CHOWCHILLA SUBBASIN

Sustainable Groundwater Management Act (SGMA)

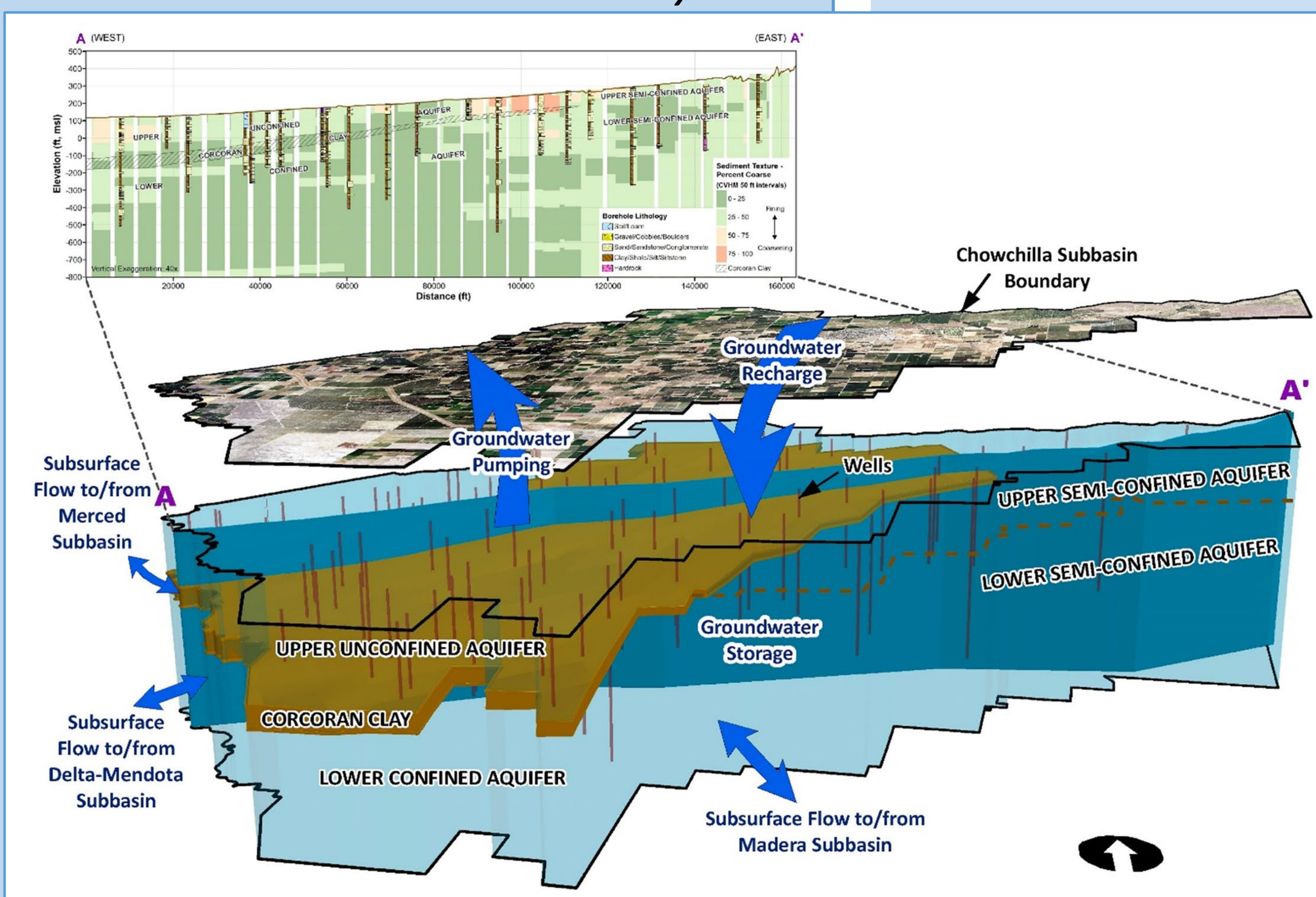
Groundwater Sustainability Plan

Executive Summary

January 2020

Prepared by

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



PUBLIC REVIEW DRAFT

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AN	above normal
AFY	acre-feet/year
AG	Agricultural Land
AWS	Automatic Weather Stations
BMP	Best Management Practice
BN	below normal
C	critical
C2VSim	California Central Valley Groundwater-Surface Water Simulation Model
C2VSim-CG	published coarse-grid version of C2VSim, Version R374
CCC	Columbia Canal Company
CCID	Central California Irrigation District
CCR	California Code of Regulations
CDEC	California Data Exchange Center
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CSUS	California State University, Sacramento
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CWC	California Water Code
CWD	Chowchilla Water District
D	dry
DE	Davids Engineering
DMS	Data Management System
DTW	depth to water
DWR	California Department of Water Resources
ERA	ERA Economics, LLC
ET	evapotranspiration
ET_a	actual ET
ET_{aw}	ET of applied water
ET_c	crop ET
ET_o	grass reference ET
ET_{pr}	ET of precipitation
ET_r	alfalfa reference ET
ET_{ref}	reference crop evapotranspiration
Flood-MAR	Flood Managed Aquifer Recharge
GAMA	Groundwater Ambient Monitoring and Assessment
GDEs	groundwater dependent ecosystems
GFWD	Gravelly Ford Water District
GIS	geographic information system
GMP	Groundwater Management Plan
GRF	Gravelly Ford
GSA	Groundwater Sustainability Agencies
GSP	Groundwater Sustainability Plan
GWS	groundwater system
HCM	hydrogeologic conceptual model
IDC	Integrated Water Flow Model Demand Calculator
IWFM	Integrated Water Flow Model
Kh	hydraulic conductivity
Kh	horizontal hydraulic conductivity
Kv	vertical hydraulic conductivity
LDC	Little Dry Creek
LSCE	Luhdorff & Scalmanini Consulting Engineers
Madera Co	Madera County
MCL	maximum contaminant level
MCWPA	Madera-Chowchilla Water and Power Authority
Merced Co	County of Merced Chowchilla
Merced ID	Merced Irrigation District
mg/L	milligrams/liter
MSL	mean sea level
MWELO	Model Water Efficient Landscape Ordinance
NOAA NCEI	National Oceanic and Atmospheric Administration National Centers for Environmental Information
NV	Native Vegetation Land
NWIS	National Water Information System
O&M	operation and maintenance
pCi/L	picocuries per liter
Qb	Quaternary flood-plain deposits

QTcd	Quaternary continental rocks and deposits
Reclamation	United States Bureau of Reclamation
redox	reduction-oxidation
RFP	Request for Proposals
RH	relative humidity
Rs	solar radiation
SAGBI	Soil Agricultural Groundwater Banking Index
SCS-CN	SCS curve number
SEBAL	Surface Energy Balance Algorithm for Land
SGMA	Sustainable Groundwater Management Act of 2014
SJRRP	San Joaquin River Restoration Program
SJV	San Joaquin Valley
SLDMWA	San Luis Delta-Mendota Water Authority
SS	Stillwater Sciences
SVMWC	Sierra Vista Mutual Water Company
SWRCB	State Water Resources Control Board
SWS	surface water system
Sy	specific yield
Ta	air temperature
TAF	thousand acre-feet
TDS	total dissolved solids
TM	Technical Memorandum
TTWD	Triangle T Water District
UR	Urban Land
USACE	United States Army Corps of Engineers
USBR	U.S. Bureau of Reclamation, or Reclamation
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
W	wet
WDL	Water Data Library
Ws	wind speed
WYI	Water Year Index
yield	groundwater benefit

ES-1 INTRODUCTION

Groundwater serves as an important source of supply for agricultural, municipal, domestic, industrial, and environmental beneficial uses throughout the Chowchilla Subbasin[1], which underlies approximately 146,000 acres within Madera and Merced Counties. For instance, agriculture in the Chowchilla Subbasin relies on approximately 300,000 acre-feet (AF) of groundwater annually to produce an array of commodities that contribute to the agricultural economies of both Madera County and Merced County, which have a total combined value of over $5 billion dollars.[2] Groundwater also supports a large portion of domestic, municipal, and industrial water use in and around the City of Chowchilla. Thus, the sustainable management of groundwater in the Chowchilla Subbasin is important for long-term prosperity within Madera and Merced Counties.

The Sustainable Groundwater Management Act of 2014 (SGMA) provides for local control of groundwater resources while requiring sustainable management of these resources. SGMA requires groundwater basins or subbasins to establish governance by forming local Groundwater Sustainability Agencies (GSAs) with the authority to develop, adopt, and implement a Groundwater Sustainability Plan (GSP, or Plan). Under this Plan, GSAs must adequately define and monitor groundwater conditions in the subbasin and establish criteria to maintain or achieve sustainable groundwater management within 20 years of GSP adoption.

Sustainable management of groundwater is defined under SGMA as the "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results" (California Water Code (CWC) Section 10721(v)). These undesirable results include significant and unreasonable lowering of groundwater levels, loss of groundwater storage and supply, degradation of water quality, land subsidence, and surface water depletion. Sea water intrusion, while a SGMA-defined undesirable result, is not applicable to the Chowchilla Subbasin.

The Chowchilla Subbasin has been identified by the California Department of Water Resources (DWR) as a critically overdrafted subbasin. Under SGMA, critically overdrafted subbasins are required to prepare and be managed under a GSP by January 31, 2020 (CWC Section 10720.7(a)(1)).

This GSP is the coordinated Plan for four GSAs that represent the entirety of the Chowchilla Subbasin area: Chowchilla Water District GSA, Madera County GSA, County of Merced Chowchilla GSA, and Triangle T Water District GSA (Figure ES-1). The Chowchilla Subbasin will satisfy SGMA requirements with this single GSP that covers the entire subbasin.

The purpose of this GSP is to characterize groundwater conditions in the Chowchilla Subbasin, to evaluate and report on conditions of overdraft, to establish sustainability goals, and to describe projects and management actions the GSAs will implement to achieve sustainable groundwater management by 2040.

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[1] Groundwater basin number 5-022.05, part of the San Joaquin Valley Groundwater Basin, as defined by DWR Bulletin 118 (DWR, 2004) and updated in 2016.

[2] According to the Madera County Department of Agricultural Weights and Measures, the gross value of all agricultural production in the County was $1,973,449,000 (2017 Crop and Livestock Report). According to the Merced County Department of Agriculture, the gross value of all agricultural commodities in the County was $3,408,866,000 (Merced County 2017 Report on Agriculture).

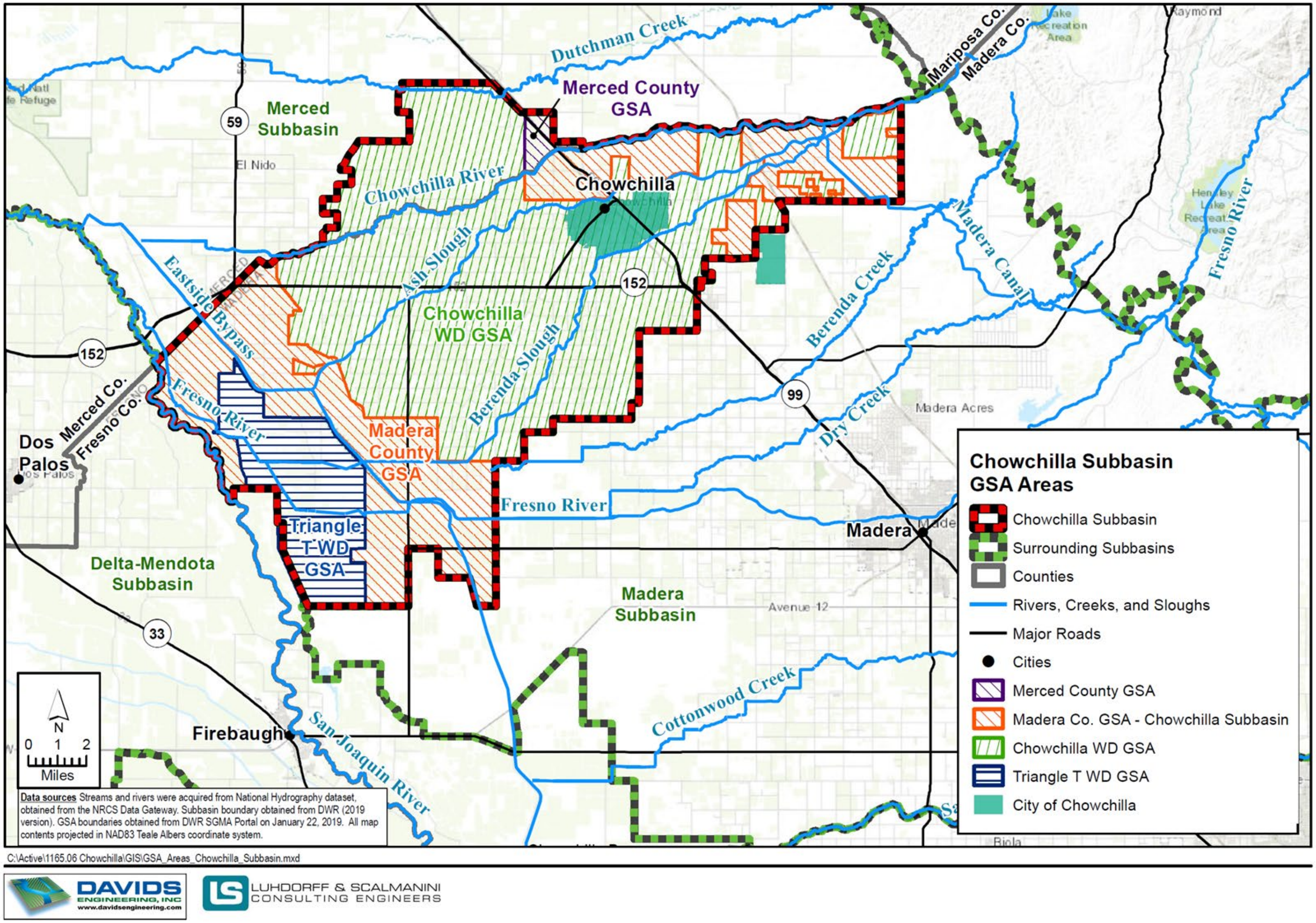

Figure ES-1. Chowchilla Subbasin GSAs Map.

This GSP also serves to comply with DWR's requirements that the Chowchilla Subbasin GSAs prepare, adopt, and implement a plan "consistent with the objective that a basin be sustainably managed within 20 years of Plan implementation without adversely affecting the ability of an adjacent basin to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon" as defined in the California Code of Regulations Title 23 (CCR), Section 350.4 (f) that detail the requirements and components of the GSP.

As mandated under 23 CCR Section 354.24, GSAs within the Chowchilla Subbasin have established a "sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline." Specifically, this sustainability goal establishes that the Chowchilla Subbasin will be operated within its sustainable yield by 2040, or 20 years following GSP submittal in January 2020.

ES-2 PLAN AREA AND BASIN SETTING

The Plan Area is defined as the Chowchilla Subbasin (5-022.05), part of the San Joaquin Valley Groundwater Basin, as described in DWR Bulletin 118 (DWR, 2016) with boundary updates approved in early 2019. The subbasin is bounded in the south and east by the Madera Subbasin, in the west by the San Joaquin River and the Delta-Mendota Subbasin, and in the north by the Merced Subbasin (**Figure ES-1**). The vertical boundaries of the subbasin are the land surface (upper boundary) and the definable bottom of the basin (lower boundary). The vertical extent of the subbasin is subdivided into a surface water system (SWS) and groundwater system (GWS). The SWS represents the land surface down to the bottom of plant root zone,[3] within the lateral boundaries of the subbasin. The GWS extends from the bottom of the root zone to the definable bottom of the subbasin, within the lateral boundaries of the subbasin.

Hydrogeologic Conceptual Model

The Chowchilla Subbasin is underlain by the Corcoran Clay over approximately the western and central two-thirds of the subbasin area. The depth to top of Corcoran Clay varies from 50 to 100 feet at its northeastern extent to in excess of 250 feet in the southwestern portion of the subbasin. In the western portion of the subbasin, the aquifer system is subdivided into an upper unconfined aquifer above the Corcoran Clay and a lower confined aquifer below the Corcoran Clay (**Figure ES-2**). In the central and eastern portions of the subbasin where the Corcoran Clay is shallow or does not exist, the aquifer system is generally considered to be semi-confined with discontinuous clay layers interspersed with more permeable coarse-grained units.

The upper 800 feet of sediments are comprised of multiple layers of coarse-grained sediments. Thus, it can be anticipated that most wells will obtain close to their maximum yield within approximately the upper 800 feet of sediments. The vast majority of water wells are constructed within the upper 1,000 feet because sediments generally become finer with depth and towards the center of the valley (Provost and Pritchard, 2014).

[3] The depth to the bottom of the root zone varies by crop, but typically ranges from 2-7 feet (ASCE, 2016).

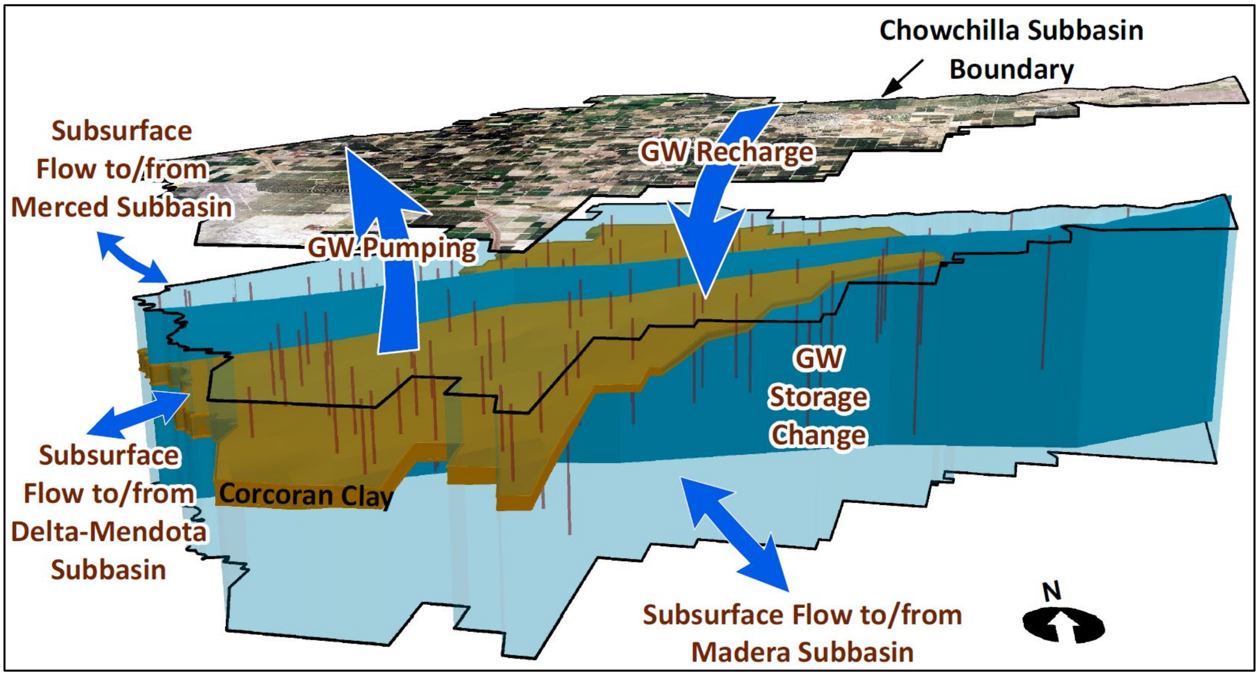

Figure ES-2. Chowchilla Subbasin Hydrogeologic Conceptual Model.

Groundwater recharge can occur throughout Chowchilla Subbasin from infiltration of precipitation and excess irrigation water, streamflow percolation, and other sources. A relatively large area of hydrologic group A and B soils with higher infiltration capacity is located in the central portion of the subbasin from north of Chowchilla River to south of Berenda Slough, and from the City of Chowchilla on the east to Eastside Bypass on the west. This large area of hydrologic group A and B soils has soil saturated vertical hydraulic conductivity from 1.1 to greater than 5 feet/day, whereas most other areas have soil saturated vertical K of less than 1 foot/day.

Under current and recent historical groundwater conditions, the primary source of groundwater discharge from the subbasin is via groundwater pumping for agricultural, municipal, domestic, and industrial uses. The majority of domestic wells are located in the central to eastern portions of the subbasin, agricultural wells are relatively spread out throughout the entire subbasin, and public supply wells are concentrated in the central to eastern portions of the subbasin. Domestic well depths vary across the subbasin, with the most common domestic well depth between 300 and 400 feet. Agricultural and public supply wells also vary in depth across the subbasin, but they tend to be somewhat deeper than domestic wells with the most typical well depths in the range of 500 to 750 feet.

Water Budget

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume[4] over a specified period of time. When the water budget volume is an entire subbasin, the water budget facilitates assessment of the total volume of groundwater and surface water entering and leaving the subbasin over time, along with the change in the volume of water stored within the subbasin. Water

[4] Where 'volume' refers to a space with length, width and depth properties, which for purposes of the GSP means the defined aquifer and associated surface water system.

budgets were developed for the Subbasin during defined historical, current, and projected study periods. A numerical integrated groundwater flow model (MCSim) was developed and utilized to support development of water budgets.

The 1989 through 2014 period was found to be representative of the long-term average based on analysis of precipitation, unimpaired flows, and CVP supplies and selected as the historical base period. Due to changes in land use occurring over the historic base period, most notably the significant shift from pasture and alfalfa to almonds, the current water budget was calculated by using land use data from 2015 to calculate consumptive use and other root zone components in the Land Surface System water budget for 1989 through 2014. The objective of completing a current water budget is to understand the impact of current land use on the water budget. This requires applying current land use conditions to the historical base period hydrologic and climatic conditions. This was accomplished by assuming the 2015 land use occurred in each year during the 1989 through 2014 historical base period. With current land use conditions and average 1989 through 2014 hydrology, the estimated overdraft in the Chowchilla Subbasin was 101,900 acre-feet (**Figure ES-3**).

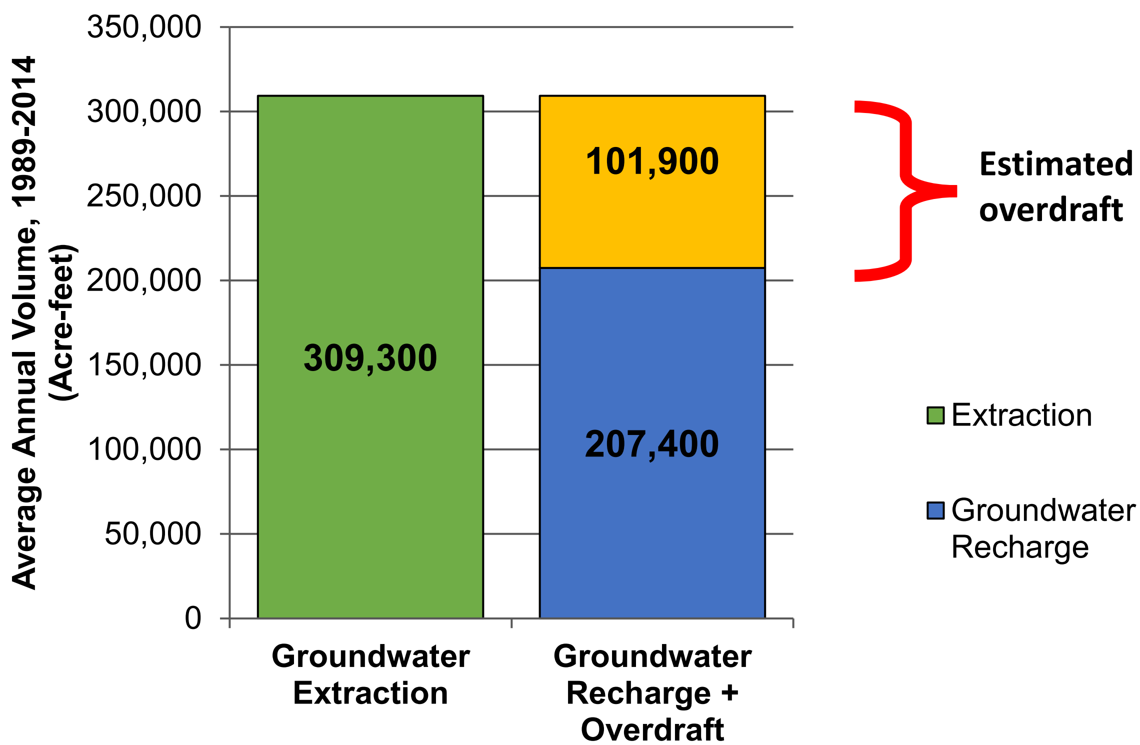

Figure ES-3. Simplified Groundwater Condition (2015 Land Use).

The groundwater model was used to estimate projected water budgets over 70 years of future hydrology under different future climate scenarios and to evaluate the effects of management actions and project. Two primary projected water budget scenarios were considered: a projected without projects (no action) scenario, and a projected with projects scenario. Both these projected scenarios were also considered in the context of potential climate change effects on surface water supply and weather parameters.

Two major time periods exist in the future projected model: the implementation period (2020-2039), during which projects and management actions are implemented to bring the basin into sustainability, and the sustainability period (2040-2090), after which projects and management actions have been fully implemented. The projected with projects scenario for the sustainability period results showed no overdraft in the Chowchilla Subbasin (**Figure ES-4**).

GSP Regulations require the water budget to quantify the sustainable yield for the subbasin. Sustainable yield is defined as “the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result” (CWC Section 10721(w)).

Sustainable yield is dependent upon conditions in existence at the time, and therefore changes during implementation of projects that increase recharge. Thus, sustainable yield was only calculated for the sustainability period (2040-2090).

Given the schedule for project implementation and the mitigation program for domestic wells, the model results for the 2040-2090 sustainability period with projects show sustainability indicators that avoid MTs and associated undesirable results. Thus, the sustainable yield for this 2040-2090 projected period ensures this is a quantity of water “…that can be withdrawn annually from a groundwater supply without causing an undesirable result” (CWC Section 10721(w)). In alignment with GSP Regulations and DWR’s Sustainable Management Criteria BMP (DWR, 2017), sustainable yield has been calculated for the 2040-2090 projected period using two methods (**Table ES-1**) with a single value of sustainable yield for the subbasin as a whole (DWR, 2017).

The first method estimates sustainable yield as the average annual groundwater extraction minus the average annual change in groundwater storage during the projected 2040-2090 period. Since average groundwater inflows approximately equal outflows during the 2040-2090 period, the average annual change in the groundwater storage was assumed to be zero over this 50-year period. The second method calculates sustainable yield as the sum of the average projected annual inflows to the groundwater system (infiltration of applied water, infiltration of precipitation, infiltration of surface water, and subsurface inflows). The average of 249,700 acre-feet is determined as the sustainable yield of the Chowchilla Subbasin after all projects and management actions have been implemented.

Table ES-1. Summary of Sustainable Yield Estimates from Projected with Projects Water Budget (23 CCR §354.18(b)(7)).

Quantification Method	Average Volume, 2040-2090 (AF)	Estimated Confidence Interval (percent)	Confidence Interval Source	Average minus CI (AF)	Average plus CI (AF)
Groundwater Extraction and GWS Change in Storage	248,500	25%	Professional judgment based on historical calculations.	186,400	310,600
Total Inflows to GWS	250,900	25%	Professional judgment based on historical calculations.	188,200	313,600
Average	249,700	25%	Professional judgment based on historical calculations.	187,300	312,100

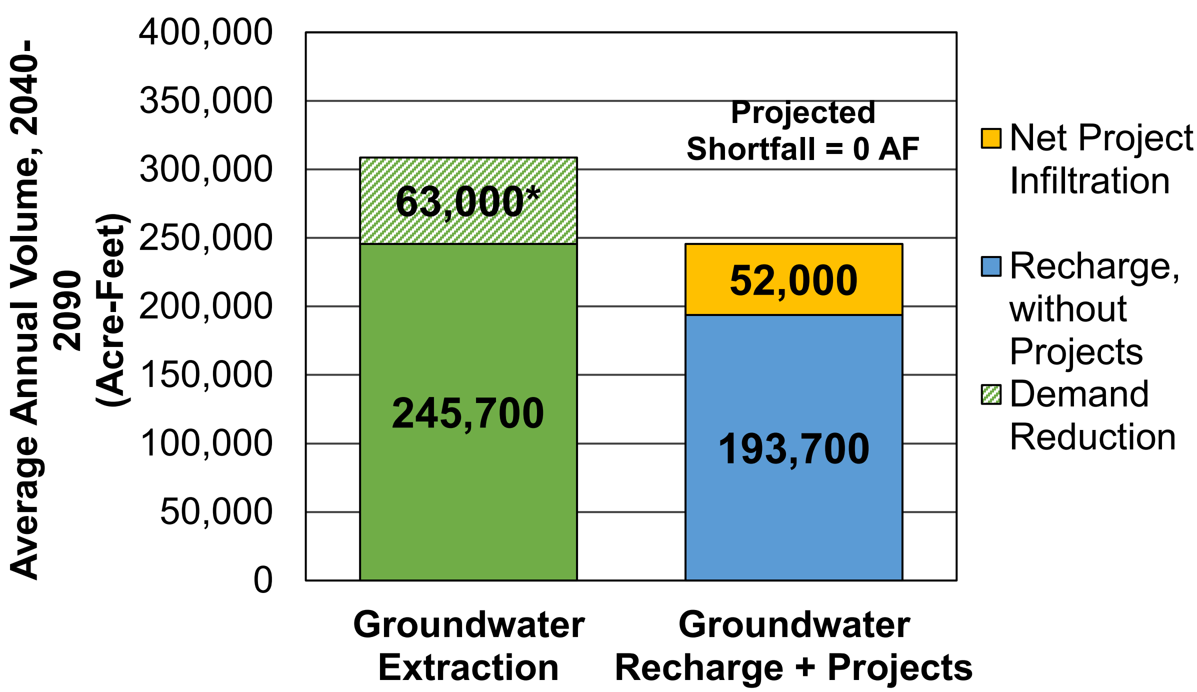

Figure ES-4. Simplified Groundwater Condition With Projects (2040-2090).

***Crop Water Use Reduction Program: Madera County East 11,300 af, Madera County West 16,250 af, TTWD 1,700 af. Remaining crop water use reduction due to permanent recharge basins replacing irrigated area and increased use of surface water in lieu of groundwater.**

ES-3 SUSTAINABLE MANAGEMENT CRITERIA

Sustainability Indicators

Undesirable results occur when significant and unreasonable effects for any of the six sustainability indicators defined by SGMA are caused by groundwater conditions occurring in the Subbasin. The overarching sustainability goal and the absence of undesirable results are expected to be achieved by 2040 through implementation of the projects and management actions (MAs). The sustainability goals will be maintained through proactive monitoring and management by the GSAs. **Table ES-2** summarizes whether, for each of the six sustainability indicators, undesirable results have occurred, is occurring, or is expected to occur in the future in the Subbasin without and with GSP implementation.

Table ES-2. Summary of Undesirable Results Applicable to the Plan Area.

Sustainability Indicator	Historical Period	Existing Conditions	Future Conditions without GSP Implementation	Future Conditions with GSP Implementation (after 2040)
Chronic Lowering of Groundwater Levels	Yes	Yes	Yes	No
Reduction of Groundwater Storage	Yes	Yes	Yes	No
Land Subsidence (Western Management Area)	Yes	Yes	Yes	No
Land Subsidence (Eastern Management Area)	No	No	Possibly	No
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Degraded Water Quality	Yes	Yes	Yes	No[1]
Depletion of Interconnected Surface Water	Yes	No[2]	No	No

[1] There may be future continued degradation of groundwater quality that is not related to GSP Projects and Management Actions.
[2] Surface water and groundwater are disconnected under existing conditions.

The regulations define undesirable results as occurring when significant and unreasonable effects are caused by groundwater conditions occurring for a given sustainability indicator. Significant and unreasonable effects occur when minimum thresholds (MTs) are exceeded for one or more sustainability indicators. A summary of the sustainable management MTs, measurable objectives (MO) and undesirable results is provided in **Table ES-3**. Locally defined undesirable results were based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.

Table ES-3. Summary of MTs, MOs and Undesirable Results.

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result
Chronic Lowering of Groundwater Levels	The lowest of a) projected lowest future groundwater level at end of estimated 10-year drought or b) lowest modeled groundwater level from projected with projects model simulation (2019-2090)	Projected average future groundwater level from projected with projects model simulation (2040-2090)	30 percent of wells below minimum threshold for two consecutive fall measurements
Reduction of Groundwater Storage	No long-term reduction in groundwater storage based on measured groundwater levels	Projected average future groundwater level from projected with projects model simulation (2040-2090)	30 percent of wells below minimum threshold for two consecutive fall measurements
Land Subsidence (Western Management Area)	The highest of (a) projected lowest future groundwater level at end of estimated 10-year drought or b) or recent groundwater level lows)	Projected average future groundwater level from projected with projects model simulation (2040-2090)	50 percent of Western MA Lower Aquifer wells below minimum threshold for two consecutive fall measurements
Land Subsidence (Eastern Management Area)*	Not Applicable	Not Applicable	Not Applicable
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable
Degraded Water Quality	Nitrate = 10 mg/L or existing level plus 20% (whichever is greater) Arsenic = 10 µg/L or existing level plus 20% (whichever is greater) TDS = 1,000 mg/L or existing level plus 20% (whichever is greater)	Current constituent concentrations	10 percent of wells above the minimum threshold for the same constituent, based on average of most recent three year period
Depletion of Interconnected Surface Water	Not Applicable	Not Applicable	Not Applicable

*Ongoing subsidence surveys being conducted by others will be reviewed on an annual basis to determine if significant and unreasonable impacts are occurring related to subsidence in this area. If necessary, minimum thresholds will be established in the Eastern Management Area to address potential future land subsidence issues.

Chronic Lowering of Groundwater Levels

The GSP regulations provide that the "minimum thresholds for chronic lowering of groundwater levels shall be the groundwater level indicating a depletion of supply at a given location that may lead to undesirable results." Chronic lowering of groundwater levels in the Subbasin cause significant and unreasonable declines if they are sufficient in magnitude to lower the rate of production of pre-existing domestic groundwater wells below that necessary to meet the minimum required to support overlying beneficial use(s) where alternative means of obtaining sufficient groundwater resources are not technically or financially feasible. In addition, groundwater levels will be managed with consideration of the minimum thresholds to ensure the major aquifers in the Subbasin are not depleted in a manner to cause significant and unreasonable impacts to other sustainability indicators. At the same time, the GSAs recognize that groundwater levels are anticipated to fall below 2015 levels during the GSP implementation period. Thus, the minimum thresholds have been developed with these considerations in mind.

With groundwater levels anticipated to decline further during the Implementation Period as projects are implemented and demand reduction programs expand, the subbasin GSAs are in the process of developing a domestic well mitigation program to provide assistance to domestic well owners adversely impacted by future groundwater level declines. By 2040 and during the sustainability period, groundwater levels are expected to stabilize and potentially rebound, thus the domestic well mitigation program is not anticipated to be needed beyond the implementation period. The alternative of specifying higher minimum thresholds consistent with current groundwater levels (to avoid need for a domestic well mitigation program) would require immediate and substantial cutbacks in groundwater pumping that result in major impacts to the local economy and all basin stakeholders, including domestic well owners. Thus, GSAs will mitigate for potential impacts to domestic wells caused by temporary further declines in groundwater levels during the implementation period.

Reduction of Groundwater Storage

The groundwater storage reduction metric will be evaluated using groundwater levels as a proxy in conjunction with annual evaluations of long-term groundwater level changes over average climatic periods during the Sustainability Period. Based on considerations applied in developing the groundwater level MTs, reduction in groundwater storage minimum thresholds do not exceed any identified significant and unreasonable level of depleted groundwater storage volume.

Land Subsidence

The cause of basin groundwater conditions that would result in significant and unreasonable land subsidence is excessive overall average annual groundwater pumping and other outflows from the subbasin that exceed average annual inflows. Significant and unreasonable land subsidence results in significant impacts to infrastructure.

The Western Management area, which has had significant historic impacts to infrastructure related to subsidence, is subject to initial subsidence-based minimum thresholds. Given subsidence that has occurred since 2005 is tied to declining groundwater levels in the Lower Aquifer, groundwater levels are being used as a proxy for subsidence (subject to contemporaneous and ongoing review of subsidence surveys in the region). After determination of the groundwater level minimum thresholds, the subsidence-based minimum threshold was established by adjusting the subsidence-based groundwater level minimum threshold to not be below recent historic groundwater levels in the well. In most cases, recent historic low groundwater levels occurred between 2014 and 2016.

Because no significant subsidence-related impacts to infrastructure have been noted to date in the Eastern Management Area, subsidence-based MTs are not being established initially within this management area. However, an adaptive management approach is being implemented for land subsidence in the Eastern Management Area. The ongoing subsidence surveys being conducted by others will be reviewed on an annual basis to determine if significant and unreasonable impacts are occurring or are likely to occur related to subsidence in this area. If future monitoring indicates it is necessary, minimum thresholds will be set in the Eastern Management Area to address potential future land subsidence issues.

Degraded Water Quality

The cause of basin groundwater conditions that would result in significant and unreasonable degraded water quality is implementation of a GSP project or management action that causes concentrations of key groundwater quality constituents to increase to concentrations exceeding the MCLs for drinking water for identified key constituents (10 mg/L for nitrate as nitrogen; 500 mg/L for TDS; 10 µg/L for arsenic). There are no known significant large-scale groundwater quality contamination plumes in regional groundwater aquifers within the Subbasin. Municipal and domestic supply (MUN) is a designated beneficial use for groundwater in the Subbasin; therefore, groundwater quality degradation is considered significant and unreasonable based on adverse impacts to this beneficial use. Significant and unreasonable degradation of water quality occurs when beneficial uses for groundwater are adversely impacted by constituent concentrations increasing to levels above the drinking water MCLs for one of the key constituents (nitrate, arsenic, TDS) at indicator wells in the representative groundwater quality monitoring network due to implementation of a GSP project or management action. When existing or historical concentrations for the key constituents already exceed the MCL, the minimum threshold is set at the recent concentration plus 20 percent.

Depletion of Interconnected Surface Water

Regional groundwater levels have been below the stream channel bottoms in Chowchilla Subbasin for at least the last several years, and for many decades in most of the subbasin. It has been determined that a hydraulic connection between regional groundwater and streams does not exist. Therefore, the surface water depletion sustainability criteria is not applicable to this subbasin.

Seawater Intrusion

The seawater intrusion sustainability criterium is not applicable to this subbasin.

Monitoring Networks

The GSP groundwater monitoring network was developed using existing wells in the subbasin and will be supplemented (and/or some initial wells replaced) by new nested monitoring wells to be installed by 2020. The database for existing wells was reviewed with the following criteria in mind:

- CASGEM wells preferred;
- Known construction (screen intervals, depth) preferred;
- Long histories of data (including recent data) preferred;
- Good spatial distribution preferred;
- Representation of both Upper (where present in western portion of subbasin) and Lower Aquifers preferred;
- Relatively good match between observed and modeled water levels preferred for water levels monitoring wells.

The selected groundwater level indicator wells (Representative Monitoring Sites) are distributed throughout the Subbasin to provide broad spatial coverage of the Subbasin, to the extent possible (**Figure ES-5**). The groundwater quality indicator wells represent a subset of the water level indicator wells with additional wells included from other groundwater quality monitoring programs. The monitoring network will be periodically reviewed and modified as needed.

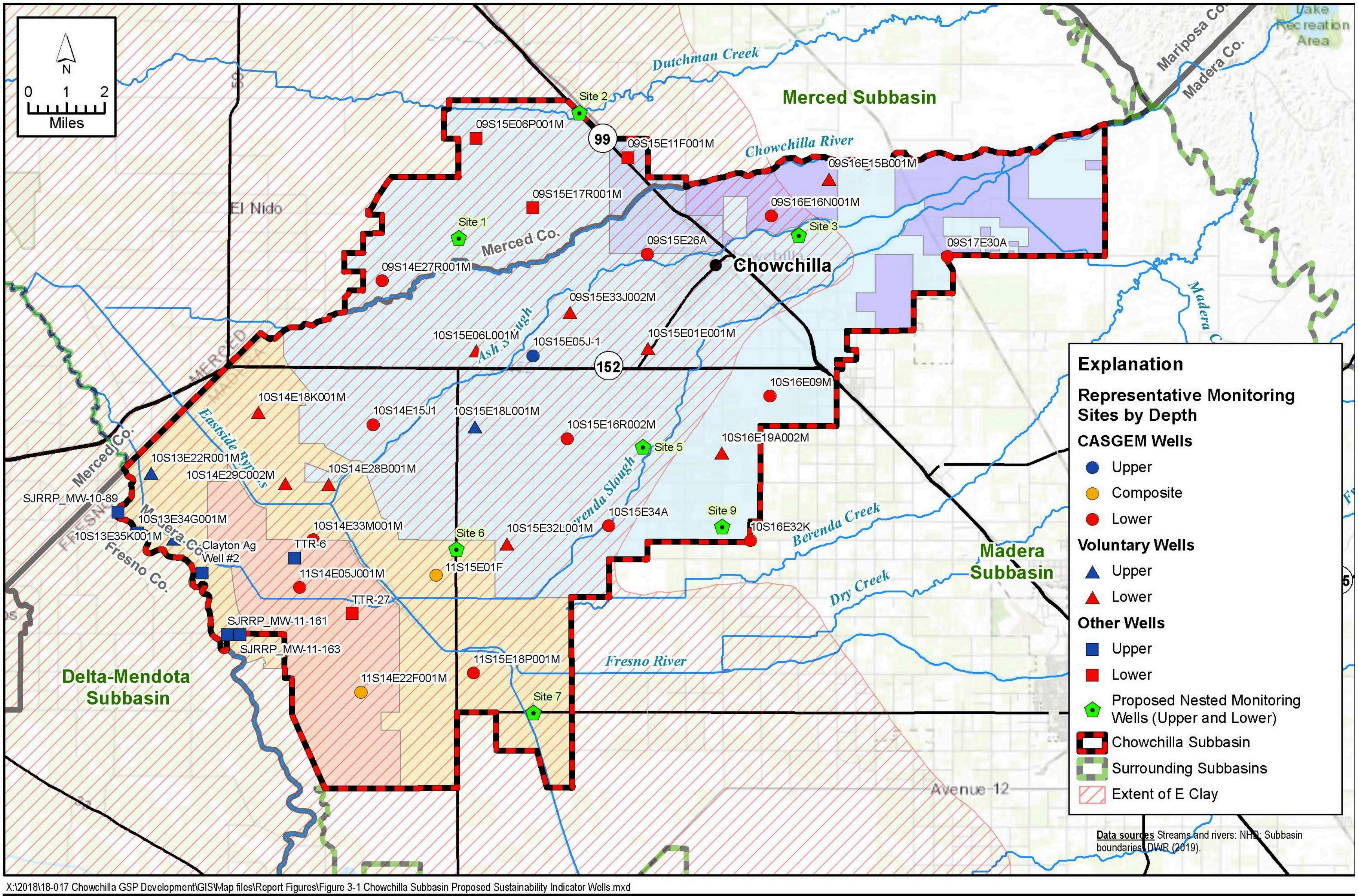

Figure ES-5. Monitoring Network: CASGEM, Voluntary and Other Wells

ES-4 SUBBASIN PROJECTS AND MANAGEMENT ACTIONS

To achieve the Subbasin sustainability goal by 2040 and avoid undesirable results through 2090 as required by SGMA regulations, a range of projects and management actions will be developed and implemented by the GSAs. Projects generally refer to structural programs whereas management actions are typically non-structural programs or policies that are intended to incentivize reductions in groundwater pumping.

Three types of projects are included in the Chowchilla Subbasin GSP for implementation: recharge, conveyance, and storage. Recharge projects are designed to support sustainability by increasing recharge. Conveyance projects facilitate the delivery of additional water supplies to increase recharge or use for irrigation, thereby reducing groundwater pumping. Storage projects store additional water supplies to increase recharge or use for irrigation, thereby reducing groundwater pumping. Some projects have a specific water source, but many of the recharge projects can draw from the same general sources. The demand management action by the Madera County GSA provides groundwater users a flexible way to meet any future pumping restrictions.

The cost, timing, and gross groundwater benefit (yield) of the projects and management actions included in the GSP vary by GSA. **Table ES-4** lists all of the projects and management actions, by GSA or implementing entity, and the estimated implementation timeline, capital cost, operating cost, and gross benefit of the projects. **Table ES-5** further summarizes the total gross benefits and costs of all projects and management actions developed for each GSA or implementing entity.

The gross yield across all projects at full implementation (2040) equals approximately 134,500 acre-feet per year. This includes the demand management program (management action) to be implemented by the Madera County GSA that will reduce net groundwater pumping by about 28,000 acre-feet per year.

Table ES-4. Chowchilla Subbasin Projects and Management Actions.

GSA[1]	Project	First Year of Implementation	Average Annual Benefit at Full Implementation (acre-feet)	Estimated Capital Cost ($, millions)	Estimated Average Annual Operating Cost ($/year, millions)
CWD	Recharge Basin	2018	1,359	3.0	0.01
CWD	Flood-MAR	2020	5,836	N/A	0.2
CWD	Additional Recharge Basins (1,000 acres)	2021	10,803	40.0	0.5
CWD	Madera Canal Capacity Increase	2035	5,147	61.2	0.3
CWD	Merced-Chowchilla Intertie	2035	7,350	6.6	1.5
CWD	Eastman Lake (Buchannan Dam) Enlargement	2040	8,753	49.0	0.2
Madera County (East)	Water Purchase/Import for In-Lieu or Recharge	2020	3,015	1.0	1.1

GSA[1]	Project	First Year of Implementation	Average Annual Benefit at Full Implementation (acre-feet)	Estimated Capital Cost ($, millions)	Estimated Average Annual Operating Cost ($/year, millions)
Madera County (West)	Water Purchase/Import for In-Lieu or Recharge	2020	27,953	120.0	0.7
Madera County (All)	Demand Management	2020	27,550	n/a	19.6[3]
SVMWC[2]	SVMWC Recharge Basin	2020	4,344	7.5	0.22
TTWD	Poso Canal Pipeline / Settlement Agreement	2020	7,647	5.2	4.5
TTWD	Eastside Bypass Flood Water / Redtop Joint Banking	2021	24,657	24.5	0.7
Total			**134,416**	**322.1**	**31.8**

[1]Projects and management actions summarized by each GSA, GSA subregion, or local agency responsible for implementation.
[2] SVMWC includes portions of both Madera County GSA and Merced County GSA.
[3] Costs of demand management include reduced economic activities in the county, this includes approximately $19.1 million per year in direct economic impacts alone (excluding multiplier effects). Demand management program capital costs are not known at this time.

Table ES-5. Summary of Chowchilla Subbasin Projects and Management Actions by GSA.

GSA[1]	Average Annual Gross Benefit at Full Implementation (acre-feet)	Estimated Capital Cost ($, millions)	Estimated Average Annual Operating Cost ($/year, millions)
CWD	39,248	159.8	5.0
Madera County	58,518	121.0[3]	21.4[3]
SVMWC[2]	4,344	7.5	0.22
TTWD	32,304	29.7	5.2
Total	**134,414**	**327.1**	**31.8**

[1]Projects and management actions summarized by each GSA or local agency responsible for implementation.
[2] SVMWC includes portions of both Madera County GSA and Merced County GSA.
[3] Costs of demand management include reduced economic activities in the county, this includes approximately $19.1 million per year in direct economic impacts alone (excluding multiplier effects).

ES5 PLAN IMPLEMENTATION

Administering the GSP and monitoring and reporting progress is projected to cost approximately $1.2 million per year across all Subbasin GSAs. Costs are expected to be higher during years in which a five-year periodic evaluation is due, and slightly lower during years in which an annual report is due. This does not include the capital and annual operating cost of projects and management actions.

Development of this GSP was funded through a Proposition 1 Grant and contributions from individual GSAs (e.g., through in-kind staff time, or separately contracted consulting services). Individual GSAs are also funding additional, ancillary studies and implementation efforts. To fund GSA operations and GSP implementation, GSAs are developing a financing plan that will include one or more of the following financing approaches:

- **Grants and low-interest loans**: GSAs will continue to pursue grants and low interest loans to help fund planning studies and other GSA activities. However, grants and low-interest loans are not expected to cover most GSA operating costs for GSP implementation.
- **Groundwater extraction charge**: A charge per acre-foot pumped could be used to fund GSP implementation activities.
- **Other Fees and charges**: Other fees may include permitting fees for new wells or development, transaction fees associated with contemplated groundwater markets, or commodity-based fees, all directed at aiding with sustainability objectives. Depending on the justification and basis for a fee, it may be considered a property-related fee subject to voting requirements of Article XIII D of the California Constitution (passed by voters in 1996 as Proposition 218) or a regulatory fee exempt from such requirements.
- **Assessments:** Special benefit assessments under Proposition 218 could include a per-acre (or per-parcel) charge to cover GSA costs.
- **Taxes:** This could include general property related taxes that are not directly related to the benefits or costs of a service (ad valorem and parcel taxes), or special taxes imposed for specific purposes related to GSA activities.

GSAs are pursuing a combined approach, targeting available grants and low interest loans, and considering a combination of fees and assessment to cover operating and program-specific costs. As required by statute and the Constitution, GSAs would complete an engineer's report, rate study, and other analysis to document and justify any rate, fee, or assessment. For example, Madera County has initiated two separate rate studies for Fall 2019. In the initial rate study, an engineering report is being produced to adequately fund an existing flood control and water conservation agency, which would allow for the agency to adequately control flood flows with existing infrastructure. In the next rate study, an engineering report is being produced for the ongoing costs associated with running the three County GSAs, which would include administration as well as sufficient planning funds for eventual project implementation.

The GSP implementation schedule allows time for GSAs to develop and implement projects and management actions and meets all sustainability objectives by 2040. While some sustainability projects began immediately after SGMA became law and are already contributing to Subbasin goals (**Figure ES-6**), the GSAs will begin implementing all other GSP activities in 2020, with full implementation of projects and management actions to achieve sustainability by 2040. **Figure ES-7** illustrates the GSP implementation schedule for projects and management actions implemented by each GSA (Madera County East and West correspond to the portion of the Madera County GSA within each Management Area). The GSP implementation schedule also shows mandatory reporting and updating for all GSAs, including annual reports and five-year periodic updates (evaluations) prepared and submitted to DWR.

The GSP Implementation Plan uses the best available information and the best available science to provide a road map for the Chowchilla Subbasin to meet its sustainability goal by 2040 and comply with the SGMA regulations. During each five-year update, progress will be assessed, and the implementation plan revised as necessary, to achieve the sustainability goal by 2040 and comply with the SGMA regulations.

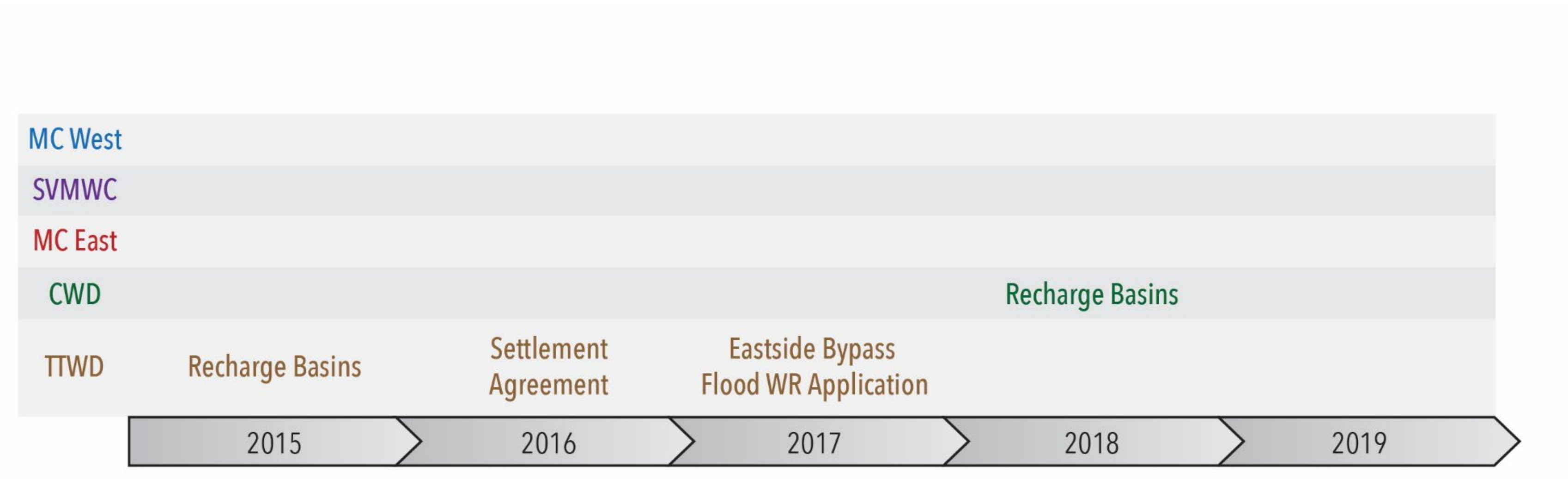

Figure ES-6. Chowchilla Subbasin Implementation Schedule (2015-2019).

	2020 – 2024	2025	2026 – 2029	2030	2031 – 2034	2035	2036 – 2039	2040
MC West	Red Top Joint Banking Project; Demand Management	Demand Management	Demand Management	Demand Management	Demand Management	Demand Management	Demand Management	Demand Management
Sierra Vista MWC	Recharge Basins	Recharge Basins						
MC East	Flood Water Recharge; Imported Water Purchase;Demand Management	Flood-MAR; Demand Management	Demand Management	Demand Management	Demand Management	Demand Management	Demand Management	Demand Management
CWD	Flood-MAR	Recharge Basins; Flood-MAR	Recharge Basins; Flood-MAR	Merced-Chowchilla Intertie; Madera Canal Capacity Increase	Recharge Basins; Flood-MAR	Recharge Basins; Flood-MAR	Recharge Basins; Flood-MAR	Eastman Lake Enlargement
TTWD	Red Top Joint Banking Project							
All GSAs	Annual Reports	Periodic Evaluation	Annual Reports	Periodic Evaluation	Annual Reports	Periodic Evaluation	Annual Reports	Periodic Evaluation

Figure ES-7. Chowchilla Subbasin Implementation Schedule (2020-2040).