sincerely,

Don Roberts, PE
General Manager

Enclosure

GRAVELLY FORD WATER DISTRICT
RESOLUTION NO. 2016-05

RESOLUTION OF THE BOARD OF DIRECTORS, GRAVELLY FORD WATER DISTRICT ELECTION TO SERVE AS GROUNDWATER SUSTAINABILITY AGENCY

RESOLVED by the Board of Directors ("Board") of the Gravelly Ford Water District ("District"), at a regular meeting duly called and held on May 11, 2016, at the business office of the Madera Irrigation District, 12152 Road 28 1/4, Madera, California 93637 as follows:

WHEREAS, the Sustainable Groundwater Management Act of 2014, Water Code sections 10720-10737.8 ("SGMA") was signed into law on September 16, 2014; and

WHEREAS, SGMA requires that each California groundwater basin or subbasin be managed by a Groundwater Sustainability Agency ("GSA"), or multiple GSAs, and that such management be implemented pursuant to an approved Groundwater Sustainability Plan ("GSP") or multiple GSPs; and

WHEREAS, the District's service area overlies a portion of the subbasin of the San Joaquin Valley Groundwater Basin knows as a portion of the Madera Subbasin (Basin No. 5-22.06 in the Department of Water Resources' CASGEM system), an unadjudicated groundwater basin overlying a portion of Madera County (the "Basin"); and

WHEREAS, the District is a local public agency as defined in section 10721 of the Water Code; and

WHEREAS, the District is authorized to be a GSA for a portion of the Basin pursuant to section 10723(a) of the Water Code; and

WHEREAS, notice a public hearing to consider whether the District should become a GSA for a portion of the Basin, a copy of which is attached hereto as Exhibit "A," was published in the Madera Tribune on April 30, 2016, and May 7, 2016, pursuant to section 6066 of the Government Code and section 10723(b) of the Water Code; and

WHEREAS, the District had provided notice by mail via U.S. Postal Service to all landowners and water users within Gravelly Ford Water District of said Public Hearing; and

WHEREAS, the District received no comments or communications either written, email, telephone or in person in response objecting to such proposed Election for the District to serve as Groundwater Sustainability Agency; and

WHEREAS, the District has made a good faith effort to provide courtesy copies of the hearing notice to the Basin's other potential GSAs, including the board of supervisors of Madera County, the City of Madera, and other districts that overly the Basin; and

WHEREAS, the District held a public hearing at which its Board of Directors considered whether the District should become a GSA for the Basin; and

WHEREAS, it would be in the best interest of the District to become a GSA for a portion of the subbasin; and

NOW, THEREFORE, BE IT RESOLVED, that the Board of Directors of Gravelly Ford Water District do order as follows:

1. The District hereby elects to be the exclusive Groundwater Sustainability Agency for the portion of the Madera Subbasin that is shown on the map attached hereto as Exhibit "B" and incorporated herein by reference.

2. Within 30 days of the date of this Resolution, the General Manager is directed to submit a notice of intent to the Department of Water Resources, pursuant to Water Code section 10723.8(a).

3. The General Manager shall, after complying with Water Code section 10727.8, begin the process of developing the Groundwater Sustainability Plan for the Basin in accordance with all applicable statutes and regulations in partnership with other GSAs in the Basin.

4. The General Manager shall create and maintain a list of persons interested in receiving notices concerning the District's SGMA process pursuant to section 10723.4 of the Water Code.

5. The General Manager shall provide regular progress reports on the SGMA implementation process to the Board.

THE FOREGOING RESOLUTION WAS DULY AND REGULARLY ADOPTED by the Board of Directors of the Gravelly Ford Water District, at a regular meeting of the Board held on the 8th day of June, 2016, by the following vote:

AYES: Directors S Kirk, K Basila, P Stewart, D Kirk, S Emmert
NOES: NONE
ABSENT: NONE
ABSTAIN: NONE

GRAVELLY FORD WATER DISTRICT
ORGANIZED
AUG 21 1961

Steven Emmert
Steven Emmert, President

ATTEST: Ken Basila
Kenneth Basila, Secretary

CERTIFICATE OF SECRETARY

The undersigned Secretary of the Board of the Gravelly Ford Water District hereby certifies that the foregoing is a full, true and correct copy of Resolution No. 2016-05 adopted June 8, 2016.

Don Roberts, Deputy Secretary

GRAVELLY FORD WATER DISTRICT
ORGANIZED
AUG 21 1961

Proof of Publication

(2015.5 C.C.P.)

NOTICE OF PUBLIC HEARING

GRAVELLY FORD WATER DISTRICT

STATE OF CALIFORNIA)
) ss.
County of Madera)

I am a citizens of the United States and a resident of the County aforesaid; I am over the age of eighteen years, and not a party to or interested in the above entitled matter. I am the principal clerk of the printer of the Madera Tribune, a newspaper of general circulation, published in the City of Madera, County of Madera, and which newspaper has been adjudged a newspaper of General circulation by the Superior Court of the County of Madera, State of California, under the date of November 9, 1966, Case Number 4875 that the notice, of which the annexed is a printed copy, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to wit:

GRAVELLY FORD WATER DISTRICT
Notice of Public Hearing
Election to become a Groundwater Sustainability Agency under the Sustainable Groundwater Management Act

NOTICE IS HEREBY GIVEN that, pursuant to Water Code Section 10723, the Gravelly Ford Water District ("District") will hold a public hearing during a regular meeting on May 11, 2016, commencing at 1:30 p.m. at the Madera Irrigation District's office at 12152 Road 28 1/4, Madera, CA, to determine whether the District will become a Groundwater Sustainability Agency (GSA) for a portion of the Madera Subbasin of the San Joaquin Valley Groundwater Basin. Written comments may be submitted to the District Office at 18811 Rd 27 Madera, CA 93638 Attn: Don Roberts, Board Deputy Secretary, or to the District at donroberts717gmail.com., no later than 4:00 p.m. on May 10, 2016.

During the hearing, the District will allow oral comments and will receive additional written comments before making a decision. The President of the Board may limit oral comments to a reasonable length.
Dated: April 26, 2016

Don Roberts, General Manager

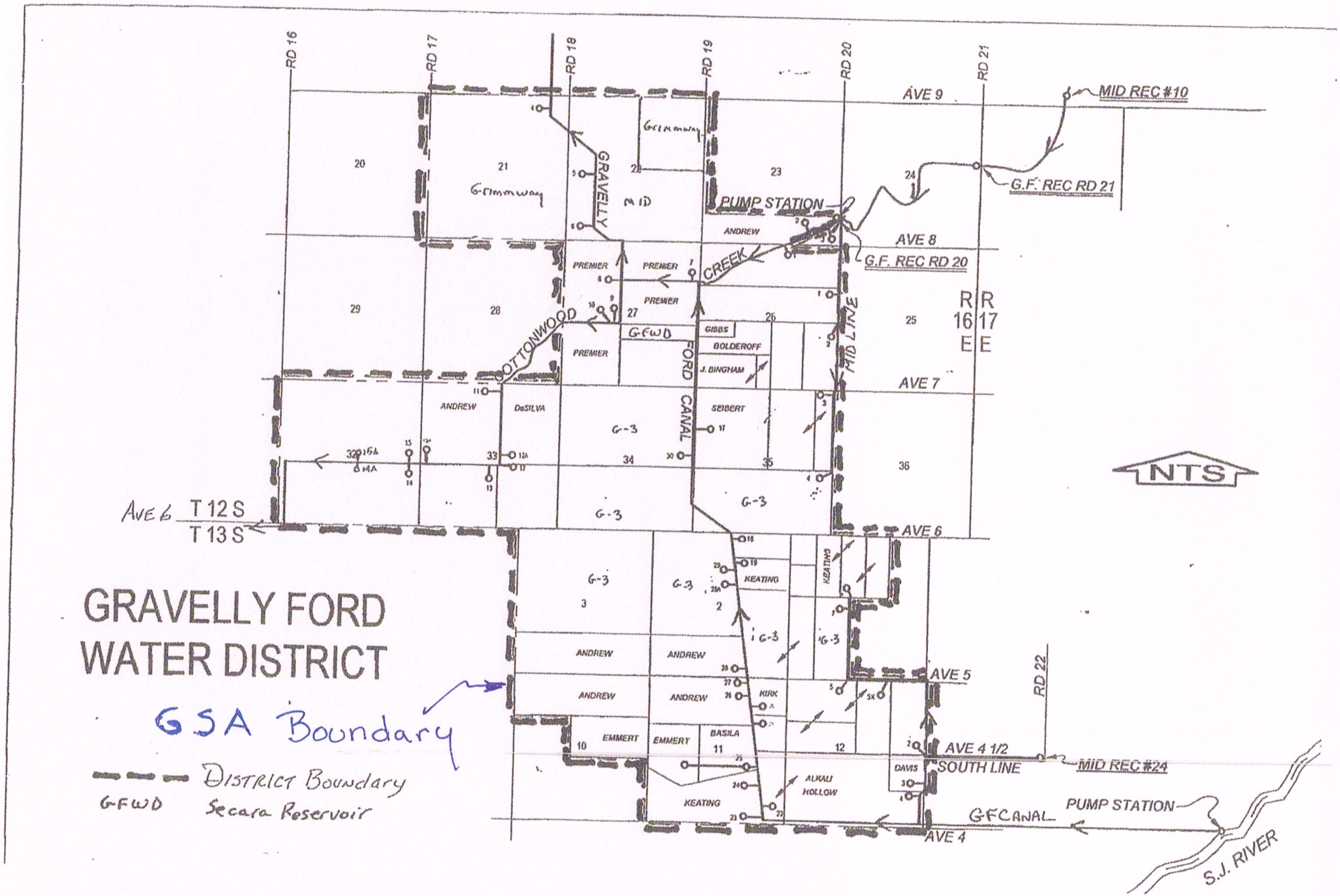
Publish Dates: April 30 and May 7, 2016
No. 2881 - April 30, May 7, 2016

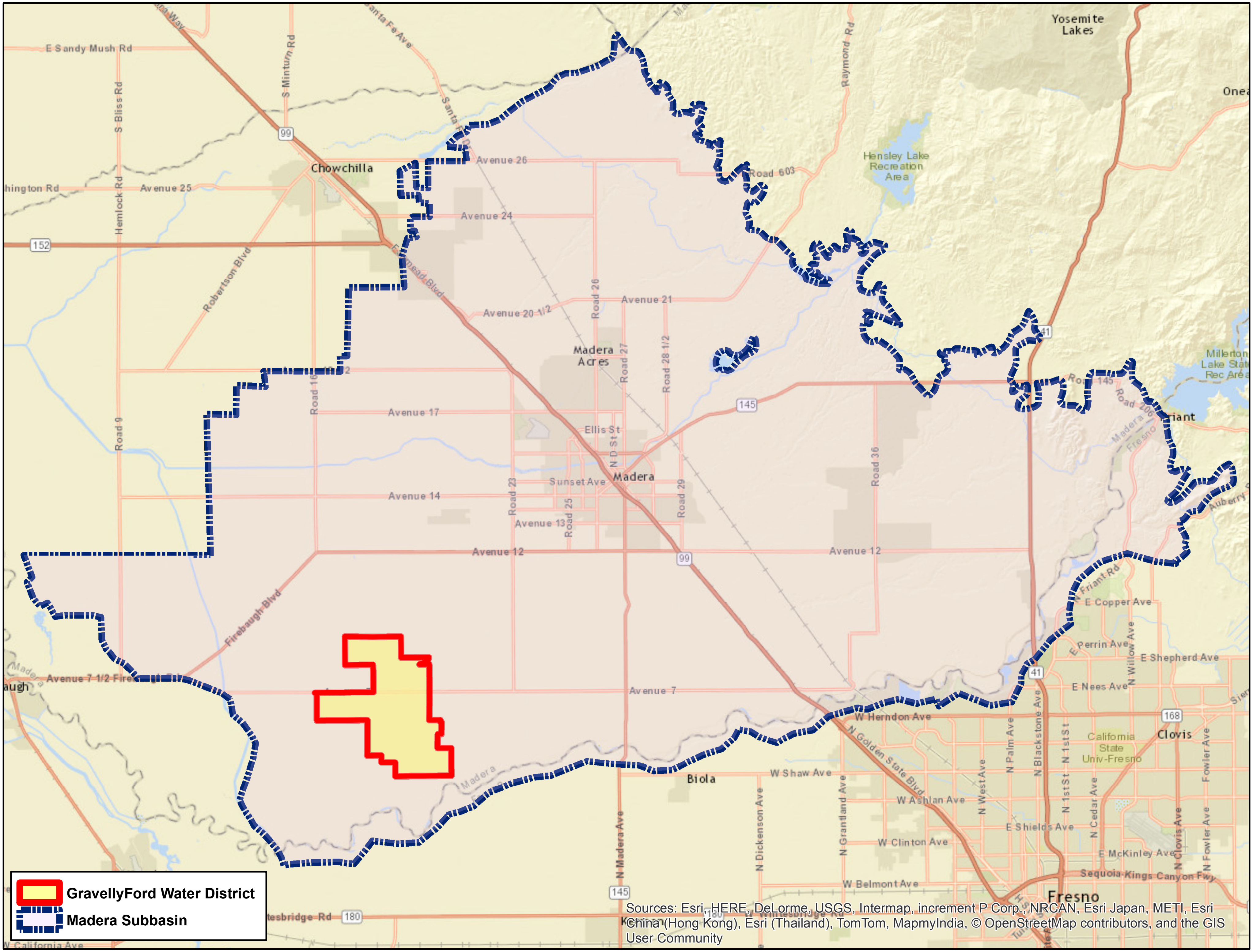
April 30, May 7, 2016

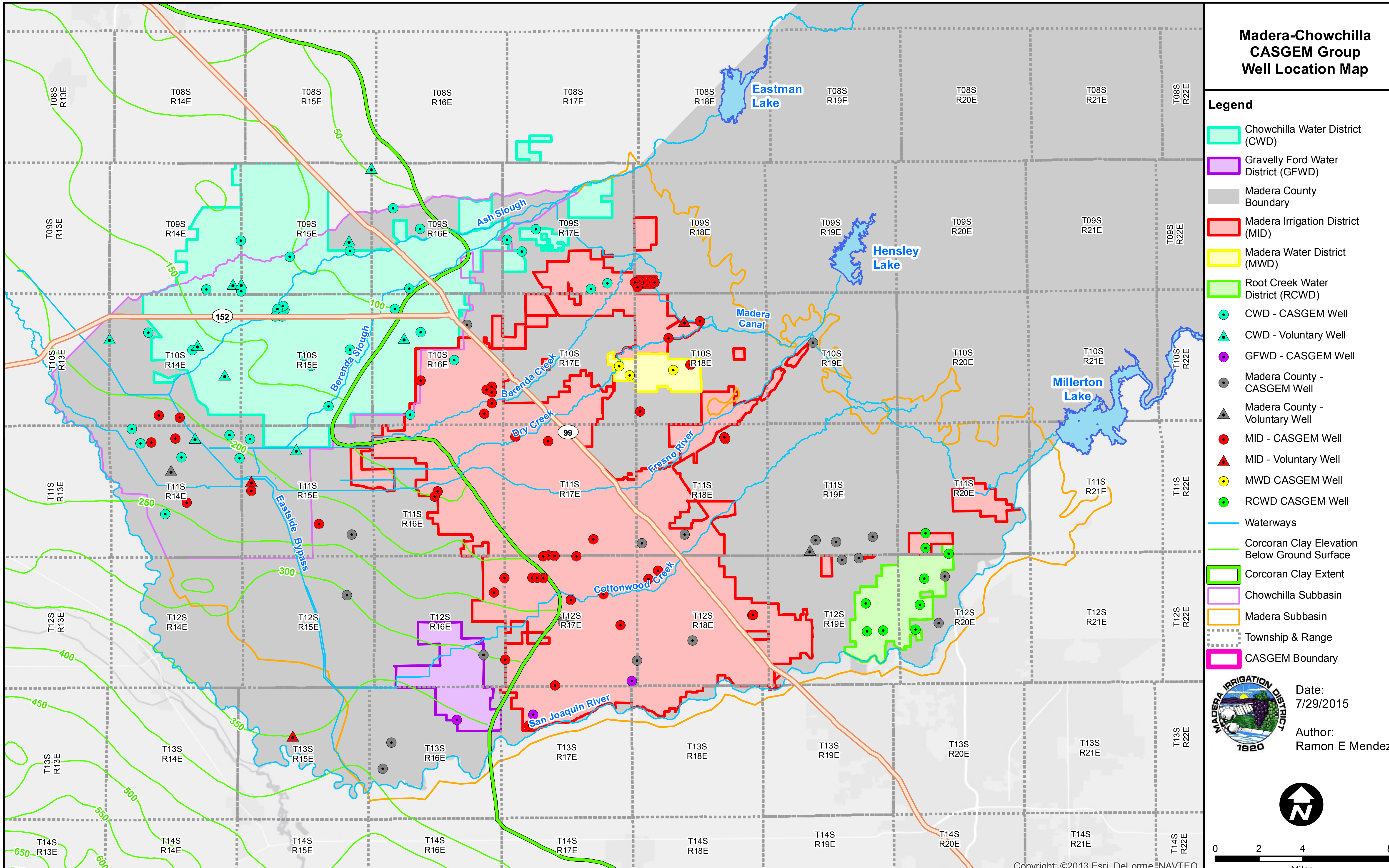
I certify or declare) under penalty of perjury that the foregoing is true and correct.

____
Signature

Date 7/7/16


GRAVELLY FORD WATER DISTRICT
GSA Boundary
DISTRICT Boundary
GFWD
Secara Reservoir
RD 16
RD 17
RD 18
RD 19
RD 20
RD 21
RD 22
AVE 9
AVE 8
AVE 7
AVE 6
AVE 5
AVE 4 1/2
AVE 4
SOUTH LINE
MID REC #10
MID REC #24
G.F. REC RD 21
G.F. REC RD 20
PUMP STATION
GRAVELLY FORD CANAL
COTTONWOOD CREEK
MID LINE
GF CANAL
S.J. RIVER
NTS
T 12 S
T 13 S
R 16 E
R 17 E
Grimmway
MID
ANDREW
PREMIER
GFWD
GIBBS
BOLDEROFF
J. BINGHAM
DeSILVA
SEIBERT
G-3
KEATING
KIRK
EMMERT
BASILA
ALKALI HOLLOW
DAVIS


GravellyFord Water District
Madera Subbasin
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Chowchilla
Madera Acres
Madera
Biola
Clovis
Fresno
Yosemite Lakes
Hensley Lake Recreation Area
California State Univ-Fresno



Date Saved: 7/29/2015 7:33:51 AM

Document Path: F:\ENGINEERING\Projects\Misc Projects\CASGEM\ArcGIS\CASGEM_Wells_LOCATION MAP.mxd

SENT TO ALL LANDOWNERS & WATER USERS

GRAVELLY FORD WATER DISTRICT

18811 Road 27· Madera, CA 93638 (559)·474·1000 Fax: (559) 673· 1086

May 2, 2016

CALIFORNIA'S SUSTAINABLE GROUNDWATER MANAGEMENT ACT AND GRAVELLY FORD WATER DISTRICT'S INVOLVEMENT

GRAVELLY FORD WATER DISTRICT (DISTRICT)

• GFWD has scheduled a public hearing at 1:30 PM on Wednesday, May 11, 2016 at the Board Room of Madera Irrigation District, 12152 Rd 28½, Madera, CA 93637, to determine whether the District will become the Groundwater Sustainability Agency (GSA) for a portion of the Madera Subbasin for areas within the District's jurisdiction (See Legal Notice).

CALIFORNIA'S SUSTAINABLE GROUNDWATER MANAGEMENT ACT (SGMA)

• **State Level**

• On September 16, 2014, Gov. Jerry Brown signed into law a three-bill legislative package related to groundwater in the State of California. This three-bill legislation is known as the Sustainable Groundwater Management Act of 2014 (SGMA). The SGMA provides a framework for sustainable management of groundwater supplies by local authorities, with a limited role of state intervention only if necessary to protect the resource. The act requires the formation of local groundwater sustainability agencies (GSAs) that must assess conditions in their local water basins and adopt locally-based management plans.

MADERA GROUNDWATER JOINT POWERS AUTHORITY (JPA)

• **County Level**

• The Madera Groundwater Authority's goal is "to provide for the conjunctive use of groundwater and surface water within the represented groundwater basins to ensure the reliability of a long-term water supply to meet current and future beneficial uses through the development of a coordinated and comprehensive regional approach to the monitoring, evaluation and management of groundwater resources."

• Formed December 21, 2014.

• Member Agencies: Madera Irrigation District, Madera County, City of Madera, Aliso Water District, Gravelly Ford Water District, Root Creek Water District, City of Chowchilla, Chowchilla Water District, and Madera Water District.

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY AGENCY (GSA)

•Subbasin Level

• The position of the Committee at this time is a multiple GSA, one Groundwater Sustainability Plan (GSP) Structure.

• Subject to the outcome of the hearing on May 11, 2016, the District plans to file with the Department of Water Resources (DWR) to become a GSA for areas within its jurisdiction.

• Formation Committee Member Agencies: Madera Irrigation District, Madera County, City of Madera, Aliso Water District, Gravelly Ford Water District, Root Creek Water District, Madera Water District, and New Sone Water District.

GRAVELLY FORD WATER DISTRICT (GFWD)

• District Level

• GFWD is an integral member of the Madera Groundwater JPA and Madera Subbasin GSA Formation committee. The District is a member of the Madera-Chowchilla Basin Regional Groundwater Monitoring Plan which achieved California Statewide Elevation Monitoring Program (CASGEM) compliance in September 2015.

• GFWD plans to file with the Department of water Resources (DWR) to become a GSA for areas within its jurisdiction.

WHAT YOU CAN DO

• Landowner Level

• Become educated on the State's legislation and requirements.

• Participate in the CASGEM program by providing GFWD or another local agency with a signed well consent letter and well log to help ensure CASGEM compliance.

• Ask questions and discuss your concerns with agency Directors and Staff.

• Stay informed - attend Board Meetings, JPA meetings and other agency meetings to understand what is happening related to groundwater in Madera County.

GRAVELLY FORD WATER DISTRICT

18811 Road 27· Madera, CA 93638 (559)·474·1000 Fax: (559) 673· 1086
email: donroberts717@gmail.com

December 3, 2018

Mr. Trevor Joseph
Sustainable Groundwater Management Section Chief
California Department of Water Resources
P.O. Box 942836
Sacramento, California 94236-0001

Subject: NOTIFICATION OF INTENT TO DEVELOP GROUNDWATER SUSTAINABILITY PLAN

Dear Mr. Joseph,

The purpose of this letter is to notify you that the Gravelly Ford Water District Groundwater Sustainability Agency (GFWDGSA) intends to develop a Groundwater Sustainability Plan (GSP) pursuant to Water Code Section 10727.8 for its service area within the Madera Subbasin (Basin Number 5-22.06, DWR Bulletin 118). The GFWDGSA is an exclusive GSA whose formation was noticed in July 2016 and later posted to the DWR website.

The GFWDGSA is engaged in several coordination and outreach efforts across the Madera Subbasin. The GFWDGSA actively participates in technical and planning meetings and forums with other GSAs in the Madera Subbasin and recognizes that the findings of the GFWDGSA's GSP will need to be coordinated with other GSP development efforts occurring in parallel within the Madera Subbasin. The GFWDGSA participates in monthly public meetings to review and discuss on-going planning activities in support of the GSA and GSP development process. These meetings welcome public input and feedback to the GSA and the GSP development process.

Ken Bonesteel will act as contact person for the development of the GSP. If you have any questions regarding our GSP development process, please contact Mr. Bonesteel. Contact information for Mr. Bonesteel: email, Ken.Bonesteel@gkinc.com and can be reached by phone at 661 616-2600.

Sincerely,

Don Roberts
Gravelly Ford Water District, General Manager

Enclosures: Resolution 2018-03

cc: Tom Campagne, Madera Regional Water Management Group

180035/ Phase 4

RESOLUTION NO. 2018-3

CERTIFIED RESOLUTION OF THE BOARD OF DIRECTORS, GRAVELLY FORD WATER DISTRICT

WHEREAS, the Gravelly Ford Water District previously formed a Groundwater Sustainability Agency (GSA) to comply with the Groundwater Sustainability Management Act. Under the Act's requirements, a Groundwater Sustainability Plan (GSP) will be developed for the Madera Subbasin, and Gravelly Ford Water District may either participate in a group GSP or Gravelly Ford can instead develop its own GSP for filing on January 1, 2020;

WHEREAS, The Board of Directors has reviewed Consultants' Ken Schmidt's and Ken Bonesteel's draft report that will be incorporated into the Gravelly Ford Water District's Groundwater Sustainability Plan, which is due for filing (when final) pursuant to the provisions of the Sustainable Groundwater Management Act of 2014 (SGMA) in January, 2020;

WHEREAS, by the terms of said draft it appears that Gravelly Ford Water District is already almost sustainable and may only require approximately 900 acre feet of overdraft recharge annually;

WHEREAS, Gravelly Ford Water District is located within the Madera Subbasin, which Subbasin encompasses the territory of the following Agencies:

1. City of Madera
2. Gravelly Ford Water District
3. Madera County Boundary
4. Madera Irrigation District
5. Madera Water District
6. New Stone Water District
7. Root Creek Water District

WHEREAS, said aforementioned Agencies within the Madera Subbasin entered into a written agreement to cooperate, share information, and to share certain expenses with respect to the State Groundwater Management Act's requirements. In entering into that written agreement, Gravelly Ford Water District specifically reserved the right to withdraw from that agreement upon notice should it ever elected to file its own separate GSP.

NOW, THEREFORE, BE IT RESOLVED, as follows:

1. The District's Manager, Mr. Don Roberts, is instructed to advise the aforementioned group of Madera Subbasin Agencies that (1) Gravelly Ford Water District is now withdrawing from the written agreement, and that (2) Gravelly Ford will be filing its own separate Groundwater Sustainability Plan for the territory of Gravelly Ford. Mr. Roberts is directed (upon giving such written notification) to further inform the organization that nevertheless Gravelly Ford Water District will continue to fully share and provide information to the organization and to all of the agencies within the Madera Subbasin.

2. In order to continue working towards having as full and complete GSP as possible for filing in January, 2020, the Board of Directors hereby directs its Consultants (Mr. Schmidt and Mr. Bonesteel) to as soon as reasonably possible take the following actions with respect to data gathering:

   a. Well Monitoring: The Consultants shall promptly implement a well monitoring program in a statistically representative number of wells in the District (approximately 20 to 30 wells) so as to monitor the "static water level" of the wells throughout the District. It is anticipated that the Consultants will use manual monitoring and measuring devices.

b. Subsidence Monitoring: The Consultants shall also gather data about whether Gravelly Ford Water District is sustaining any "subsidence" problems, particularly as a result of neighboring Agencies overdraft. It is anticipated that a reasonable statistical monitoring locations will consist of at least approximately 6 different locations.

c. Water Quality Sampling: The Consultants shall perform water quality sampling on a statistically appropriate number of Gravelly Ford's wells. It is anticipated that this sampling will occur in about 20 to 30 of the approximate 70 to 80 wells located within Gravelly Ford territory so as to achieve a representative sampling of quality to be presented within the Plan.

d. Ponding Tests: The current draft GSP indicates that Gravelly Ford's territory is almost virtually in balance so the final plan may call for about 900 acre feet annually in overdraft replacement through percolating ponds or canals. The Gravelly Ford territory already contains certain ponds areas and canal delivering systems, which all percolate very rapidly. The Consultants are directed to fill and test certain ponds or percolating canals with water, so as to thereafter measure the amount of water inflowing into the percolation area and the amount and speed of water percolation occurring thereafter. The goal is to establish by verifiable test data of measured percolation that the Board's opinion is hopefully correct that it will be relatively easy for the Gravelly Ford Water District to replace 900 acre feet of overdraft annually through pond and/or canal percolation of surface water.

e. The Board of Directors recognizes that the GSP will include a description of Gravelly Ford's exact territorial boundaries. The Board acknowledges that in August 2018 Gravelly Ford filed an application with the Madera Local Agency Formation Commission to annex certain acreage adjacent to the southeast corner of Gravelly Ford's current boundary, proceeding from that corner to the edge of the San Joaquin River. (said land is within Sections 17 and 18, Township 13 South, Range 17 East, M.D.B.&M. lying north of the San Joaquin River). The Board hereby directs Manager Don Roberts to please request the landowner and LAFCO's staff to complete the annexation process before the GSP is filed on January 1, 2020. It is assumed that the data from this area (once annexed) will support Gravelly Ford Water District's good sustainability results.

BE IT FURTHER RESOLVED, that this Resolution shall become effective immediately.

THE FOREGOING RESOLUTION WAS DULY AND REGULARLY ADOPTED by the Gravelly Ford Water District's Board of Directors, at the regular monthly meeting of the Board held on the 19th day of November, 2018, by the following vote of the Board Members:

Steven Emmert, President	Yes/No/Abstain
Seth Kirk, Vice President	Yes/No/Abstain Absent
Kenneth Basila	Yes/No/Abstain
Diane Kirk	Yes/No/Abstain
Paul Stewart	Yes/No/Abstain

ATTEST: ______________________
Kenneth Basila, Secretary

ATTEST: ______________________
Steven Emmert, President

CERTIFICATE OF SECRETARY

The undersigned Deputy Secretary of the Board of the Gravelly Ford Water District hereby certifies that the foregoing is a full, true and correct copy of Resolution No. 2018-03 which was adopted on November 19, 2018.

____
Don Roberts, Deputy Secretary

GRAVELLY FORD WATER DISTRICT
ORGANIZED
AUG 21 1961

APPENDIX B

HYDROGEOLOGIC CONCEPTUAL MODEL AND GROUNDWATER CONDITIONS FOR THE GRAVELLY FORD WATER DISTRICT GSP

HYDROGEOLOGIC CONCEPTUAL MODEL AND GROUNDWATER CONDITIONS FOR THE GRAVELLY FORD WATER DISTRICT GSP

<u>Draft Report</u>

prepared for
Gravelly Ford Water District
Madera, California

by
Kenneth D. Schmidt & Associates
Groundwater Quality Consultants
Fresno, California

October 2018

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HYDROGEOLOGIC CONCEPTUAL MODEL AND GROUNDWATER CONDITIONS FOR THE GRAVELLY FORD WATER DISTRICT GSP

INTRODUCTION

This report is intended to satisfy Sections 354.14 (Hydrologic Conceptual Model) and Section 354.16 (Groundwater Conditions) of a Groundwater Sustainability Plan (GSP) for the Gravelly Ford Water District (GFWD). The GFWD (the GSA) is located north of the San Joaquin River and southwest of the City of Madera.

SURFICIAL CHARACTERISTICS OF BASIN

Topography

Figure 1 shows topographic conditions in the basin. The land surface generally slopes to the west. Land surface elevations range from about 200 feet above mean sea level near the northeast corner of the GSA to about 175 feet above mean sea level near the southwest corner of the GSA. The southeast corner of the GSA is near the San Joaquin River and Road 21. The Chowchilla Canal Bypass is several miles west of the west edge of the GSA. Cottonwood Creek flows into the District from the northeast.

Surficial Geology

Wagner (2002) mapped the surficial geology of the Madera area,

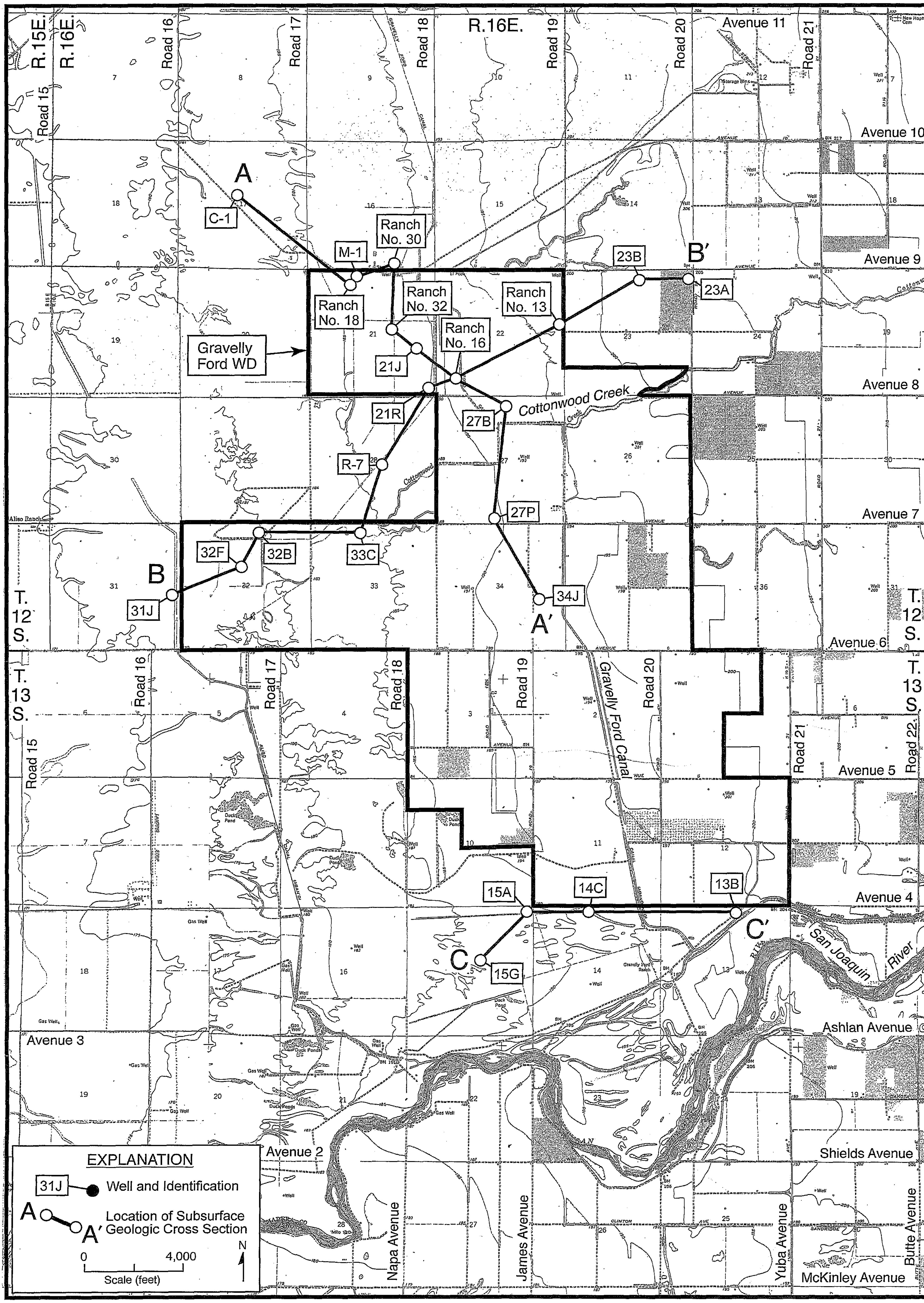


FIGURE 1 - TOPOGRAPHIC MAP OF GSA AND LOCATIONS OF SUBSURFACE GEOLOGIC CROSS SECTIONS

which include the GFWD GSA. Figure 2 shows the part of his map that covers the GSA. The southern part of the GSA was mapped as Quaternary fan deposits. The northern part of the District was mapped as Quaternary basin deposits.

Topsoils

Figure 3 shows the major types of topsoils in the GSA from the U.S. Soil Conservation Service report on soils in the Madera area (Ulrich and Stromberg, 1962). Four soil associations were shown in the GSA. Topsoils in most of the GSA were mapped as the Dinuba-El Peco association. North of Avenue 6, some topsoils are of the Fresno-El Peco association. Both of these soils have hardpan development. Traver-Chino association soils are present in only a small area, south of Avenue 7 and east of Road 16. These soils don't have a hardpan, but have more clay in the subsoil. Between Avenues 4 and 5, soils of the Hanford-Tujunga association are present. These soils are coarse-grained and the most permeable of the topsoils in the GSA.

Surface Water Bodies

Figure 1 shows the location of surface water bodies in and near the GSA. The San Joaquin River is the mayor stream in the area and is near the southeast corner of the GSA. Cottonwood Creek drains a considerable area in the foothills and enters the

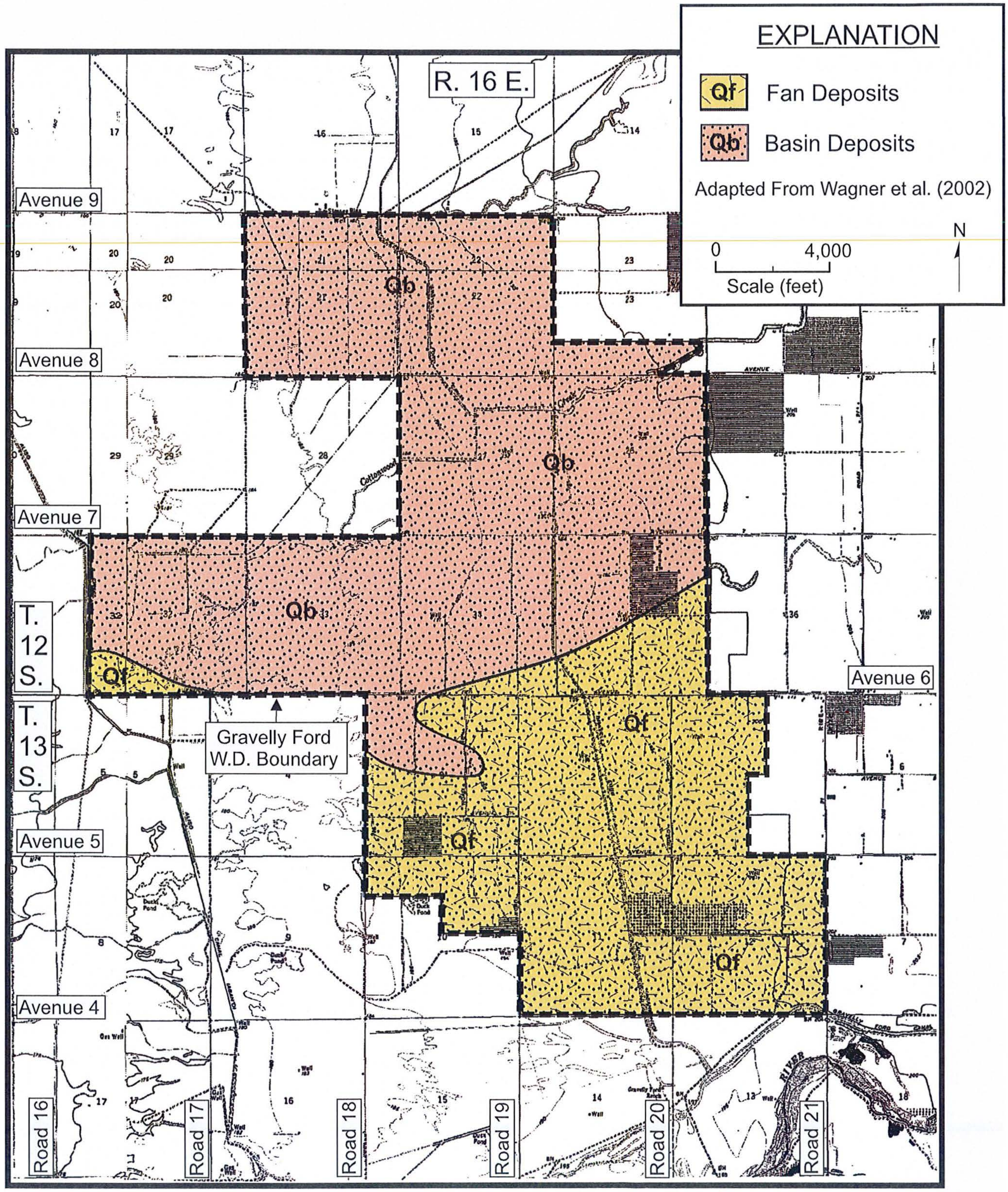


FIGURE 2 - SURFICIAL GEOLOGIC MAP

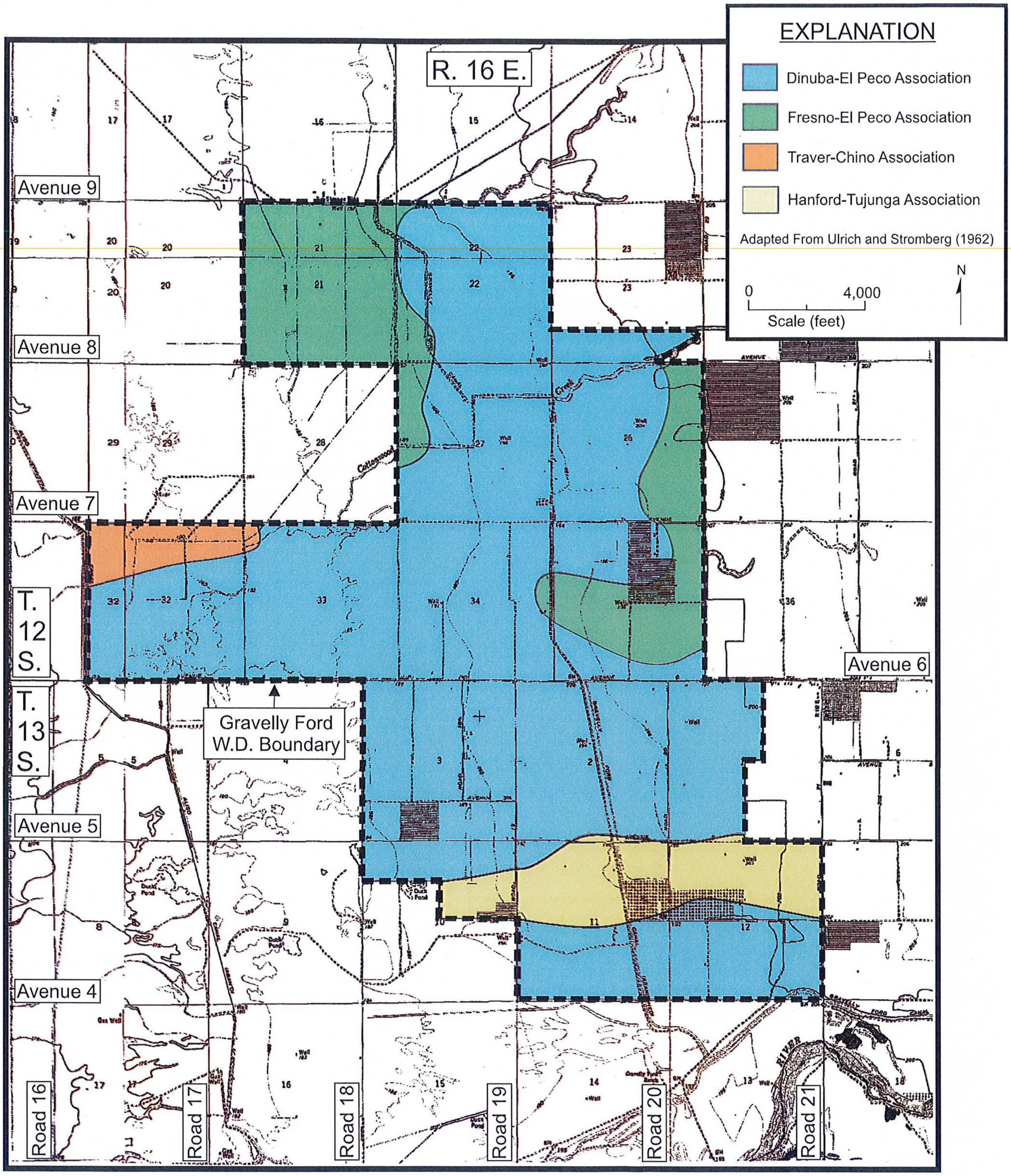


FIGURE 3 - TOPSOILS

GSA from the northeast. The Chowchilla Canal Bypass is a major flood control channel that passes from the south to north several miles west of the east edge of the District.

SUBSURFACE GEOLOGIC CONDITIONS

Mitten, LeBlanc, and Bertoldi (1970) described the geology, hydrology, and water quality of the Madera Area, which includes the GSA.

Regional Geologic and Structural Setting

The GSA is within the San Joaquin Valley, which is a topographic and structural through, bounded on the east by the Sierra Nevada fault block and on the west by the folded and faulted Coast Ranges. Both mountains blocks have contributed to marine and continental deposits in the Valley. In the west-central part of the valley, more than 12,000 feet of sediments are present. Alluvial deposits comprise the aquifer in the area. These interlayered deposits dip slightly to the south-southwest in the area.

Lateral Basin Boundaries

Figure 1 shows the boundaries of the basin. The basin boundaries include the San Joaquin River on the south end. The remaining boundaries are political boundaries, including the Aliso W.D. service area on the west and the Madera Irrigation District service area to the north and east. All of the basin is in Madera County.

Definable Bottom of the Basin

Figure 4 shows the definable bottom of the basin. Historically, the U.S. Geological Survey (Page, 1973) used an electrical conductivity of about 3,000 micromhos per centimeter at 25°C to delineate the regional base of the fresh groundwater in the San Joaquin Valley. The base of the fresh groundwater could be called the "bottom of the basin". However, another factor to consider is where the deposit predominantly become fine-grained at depth. As part of this evaluation, electric logs for deep holes were obtained from the California Division of Oil & Gas, and Geothermal Resources. A review of these logs indicated depths to the bottom of the basin ranging from about 800 to 1,100 feet. The bottom of the basin is generally the shallowest beneath the southwest part of GSA and deepest beneath the northeast and east parts of the GSA.

Formation Names

Mitten, LeBlanc, and Bertoldi (1970) divided the unconsolidated deposits in the Madera area into the younger alluvium (normally less than about 50 feet thick), the Quaternary older alluvium (less than 1,000 feet thick), and the Tertiary-Quarternary continental deposits (about 1,000 to 2,200 feet thick). The Corcoran Clay is a regional confining bed. This clay divides the groundwater into an upper aquifer and lower aquifer. Depos-

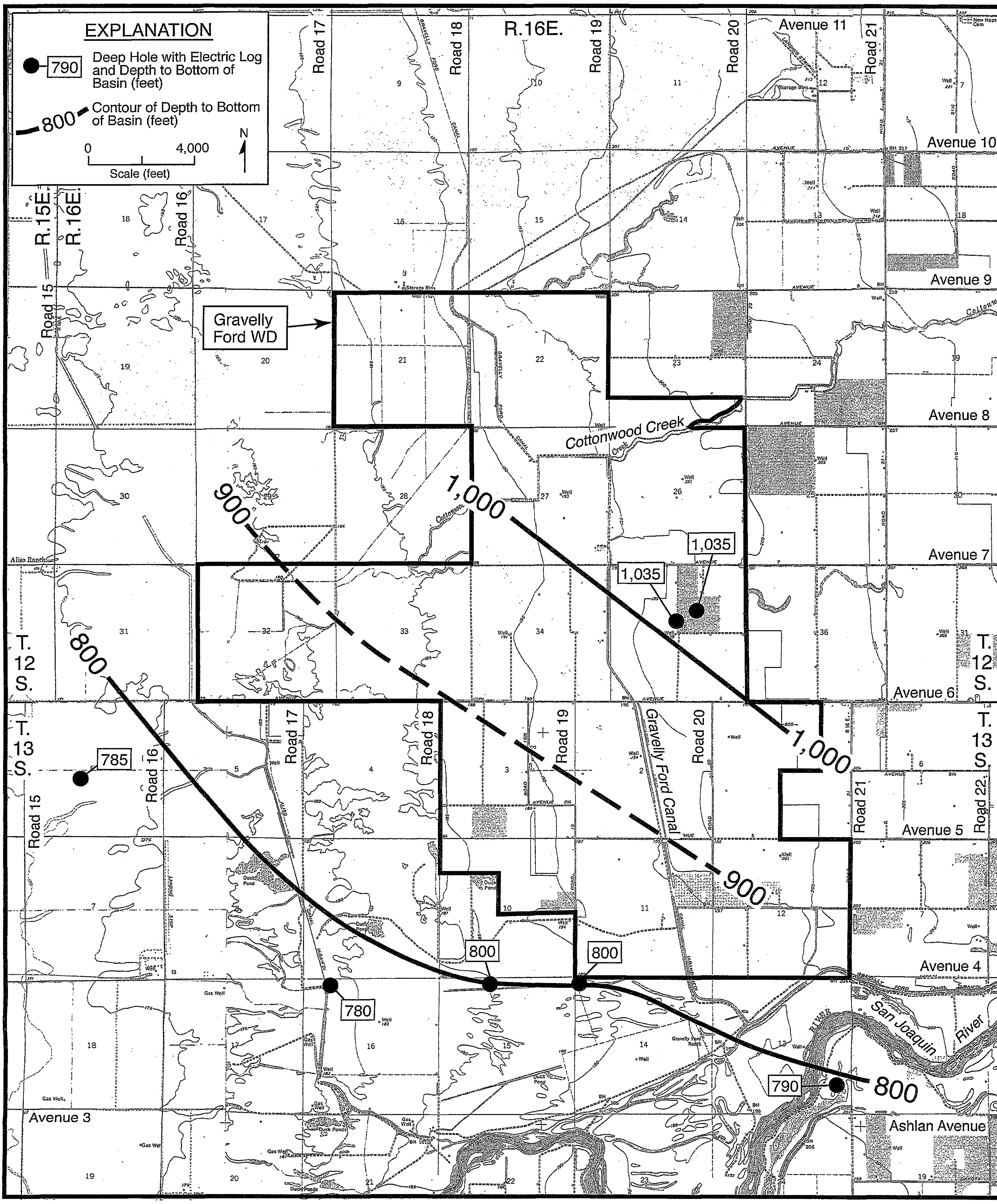


FIGURE 4 - DEFINABLE BOTTOM OF BASIN

aquifer. Deposits in the GSA are generally termed the Sierra deposits, as they were derived from the Sierra Nevada.

Confining Beds

The confining bed that is important beneath the GSA is the E-Clay or Corcoran Clay. Figure 5 shows the depth to the top of the Corcoran Clay. The top of this clay is shallowest (about 300 feet deep) in the north part of the GSA and is deepest (about 380 feet deep) near the south edge of the GSA. The depth to the top of the Corcoran Clay essentially defines the base of the upper aquifer. The Corcoran Clay generally thickens to the southwest beneath the GSA.

Principal Aquifers

Based on subsurface geologic cross sections (presented in the next section) and water well drillers logs and completion reports, the lower part of the upper aquifer and the upper part of the lower aquifer comprise the principal strata tapped by irrigation wells in most of the District. Because of relatively shallow water levels, near the San Joaquin River some wells in this part of the GSA tap only the upper aquifer.

Subsurface Geologic Cross Sections

KDSA have developed three subsurface geologic cross sections in and near the GSA. Locations of these cross sections are pro-

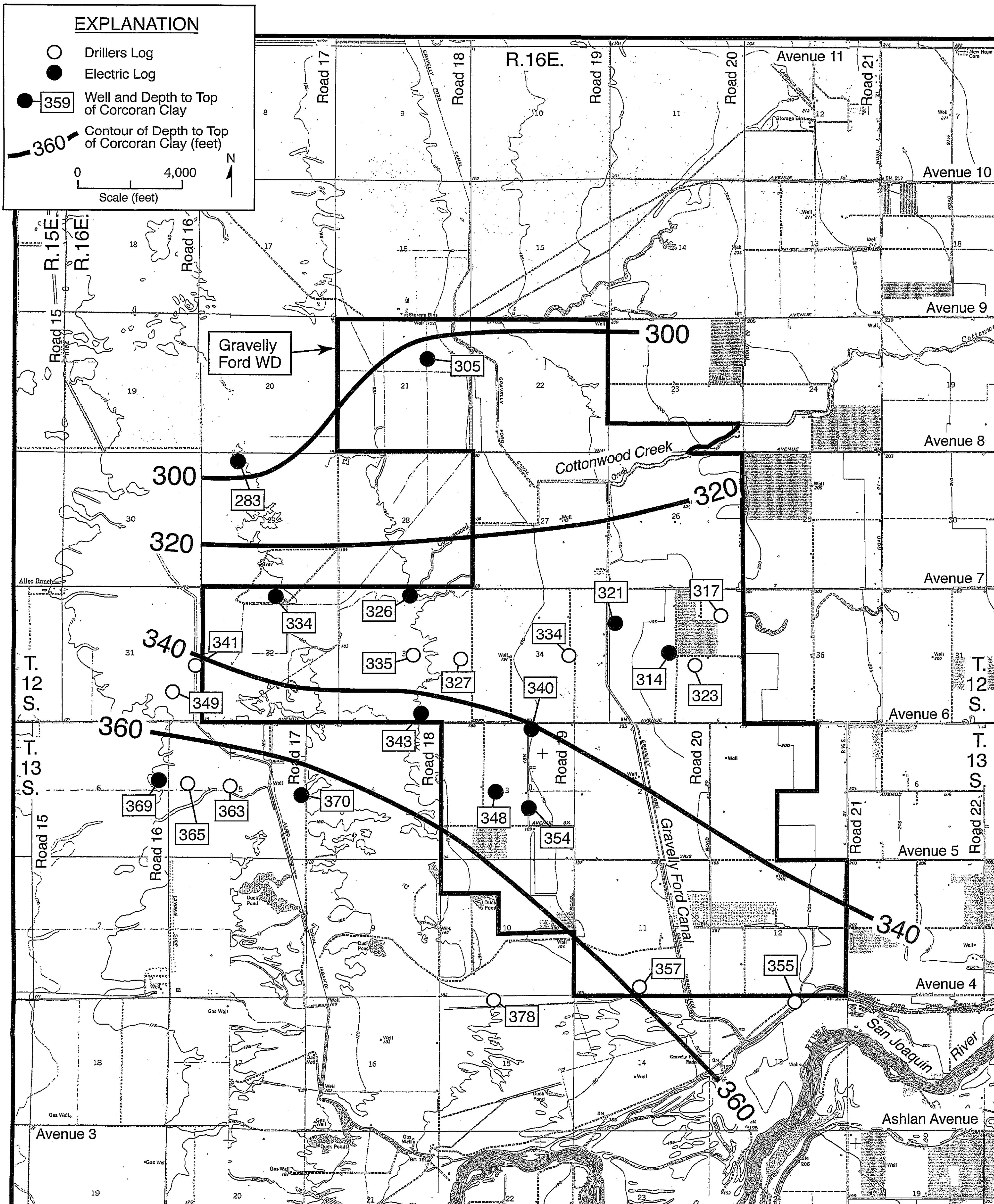


FIGURE 5 - DEPTH TO TOP OF CORCORAN CLAY

vided on Figure 1. The important confining beds (clay layers) and major water producing strata (sand and gravel) are shown on these sections. Cross Section A-A′ generally extends from the northwest to the southeast, perpendicular to the inferred dip of the alluvial deposits. In contrast, Cross Sections B-B′ and C-C′ extend from the southwest to the northeast, generally perpendicular to Cross Section A-A′, and along the inferred dip of the deposits.

Cross Section A-A′ (Figure 6) extends from near Avenue 9-1/2 and Road 16-1/2 on the northwest, to near Avenue 6-1/2 and Road 19 on the southeast. The Corcoran Clay thickens to the northwest along the section, from about 10 feet near the southeast edge to about 30 feet beneath the northwest part. Sand or gravel layers are common above the Corcoran Clay and below the water level along this section. Interbedded sand and clay layers are present below the Corcoran Clay along the section. In general, clays are thicker and more predominant below the Corcoran Clay than above. More sand is indicated below the Corcoran Clay along the northwest point of the section than elsewhere.

Cross Section B-B′ (Figure 7) extends from near Avenue 6-1/2 and Road 16 in the southwest to the northeast, to near Avenue 9 and Road 20. The Corcoran Clay generally thickens to the southwest along this section, from about 15 feet near the northeast edge to about 40 feet near the southwest end. Sand layers are

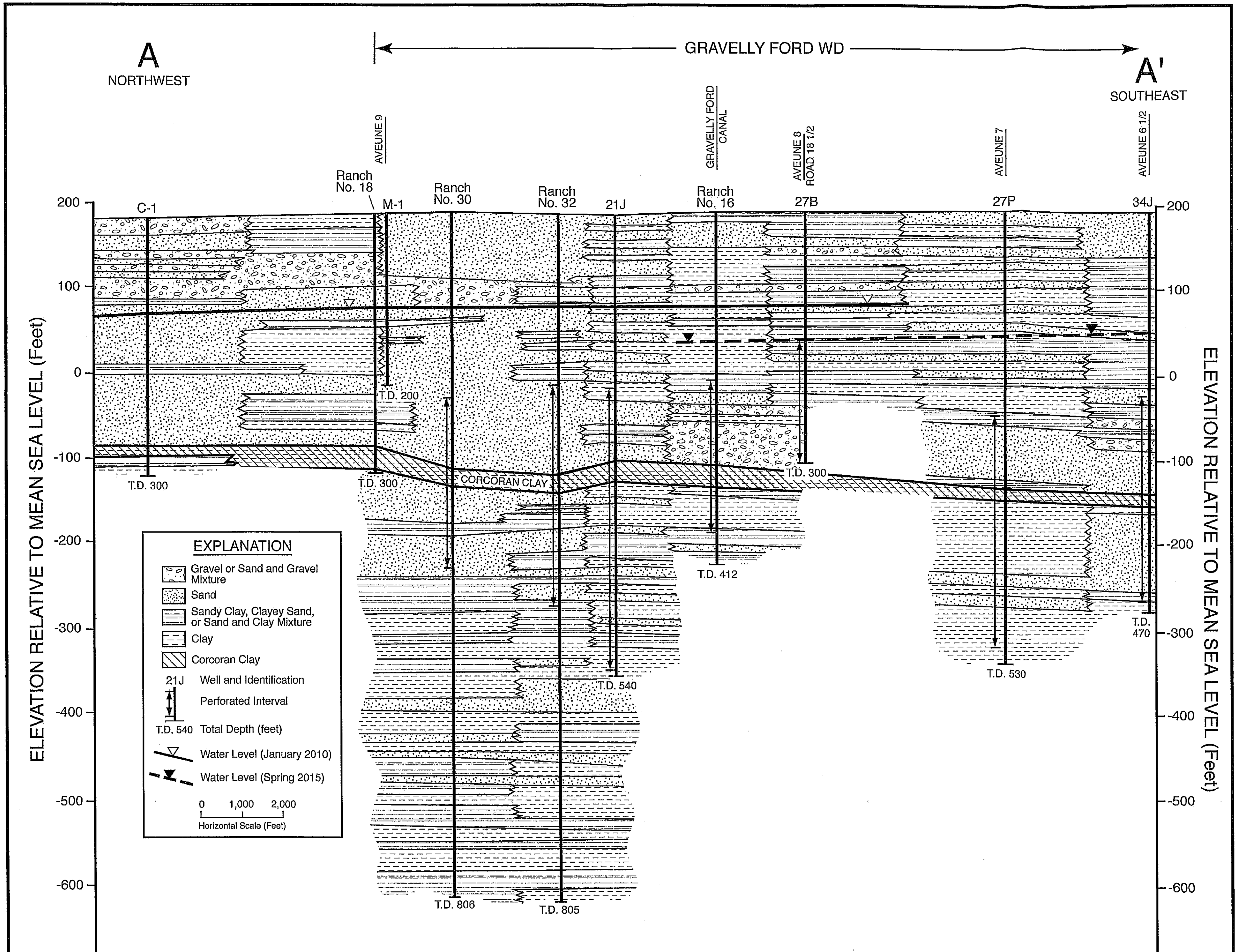


FIGURE 6 - SUBSURFACE GEOLOGIC CROSS SECTION A - A'

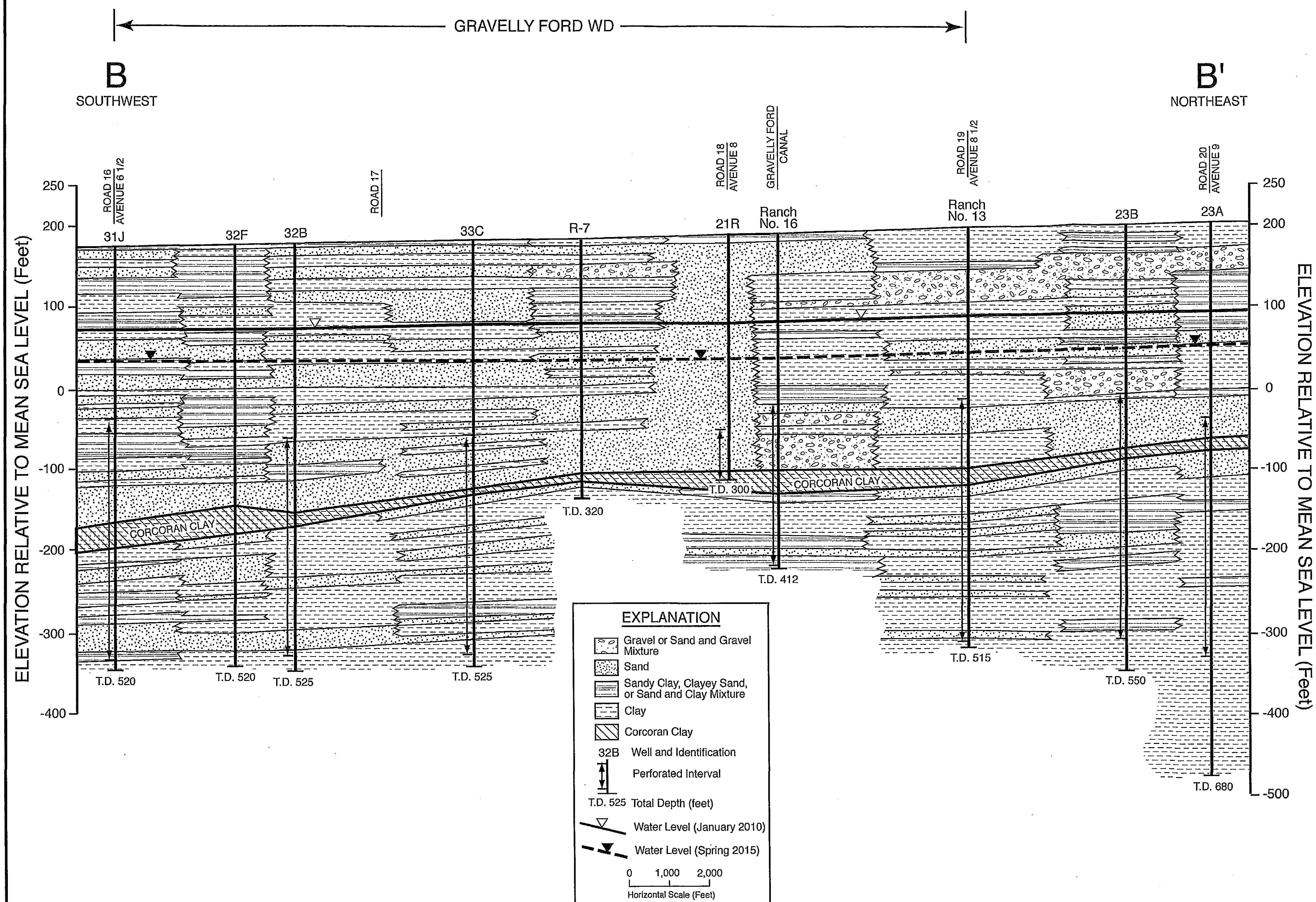


FIGURE 7 - SUBSURFACE GEOLOGIC CROSS SECTION B - B'

common above the Corcoran Clay and below the water level at most locations. Based on the available data, sands below the Corcoran Clay are thickest beneath the southwest part of the section. Clay strata are thick and fairly extensive below the Corcoran Clay along much of this section.

Cross Section C-C′ (Figure 8) extends from near Avenue 3 and Road 17-1/2 on the southwest to the northeast and east to near Avenue 4 and Road 20-1/2. The Corcoran Clay ranges from about 15 to 30 feet thick along the section. There are a number of laterally extensive sand layers above the Corcoran Clay and below the water level along much of the section. Interbedded sand and clay layers are present below the Corcoran Clay along most of the section. Sands below the Corcoran Clay are more common beneath the northeast part of the section.

GROUNDWATER USE AND WELL DATA

Primary Uses of Each Aquifer

Within the GSA, the primary use of the upper and lower aquifer is for irrigation. Some water is also used for private domestic use.

Depths of Supply Wells

Driller′s logs and well completion reports indicate that depths of the majority of active irrigation wells in the GSA

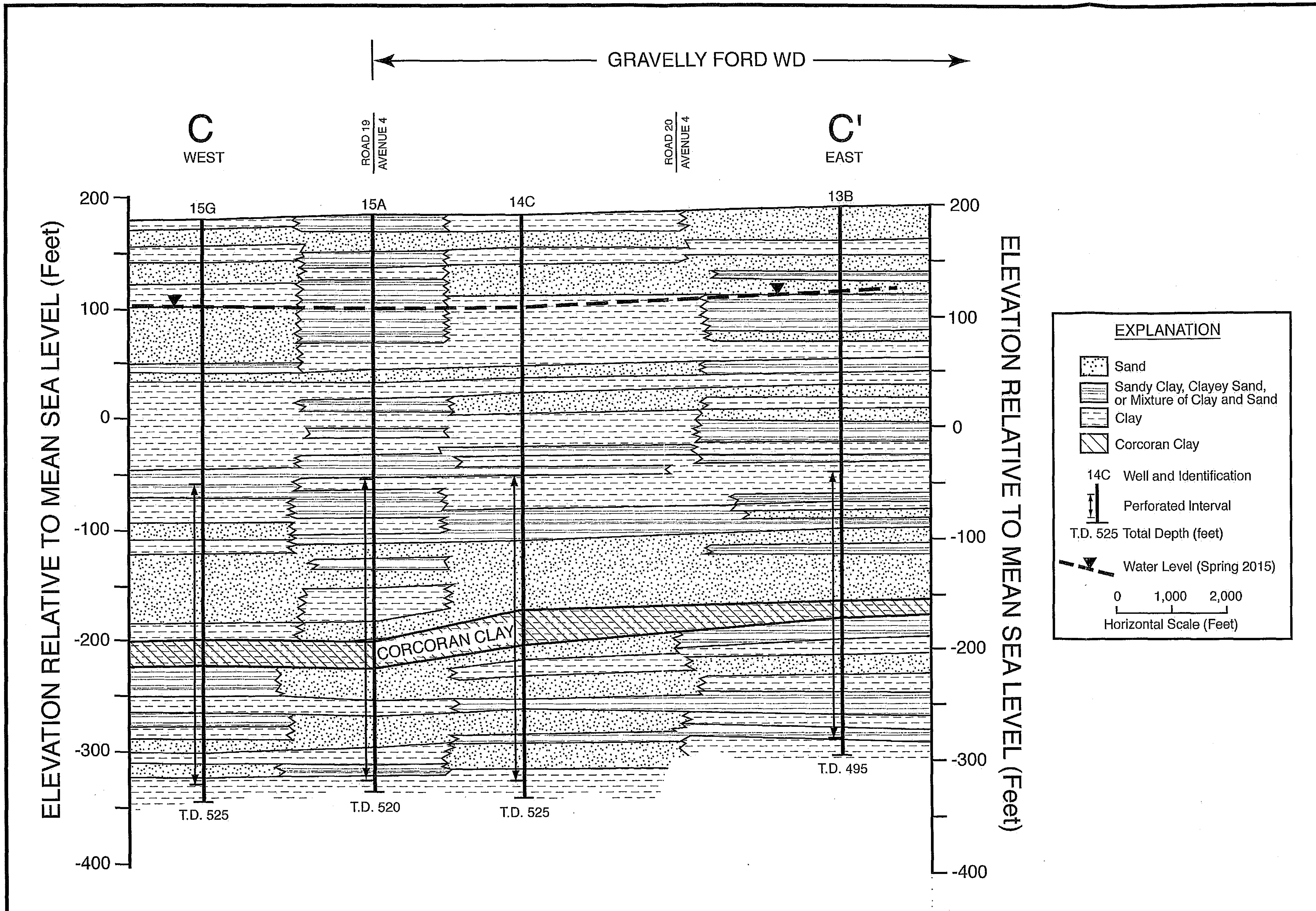


FIGURE 8 - SUBSURFACE GEOLOGIC CROSS SECTION C - C'

with records range from about 350 to 600 feet. Only a small percent of these wells tap only the upper aquifer. Almost all of the remaining irrigation wells are indicated to be composite wells, tapping strata both above and below the Corcoran Clay.

WATER LEVELS

This water-level discussion focuses on measurements primarily for irrigation wells, many of which are composite wells, tapping both the upper and lower aquifers. Because of the lack of wells that solely tap the lower aquifer in and near the GSA, it is not possible to prepare a water-level map for the lower aquifer. However, limited data based on a few wells in nearby areas indicate a southwesterly direction of groundwater flow in the lower aquifer.

Water-Level Elevations and Direction Of Groundwater Flow

Figure 9 shows water-level elevations in Spring 2015, based largely on measurements for composite wells. Water-level elevations ranged from more than 110 feet above mean sea level near the southeast corner of the GSA to about 30 feet near the north part of the GSA. The direction of groundwater flow was away from the San Joaquin River to the northwest or north. This map indicates the importance of recharge from streamflow in the river to groundwater tapped by irrigation wells in the GSA.

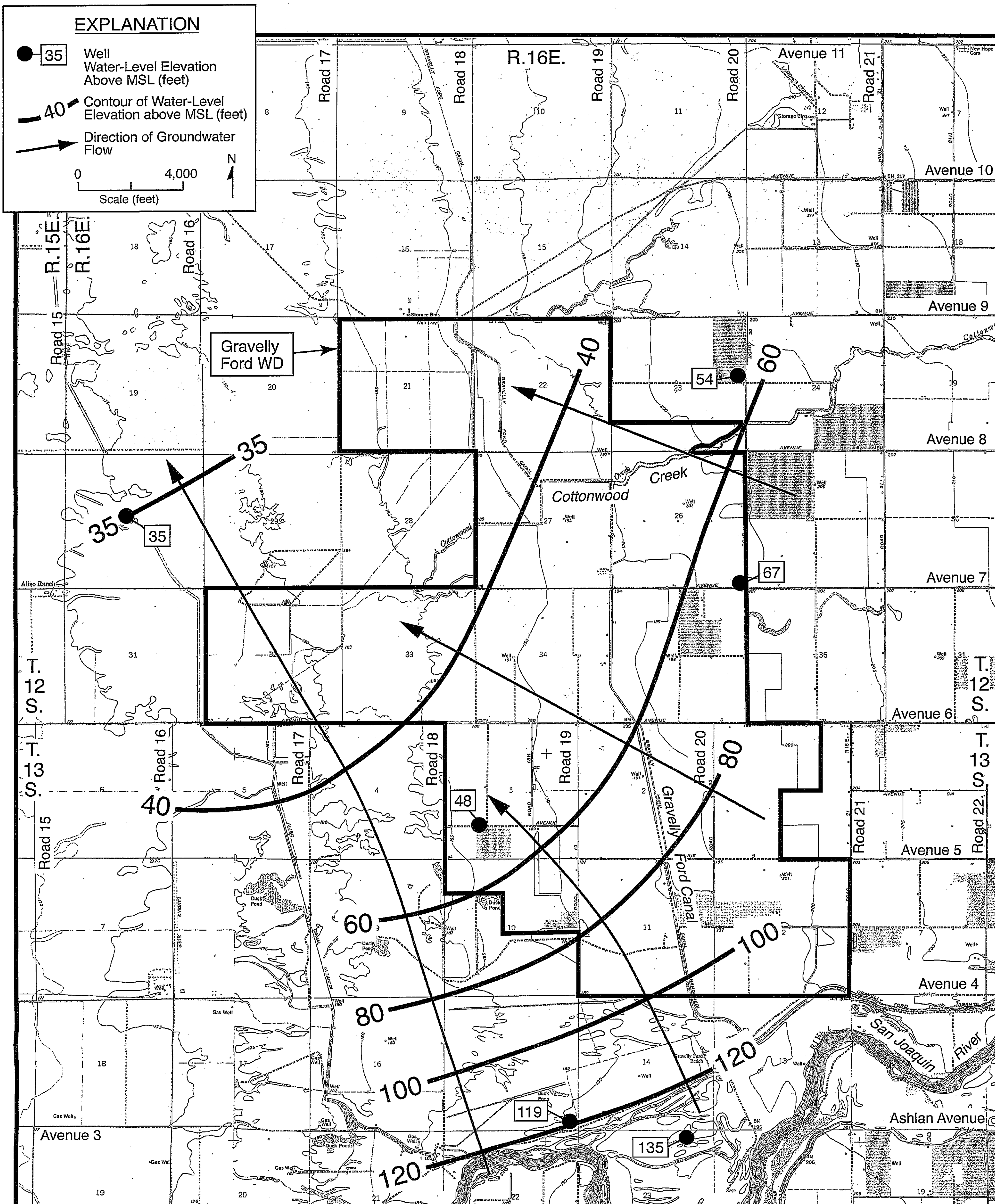


FIGURE 9 - WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW FOR IRRIGATION WELLS (SPRING 2015)

Groundwater was flowing from the river toward a pumping depression located primarily north of Avenue 6.

Water-Level Fluctuations

Long-term water-level hydrographs from the DWR website were accessed for five wells in or near the GFWD. Figure 10 shows representative water-level hydrographs for two of these wells.

Well T12S/R16E-23H1 is located near Avenue 8-1/2 and Road 20, about half a mile north of Cottonwood Creek. The water level in this well fell from about 20 feet deep in 1938 to about 60 feet deep in 1954 or an average of about 2.5 feet per year. Spring water levels fell an average of about 0.8 foot per year since 1960 (Figure 10).

Well T12S/R16E-26H1 is located near Avenue 7 and Road 20, about three-fourths of south of Cottonwood Creek. Spring water levels fell an average of 1.0 foot per year between 1950 and 1980. The average water-level decline after 1980 has been about 1.2 feet per year. Both wells 23H1 and 26H1 are indicated to be composite wells, tapping both aquifers.

Well T12S/R16E-26R1 is indicated to be a shallow well and is located near Avenue 7 and Road 20, about a mile and a quarter south of Cottonwood Creek. Water-level records for this well are available since 1949. Spring water levels in this well have fallen at an average rate of 0.4 foot per year since 1960.

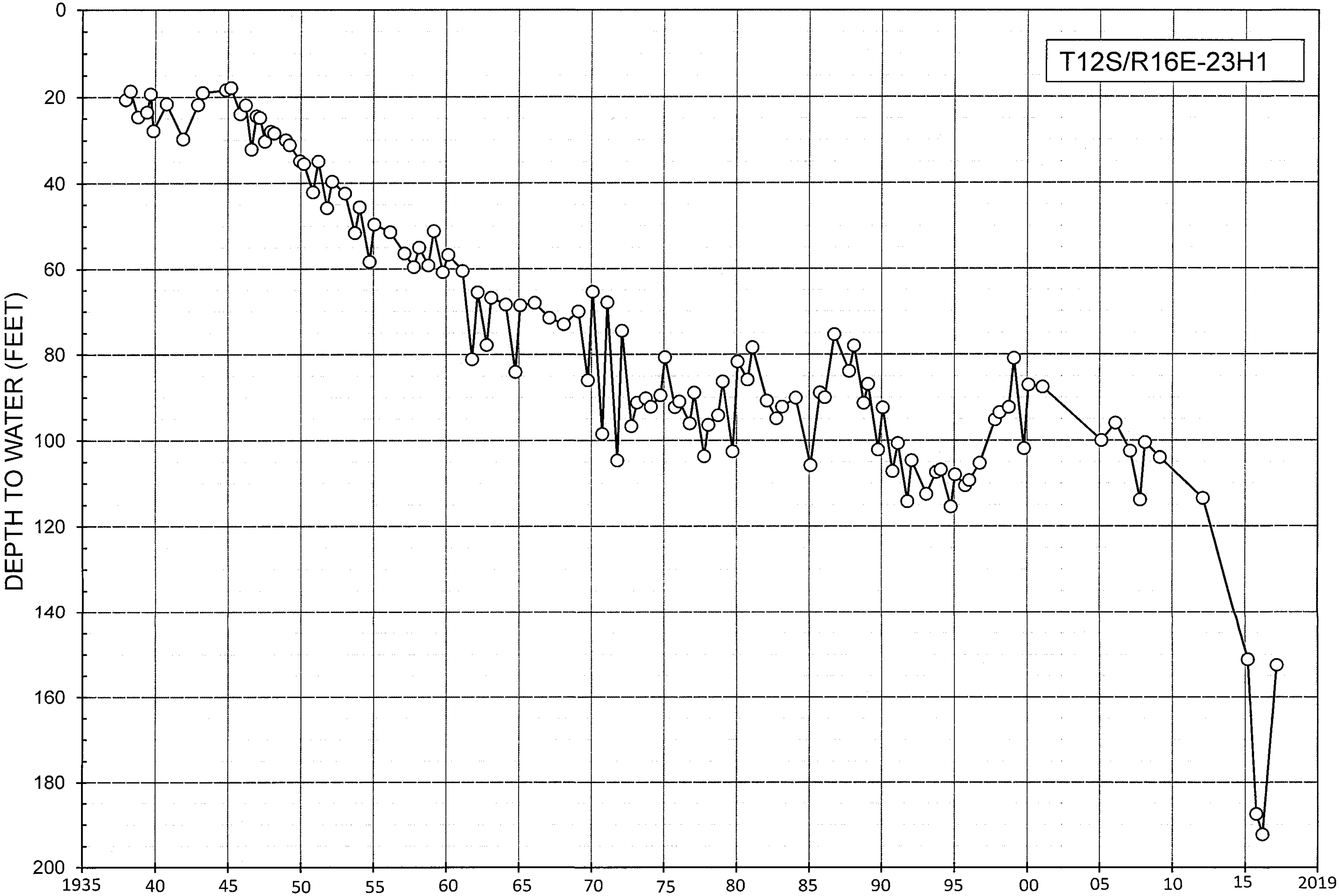


FIGURE 10 - REPRESENTATIVE WATER-LEVEL HYDROGRAPHS FOR IRRIGATION WELLS

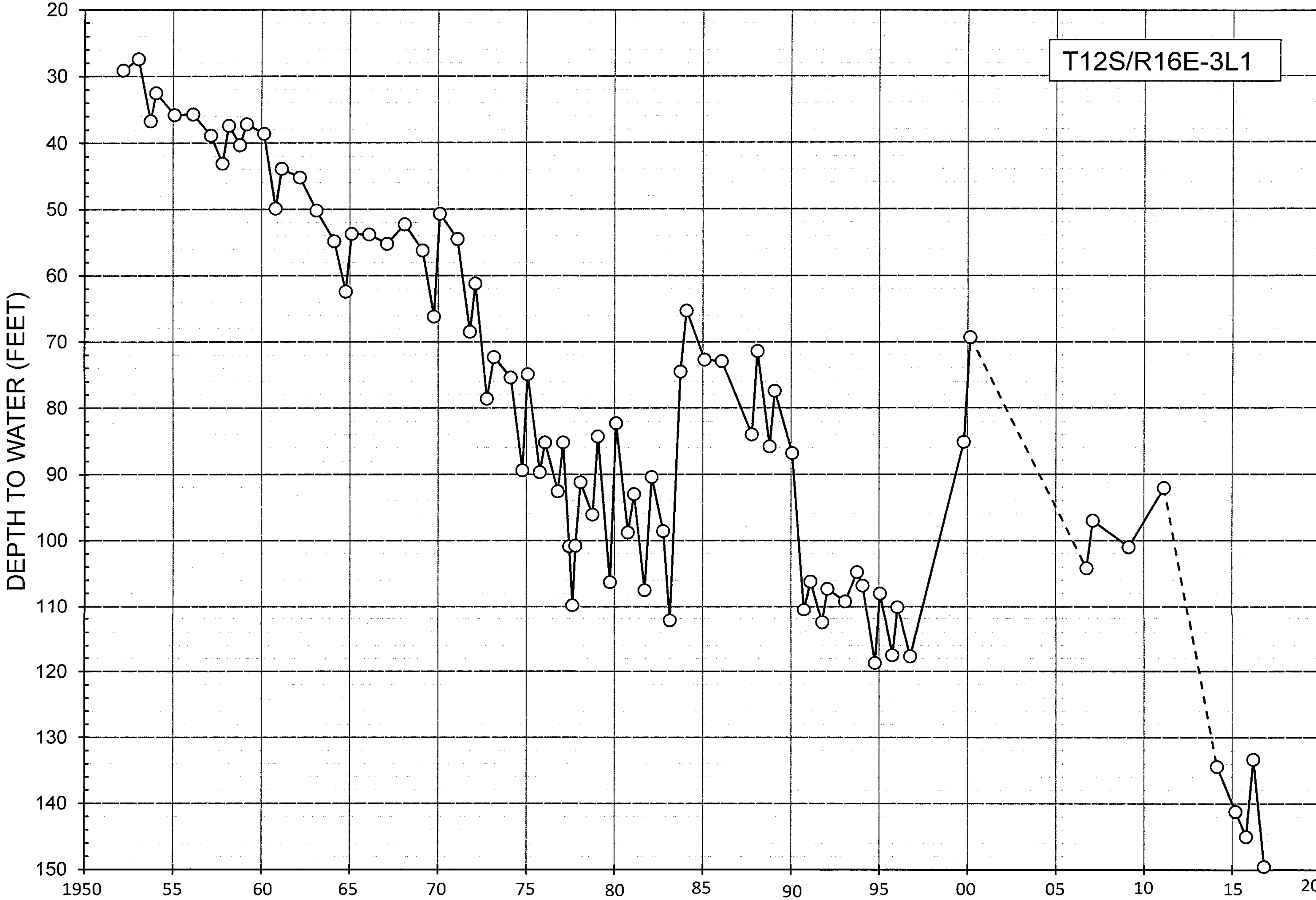


FIGURE 10 - REPRESENTATIVE WATER-LEVEL HYDROGRAPHS FOR IRRIGATION WELLS (continued)

Well T12S/R16E-31G is located near Avenue 6-1/2 and Road 15-1/2, about two miles northeast of the Chowchilla Bypass. Spring water levels fell from 50 feet deep in 1987 to about 105 feet deep in 2009, or an average of about 2.5 feet per year. Water levels fell significantly during 2013-16 during the drought. Water levels for this well appear to be more indicative of the lower confined aquifer.

Well T13S/R16E-3L1 is located near Avenue 5-1/2 and Road 18-1/2. Spring levels fell from about 35 feet in 1960 to 92 feet in 2011, or an average of about 1.1 feet per year (Figure 10).

Overall, the average water-level decline for these wells in recent decades has been about 0.9 foot per year.

Groundwater Overdraft

The best method to calculate groundwater overdraft is to use the specific yield for the unconfined groundwater and the long-term average water-level change over a hydrologic base period. Using an area of 8,500 acres, specific yield of 0.12, and average water-decline of 0.9 foot per year, the overdraft in the GSA is about 900 acre-feet per year. David's Engineering, as part of studies of the Madera Sub-basin, has made water budget estimates for the Gravelly Ford GSA. They estimated recharge to average about 15,000 acre-feet per year for 1989-2014. They estimated the average groundwater pumpage to be about 16,700 acre-feet per year. This leaves a residual of 1,700 acre-feet per year. Because the GSA is in a subsiding area, an additional source of water is compaction from the Corcoran Clay and underlying clay layers. Assuming that the average compaction during 1989-2014 was about 0.08 foot per year (half of the subsidence between 2011 and 2016), the amount of water expelled from the clays would be about 2.2 feet times 8,500 acres, or about 700 acre-feet per year. This would reduce the net imbalance to about 1,000 acre-feet per year, in good agreement with the value determined from the water-level change-specific yield estimate.

SOURCES OF RECHARGE

Figure 11 shows potential groundwater recharge areas in the GSA. Water-level maps indicate that seepage from the San Joaquin River streamflow has been an important source of recharge to the groundwater in the GSA. Historically, there has been also been recharge from flows in Cottonwood Creek. Seepage from conveyance facilities has also been important.

SOURCE OF DISCHARGE

Groundwater discharge in the GSA is primarily from pumping wells and secondarily from groundwater outflow to the northwest. Figure 12 shows potential groundwater discharge areas.

AQUIFER CHARACTERISTICS

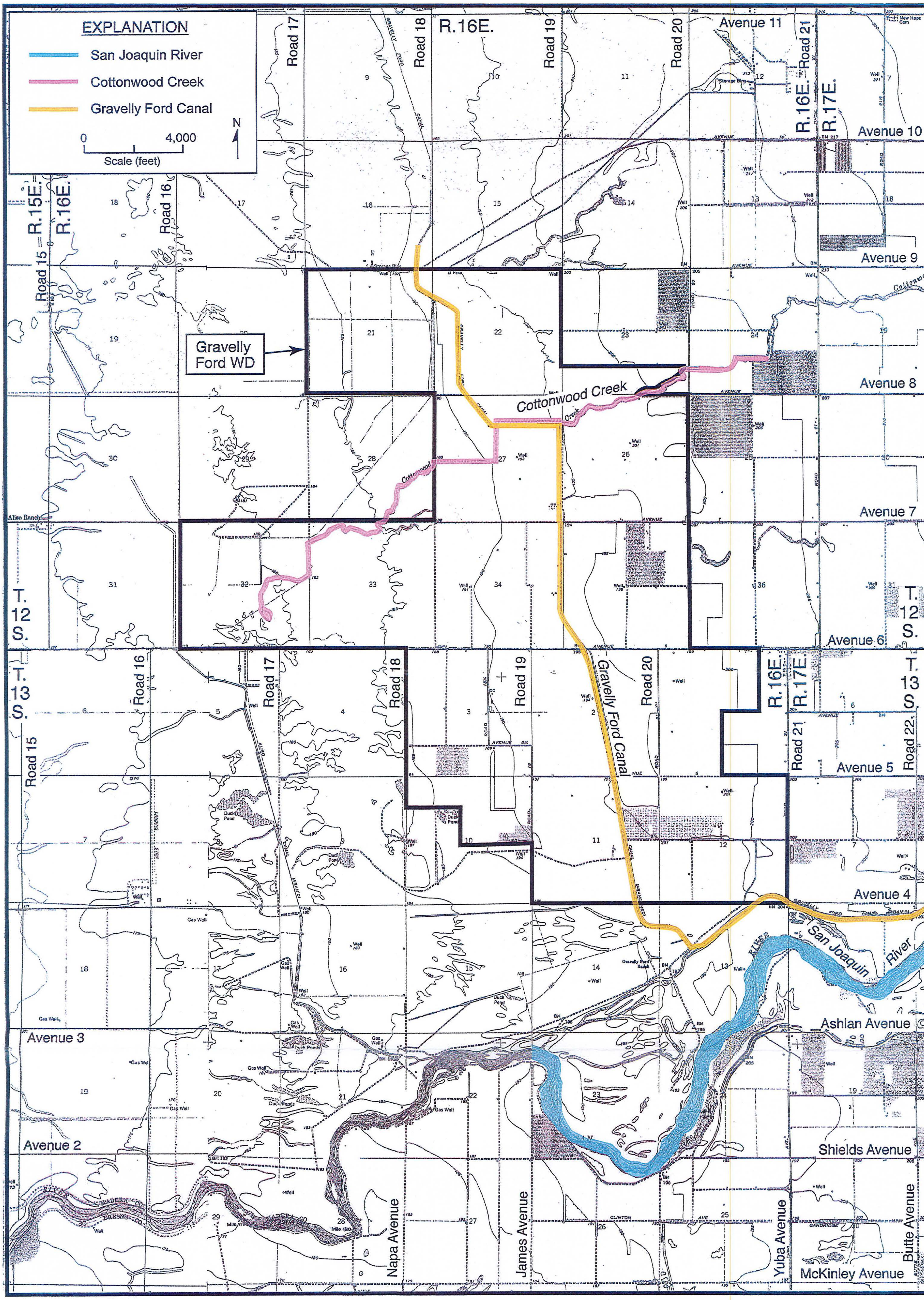


FIGURE 11 - POTENTIAL GROUNDWATER RECHARGE AREAS

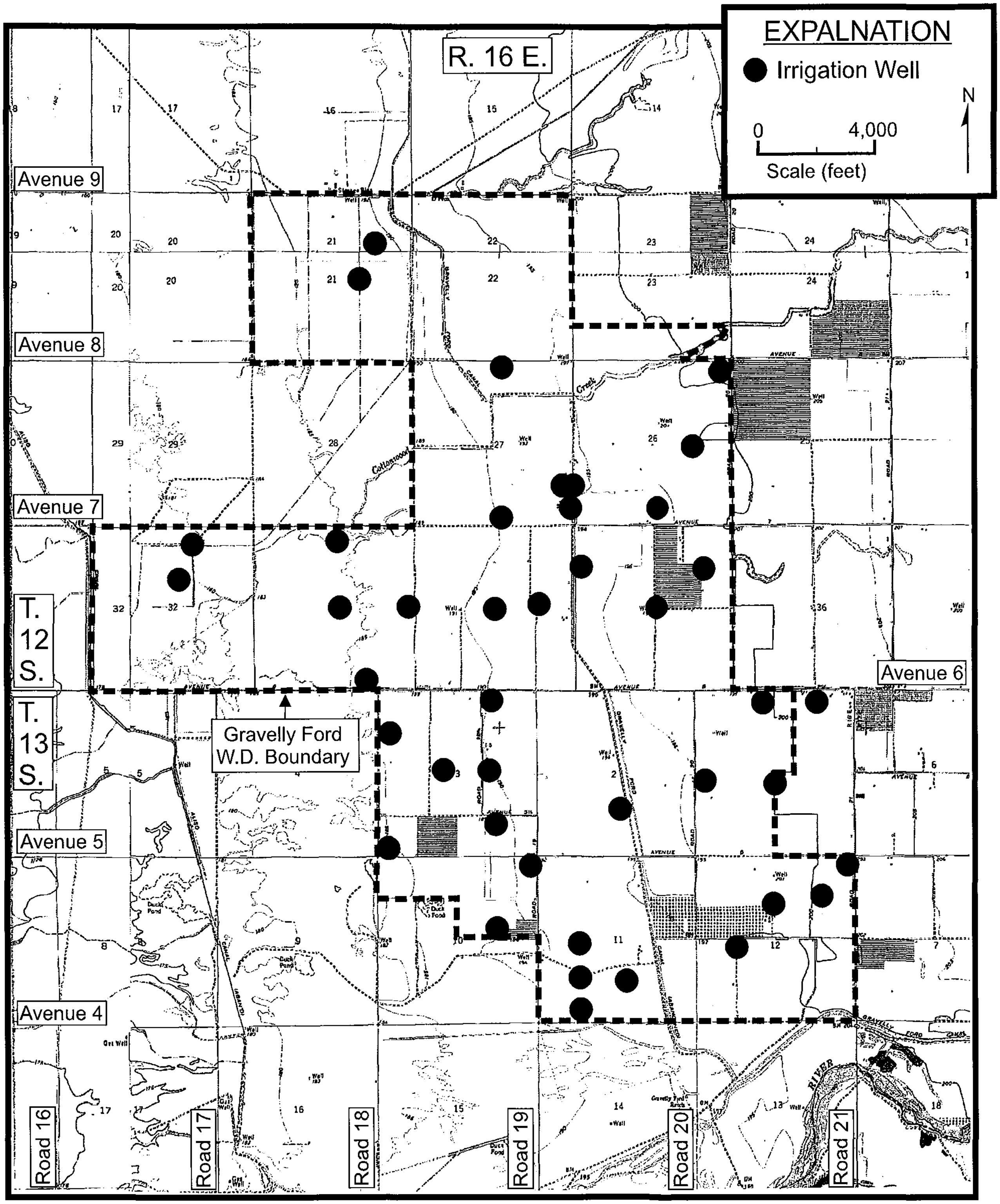


FIGURE 12 - POTENTIAL GROUNDWATER DISCHARGE AREAS

Pump tests area available for dozens of irrigation wells in the GSA. Pumping rates for many irrigation wells range from about 800 to 2,300 gpm. Specific capacities of most wells range from about 25 to 70 gpm per foot. For wells tapping both aquifers, specific capacities can be multiplied by a factor of 1,750 to estimate aquifer transmissivity. Based on the range of specific capacities, transmissivities would be expected to range from about 45,000 to 120,000 gpd per foot. Transmissivity has been determined at some wells, and values range from about 60,000 to 120,000 gpd per foot. The best values of specific yield for the upper aquifer are derived from textural descriptions and specific yield estimates commonly used by the U.S. Geological Survey. For the GSA, a specific yield of 12 percent is reasonable, based on a review of the subsurface geologic cross sections presented in this report. For the groundwater confined below the Corcoran Clay, a storage coefficient of 0.001 to 0.0001 is considered reasonable.

CHANGE IN STORAGE

Based on the average water-level decline of 0.9 foot per year in recent decades in the GSA, and using an average specific yield of 0.12, the groundwater overdraft beneath the 8,500-acre GSA has averaged about 900 acre-feet per year.

Figure 13 shows annual changes in groundwater storage for strata tapped by irrigation wells in the District.

LAND SUBSIDENCE

Land subsidence has become a large issue in the Red Top area in the last several years, due to increased pumping from numerous new wells tapping the lower aquifer. This subsidence has affected conveyance facilities, including the Eastside Bypass. Water-level declines have been much greater in that area than in the GSA. In addition, a number of wells in that area tap only the lower aquifer. Measures are being undertaken to reduce future subsidence in the Red Top area by decreasing lower aquifer pumping. Included are in-lieu recharge (delivering surface water to lands where irrigation water has been pumped from the lower aquifer), and intentional recharge through percolation basins and development of more upper aquifer wells to tap this water.

Land subsidence in and near the GSA has been measured as part of the San Joaquin River restoration project between December 2011 and June 2016 (Figure 14). One station is located north of the San Joaquin River about a mile and a half upstream of the east boundary of the GSA. The land subsidence at this station averaged 0.15 foot per year between December 2011 and June 2016. Another station was located near the west edge of the GSA and Avenue 7. The land subsidence at this station averaged 0.18 foot

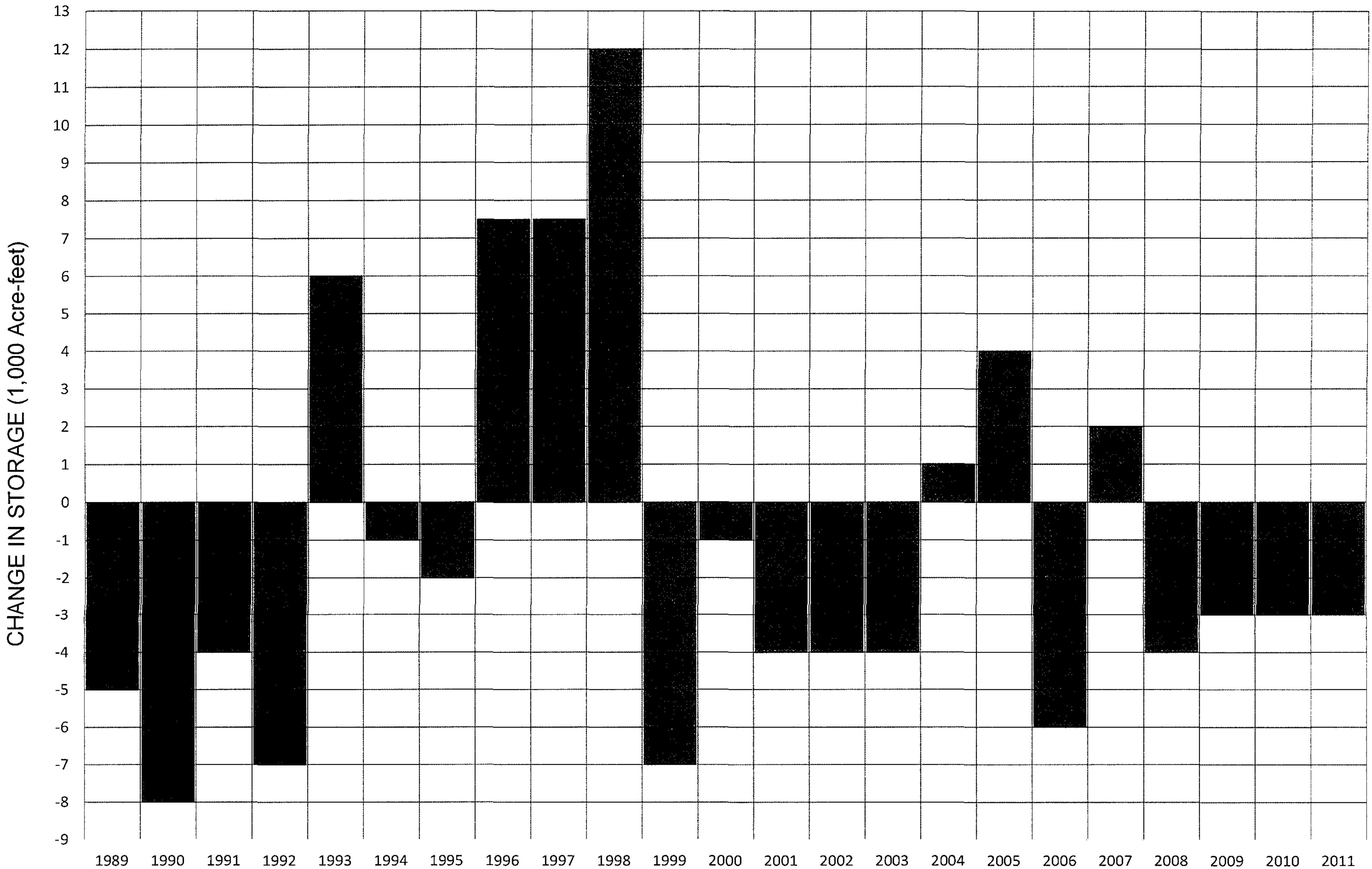
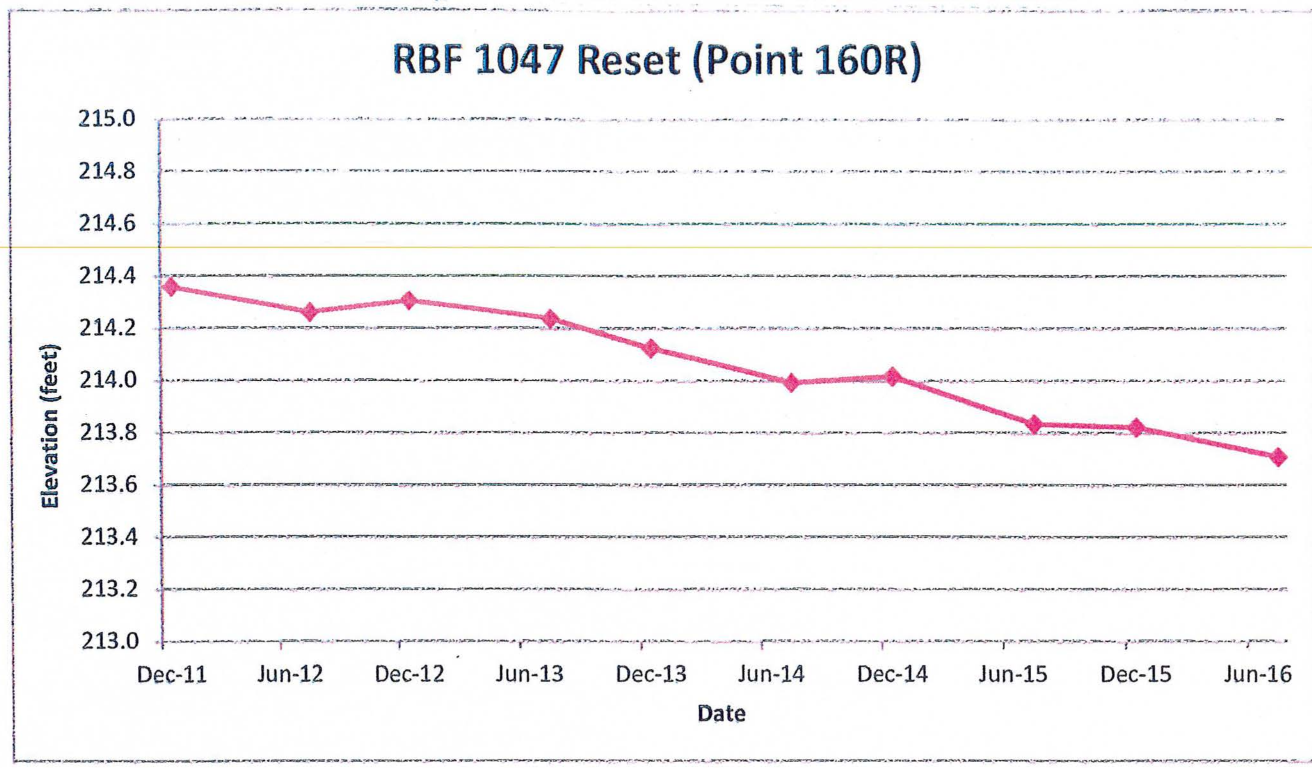
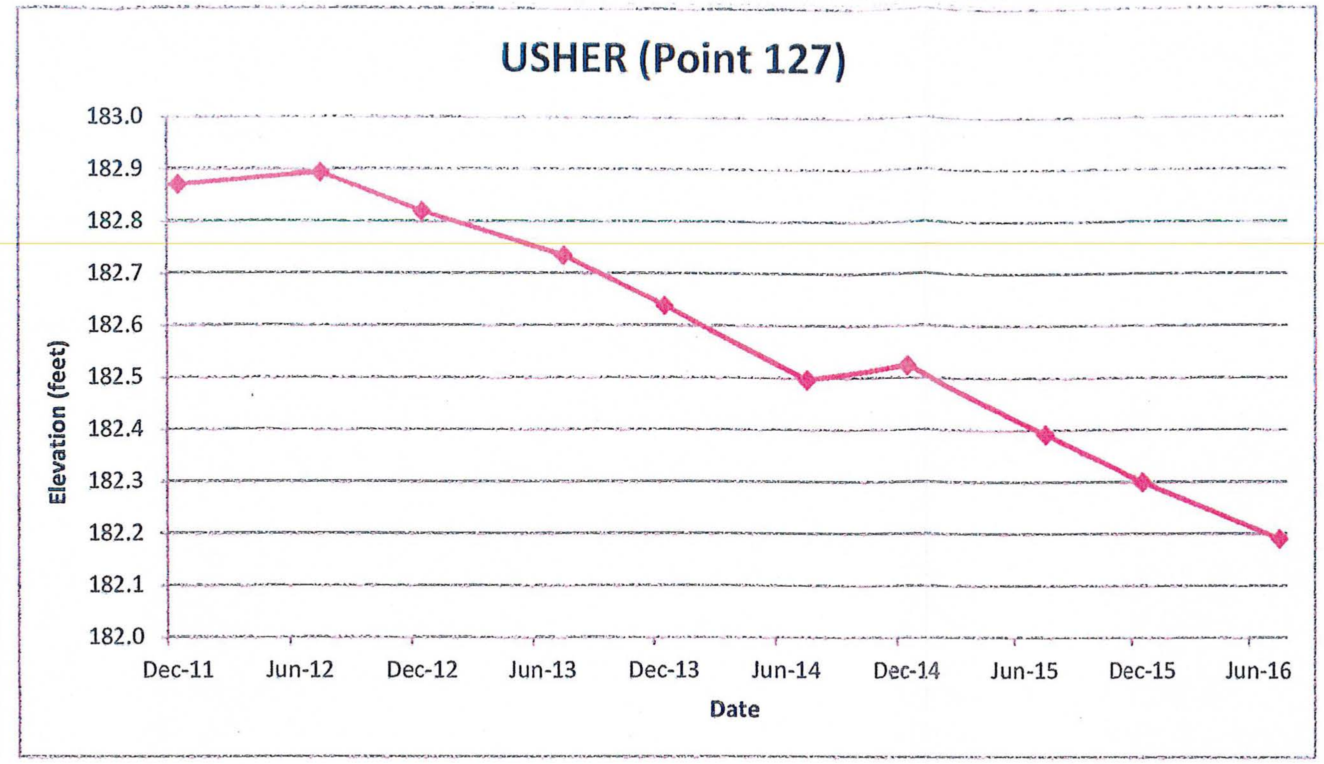


FIGURE 13 - CHANGES IN GROUNDWATER STORAGE

SAN JOAQUIN RIVER NEAR GRAVELY FORD



EASTSIDE BYPASS NEAR AVENUE 7



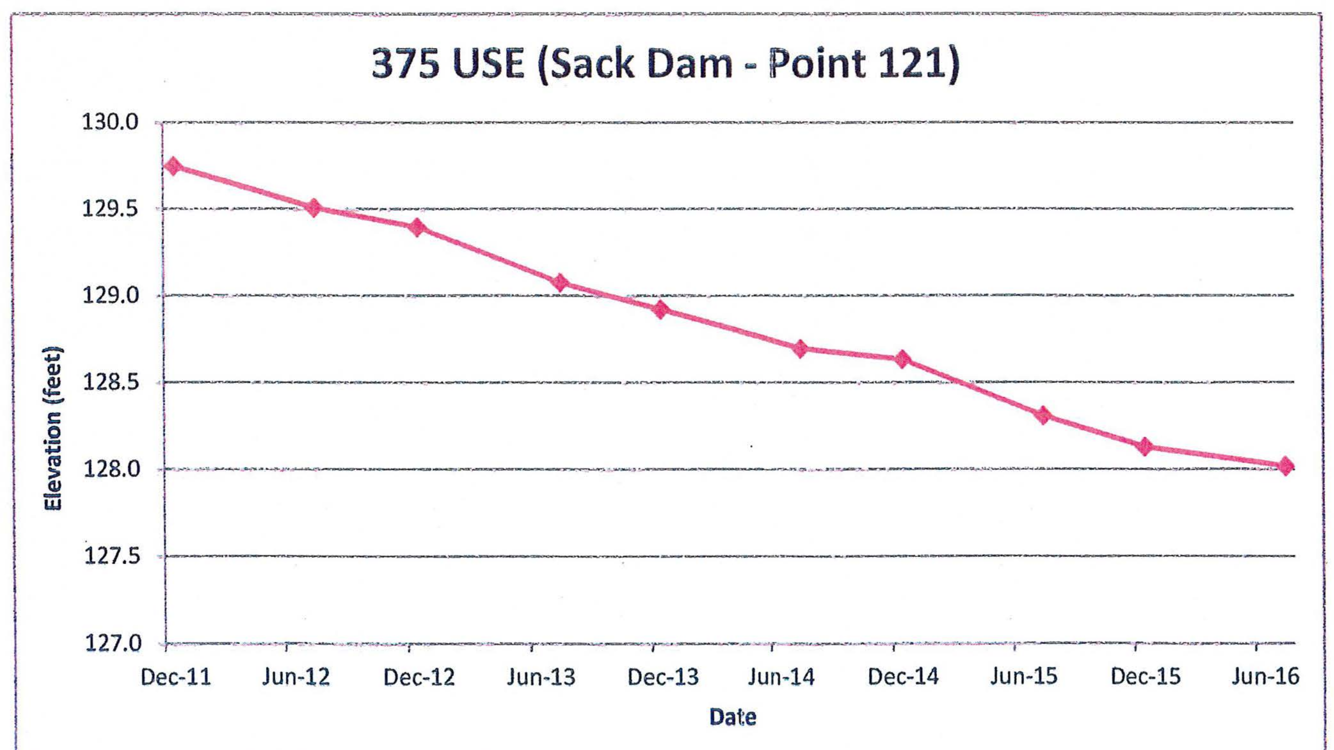


FIGURE 14 - LAND SUBSIDENCE (2011-16)

per year between June 2012 and June 2016. This land subsidence is attributed primarily to pumping from the lower aquifer, primarily east of the Chowchilla Bypass in Madera County and south of the San Joaquin River in Fresno County.

GROUNDWATER QUALITY

Total dissolved solids (TDS) concentrations range from about 160 mg/l to 500 mg/l. The lowest TDS concentrations are generally in shallow groundwater near the San Joaquin River. Some of the higher TDS concentrations are in shallow groundwater beneath irrigated areas more than several miles from the river. The shallow groundwater tends to have higher hardness concentrations. Overall, the chemical quality of the groundwater is suitable for irrigation of most crops. Some of the groundwater requires treatment to lower the pH and/or sodium adsorption ratio (SAR).

INTERCONECTED SURFACE AND GROUNDWATER SYSTEMS

A source of information that can be used to address the interconnection of surface water and groundwater are water-level measurements for a number of shallow monitor wells that were installed for Reclamation along the San Joaquin River as part of the river restoration program. In general, river flows have been always been present in the area east of Gravelly Ford (about a mile and a half east of the southeast corner of the GSA). A review of these measurements for the area farther west indicates that during periods of no flow in the river, the shallow groundwater levels have been below the river channel along the river west of Gravelly Ford. When the river is flowing, there has been a direct connection between the surface water and groundwater. Figure 15 shows the locations of interconnected surface and groundwater bodies in or near the GSA.

KNOWN GROUNDWATER CONTAMINATION SITES

Information on known contamination sites in and near the GSA was obtained from the Central Valley Regional WLB Geotracker website. No such sites are present in or near the GSA.

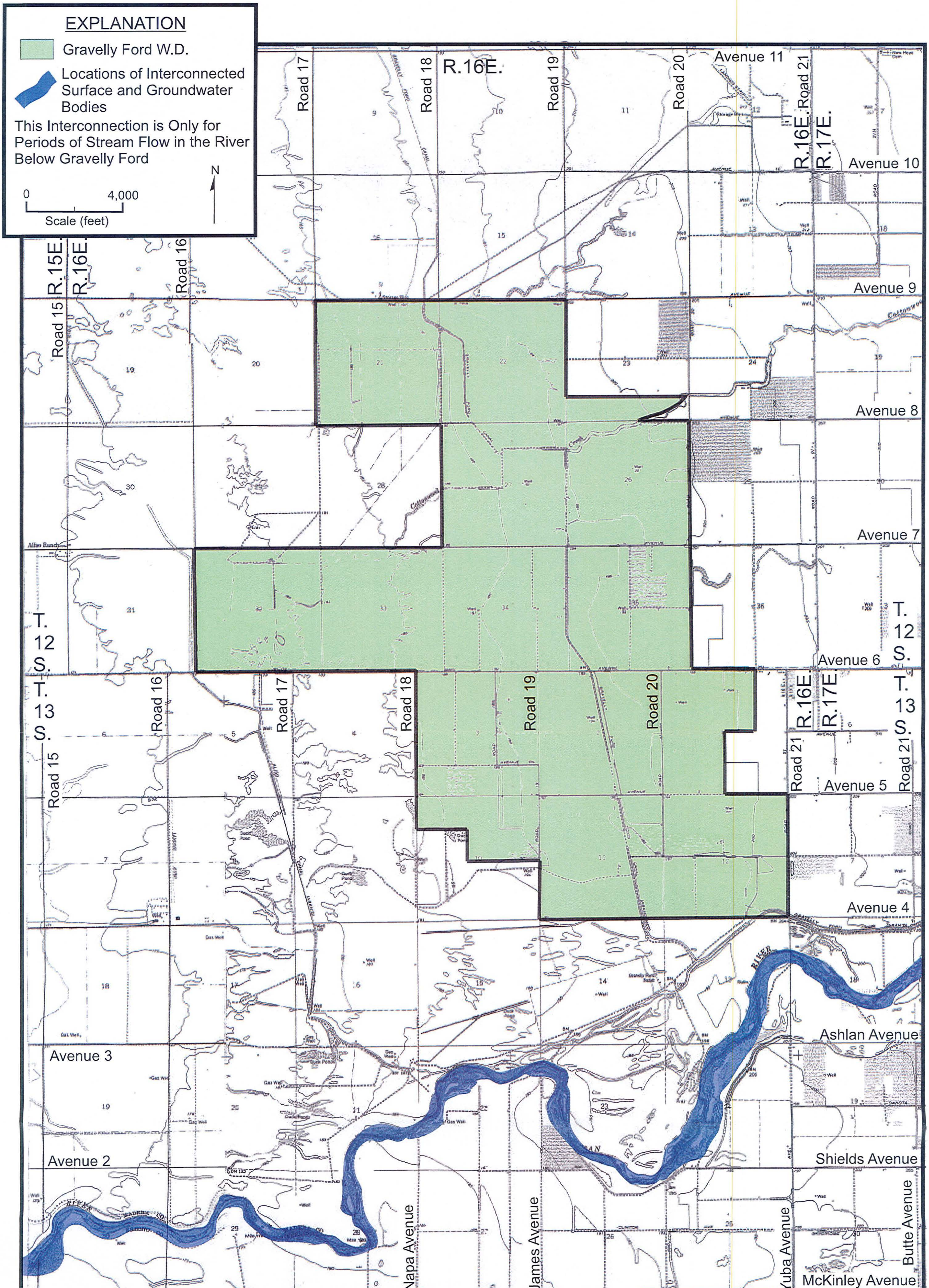


FIGURE 15 - LOCATIONS OF INTERCONNECTED SURFACE AND GROUNDWATER BODIES

APPENDIX C

Contact Information for Plan Manager & GSA Mailing Address (Reg 354.6)

Contact Information

Plan Manager: Don Roberts, General Manager
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Donroberts717@gmail.com

GSA Mailing Address: Gravelly Ford Water District, GSA
18811 Road 27
Madera, CA 93638
(559) 474-1000

APPENDIX D

Appendix 2.F. Water Budget Information

APPENDIX 2.F. WATER BUDGET INFORMATION

2.F.e. Surface Water System Water Budget: Gravelly Ford Water District GSA

Prepared as part of the

Groundwater Sustainability Plan
Madera Subbasin

January 2020

GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

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1 INTRODUCTION

To ensure sustainable groundwater management throughout California's groundwater basins, the Sustainable Groundwater Management Act of 2014 (SGMA) requires Groundwater Sustainability Agencies (GSAs) to prepare and adopt Groundwater Sustainability Plans (GSPs) with strategies to achieve subbasin groundwater sustainability within 20 years of plan adoption. Integral to each GSP is a water budget used to quantify the subbasin's groundwater overdraft (if applicable) and sustainable yield.

In 2017, Gravelly Ford Water District (GFWD) GSA formed to manage approximately 8,400 acres of the Madera Subbasin. This document presents results of the surface water system (SWS) water budgets developed for historical and current land use conditions in GFWD GSA. The GFWD GSA water budgets were integrated with separate water budgets developed for the other six (6) GSAs in Madera Subbasin to prepare a boundary water budget for the Madera Subbasin SWS. Results of the subbasin boundary water budget are reported in the Madera Subbasin GSP Section 2.2.3 and were integrated with a subbasin groundwater model (GSP Appendix 6.E) to estimate subbasin sustainable yield (GSP Section 2.2.3).

2 WATER BUDGET CONCEPTUAL MODEL

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume (e.g., a subbasin or a GSA) over a specified period of time. The conceptual model (or structure) of the GFWD GSA water budget developed for this investigation is consistent with the GSP Regulations defined under Title 23 of California Code of Regulations[1] (CCR) and adheres to sound water budget principles and practices defined by California Department of Water Resources (DWR) in the Water Budget Best Management Practice (BMP) guidelines (DWR, 2016).

The lateral extent of GFWD GSA is defined by the boundaries indicated in Figure 1. The vertical extent of GFWD GSA is the land surface (top) and the base of fresh water at the bottom of the basin (bottom), as described in the hydrogeologic conceptual model (HCM) developed in GSP Section 2.2.1. The vertical extent of Madera Subbasin and its GSAs is subdivided into a surface water system (SWS) and the underlying groundwater system (GWS), with separate but related water budgets prepared for each that together represent the overall subbasin water budget.

A conceptual representation of the GFWD GSA water budget is represented in Figure 2. This document details only the SWS portion of the GFWD GSA water budget. The SWS is divided into three primary accounting centers: the Land Surface System, the Rivers and Streams System, and the Canal System. The Land Surface System is further divided into three accounting centers representing GFWD GSA's water use sectors: Agricultural Land, Native Vegetation Land, and Urban Land (urban, industrial, and semi-agricultural).

Water budget components, or directional flow of water between accounting centers and across the SWS boundary, are indicated by arrows. Inflows and outflows were calculated using measurements and other historical data or were calculated as the water budget closure term – the difference between all other estimated or measured inflows and outflows from each accounting center or water use sector (bold arrows).

[1] California Code of Regulations Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans.

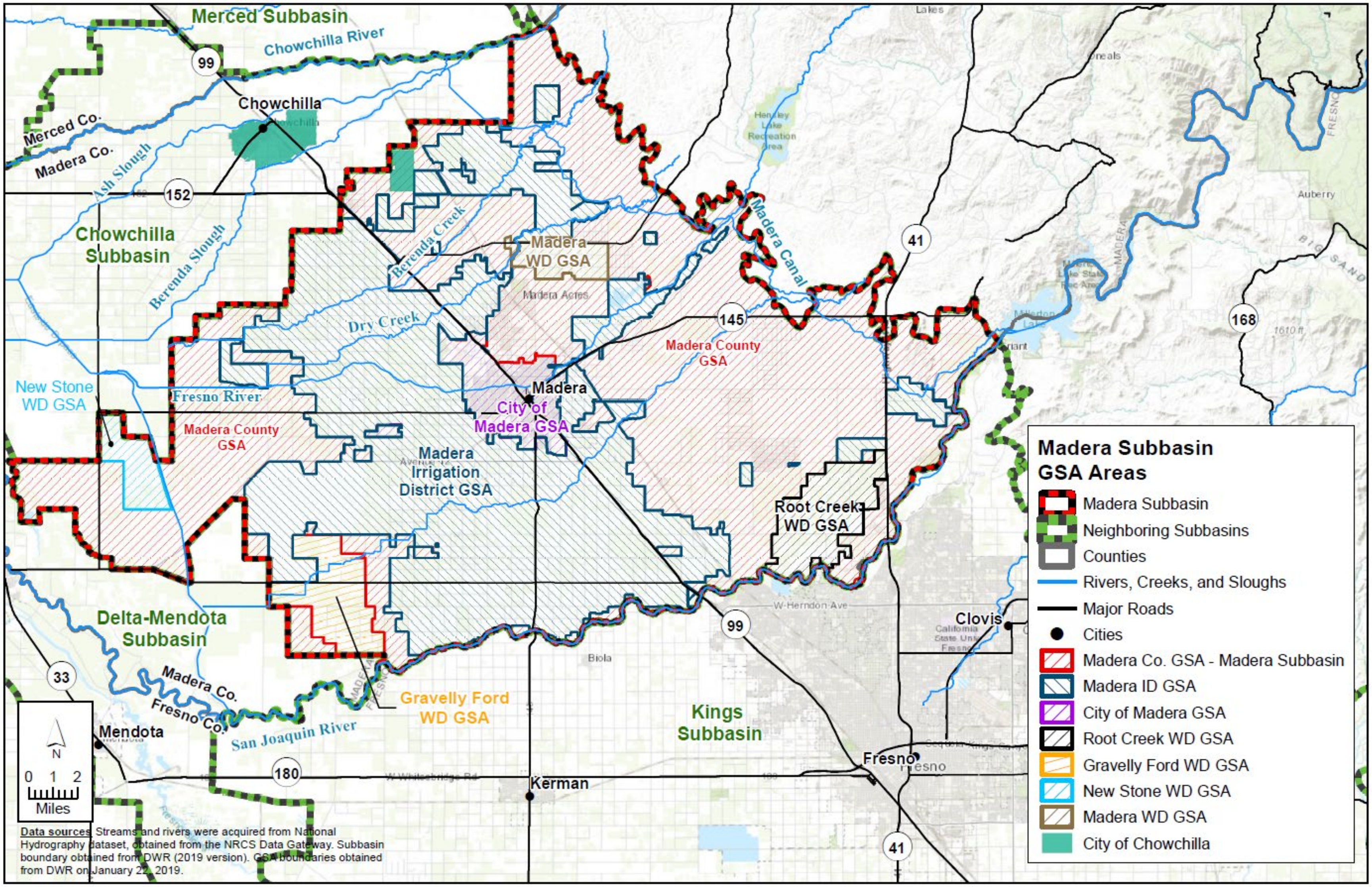


Figure 1. Madera Subbasin GSA Map

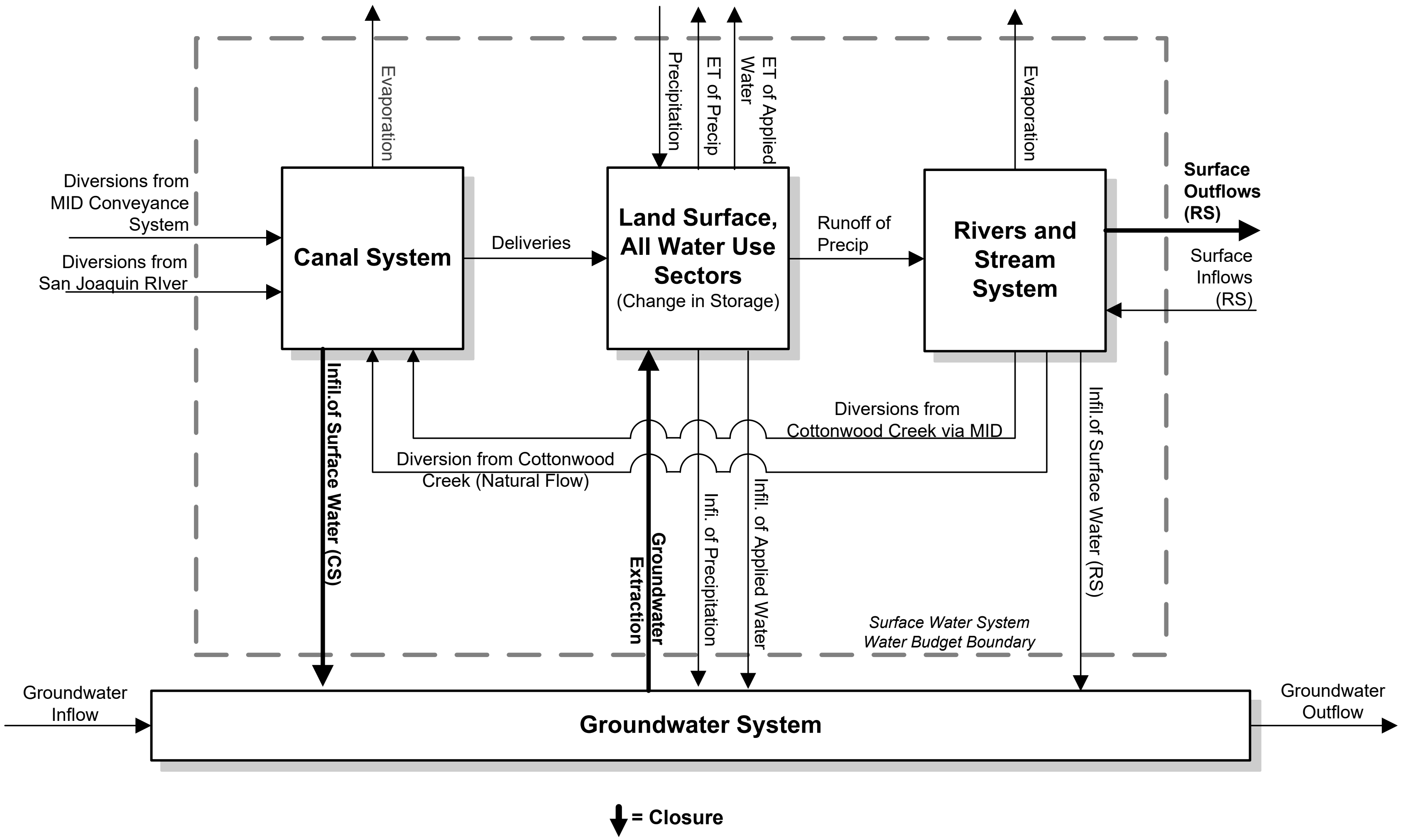


Figure 2. Gravelly Ford Water District GSA Water Budget Structure

Inflows to the SWS include precipitation, surface water inflows (in various canals and streams), and groundwater extraction. Outflows from the SWS include evapotranspiration (ET), surface water outflows (in various canals and streams), and infiltration to the groundwater system (seepage and deep percolation). Also represented in Figure 2 are inflows and outflows from the GWS, which are discussed and quantified at the subbasin level in the GWS water budget in GSP Section 2.2.3. Subsurface GWS inflows and outflows are not quantified on the water budget subregion scale.

Inflows and outflows were quantified following the process described in GSP Section 2.2.3 on a monthly time step for water years in the historical water budget base period (1989-2014 hydrologic and land use conditions), the current water budget (2015 land use using 1989-2014 average hydrologic conditions), and projected water budget. Four projected water budgets were prepared for the years 2019 through 2090 based on 1965 through 2015 hydrologic conditions:

1. Historical hydrologic conditions
    a. Without projects and management actions, and
    b. With projects and management actions
2. Historical hydrologic conditions adjusted for anticipated climate change per DWR-provided 2030 climate change factors
    a. Without projects and management actions, and
    b. With projects and management actions.

3 WATER BUDGET ANALYSIS

The historical water budget and current land use water budget for GFWD GSA are presented below following a summary of land use data relevant to water budget development. Land use data is provided for the 1989-2014 historical water budget period and for 2015, the current land use water budget period.

3.1 Land Use

Land use estimates for 1989 through 2015 corresponding to water use sectors (as defined by the GSP Regulations) are summarized in Figure 3 and Table 1 for GFWD GSA. According to GSP Regulations (23 CCR § 351(al)):

> *"Water use sector" refers to categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation.*

In GFWD GSA, water use sectors include agricultural, native vegetation, and urban land use. The urban land use category includes urban and semi-agricultural[2] lands as well as industrial land, which covers only a small area in the subbasin.

As indicated, the majority of land in GFWD GSA is used for agriculture, covering an average of approximately 7,600 acres between 1989 and 2014. Agricultural lands remained generally constant between 1989 and 2001, after which a slight decrease in agricultural acreage coincided with expansion of areas classified as native vegetation and water surfaces. Urban lands covered approximately 700 acres between 1989 and 2014.

[2] As defined in the DWR county land use surveys, semi-agricultural land use subclasses include farmsteads, livestock feed lot operations, dairies, poultry farms, and miscellaneous semi-agricultural land use incidental to agriculture (small roads, ditches, non-planted areas of cropped fields (DWR, 2009).

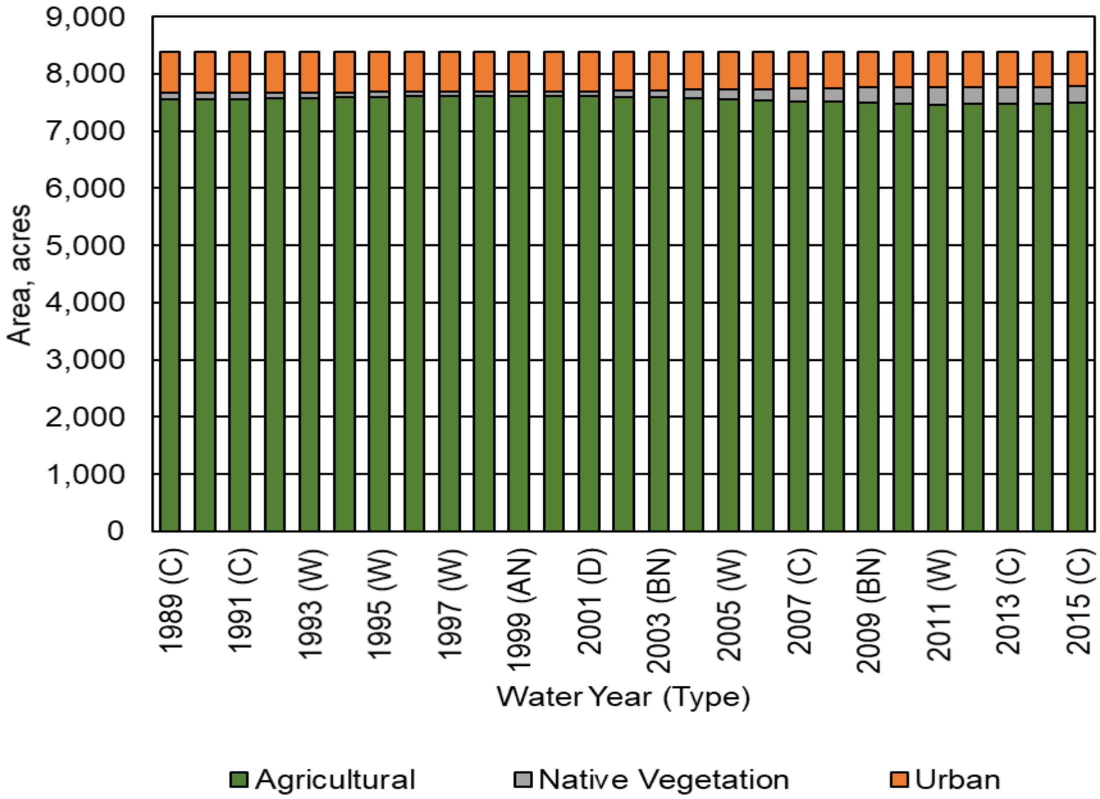


Figure 3. Gravelly Ford Water District GSA Land Use Areas

Table 1. Gravelly Ford Water District GSA Land Use Areas, acres

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
1989 (C)	7,559	108	712	8,379
1990 (C)	7,558	105	716	8,379
1991 (C)	7,564	103	712	8,379
1992 (C)	7,573	98	707	8,379
1993 (W)	7,583	94	702	8,379
1994 (C)	7,593	86	700	8,379
1995 (W)	7,601	81	696	8,379
1996 (W)	7,604	82	694	8,379
1997 (W)	7,606	82	691	8,379
1998 (W)	7,608	82	688	8,379
1999 (AN)	7,611	82	686	8,379
2000 (AN)	7,613	83	683	8,379
2001 (D)	7,615	83	681	8,379
2002 (D)	7,601	106	673	8,379
2003 (BN)	7,586	128	665	8,379
2004 (D)	7,571	151	657	8,379
2005 (W)	7,556	174	650	8,379

Water Year (Type)	Agricultural	Native Vegetation[1]	Urban[2]	Total
2006 (W)	7,541	196	642	8,379
2007 (C)	7,526	219	634	8,379
2008 (C)	7,511	242	627	8,379
2009 (BN)	7,496	265	619	8,379
2010 (AN)	7,481	287	611	8,379
2011 (W)	7,466	310	603	8,379
2012 (D)	7,470	305	603	8,379
2013 (C)	7,475	301	603	8,379
2014 (C)	7,480	296	603	8,379
2015 (C)	7,503	292	585	8,379
Average (1989-2014)	7,556	160	664	8,379

[1] Area includes land classified as native vegetation and water surfaces.
[2] Area includes land classified as urban, industrial, and semi-agricultural.

Agricultural land uses are further detailed in Figure 4 and Table 2. Historically, a majority of the agricultural area in GFWD has been comprised of permanent crops, such as grapes and orchard crops. While grape acreage has decreased since peaking in 2000, orchard acreage more than doubled between 1989 and 2015.

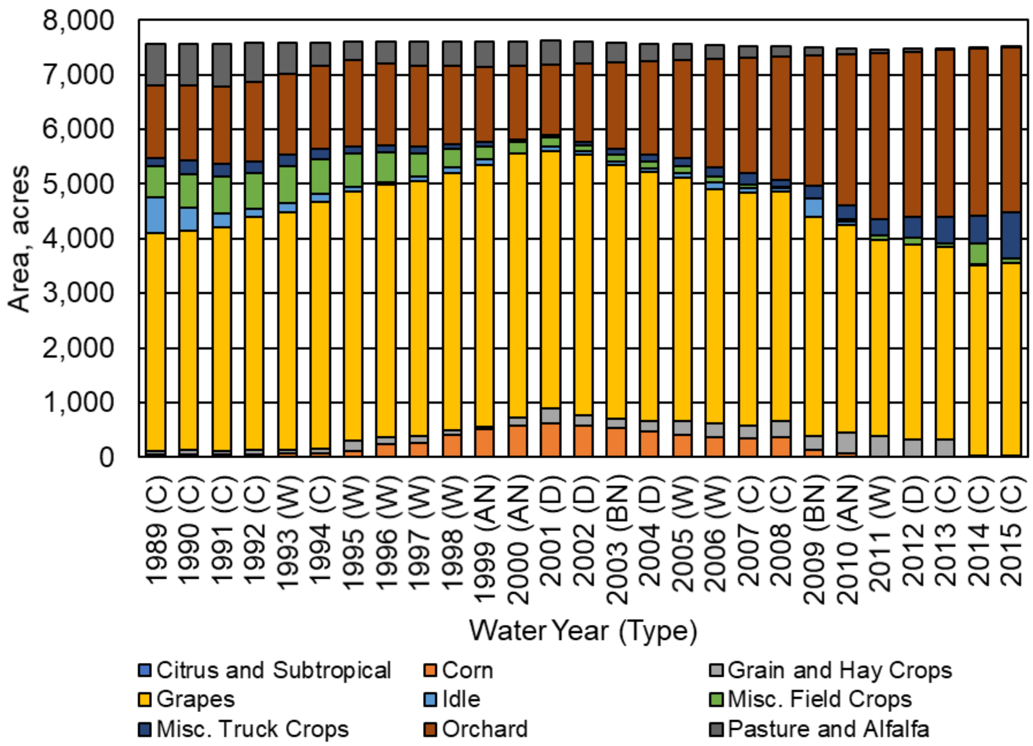


Figure 4. Gravelly Ford Water District GSA Agricultural Land Use Areas

Table 2. Gravelly Ford Water District GSA Agricultural Land Use Areas

Water Year (Type)	Citrus and Subtropical	Corn	Grain and Hay Crops	Grapes	Idle	Misc. Field Crops	Misc. Truck Crops	Orchard	Pasture and Alfalfa	Total
1989 (C)	1	42	60	3,990	670	573	146	1,325	752	7,559
1990 (C)	1	41	84	4,013	421	608	258	1,370	760	7,558
1991 (C)	2	42	61	4,106	244	675	235	1,410	789	7,564
1992 (C)	2	51	78	4,269	146	651	221	1,447	709	7,573
1993 (W)	2	59	80	4,338	179	659	209	1,483	574	7,583
1994 (C)	2	66	77	4,520	161	625	195	1,517	430	7,593
1995 (W)	2	103	189	4,567	84	603	137	1,575	341	7,601
1996 (W)	3	243	119	4,618	49	545	123	1,513	392	7,604
1997 (W)	6	248	136	4,659	79	434	120	1,478	447	7,606
1998 (W)	2	401	90	4,702	110	327	102	1,427	448	7,608
1999 (AN)	1	505	44	4,802	97	242	75	1,383	461	7,611
2000 (AN)	3	563	160	4,833	6	206	44	1,336	462	7,613
2001 (D)	3	608	286	4,714	68	185	26	1,288	439	7,615
2002 (D)	3	574	198	4,750	64	122	55	1,431	402	7,601
2003 (BN)	2	531	172	4,647	66	125	89	1,590	365	7,586
2004 (D)	2	478	187	4,549	61	142	115	1,709	327	7,571
2005 (W)	2	405	246	4,468	79	125	141	1,800	290	7,556
2006 (W)	1	367	244	4,294	133	93	179	1,976	253	7,541
2007 (C)	1	350	219	4,268	85	66	199	2,121	215	7,526
2008 (C)	1	371	280	4,200	70	18	124	2,269	178	7,511
2009 (BN)	0	124	259	4,021	321	3	235	2,392	141	7,496
2010 (AN)	0	73	372	3,805	71	35	261	2,759	104	7,481
2011 (W)	0	0	388	3,584	5	89	287	3,046	66	7,466
2012 (D)	0	13	318	3,550	10	122	377	3,023	57	7,470
2013 (C)	0	9	318	3,515	14	64	468	3,058	28	7,475
2014 (C)	0	0	36	3,481	6	395	496	3,060	6	7,480
2015 (C)	0	0	21	3,532	3	89	833	3,018	6	7,503
Average (1989-2014)	2	241	181	4,279	127	297	189	1,876	363	7,556

3.2 Surface Water System Water Budget

This section presents surface water system water budget components within GFWD GSA as per GSP regulations. These are followed by a summary of the water budget results by accounting center.

3.2.1 Inflows

3.2.1.1 Surface Water Inflow by Water Source Type

Surface water inflows include surface water flowing into GFWD across the subregion boundary. Per the Regulations, surface inflows must be reported by water source type. According to the Regulations:

> *"Water source type" represents the source from which water is derived to meet the applied beneficial uses, including groundwater, recycled water, reused water, and surface water sources identified as Central Valley Project, the State Water Project, the Colorado River Project, local supplies, and local imported supplies.*

Additionally, runoff of precipitation from upgradient areas adjacent to the subregion represents a potential source of surface water inflow.

Local Supplies

Surface water inflows to GFWD GSA include local supplies of Cottonwood Creek natural flows. A portion of these flows are diverted into the GFWD conveyance system, while the remainder transverses and leaves the GSA as surface water outflows.

Local Imported Supplies

GFWD GSA does not receive local imported supplies for irrigation purposes.

CVP Supplies

GFWD GSA receives CVP supplies for irrigation purposes from the San Joaquin River and from the Madera Canal via MID. A portion of CVP supplies received via MID are diverted from MID's releases to Cottonwood Creek, while the remainder is received directly from the MID conveyance system.

Recycling and Reuse

Recycling and reuse are not a significant source of supply within GFWD.

Other Surface Inflows

For the water budgets presented herein, precipitation runoff from outside the subregion is considered relatively minimal and is expected to pass through the waterways accounted above following relatively large storm events. Precipitation runoff from lands inside the subregion is internal to the surface water system and is thus not considered as surface inflows to the subregion boundary.

Summary of Surface Inflows

The surface water inflows described above are summarized by water source type in Figure 5 and Table 3. During the study period, local supplies vary by water year type, averaging 14 taf during wet years and less than 2 taf during below normal, dry, and critical years. CVP supplies are steadier between years, averaging 10 taf per year between 1989 and 2014.

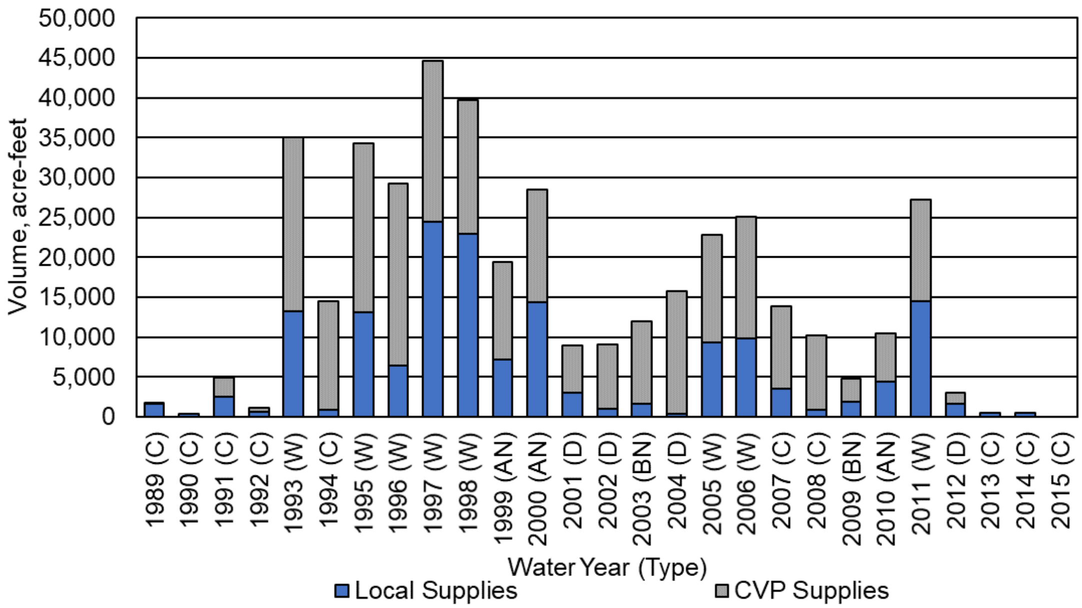


Figure 5. Gravelly Ford Water District GSA Surface Water Inflows by Water Source Type.

Table 3. Gravelly Ford Water District GSA Surface Water Inflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supply	CVP Supply	Total
1989 (C)	1,642	65	1,707
1990 (C)	426	0	426
1991 (C)	2,472	2,472	4,944
1992 (C)	660	424	1,084
1993 (W)	13,206	21,855	35,061
1994 (C)	839	13,657	14,496
1995 (W)	13,128	21,184	34,311
1996 (W)	6,464	22,801	29,265
1997 (W)	24,469	20,150	44,619
1998 (W)	22,914	16,777	39,691
1999 (AN)	7,182	12,221	19,403
2000 (AN)	14,329	14,155	28,484
2001 (D)	3,073	5,888	8,960
2002 (D)	975	8,070	9,045
2003 (BN)	1,674	10,262	11,936

Water Year (Type)	Local Supply	CVP Supply	Total
2004 (D)	439	15,329	15,768
2005 (W)	9,281	13,578	22,860
2006 (W)	9,847	15,211	25,058
2007 (C)	3,485	10,325	13,810
2008 (C)	899	9,348	10,247
2009 (BN)	1,881	2,929	4,810
2010 (AN)	4,466	6,049	10,515
2011 (W)	14,491	12,783	27,274
2012 (D)	1,655	1,390	3,045
2013 (C)	519	0	519
2014 (C)	528	0	528
2015 (C)	0	0	0
Average (1989-2014)	6,190	9,882	16,072
Average (1989-2014) W	14,225	18,042	32,267
Average (1989-2014) AN	8,659	10,808	19,467
Average (1989-2014) BN	1,777	6,596	8,373
Average (1989-2014) D	1,535	7,669	9,205
Average (1989-2014) C	1,274	4,032	5,307

3.2.1.2 Precipitation

Precipitation estimates for GFWD GSA are provided in Figure 6 and Table 4. Precipitation estimates are reported by water use sector.

Total precipitation is highly variable between years in the study area, ranging from approximately 6 taf (7.6 inches) during average dry years to 10 taf (14.4 inches) during average wet years.

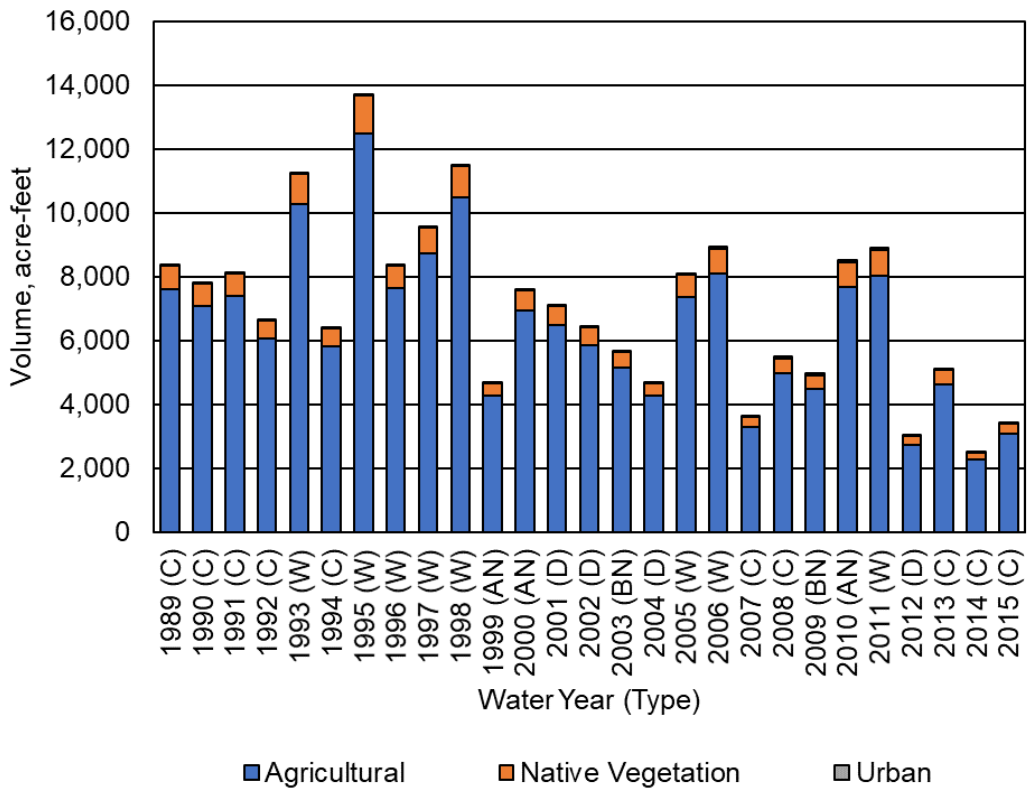


Figure 6. Gravelly Ford Water District GSA Precipitation by Water Use Sector.

Table 4. Gravelly Ford Water District GSA Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	7,597	738	15	8,350
1990 (C)	7,079	691	15	7,785
1991 (C)	7,400	717	15	8,132
1992 (C)	6,053	582	12	6,647
1993 (W)	10,265	978	19	11,262
1994 (C)	5,821	551	11	6,383
1995 (W)	12,504	1,176	20	13,700
1996 (W)	7,642	715	15	8,372
1997 (W)	8,732	815	17	9,564
1998 (W)	10,499	974	24	11,497
1999 (AN)	4,259	394	9	4,662
2000 (AN)	6,946	640	18	7,604
2001 (D)	6,481	595	19	7,095
2002 (D)	5,872	544	22	6,438
2003 (BN)	5,151	481	23	5,655
2004 (D)	4,273	404	23	4,700
2005 (W)	7,360	700	46	8,106
2006 (W)	8,096	776	59	8,931
2007 (C)	3,274	316	27	3,617

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2008 (C)	4,965	484	46	5,495
2009 (BN)	4,480	440	46	4,966
2010 (AN)	7,681	761	84	8,526
2011 (W)	8,025	802	95	8,922
2012 (D)	2,734	271	31	3,036
2013 (C)	4,622	458	52	5,132
2014 (C)	2,260	223	26	2,509
2015 (C)	3,093	295	35	3,423
Average (1989-2014)	6,541	624	30	7,196
Average (1989-2014) W	9,140	867	37	10,044
Average (1989-2014) AN	6,295	598	37	6,931
Average (1989-2014) BN	4,816	461	35	5,311
Average (1989-2014) D	4,840	454	24	5,317
Average (1989-2014) C	5,452	529	24	6,006

3.2.1.3 Groundwater Extraction by Water Use Sector

Estimates of groundwater extraction by water use sector are provided in Figure 7 and Table 5. For agricultural and urban (urban, semi-agricultural, industrial) lands, groundwater extraction represents pumping, while for native lands, groundwater extraction by riparian vegetation was considered to be negligible. In all water use sector water budgets, groundwater extraction served as the water budget closure term. Groundwater extraction is dominated by irrigated agriculture, varying substantially from year to year based on variability and/or uncertainty in surface water supplies, particularly during wet years in the 1990s.

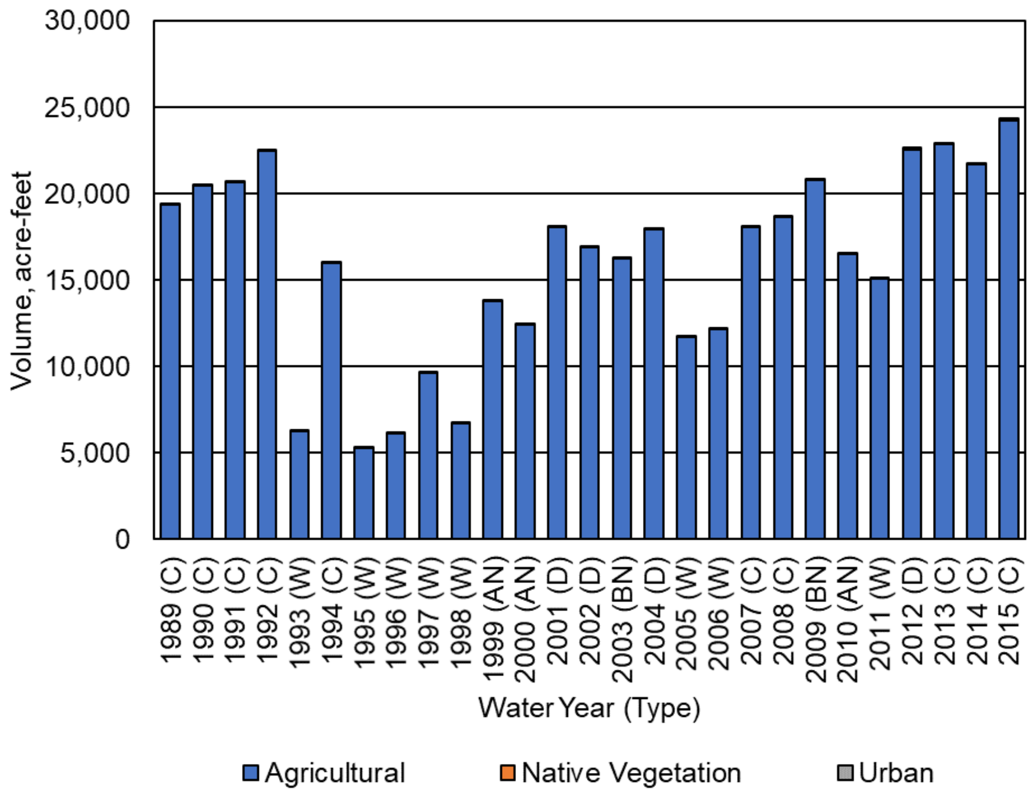


Figure 7. Gravelly Ford Water District GSA Groundwater Extraction by Water Use Sector.

Table 5. Gravelly Ford Water District GSA Groundwater Extraction by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	19,371	0	15	19,386
1990 (C)	20,501	0	14	20,515
1991 (C)	20,687	0	11	20,698
1992 (C)	22,506	0	16	22,522
1993 (W)	6,230	0	12	6,242
1994 (C)	15,999	0	12	16,011
1995 (W)	5,307	0	9	5,316
1996 (W)	6,111	0	9	6,120
1997 (W)	9,621	0	22	9,643
1998 (W)	6,699	0	14	6,713
1999 (AN)	13,764	0	22	13,786
2000 (AN)	12,422	0	21	12,443
2001 (D)	18,049	0	18	18,067
2002 (D)	16,903	0	29	16,932
2003 (BN)	16,264	0	41	16,305
2004 (D)	17,941	0	57	17,998
2005 (W)	11,707	0	38	11,745
2006 (W)	12,191	0	46	12,237
2007 (C)	18,084	0	74	18,158

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2008 (C)	18,650	0	75	18,725
2009 (BN)	20,779	0	83	20,862
2010 (AN)	16,519	0	61	16,580
2011 (W)	15,071	0	74	15,145
2012 (D)	22,571	0	99	22,670
2013 (C)	22,850	0	104	22,954
2014 (C)	21,698	0	98	21,796
2015 (C)	24,249	0	103	24,352
Average (1989-2014)	15,711	0	41	15,753
Average (1989-2014) W	9,117	0	28	9,145
Average (1989-2014) AN	14,235	0	35	14,270
Average (1989-2014) BN	18,522	0	62	18,584
Average (1989-2014) D	18,866	0	51	18,917
Average (1989-2014) C	20,038	0	47	20,085

3.2.1.4 Groundwater Discharge to Surface Water Sources

The depth to groundwater is greater than 100-200 ft across much of the Madera Subbasin. Given the depth to the water table in the Madera Subbasin, groundwater discharge to surface water sources is negligible.

3.2.2 Outflows

3.2.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in Figures 8 to 10 and Tables 6 to 8. First, total ET is reported, followed by ET from applied water and ET from precipitation.

Total ET varies between years, with the lowest observed in 1991, at approximately 18 taf, and greatest in 2004, at approximately 21 taf. Agricultural ET tends to increase in drier years, while native ET decreases.

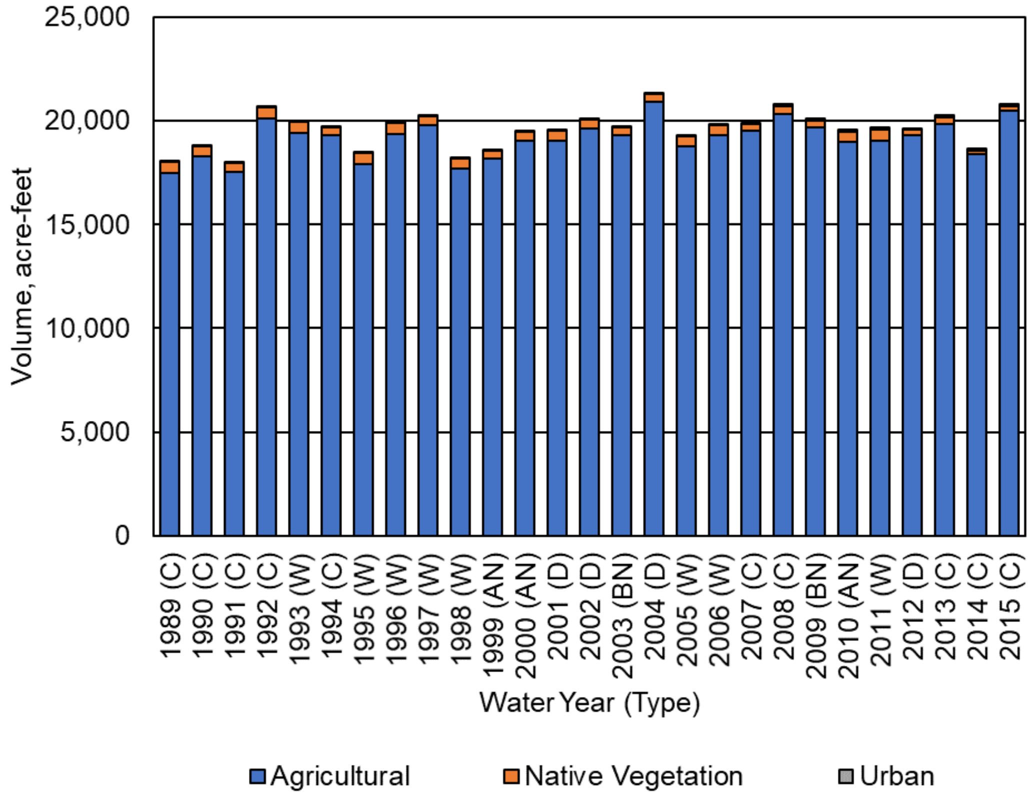


Figure 8. Gravelly Ford Water District GSA Evapotranspiration by Water Use Sector.

Table 6. Gravelly Ford Water District GSA Evapotranspiration by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	17,488	512	17	18,017
1990 (C)	18,287	486	19	18,792
1991 (C)	17,520	442	14	17,976
1992 (C)	20,098	518	18	20,634
1993 (W)	19,407	545	16	19,968
1994 (C)	19,304	386	15	19,705
1995 (W)	17,898	537	13	18,448
1996 (W)	19,348	522	14	19,884
1997 (W)	19,757	444	21	20,222
1998 (W)	17,714	467	21	18,202
1999 (AN)	18,180	353	21	18,554
2000 (AN)	19,016	437	24	19,477
2001 (D)	19,033	468	25	19,526
2002 (D)	19,609	442	35	20,086
2003 (BN)	19,326	360	45	19,731
2004 (D)	20,901	390	57	21,348
2005 (W)	18,774	471	53	19,298
2006 (W)	19,284	504	63	19,851
2007 (C)	19,492	330	73	19,895
2008 (C)	20,309	392	86	20,787

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2009 (BN)	19,685	337	94	20,116
2010 (AN)	18,981	494	89	19,564
2011 (W)	19,043	518	100	19,661
2012 (D)	19,304	253	89	19,646
2013 (C)	19,810	360	106	20,276
2014 (C)	18,377	196	88	18,661
2015 (C)	20,496	221	95	20,812
Average (1989-2014)	19,075	429	47	19,551
Average (1989-2014) W	18,903	501	38	19,442
Average (1989-2014) AN	18,726	428	45	19,198
Average (1989-2014) BN	19,506	349	70	19,924
Average (1989-2014) D	19,712	388	52	20,152
Average (1989-2014) C	18,965	402	48	19,416

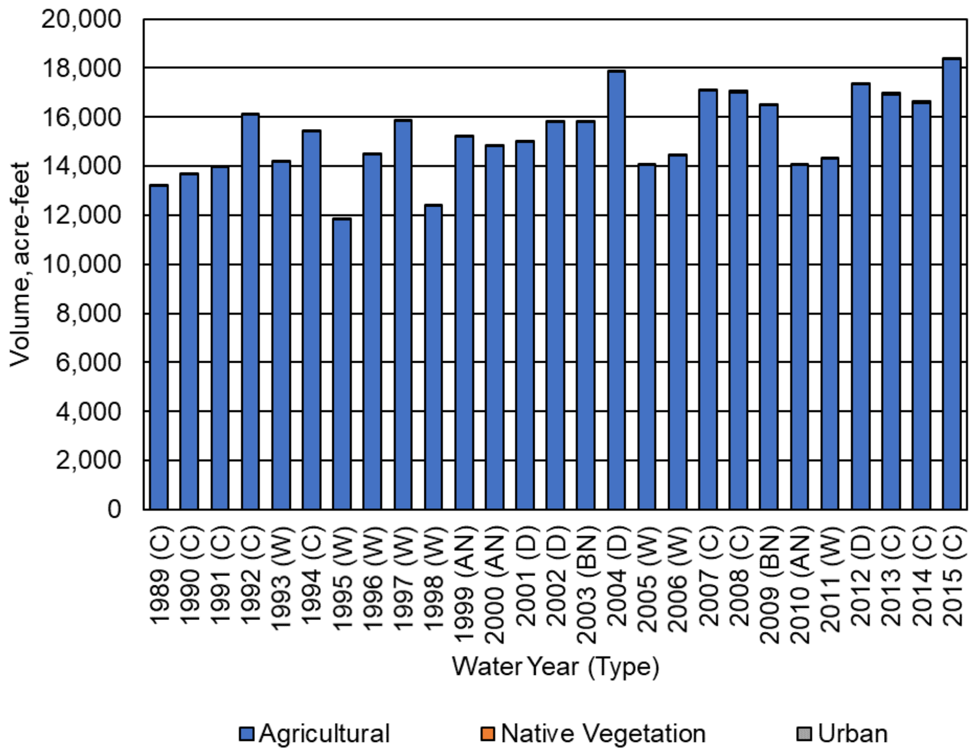


Figure 9. Gravelly Ford Water District GSA Evapotranspiration of Applied Water by Water Use Sector.

Table 7. Gravelly Ford Water District GSA Evapotranspiration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	13,179	0	9	13,188
1990 (C)	13,654	0	10	13,664
1991 (C)	13,983	0	7	13,990
1992 (C)	16,115	0	11	16,126
1993 (W)	14,161	0	8	14,169
1994 (C)	15,418	0	10	15,428
1995 (W)	11,829	0	3	11,832
1996 (W)	14,479	0	6	14,485
1997 (W)	15,836	0	12	15,848
1998 (W)	12,364	0	9	12,373
1999 (AN)	15,221	0	13	15,234
2000 (AN)	14,816	0	14	14,830
2001 (D)	14,985	0	14	14,999
2002 (D)	15,791	0	20	15,811
2003 (BN)	15,786	0	27	15,813
2004 (D)	17,858	0	38	17,896
2005 (W)	14,061	0	26	14,087
2006 (W)	14,424	0	30	14,454
2007 (C)	17,074	0	47	17,121
2008 (C)	17,003	0	55	17,058
2009 (BN)	16,460	0	62	16,522
2010 (AN)	14,054	0	44	14,098
2011 (W)	14,310	0	48	14,358
2012 (D)	17,334	0	63	17,397
2013 (C)	16,914	0	70	16,984
2014 (C)	16,578	0	66	16,644
2015 (C)	18,339	0	73	18,412
Average (1989-2014)	15,142	0	28	15,170
Average (1989-2014) W	13,933	0	18	13,951
Average (1989-2014) AN	14,697	0	24	14,721
Average (1989-2014) BN	16,123	0	45	16,168
Average (1989-2014) D	16,492	0	34	16,526
Average (1989-2014) C	15,546	0	32	15,578

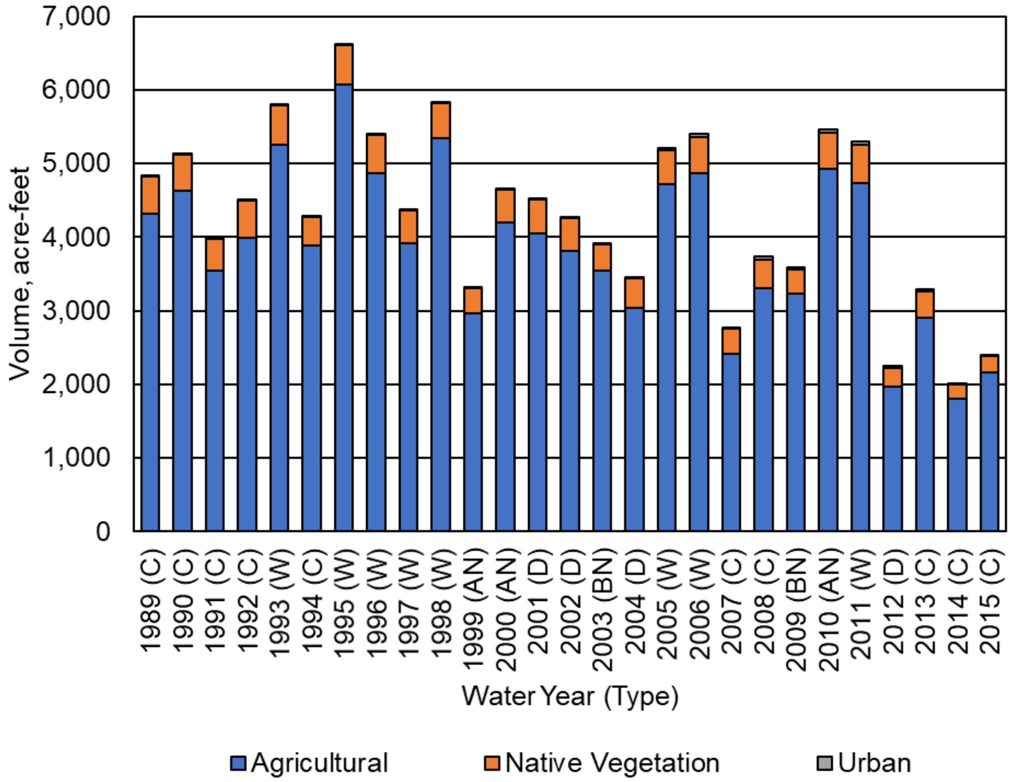


Figure 10. Gravelly Ford Water District GSA Evapotranspiration of Precipitation by Water Use Sector.

Table 8. Gravelly Ford Water District GSA Evapotranspiration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	4,309	512	8	4,829
1990 (C)	4,633	486	9	5,128
1991 (C)	3,537	442	7	3,986
1992 (C)	3,983	518	7	4,508
1993 (W)	5,246	545	8	5,799
1994 (C)	3,886	386	5	4,277
1995 (W)	6,069	537	10	6,616
1996 (W)	4,869	522	8	5,399
1997 (W)	3,921	444	9	4,374
1998 (W)	5,350	467	12	5,829
1999 (AN)	2,959	353	8	3,320
2000 (AN)	4,200	437	10	4,647
2001 (D)	4,048	468	11	4,527
2002 (D)	3,818	442	15	4,275
2003 (BN)	3,540	360	18	3,918
2004 (D)	3,043	390	19	3,452
2005 (W)	4,713	471	27	5,211
2006 (W)	4,860	504	33	5,397
2007 (C)	2,418	330	26	2,774

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
2008 (C)	3,306	392	31	3,729
2009 (BN)	3,225	337	32	3,594
2010 (AN)	4,927	494	45	5,466
2011 (W)	4,733	518	52	5,303
2012 (D)	1,970	253	26	2,249
2013 (C)	2,896	360	36	3,292
2014 (C)	1,799	196	22	2,017
2015 (C)	2,157	221	22	2,400
Average (1989-2014)	3,933	429	19	4,381
Average (1989-2014) W	4,970	501	20	5,491
Average (1989-2014) AN	4,029	428	21	4,478
Average (1989-2014) BN	3,383	349	25	3,756
Average (1989-2014) D	3,220	388	18	3,626
Average (1989-2014) C	3,419	402	17	3,838

In addition to ET from land surfaces, estimates of evaporation from GFWD canals and rivers and streams are reported in Figure 11 and Table 9. Evaporation from the Rivers and Streams System includes evaporation of both surface inflows and of precipitation runoff within local sloughs and depressions. Evaporation from the canals includes evaporation of CVP supplies from MID via Cottonwood Creek and varies between years according to water availability. Total evaporation from all sources averaged less than 0.2 taf per year between 1989 and 2014.

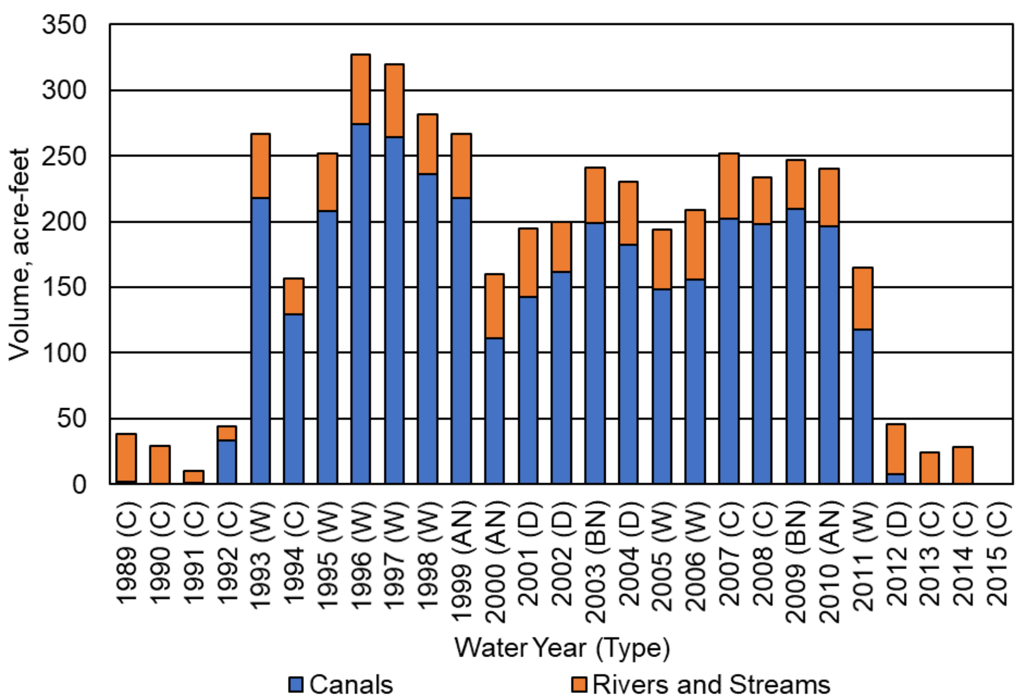


Figure 11. Gravelly Ford Water District GSA Evaporation from the Surface Water System.

Table 9. Gravelly Ford Water District GSA Evaporation from the Surface Water System (Acre-Feet).

Water Year (Type)	Canals	Rivers and Streams[1]	Total
1989 (C)	2	36	38
1990 (C)	0	29	29
1991 (C)	1	9	10
1992 (C)	33	11	44
1993 (W)	218	49	267
1994 (C)	129	28	157
1995 (W)	208	44	252
1996 (W)	274	53	327
1997 (W)	264	56	320
1998 (W)	236	46	282
1999 (AN)	218	49	267
2000 (AN)	111	49	160
2001 (D)	143	52	195
2002 (D)	162	38	200
2003 (BN)	199	42	241
2004 (D)	182	48	230
2005 (W)	148	46	194
2006 (W)	156	53	209
2007 (C)	202	50	252
2008 (C)	198	36	234
2009 (BN)	210	37	247
2010 (AN)	196	44	240
2011 (W)	118	47	165
2012 (D)	8	38	46
2013 (C)	0	24	24
2014 (C)	0	28	28
2015 (C)	0	0	0
Average (1989-2014)	139	40	179
Average (1989-2014) W	203	49	252
Average (1989-2014) AN	175	47	222
Average (1989-2014) BN	205	40	244
Average (1989-2014) D	124	44	168
Average (1989-2014) C	63	28	91

[1] Includes evaporation of surface inflows and of precipitation runoff.

3.2.2.2 Surface Water Outflow by Water Source Type

Surface water outflows by water source type are summarized in Figure 12 and Table 10. In GFWD GSA, runoff of applied water is assumed negligible and runoff of precipitation is collected in waterways within GFWD GSA, with most infiltrating to the groundwater system except following the largest storm events. Surface inflows of CVP supplies are expected to be used entirely in GFWD GSA. Thus, surface outflows from the GSA are expected to be primarily local supplies along Cottonwood Creek. Between 1989 and 2014, these outflows averaged over 9 taf during wet years and 1 taf during below normal, dry, and critical years.

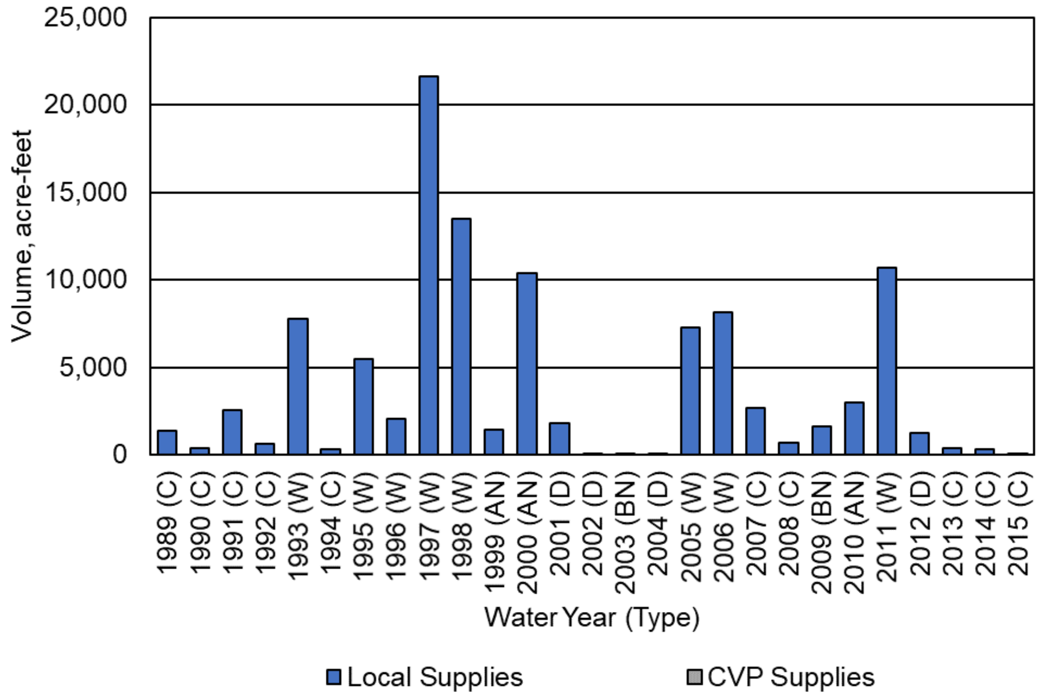


Figure 12. Gravelly Ford Water District GSA Surface Outflows by Water Source Type.

Table 10. Gravelly Ford Water District GSA Surface Outflows by Water Source Type (Acre-Feet).

Water Year (Type)	Local Supplies	CVP Supplies	Total
1989 (C)	1,374	0	1,374
1990 (C)	398	0	398
1991 (C)	2,586	0	2,586
1992 (C)	658	0	658
1993 (W)	7,762	0	7,762
1994 (C)	332	0	332
1995 (W)	5,501	0	5,501
1996 (W)	2,042	0	2,042
1997 (W)	21,651	0	21,651
1998 (W)	13,457	0	13,457
1999 (AN)	1,416	0	1,416
2000 (AN)	10,379	0	10,379
2001 (D)	1,820	0	1,820
2002 (D)	61	0	61
2003 (BN)	17	0	17
2004 (D)	8	0	8
2005 (W)	7,281	0	7,281
2006 (W)	8,170	0	8,170
2007 (C)	2,705	0	2,705
2008 (C)	721	0	721
2009 (BN)	1,643	0	1,643
2010 (AN)	3,022	0	3,022
2011 (W)	10,692	0	10,692

Water Year (Type)	Local Supplies	CVP Supplies	Total
2012 (D)	1,240	0	1,240
2013 (C)	354	0	354
2014 (C)	328	0	328
2015 (C)	85	0	85
Average (1989-2014)	4,062	0	4,062
Average (1989-2014) W	9,569	0	9,569
Average (1989-2014) AN	4,939	0	4,939
Average (1989-2014) BN	830	0	830
Average (1989-2014) D	782	0	782
Average (1989-2014) C	1,051	0	1,051

3.2.2.3 Infiltration of Precipitation

Estimated infiltration of precipitation (deep percolation of precipitation) by water use sector is provided in Figure 13 and Table 11. Infiltration of precipitation to the groundwater system is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from less than 1 taf annually during some critical and dry years to more than 6 taf during 1995.

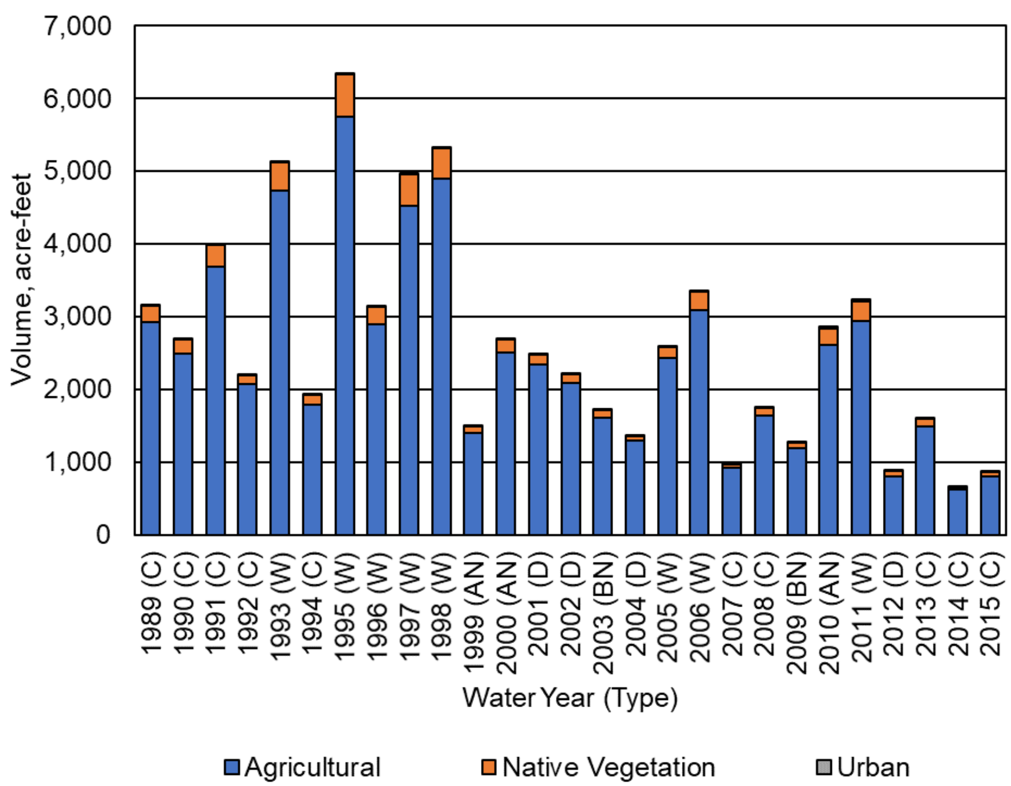


Figure 13. Gravelly Ford Water District GSA Infiltration of Precipitation by Water Use Sector.

Table 11. Gravelly Ford Water District GSA Infiltration of Precipitation by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	2,928	214	6	3,148
1990 (C)	2,485	199	5	2,689
1991 (C)	3,686	295	6	3,987
1992 (C)	2,071	126	3	2,200
1993 (W)	4,734	383	7	5,124
1994 (C)	1,789	135	1	1,925
1995 (W)	5,748	579	9	6,336
1996 (W)	2,900	238	4	3,142
1997 (W)	4,520	431	8	4,959
1998 (W)	4,902	420	11	5,333
1999 (AN)	1,404	85	1	1,490
2000 (AN)	2,508	177	6	2,691
2001 (D)	2,345	133	4	2,482
2002 (D)	2,085	121	6	2,212
2003 (BN)	1,610	102	7	1,719
2004 (D)	1,290	69	5	1,364
2005 (W)	2,425	159	16	2,600
2006 (W)	3,094	244	24	3,362
2007 (C)	916	54	6	976
2008 (C)	1,645	104	14	1,763
2009 (BN)	1,192	68	12	1,272
2010 (AN)	2,611	228	32	2,871
2011 (W)	2,946	260	36	3,242
2012 (D)	806	64	13	883
2013 (C)	1,487	109	17	1,613
2014 (C)	621	32	7	660
2015 (C)	807	57	9	873
Average (1989-2014)	2,490	193	10	2,694
Average (1989-2014) W	3,909	339	14	4,262
Average (1989-2014) AN	2,174	163	13	2,351
Average (1989-2014) BN	1,401	85	10	1,496
Average (1989-2014) D	1,632	97	7	1,735
Average (1989-2014) C	1,959	141	7	2,107

3.2.2.4 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by source is provided in Figure 14 and Table 12. Seepage from the Rivers and Streams System includes seepage of both surface inflows and of precipitation runoff into local sloughs and depressions. The canal system predominantly contributes to seepage in GFWD, with seepage averaging 5.9 taf per year between 1989 and 2014. Seepage from rivers and streams is comparatively lower, averaging less than 1 taf per year.

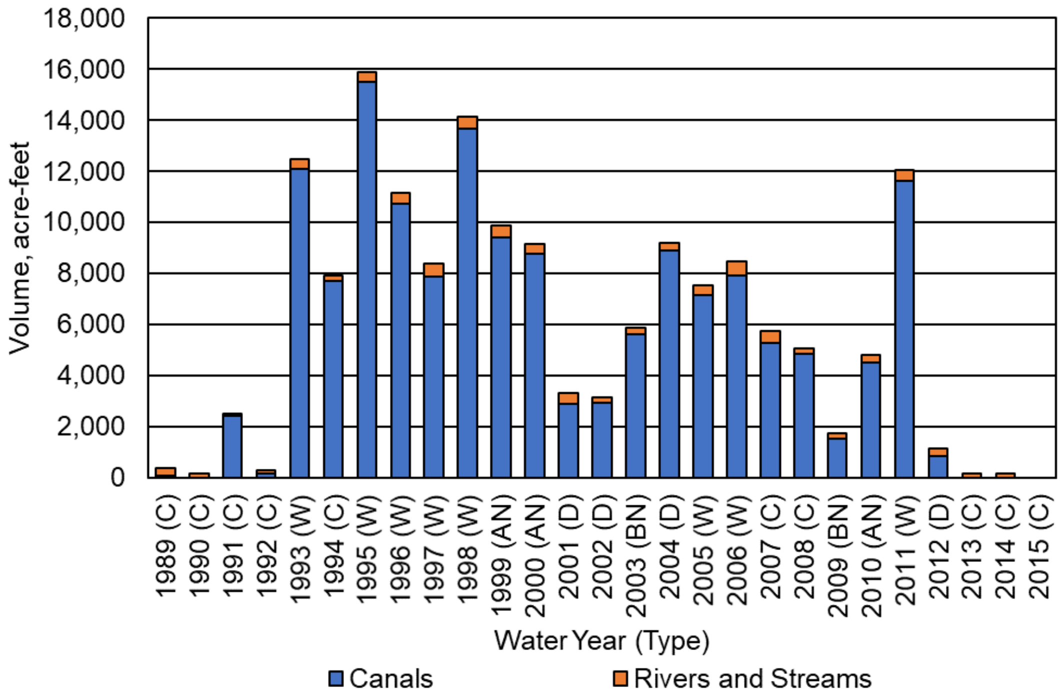


Figure 14. Gravelly Ford Water District GSA Infiltration of Surface Water.

Table 12. Gravelly Ford Water District GSA Infiltration of Surface Water (Acre-Feet).

Water Year (Type)	Canals	Rivers and Streams[1]	Total
1989 (C)	65	304	369
1990 (C)	0	172	172
1991 (C)	2,423	95	2,518
1992 (C)	191	86	277
1993 (W)	12,083	386	12,469
1994 (C)	7,698	205	7,903
1995 (W)	15,514	386	15,900
1996 (W)	10,721	428	11,149
1997 (W)	7,884	516	8,400
1998 (W)	13,684	465	14,149
1999 (AN)	9,427	432	9,859
2000 (AN)	8,765	386	9,151
2001 (D)	2,884	428	3,312
2002 (D)	2,945	216	3,161
2003 (BN)	5,629	258	5,887
2004 (D)	8,905	302	9,207
2005 (W)	7,151	386	7,537
2006 (W)	7,940	516	8,456
2007 (C)	5,292	443	5,735
2008 (C)	4,865	216	5,081
2009 (BN)	1,522	216	1,738
2010 (AN)	4,530	302	4,832
2011 (W)	11,607	430	12,037

Water Year (Type)	Canals	Rivers and Streams[1]	Total
2012 (D)	830	308	1,138
2013 (C)	0	156	156
2014 (C)	0	174	174
2015 (C)	0	0	0
Average (1989-2014)	5,867	316	6,183
Average (1989-2014) W	10,823	439	11,262
Average (1989-2014) AN	7,574	373	7,947
Average (1989-2014) BN	3,575	237	3,812
Average (1989-2014) D	3,891	314	4,205
Average (1989-2014) C	2,281	206	2,487

[1] Includes infiltration of surface inflows and of precipitation runoff.

3.2.2.5 Infiltration of Applied Water

Estimated infiltration of applied water (deep percolation of applied water) by water use sector is provided in Figure 15 and Table 13. Infiltration of applied water is dominated by agricultural irrigation and has slowly decreased over time, likely due to increase use of drip and micro-irrigation systems in place of flood irrigation.

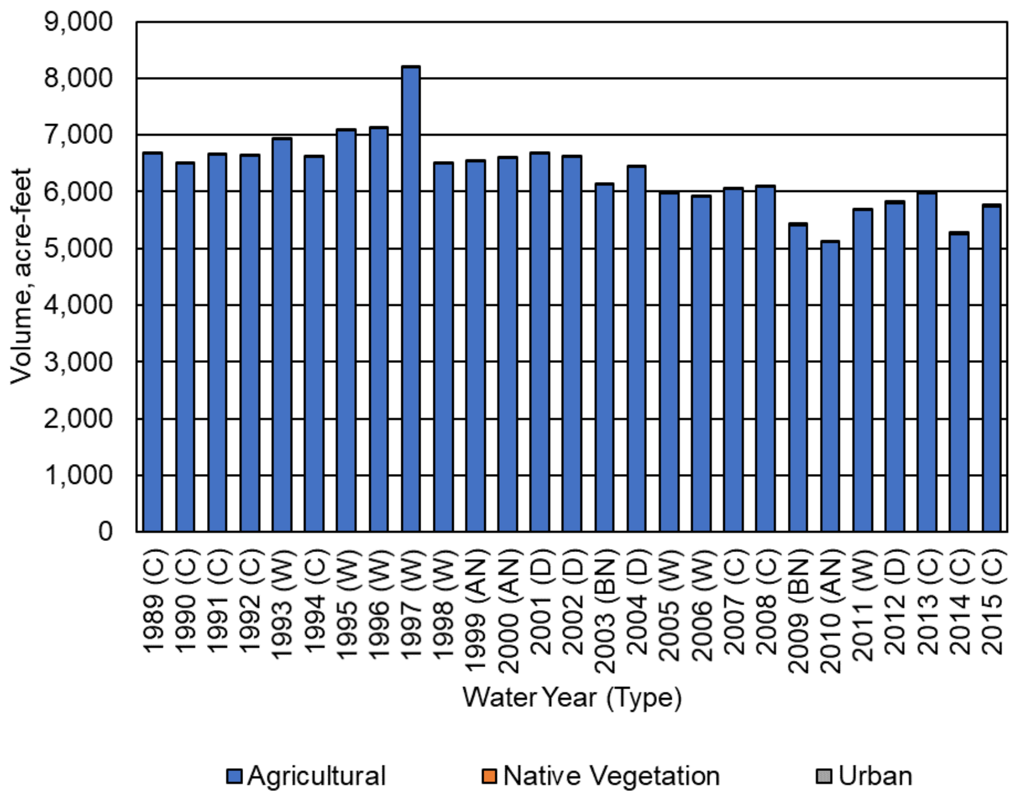


Figure 15. Gravelly Ford Water District GSA Infiltration of Applied Water by Water Use Sector.

Table 13. Gravelly Ford Water District GSA Infiltration of Applied Water by Water Use Sector (Acre-Feet).

Water Year (Type)	Agricultural	Native Vegetation	Urban	Total
1989 (C)	6,663	0	7	6,670
1990 (C)	6,492	0	5	6,497
1991 (C)	6,645	0	6	6,651
1992 (C)	6,637	0	7	6,644
1993 (W)	6,933	0	9	6,942
1994 (C)	6,614	0	7	6,621
1995 (W)	7,086	0	6	7,092
1996 (W)	7,116	0	7	7,123
1997 (W)	8,189	0	11	8,200
1998 (W)	6,490	0	7	6,497
1999 (AN)	6,528	0	7	6,535
2000 (AN)	6,587	0	8	6,595
2001 (D)	6,668	0	8	6,676
2002 (D)	6,619	0	9	6,628
2003 (BN)	6,131	0	13	6,144
2004 (D)	6,446	0	16	6,462
2005 (W)	5,963	0	15	5,978
2006 (W)	5,906	0	16	5,922
2007 (C)	6,042	0	22	6,064
2008 (C)	6,078	0	21	6,099
2009 (BN)	5,409	0	26	5,435
2010 (AN)	5,112	0	23	5,135
2011 (W)	5,671	0	30	5,701
2012 (D)	5,801	0	27	5,828
2013 (C)	5,972	0	33	6,005
2014 (C)	5,256	0	28	5,284
2015 (C)	5,734	0	32	5,766
Average (1989-2014)	6,348	0	14	6,363
Average (1989-2014) W	6,669	0	13	6,682
Average (1989-2014) AN	6,076	0	13	6,088
Average (1989-2014) BN	5,770	0	20	5,790
Average (1989-2014) D	6,384	0	15	6,399
Average (1989-2014) C	6,267	0	15	6,282

3.2.3 Change in Surface Water System Storage

Estimates of change in SWS storage are provided in Figure 16 and Table 14. Inter-annual changes in storage within the surface water system consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

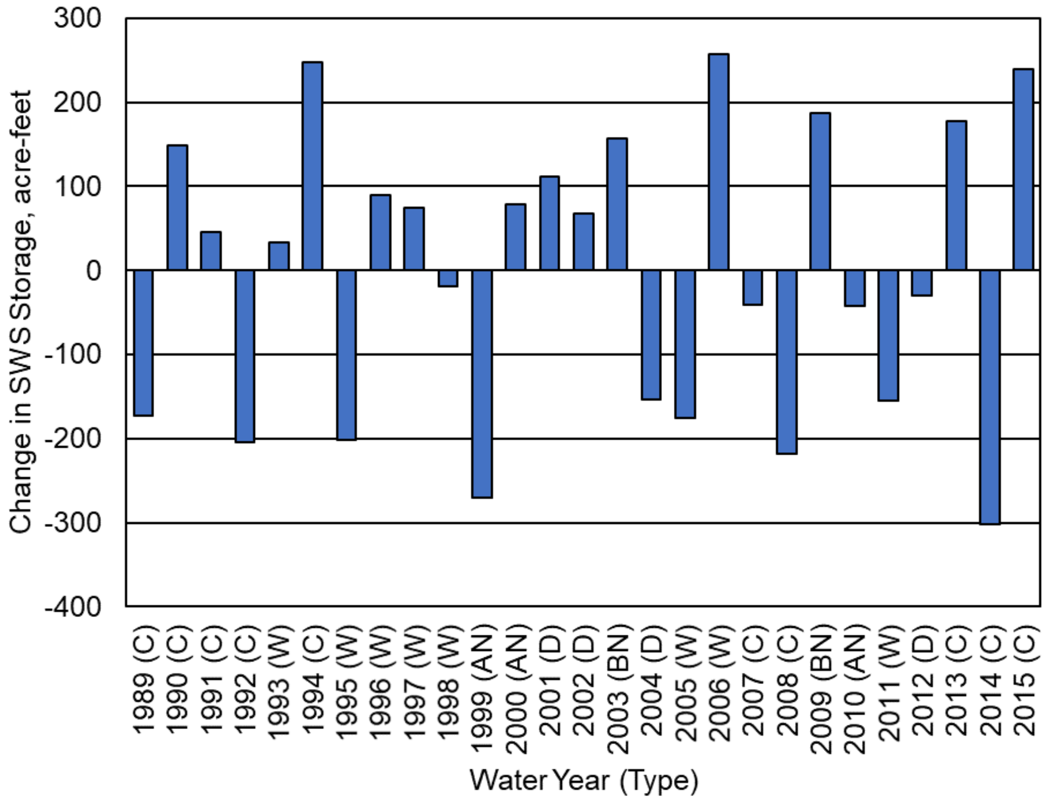


Figure 16. Gravelly Ford Water District GSA Change in Surface Water System Storage.

Table 14. Gravelly Ford Water District GSA Change in Surface Water System Storage (Acre-Feet).

Water Year (Type)	Change in SWS Storage
1989 (C)	-173
1990 (C)	149
1991 (C)	46
1992 (C)	-204
1993 (W)	33
1994 (C)	247
1995 (W)	-202
1996 (W)	90
1997 (W)	74
1998 (W)	-19
1999 (AN)	-270
2000 (AN)	78
2001 (D)	112
2002 (D)	67
2003 (BN)	157
2004 (D)	-153
2005 (W)	-176
2006 (W)	257

Water Year (Type)	Change in SWS Storage
2007 (C)	-41
2008 (C)	-218
2009 (BN)	187
2010 (AN)	-42
2011 (W)	-155
2012 (D)	-30
2013 (C)	177
2014 (C)	-302
2015 (C)	239
Average (1989-2014)	-12
Average (1989-2014) W	-12
Average (1989-2014) AN	-78
Average (1989-2014) BN	172
Average (1989-2014) D	-1
Average (1989-2014) C	-35

3.3 Historical Water Budget Summary

Annual inflows, outflows, and change in SWS storage during the historical water budget period (1989-2014) are summarized in Figure 17 and Table 15. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values. Review of the variability in component volumes across years provides insight into the impacts of hydrology on the surface water system water budget.

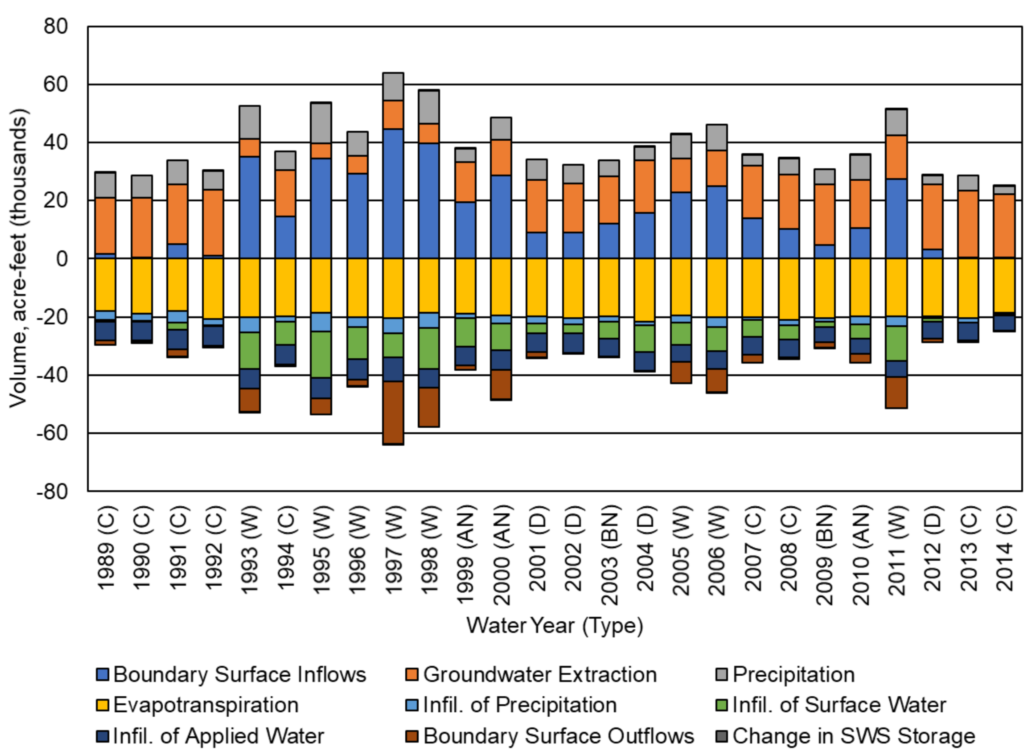


Figure 17. Gravelly Ford Water District GSA Surface Water System Historical Water Budget, 1989-2014.

Table 15. Gravelly Ford Water District GSA Surface Water System Historical Water Budget, 1989-2014 (Acre-Feet).

Water Year	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water[2]	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	1,707	19,386	8,350	-18,055	-3,148	-369	-6,670	-1,374	173
1990 (C)	426	20,515	7,785	-18,821	-2,689	-172	-6,497	-398	-149
1991 (C)	4,944	20,698	8,132	-17,986	-3,987	-2,518	-6,651	-2,586	-46
1992 (C)	1,084	22,522	6,647	-20,678	-2,200	-277	-6,644	-658	204
1993 (W)	35,061	6,242	11,262	-20,235	-5,124	-12,469	-6,942	-7,762	-33
1994 (C)	14,496	16,011	6,383	-19,862	-1,925	-7,903	-6,621	-332	-247
1995 (W)	34,311	5,316	13,700	-18,700	-6,336	-15,900	-7,092	-5,501	202
1996 (W)	29,265	6,120	8,372	-20,211	-3,142	-11,149	-7,123	-2,042	-90
1997 (W)	44,619	9,643	9,564	-20,542	-4,959	-8,400	-8,200	-21,651	-74
1998 (W)	39,691	6,713	11,497	-18,484	-5,333	-14,149	-6,497	-13,457	19
1999 (AN)	19,403	13,786	4,662	-18,821	-1,490	-9,859	-6,535	-1,416	270
2000 (AN)	28,484	12,443	7,604	-19,637	-2,691	-9,151	-6,595	-10,379	-78
2001 (D)	8,960	18,067	7,095	-19,721	-2,482	-3,312	-6,676	-1,820	-112
2002 (D)	9,045	16,932	6,438	-20,286	-2,212	-3,161	-6,628	-61	-67
2003 (BN)	11,936	16,305	5,655	-19,972	-1,719	-5,887	-6,144	-17	-157
2004 (D)	15,768	17,998	4,700	-21,578	-1,364	-9,207	-6,462	-8	153
2005 (W)	22,860	11,745	8,106	-19,492	-2,600	-7,537	-5,978	-7,281	176
2006 (W)	25,058	12,237	8,931	-20,060	-3,362	-8,456	-5,922	-8,170	-257
2007 (C)	13,810	18,158	3,617	-20,147	-976	-5,735	-6,064	-2,705	41
2008 (C)	10,247	18,725	5,495	-21,021	-1,763	-5,081	-6,099	-721	218
2009 (BN)	4,810	20,862	4,966	-20,363	-1,272	-1,738	-5,435	-1,643	-187
2010 (AN)	10,515	16,580	8,526	-19,804	-2,871	-4,832	-5,135	-3,022	42
2011 (W)	27,274	15,145	8,922	-19,826	-3,242	-12,037	-5,701	-10,692	155
2012 (D)	3,045	22,670	3,036	-19,692	-883	-1,138	-5,828	-1,240	30
2013 (C)	519	22,954	5,132	-20,300	-1,613	-156	-6,005	-354	-177
2014 (C)	528	21,796	2,509	-18,689	-660	-174	-5,284	-328	302
Average (1989-2014)	16,072	15,753	7,196	-19,730	-2,694	-6,183	-6,363	-4,062	12
W	32,267	9,145	10,044	-19,694	-4,262	-11,262	-6,682	-9,569	12
AN	19,467	14,270	6,931	-19,421	-2,351	-7,947	-6,088	-4,939	78
BN	8,373	18,584	5,311	-20,168	-1,496	-3,812	-5,790	-830	-172
D	9,205	18,917	5,317	-20,319	-1,735	-4,205	-6,399	-782	1
C	5,307	20,085	6,006	-19,507	-2,107	-2,487	-6,282	-1,051	35

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.
[2]Includes infiltration from the Rivers and Streams System and the Canal System.

3.4 Current Water Budget Summary

The current water budget was developed following a similar process to the historical water budget using the 2015 land use in Table 1 and the same 1989-2014 average hydrologic conditions of the historical base period, including surface water flows, precipitation, and weather parameters. This allowed quantification of groundwater inflows and outflows for current consumptive use in the context of average water supply conditions.

Annual inflows, outflows, and change in SWS storage from the current water budget are summarized in Figure 18 and Table 16. Inflows are shown as positive values, while outflows and change in SWS storage are shown as negative values.

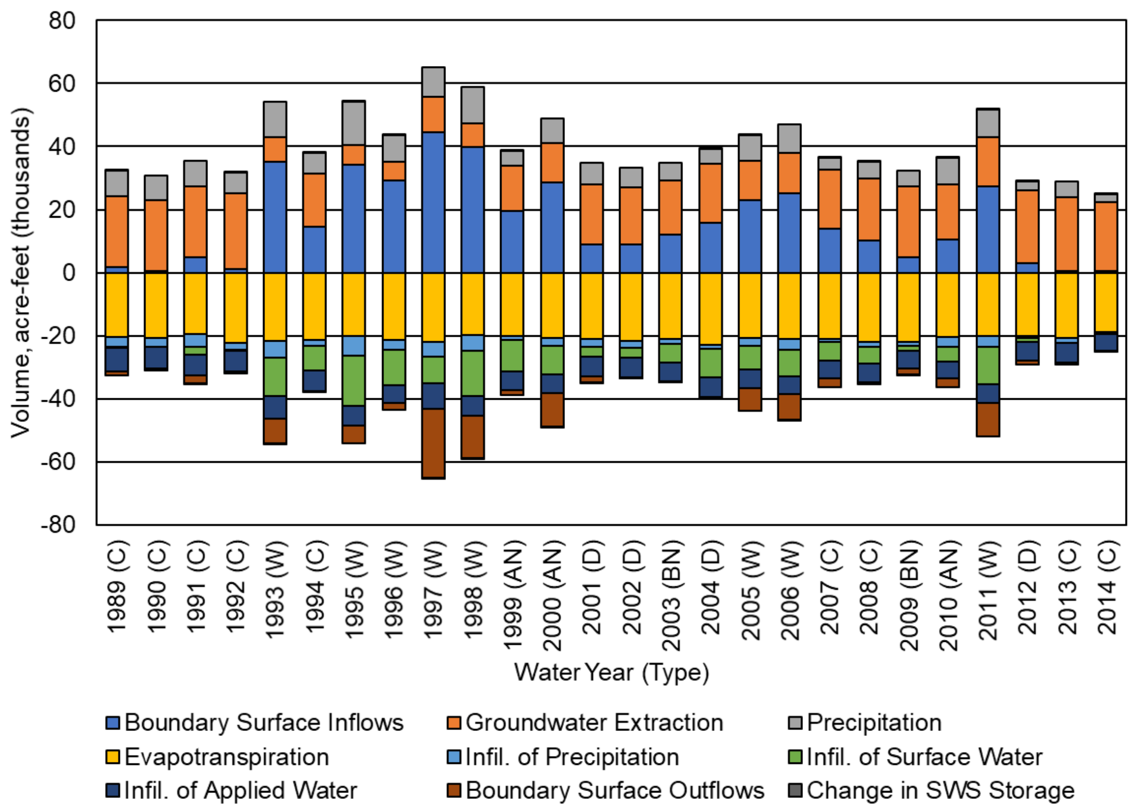


Figure 18. Gravelly Ford Water District GSA Surface Water System Current Water Budget.

Table 16. Gravelly Ford Water District GSA Surface Water System Current Water Budget (Acre-Feet).

Water Year	Boundary Surface Inflows	Groundwater Extraction	Precipitation	Evapo-transpiration[1]	Infil. of Precipitation	Infil. of Surface Water[2]	Infil. of Applied Water	Boundary Surface Outflows	Change in SWS Storage
1989 (C)	1,707	22,384	8,351	-20,505	-3,062	-369	-7,318	-1,320	132
1990 (C)	426	22,622	7,786	-20,852	-2,596	-172	-6,786	-354	-74
1991 (C)	4,944	22,317	8,135	-19,628	-3,880	-2,518	-6,689	-2,554	-127
1992 (C)	1,084	24,051	6,647	-22,292	-2,132	-277	-6,639	-649	208
1993 (W)	35,061	7,904	11,263	-21,764	-5,091	-12,468	-7,044	-7,744	-118
1994 (C)	14,499	17,022	6,382	-21,324	-1,811	-7,903	-6,581	-327	44
1995 (W)	34,312	6,112	13,700	-19,981	-6,264	-15,900	-6,528	-5,499	48
1996 (W)	29,265	5,834	8,372	-21,439	-3,029	-11,150	-5,840	-2,041	28
1997 (W)	44,619	11,057	9,566	-21,921	-4,914	-8,404	-8,151	-21,653	-198
1998 (W)	39,691	7,702	11,500	-19,690	-5,199	-14,149	-6,361	-13,452	-43
1999 (AN)	19,403	14,421	4,664	-20,050	-1,342	-9,858	-6,146	-1,416	325
2000 (AN)	28,484	12,735	7,604	-20,740	-2,555	-9,152	-5,915	-10,383	-77
2001 (D)	8,960	18,891	7,094	-21,196	-2,260	-3,312	-6,269	-1,816	-92
2002 (D)	9,045	17,910	6,438	-21,659	-2,069	-3,161	-6,442	-61	-1
2003 (BN)	11,936	17,160	5,656	-21,176	-1,556	-5,887	-5,925	-15	-193
2004 (D)	15,768	18,796	4,699	-22,843	-1,216	-9,207	-6,123	-7	133
2005 (W)	22,860	12,703	8,107	-20,699	-2,433	-7,537	-5,887	-7,281	168
2006 (W)	25,058	12,970	8,931	-21,158	-3,225	-8,453	-5,757	-8,166	-201
2007 (C)	13,810	18,839	3,617	-21,162	-882	-5,735	-5,817	-2,704	35
2008 (C)	10,247	19,543	5,495	-22,011	-1,667	-5,081	-5,952	-718	144
2009 (BN)	4,810	22,579	4,965	-21,901	-1,235	-1,738	-5,705	-1,638	-136
2010 (AN)	10,515	17,377	8,526	-20,552	-2,867	-4,832	-5,201	-3,025	59
2011 (W)	27,274	15,579	8,924	-20,183	-3,258	-12,038	-5,746	-10,706	154
2012 (D)	3,045	22,932	3,037	-19,996	-864	-1,139	-5,799	-1,241	25
2013 (C)	519	23,307	5,132	-20,606	-1,601	-156	-6,043	-356	-196
2014 (C)	528	21,805	2,507	-18,737	-657	-174	-5,246	-328	302
Average (1989-2014)	16,072	16,714	7,196	-20,926	-2,603	-6,183	-6,227	-4,056	13
W	32,267	9,983	10,045	-20,854	-4,177	-11,262	-6,414	-9,568	-20
AN	19,467	14,844	6,931	-20,447	-2,255	-7,947	-5,754	-4,941	102
BN	8,373	19,870	5,310	-21,539	-1,396	-3,812	-5,815	-827	-164
D	9,205	19,632	5,317	-21,424	-1,603	-4,205	-6,158	-781	16
C	5,307	21,321	6,006	-20,791	-2,032	-2,487	-6,341	-1,035	52

[1]Includes ET of applied water, ET of precipitation, and evaporation from rivers and streams.
[2]Includes infiltration from the Rivers and Streams System and the Canal System.

3.5 Net Recharge from SWS

Overdraft is defined in DWR Bulletin 118 as "the condition of a groundwater basin or subbasin 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 the water supply conditions approximate average conditions" (DWR 2003). The Madera Subbasin water budget indicates that overdraft conditions occurred during the 1989-2014 historical base period. Per 23 CCR Section 354.18(b)(5), the subbasin overdraft has been quantified for this base period. The evaluation of overdraft conditions includes estimates of recharge from subsurface flows. However, estimates of recharge from subsurface flows are less accurate when estimated for areas less that an entire subbasin. Thus, for estimates of GSA level contribution to overdraft, the term net recharge from the SWS is defined as groundwater recharge minus groundwater extraction. Net recharge from the SWS is useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS.

When calculated from the historical water budget, average net recharge from the SWS represents the average recharge (when positive) or shortage of recharge (when negative) based on historical cropping, land use practices, and average hydrologic conditions. When calculated from the current land use water budget, average net recharge represents the average recharge or shortage (negative net recharge) based on current cropping, land use practices, and average hydrologic conditions.

Average net recharge from the SWS is presented below for the GFWD GSA portion of the Madera Subbasin. Table 17 shows the average net recharge from the SWS for 1989-2014 based on the historical water budget, and Table 18 shows the same for the current water budget. Historically, the average net recharge in GFWD GSA was approximately -0.5 taf per year between 1989 and 2014. Under current land use conditions, the average net recharge in GFWD GSA is approximately -1.7 taf, indicating shortage conditions.

Table 17. Historical Water Budget: Average Net Recharge from SWS by Water Year Type, 1989-2014 (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	6,682	4,262	11,262	9,145	13,061
AN	3	6,088	2,351	7,947	14,270	2,116
BN	2	5,790	1,496	3,812	18,584	-7,486
D	4	6,399	1,735	4,205	18,917	-6,578
C	9	6,282	2,107	2,487	20,085	-9,209
Annual Average (1989-2014)	26	6,363	2,694	6,183	15,753	-513

[1] Includes infiltration from the Rivers and Streams System and Canal System.

Table 18. Current Water Budget: Average Net Recharge from SWS by Water Year Type (Acre-Feet).

Year Type	Number of Years	Infiltration of Applied Water (a)	Infiltration of Precipitation (b)	Infiltration of Surface Water[1] (c)	Groundwater Extraction (d)	Net Recharge from SWS (a+b+c-d)
W	8	6,414	4,177	11,262	9,983	11,870
AN	3	5,754	2,255	7,947	14,844	1,112
BN	2	5,815	1,396	3,812	19,870	-8,847
D	4	6,158	1,603	4,205	19,632	-7,667
C	9	6,341	2,032	2,487	21,321	-10,461
Annual Average (1989-2014)	26	6,227	2,603	6,183	16,714	-1,700

[1] Includes infiltration from the Rivers and Streams System and Canal System.

3.6 Uncertainties in Water Budget Components

Uncertainties associated with each water budget component were estimated as a percentage representing approximately a 95% confidence interval following the procedure described by Clemmens and Burt (1997). Uncertainties for all independently measured or estimated water budget components were estimated based on the measurement accuracy, typical values reported in technical literature, typical values calculated in other water budgets, and professional judgement.

Table 19 provides a summary of typical uncertainty values associated with major SWS inflow and outflow components. These uncertainties provide a basis for evaluating confidence in water budget results and help to identify data needs that may be addressed during GSP implementation.

Table 19. Estimated Uncertainty of GSA Water Budget Components.

Flowpath Direction (SWS)	Water Budget Component	Data Source	Estimated Uncertainty (%)	Source
Inflows	Surface Water Inflows	Calculation	20%	Estimated streamflow measurement accuracy and adjustment for losses.
	Surface Water Diversions	Measurement	10%	Estimated measurement accuracy.
	Surface Water Deliveries	Measurement	6%	Estimated measurement accuracy.
	Precipitation	Calculation	30%	Clemmens, A.J. and C.M. Burt, 1997.
	Groundwater Extraction	Closure	20%	Typical uncertainty calculated for Land Surface System water balance closure.
Outflows	Surface Water Outflows	Closure	20%	Typical uncertainty calculated for Rivers and Streams System water balance closure.
	Evaporation	Calculation	20%	Estimated accuracy of calculation based on CIMIS reference ET and free water surface evaporation coefficient.
	ET of Applied Water	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, estimated crop coefficients from SEBAL energy balance, and annual land use.
	ET of Precipitation	Calculation	10%	Estimated accuracy of daily IDC root zone water budget component based on CIMIS reference ET, precipitation, estimated crop coefficients from SEBAL energy balance, and annual land use.
	Infiltration of Applied Water	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use and NRCS soils characteristics.
	Infiltration of Precipitation	Calculation	20%	Estimated accuracy of daily IDC root zone water budget component based on annual land use, NRCS soils characteristics, and CIMIS precipitation.
	Infiltration of Surface Water	Calculation	15%	Estimated accuracy of daily seepage calculation using NRCS soils characteristics and measured streamflow data.
	Change in SWS Storage	Calculation	50%	Professional Judgment.
Net Recharge from SWS		Calculation	25%	Estimated water budget accuracy; typical value calculated for GSA-level net recharge from SWS.

3.7 Comparison of Current Water Budget with GFWD GSA Individual GSP

GFWD GSA is among the three GSAs that are each separately satisfying the requirements of SGMA by preparing individual GSPs. These individual GSPs have been prepared separately from this coordinated plan. A coordination agreement is being developed by all seven GSAs in the Madera Subbasin detailing required GSA and GSP cooperation and coordination.

To maintain consistent estimates of subbasin groundwater storage and overdraft conditions between these GSPs, comparisons of surface water supply and demand under current land use conditions have been prepared between the GSA-level current water budget from this coordinated plan and the current water budget from the individual GSP.

Table 20 provides a comparison between the GFWD GSA current water budget developed as part of this coordinated plan and the GFWD GSA current water budget developed by the District for its individual GSP. During the current water budget period (2015 land use, 1989-2014 average water supply), the District's water supplies and rural residential consumptive use volumes are within 30 AF/yr volume, indicating close correspondence between the water budgets. Land use areas are approximately identical between the plans, though agricultural consumptive use volumes differ by over 2,000 AF/yr on account of different estimated rates of ET of applied water.

ET of applied water in 2015 was estimated in the coordinated GSP water budget based on both the 2015 crop areas and the 2015 crop ET rates estimated from daily ET_o at the Madera II CIMIS station and crop coefficients derived from actual ET (ET_a) estimated by the Surface Energy Balance Algorithm for Land (SEBAL). In contrast, the 2015 ET of applied water was estimated in the individual GSP water budget based on a weighted-average rate derived from the 1989-2014 average ET of applied water rate of each crop and the 2015 acreage of each crop. As drought conditions in 2015 are estimated to have increased ET of applied water (due in part to lower than average precipitation), the process used in the individual GSP water budget would potentially underestimate ET of applied water in 2015, thus explaining the differences observed between the two water budgets.

Table 20. Comparison of Current Water Budget Results between GFWD GSA Individual GSP and Coordinated GSP, 2003-2012.

Period of Record: 2015 land use, 1989-2014 average water supply

	GFWD GSA, Individual GSP	GFWD GSA, Coordinated GSP	Difference (Coordinated - Individual)	Units
Parameter	**Value**	**Value**	**Value**	**Units**
Agricultural Land				
Total Area	8,380	8,379	-1	ac (total in GSA area)
Average Agricultural Area (2015)	7,501	7,503	2	ac (including idle)
Average current ETAW (2015)	2.16	2.44	0	AF/ac/yr
Consumptive Use (2015)	16,200	18,339	2,139	AF/yr (for agricultural area)
Rural Residential Land				
Rural Residential Consumptive Use (2015)	100	73	-27	AF/yr
Total Consumptive Use				
Total Consumptive Use (2015)*	**16,300**	**18,412**	**2,112**	**AF/yr**
Water Supply (Average 1989-2014)				
Native Groundwater @ 0.5 af/ac	4,190	4,190	0	af/yr (for total area)
San Joaquin River (Class 2)	6,361	6,359	-2	AF/yr
Diversion from MID (6.2)	1,506	1,506	0	AF/yr
Diversion from Cottonwood Creek - MID	2,016	2,016	0	AF/yr
Diversion from Cottonwood Creek natural flow	1,849	1,874	25	AF/yr
Total Water Supply (Average 1989-2014)	**15,922**	**15,945**	**23**	**AF/yr**
Estimated Imbalance				
Estimated Imbalance (2015)**	**378**	**2,467**	**2,089**	**AF/yr**

*2015 Total Consumptive Use in Individual GSP based on average 1989-2014 crop ETAW rate, based on 2015 crop ETAW rate in Coordinated GSP

**Calculated as the difference between total consumptive use (2015) and total water supply (average 1989-2014).

APPENDIX E

Comments & Responses (Reg 354.10)

2816 Park Avenue | Merced, CA 95348

January 13, 2020

Gary R. Serrato
Executive Officer
North Kings Groundwater Sustainability Agency
c/o Fresno Irrigation District
2907 S. Maple Avenue
Fresno, CA 93725-2208

Subject: Comment letter on the Gravelly Ford Water District Groundwater Sustainability Plan

Dear Mr. Serrato:

Thank you for your response letter on the draft Groundwater Sustainability Plan (GSP) for the Gravelly Ford Water District (GFWD) dated December 2, 2019. The comments made in your letter have been addressed in modifications to the final GSP report or are addressed in the attached memo from Ken Schmidt on behalf of GFWD starting from item #4. This response letter will be included in the final report and those items addressed will be noted as well.

An additional table will be added to the report to define the Water Budget for GFWD as suggested in your letter, along with the comments made in the attached Memo by Ken Schmidt.

Again, thank you for taking the time to review the draft GSP and provide your comments on the draft language of the report.

Sincerely,

Garth A. Pecchenino, PE, PLS
Consulting District Engineer

Enclosures: Ken Schmidt Memo, 12/05/19

cc: Board of Directors, Gravelly Ford Water District

180035
GAP/ JK

NORTH KINGS GROUNDWATER *SUSTAINABILITY AGENCY*

November 27, 2019

Internet
www.NorthKingsGSA.org

Mail
North Kings GSA
c/o Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

Phone
559-233-7161

Via U.S. Mail and E-Mail (donroberts717@gmail.com)

Mr. Don Roberts, General Manager
Gravelly Ford Water District GSA
18811 Road 27
Madera, CA 93638

RE: <u>Gravelly Ford Water District Groundwater Sustainability Agency (GSA) Draft Groundwater Sustainability Plan (GSP) Comments</u>

Dear Mr. Roberts

The North Kings Groundwater Sustainability Agency (NKGSA) consists of member agencies including Fresno Irrigation District, the cities of Fresno, Clovis and Kerman, Fresno County, Bakman Water Company, Biola Community Services District, International Water District, Garfield Water District, and the Fresno Metropolitan Flood Control District. The NKGSA also consists of disadvantaged communities, private well owners, and other landowners. The Gravelly Ford Water District Groundwater Sustainability Agency (GSA) shares a small border with the NKGSA boundary. The NKGSA submits this letter to the Gravelly Ford Water District GSA (GFWD) regarding the draft Groundwater Sustainability Plan prepared for purposes of the Sustainability Groundwater Management Act (SGMA).

The NKGSA appreciates the opportunity to comment on the GFWD GSA's draft GSP. The water balances presented in Tables 2-2 and 2-3 do not appear to consider all the factors evaluated when creating a water balance. The water balance does not appear to consider boundary flows or mention correcting for boundary flows. The other GSAs in the Madera Subbasin have more complex water budgets that address boundary flows and make claim to boundary flows presumably from the NKGSA, and its member agencies. The NKGSA, including its member agencies and stakeholders, intends to capture and recapture water (as has been historically and currently occurring), whether surface water, groundwater, or recharge water, which other

Madera Subbasin GSAs indicate is flowing into the Madera Subbasin which may include some flow into the GFWD GSA.

The NKGSA looks forward to continuing to collaborate with the Madera Subbasin GSAs, including the Gravelly Ford Water District GSA, on mitigating for any boundary flows that may be occurring. Please contact me at (559) 233-7161 should you have any questions.

Sincerely,

Gary R. Serrato

Gary R. Serrato
Executive Officer

MEMO

To: Garth Pecchenino, QK
From: Ken Schmidt
Topic: Gravelly Ford WD GSP
Date: December 5, 2019

Following is my response to the correspondence of December 2, 2019 from the Fresno Irrigation District to the Gravelly Ford WD GSA.

1. The surface water deliveries mentioned don't need to be made every year. These deliveries (in excess of historical ones) only need to be enough to equal the average amount of groundwater overdraft (about 2,700 acre-feet per year) over a hydrologic base period. As such they can be made only in wet years if necessary.

2. Water-level changes were discussed for a hydrologic base period. This information combined with estimates of the specific yield are the best way to determine groundwater overdraft.

3. I have reviewed in great detail the draft GSP for the Madera Subbasin. A statement was made that "the other GSAs in the Madera Subbasin have more complex water budgets that address boundary flows". The fact that some water budgets are "more complex" than others doesn't mean that they are more correct. The Madera Subbasin GSP was based largely on groundwater modeling, which made use of numerous assumptions for dozens of parameters, as opposed to measured data. No groundwater flows split into above and below the Corcoran Clay were provided. No aquifer tests were used to determine transmissivity, which is a huge data gap.

4. Root Creek WD didn't "make claim to boundary flows". What they did make claim to is part of the San Joaquin River seepage that moves north and into their District. This water was never in Fresno County or the FID.

5. The FID has no reason to "capture and recapture water" which seeps out of the San Joaquin River and moves into Madera County.

6. In terms of groundwater quality concerns, irrigation suitability analyses are periodically done by some growers for water from their wells. It is expected that some of these will be made available for use by the GSA.

7. The GSA doesn't intend to get involved with the quality of water pumped from the few private domestic wells that are present. This is more an issue for the Madera County Environmental Health.

Please call me if you have any questions.

2816 Park Avenue | Merced, CA 95348

January 13, 2020

Bill Stretch
General Manager
Fresno Irrigation District
2907 S. Maple Avenue
Fresno, CA 93725-2208

Subject: Comment letter on the Gravelly Ford Water District Groundwater Sustainability Plan

Dear Mr. Stretch:

Thank you for your response letter on the draft Groundwater Sustainability Plan (GSP) for the Gravelly Ford Water District (GFWD) dated December 2, 2019. The comments made in your letter have been addressed in modifications to the final GSP report or are addressed in the attached memo from Ken Schmidt on behalf of GFWD. This response letter will be included in the final report and those items addressed will be noted as well.

An additional table will be added to the report to define the Water Budget for GFWD as suggested in your letter, along with the comments made in the attached Memo by Ken Schmidt.

Again, thank you for taking the time to review the draft GSP and provide your comments on the draft language of the report.

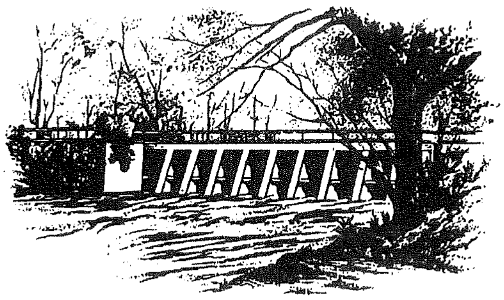
Sincerely,

Garth A. Pecchenino, PE, PLS
Consulting District Engineer

Enclosures: Ken Schmidt Memo, 12/05/19

cc: Board of Directors, Gravelly Ford Water District

180035
GAP/ JK



YOUR MOST VALUABLE RESOURCE - WATER

OFFICE OF

FRESNO IRRIGATION DISTRICT

TELEPHONE (559) 233-7161
FAX (559) 233-8227
2907 S. MAPLE AVENUE
FRESNO, CALIFORNIA 93725-2208

December 2, 2019

Via U.S. Mail and E-Mail (E-Mail Address)

Mr. Don Roberts, General Manager
Gravelly Ford Water District GSA
18811 Road 27
Madera, CA 93638

Re: <u>Gravelly Ford Water District Groundwater Sustainability Agency Draft Groundwater Sustainability Plan</u>

Dear Mr. Roberts:

The Fresno Irrigation District (FID) submits this letter to the Gravelly Ford Water District Groundwater Sustainability Agency (GFGSA) regarding the draft Groundwater Sustainability Plan (GSP) prepared for purposes of the Sustainable Groundwater Management Act (SGMA).

Leading our region in water resources management, FID is a founding member of the North Kings Groundwater Sustainability Agency (NKGSA), which is adjacent to the Madera Subbasin that includes the GFGSA. The NKGSA is one of the seven groundwater sustainability agencies (GSAs) within the Kings Subbasin. Other NKGSA members include the cities of Fresno, Clovis, and Kerman, Fresno County, Bakman Water Company, Biola Community Services District, International Water District, Garfield Water District, and the Fresno Metropolitan Flood Control District. FID makes up a significant portion of the NKGSA and consists of disadvantaged communities, private well owners, and other landowners. Since 1920, FID has proudly delivered water to agricultural and urban communities within Fresno County. Today, FID encompasses over 245,000 acres of prime farmland and municipal areas, including the cities of Fresno and Clovis. As one of the premier irrigation districts in the Central Valley, FID is extensively involved in a host of local, state and federal water issues.

FID appreciates the opportunity to comment on the GFGSA's draft GSP. FID is concerned about the GFGSA governing board adopting the draft GSP and requests the GFGSA board to consider the issues described below.

The draft GSP indicates, in Table 2-1, there were no surface water deliveries in 2013, 2014 or 2015. The remainder of the GSP indicates the sustainability goals for the GFGSA are dependent upon surface water deliveries from the San Joaquin River and Cottonwood Creek. Given the changing climate conditions, surface water deliveries could vary drastically in the future from what historical water deliveries. As such, the reliance on surface water deliveries is problematic for achieving sustainability.

The water balances presented in Tables 2-2 and 2-3 do not appear to consider all the factors evaluated when creating a water balance. Namely, the water budget in Table 2-2 only considers the sources of water between 1989 and 2014 and the 2015 consumptive use which results in an imbalance, deficit, of 378 AF/year. However, in 2015 there were no surface water deliveries according to Table 2-1 which indicates the imbalance/deficit would be closer to 12,110 AF. The water budget does not consider boundary flows or mention correcting for boundary flows. The other GSAs in the Madera Subbasin have more complex water budgets that address boundary flows and make claim to boundary flows presumably from FID and the other NKGSA member agencies. It is important to note that while the NKGSA (including FID) and the Gravelly Ford Water District GSA boundaries are not immediately adjacent but are in close proximity, there is a much larger common boundary between the NKGSA (including FID) and other Madera Subbasin GSAs including Root Creek Water District GSA, that make claim to boundary flows. FID and the NKGSA, including its other member agencies and stakeholders, intend to capture and recapture water (as has been historically and currently occurring), whether surface water, groundwater, or recharge water, which other Madera Subbasin GSAs indicate is flowing into the Madera Subbasin which may include some flow into the GFGSA.

Lastly, the GFGSA's draft GSP does not appear to adequately address potential water quality concerns within the GFGSA boundary. Given the area is predominately used for agriculture, the GSP indicates the water quality monitoring will consist of annual water sampling of about 24 wells and will include electroconductivity, pH and water temperature. While the GSA is predominantly used for agricultural activities, there are rural residential parcels with private domestic wells and there could be more in the future. Page 2-30 describes the CV-SALTS and Nitrate Management Plan but the GSP does not indicate any of the water quality monitoring network will be monitored for salinity or nitrate. The GSP should be modified to include water quality monitoring for nitrate and other water quality constituents that are predominant in the area near the GFGSA boundary.

FID and the NKGSA look forward to continuing to collaborate with the Madera Subbasin GSAs, including the Gravelly Ford Water District GSA, on the correction of the concerns contained in this letter. Please contact me at (559) 233-7161 should you have any questions.

Sincerely,

William R. Stretch

Bill Stretch
General Manager

cc: Madera Irrigation District GSA
Madera County GSA
County of Fresno – Bernard Jimenez

2816 Park Avenue | Merced, CA 95348

January 13, 2020

Stephanie Anagnoson
Director, Water and Natural Resources Department
Madera County
200 W. Fourth Street
Madera, CA 93637

Subject: GSP response letter from NOAA

Dear Ms. Anagnoson:

This letter is in response to the letter your department received from NOAA's National Marine Fisheries Service (NMFS), dated November 27, 2019, in regard to their review of the draft Groundwater Sustainability Plan for the Madera Sub-basin. The letter from NMFS referenced sections of the Madera GSP draft report and in those referenced sections it highlighted out Cottonwood Creek and the San Joaquin River with regard to those streams interaction with groundwater levels and the hydraulic connection to seasonal habitat where the groundwater aquifer supplements streamflow.

The historical, current and projected surface inflow and groundwater levels in the area of the Gravelly Ford Water District (GFWD) have not presented a condition as described in the letter from NMFS for the short portion of the two (2) streams noted in their response letter. The influence on the groundwater levels outside of the area of the GFWD has more impact to the condition covered in their letter than the balance operation of the GFWD. GFWD will be collecting data on the pumping levels, subsidence and volume of surface inflow during the next five (5) year period to support the continued balanced operation of the area under the control of the GFWD. GFWD assumes that the area covered by the Madera draft GSP will provide a similar level of data collection to show the specific location of above normal overdraft of the groundwater storage volume to address the concerns of the NMFS.

GFWD does not see any severe impact to the stream habitat as defined in the letter from NMFS, as the instream flows are regulated by the upstream water control structures and the timing of the surface flows with pumping within the GFWD area is outside the migration periods of the fishery stated in the letter. Please copy our GFWD on your response to the NMFS in regard to their letter and how your approach will address their concerns. GFWD will provide the data collected for the district during the five (5) year period to add to your analysis.

Sincerely,

Garth A. Pecchenino, PE, PLS
Consulting District Engineer

cc: Board of Directors, Gravelly Ford Water District

180035
GAP/JK

GFWD
Rcvd 12/02/19

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

November 27, 2019

Stephanie Anagnoson
Director, Water and Natural Resources Department
Madera County
200 W. Fourth Street
Madera, CA 93637

Re: NOAA's National Marine Fisheries Service comments on the draft Groundwater Sustainability Plan for the Madera Sub-basin

Dear Director Anagnoson:

NOAA's National Marine Fisheries Service (NMFS) is the federal agency responsible for managing, conserving, and protecting living marine resources in inland, coastal, and offshore waters of the United States. We derive our mandates from numerous statutes, including the Federal Endangered Species Act (ESA). The purpose of the ESA is to conserve threatened and endangered species and their ecosystems.

Madera County recently released a draft Groundwater Sustainability Plan (draft GSP) for the Madera Sub-basin, located in the southern San Joaquin Valley near the town of Madera, California. The California Department of Water Resources (DWR) has designated the Madera Sub-basin a "critical" priority for groundwater management, necessitating the development of a GSP by January 31, 2020, as required under California's Sustainable Groundwater Management Act of 2014 (SGMA). Waterways that overlie portions of the Madera Sub-basin (e.g., San Joaquin River) support federally threatened Central Valley (CV) steelhead (*Oncorhynchus mykiss*). These waterways also play a critical role in NMFS' efforts to re-establish threatened CV spring-run Chinook salmon (*O. tshawytscha*) in the San Joaquin River basin. This letter transmits NMFS' comments regarding Madera County's draft Madera Sub-basin GSP.

Surface water and groundwater are hydraulically linked in the Madera Sub-basin, and this linkage is critically important in creating seasonal habitat for CV steelhead and CV spring-run Chinook salmon. Where the groundwater aquifer supplements streamflow, the influx of cold, clean water is critically important for maintaining temperature and flow volume. Pumping water from these aquifer-stream complexes has the potential to affect salmon and steelhead habitat by lowering groundwater levels and interrupting the hyporheic flow between the aquifer and stream. Given the widespread aquifer depletion documented throughout the San Joaquin valley, NMFS has concerns that groundwater extraction in the Madera Sub-basin may compromise CV steelhead and CV spring-run Chinook salmon instream habitat.

Comments

Pg. 2-40: the draft GSP states the following with regard to groundwater-surface water interaction:

> *"A review of historical regional aquifer groundwater levels compared to stream thalweg (deepest portion of stream channel) elevations conducted for this study indicate that surface water – groundwater interactions are not a significant issue (i.e., regional groundwater levels are relatively far below creek thalweg elevations) along Berenda Creek, Dry Creek, the Fresno River, and Cottonwood Creek in the Madera Subbasin. However, comparison of historical groundwater levels to the stream thalweg indicate that the San Joaquin River along the southern subbasin boundary was connected with groundwater from 1958 (and likely before) through 1984. Groundwater levels were generally below (and apparently disconnected from) the San Joaquin River by about 10 to 50 feet from 1989 through 2016."*

These statements are very general and require further explanation. NMFS recommends that the draft GSP explain in detail the significance of the range "10 to 50 feet" and why this range was used as an indicator of groundwater/surface water disconnection. On the other hand, this type of criteria (i.e., comparing groundwater levels to the stream thalweg) does not clearly define where the depth to groundwater is measured (Brunner et al. 2009). This criteria only takes into account a particular location along the stream length. Further lowering the groundwater table by groundwater pumping in an already disconnected system is expected to increase the length of stream over which disconnection occurs (Brunner et al. 2009). Moreover, the state of connection assessed at one particular point in time might change (Cook et al. 2010, Brunner et al. 2011). Even if the surface water is disconnected from groundwater at some specific periods between 1989 and 2016, the state of connection can be transient changes in the water table and river flow can and do alter the state of connection (Cook et al. 2010, Brunner et al. 2011). There could be other periods between 1989 and 2016 where the river is connected to groundwater. Therefore, we recommend the GSA perform a more detailed and robust analysis to classify a streamflow reach as connected or disconnected.

Pg. 2-41: The GSP analyzes the depths of groundwater and groundwater/surface water interactions from the results indicated in Figures 2-71 and 2-72, acknowledging that "given the apparent fully saturated water column at these locations, there is at least potential for regional groundwater pumping to impact groundwater dependent ecosystems (GDEs)." These figures display the depths to groundwater for 2014 and 2016, respectively. However, these years (2014 and 2016) were the third and fifth year, respectively, of a multi-year drought in the Madera Sub-basin. Given the likely depressed groundwater elevation expected during the latter half of a multi-year drought, using this time period may be misleading. We recommend using a normal water year baseline for groundwater elevations and performing the interconnected surface water analysis with an appropriate time period of historical data. NMFS can provide additional technical assistance if needed.

Also, groundwater connection to streamflow is a dynamic process. Streamflow accretion is likely greatest at the point when spring rains cease, and streamflow depletion likely accelerates during summer and fall as groundwater pumping accelerates.

Pg. 2-42: Groundwater Dependent Ecosystems (GDEs) are characterized entirely by riparian vegetation function and viability. While considering a 30-foot depth to water may be effective when considering riparian function, the metric has little informative value concerning how streamflow depletion caused by groundwater pumping may impact aquatic organisms and their habitat. Rohde et al. (2018) may be appropriate for informing potential impacts to riparian habitat; it is not appropriate for investigating potential impacts of streamflow depletion.

The draft GSP clearly supports the conclusion that there is, at the very least, potential connectivity and exchange between groundwater and surface flow in the Madera Sub-basin (see prior comment), and unsustainable groundwater pumping has in the past been shown to harm salmon and steelhead in other San Joaquin tributaries (Fleckenstein et al. 2004). Given these two findings, an appropriate GSP approach would be to investigate whether streamflow depletion is impacting beneficial uses of surface water within the Madera Sub-basin. NMFS recommends the draft GSP follow guidance from California Department of Fish and Game (2019) and develop conservative streamflow depletion thresholds as a cautionary principle until the surface flow/groundwater dynamic in the Madera Sub-basin is better studied and understood.

Pg. 3-15, 3-34: The draft GSP attempts to argue that streamflow depletion criteria is not applicable to the plan area because "the connection between regional groundwater and streams was broken prior to 2015." Again, the draft GSP acknowledges, based upon water year 2014 and 2016 data, that there is "at least potential for regional groundwater pumping to impact groundwater dependent ecosystems (GDEs)." Given that 2014 and 2016 coincided with a historic drought, the analysis likely underestimates the potential for streamflow depletion caused by groundwater pumping. The allusion to 2015 has little bearing on whether continuing streamflow depletion is impacting beneficial uses of surface water.

Studies document past and continuing streamflow depletion resulting from groundwater pumping throughout much of the San Joaquin River valley (e.g., The Nature Conservancy 2014), and DWR's own prioritization process for the Madera Sub-basin concludes ongoing impacts to streamflow and instream habitat are occurring. The Madera Sub-basin, prioritized as a "critical" basin with regard to achieving sustainable groundwater management, received extra priority points for streamflow and habitat impacts during the 2018 prioritization process. The DWR prioritization handbook (DWR 2018) makes clear that those points reflect potential impacts to GDEs and their habitat by stating that "...habitat and/or streamflow point(s) were not applied to basin prioritization until it was determined that one or more of the habitats and/or streamflows were potentially being adversely impacted."

The mechanism by which stream-dwelling organisms are impacted by groundwater pumping is habitat degradation caused by the draw-down of surface flows (Barlow and Leake 2012), and can occur in both "gaining" and "losing" stream reaches[1]. The impacts can be both physical (*e.g.*,

[1] Increasing the rate of streamflow depletion in a "losing reach" (*i.e.*, where surface water supplements the underlying groundwater aquifer) can impact groundwater dependent ecosystems, including those that support

pool volume shrinks as water surface elevation declines) and chemical (*e.g.*, water quality can suffer as pools and riffles lose connectivity). Thus, the appropriate method to determine whether pumping is having "significant and unreasonable adverse impacts" on beneficial uses of surface water is to understand the level of impact (*i.e.*, volume of streamflow depletion) and how habitat quality and functionality change because of that impact. Further data is required throughout the Madera Sub-basin to establish localized relationships between streamflow depletion and the resulting instream habitat characteristics. NMFS recommends the draft GSP elaborate sufficiently as to when, where, and how this data will be collected during the first few years of GSP implementation.

Page 3-18: The draft GSP again acknowledges the potential for impacts to GDEs within the Madera Sub-basin by stating, "although groundwater pumping from the regional aquifer is unlikely to affect surface water flows in the Plan area, there is at least some potential for the shallow groundwater system supporting GDEs to be affected by regional pumping."

Salmon and steelhead typically utilize varied habitat across a watershed landscape, seeking suitable water volume, water quality, and instream habitat supporting a specific life-stage (Quinn 2005). NMFS recommends the plan investigate and document potential streamflow depletion within the sub-basin, including considering the dynamic spatial and temporal patterns of groundwater accretion to surface flow that ultimately influence fish habitat use.

Page 3-56: NMFS recommends a streamflow depletion investigation/monitoring plan be included under "Description of Steps to Fill Data Gaps." In order to meet the SGMA requirement that streamflow depletion be characterized as a rate or volume of water, we recommend Madera County incorporate more surface water gauges that can better inform their analytical modeling efforts and validate their assumptions. The current distribution of streamflow gauges (i.e., per Figure 2-84, apparently 3 gauges) is insufficient for this task.

NMFS appreciates the opportunity to comment on the Madera Sub-basin draft GSP. Addressing streamflow depletion through effective groundwater management is essential to recovering listed salmonids within the San Joaquin River and tributaries. NMFS is prepared to engage with the Madera County, DWR, regulatory agencies and interested stakeholders to craft solutions to groundwater and streamflow issues in the Madera Sub-basin.

If you have any questions or concerns regarding this letter, please contact me at 916-930-3653 or Erin.Strange@noaa.gov.

Sincerely,

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salmon and steelhead. For instance, accelerating streamflow depletion in a losing reach can alter the timing when instream habitat becomes unsuitable for a given life-stage of fish.

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