GRAVELLY FORD WATER DISTRICT
GROUNDWATER SUSTAINABILITY PLAN

Prepared for:

Gravelly Ford Water District
18811 Road 27
Madera, CA 93638
Contact Person: Don Roberts

Consultant:

2816 Park Avenue
Merced, CA 95348
Contact: Garth Pecchenino, P.E.
Phone: (209) 723-2066
Fax: (559) 733-7821

and

Kenneth D. Schmidt & Associates
Fresno, California

January 2020

Project #180035

Table of Contents

LIST OF FIGURES

LIST OF TABLES

Appencies

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)

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.

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.

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.

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.

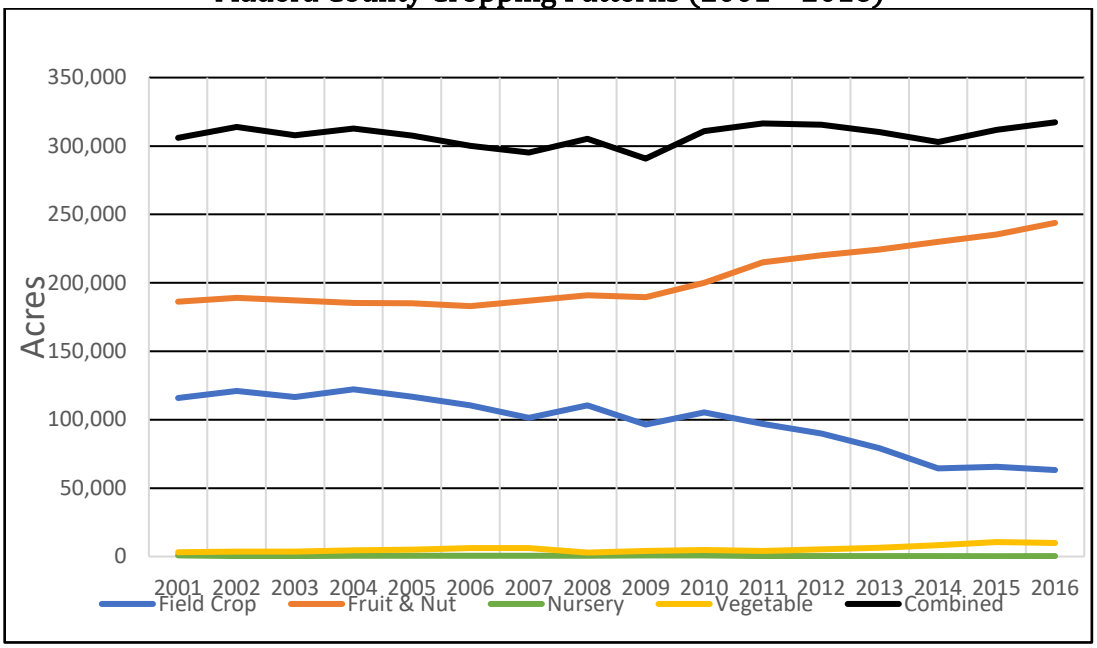
Agricultural Water Demands

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.

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.

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."

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)