TURLOCK IRRIGATION DISTRICT

2015 AGRICULTURAL WATER MANAGEMENT PLAN

Prepared by:

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Prepared for compliance with:

Part 2.8 of Division 6 of the Water Code, pertaining to Agricultural Water Management Planning (Senate Bill SBx7-7, the Water Conservation Act of 2009) and Executive Order B-29-15 (April 1, 2015)

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Preface

This Agricultural Water Management Plan (AWMP or Plan) has been prepared by Turlock Irrigation District (TID or District) in accordance with the requirements of the Water Conservation Act of 2009 (SBx7-7) and Executive Order B-29-15 (April 1, 2015). SBx7-7 modifies Division 6 of the California Water Code (CWC or Code), adding Part 2.55 (commencing with §10608) and replacing Part 2.8 (commencing with §10800). In particular, SBx7-7 requires all agricultural water suppliers to prepare and adopt an update to their AWMP as set forth in the CWC and the California Code of Regulations (CCR) on or before December 31, 2015**.** The Plan must be updated every 5 years thereafter (§10820 (a)). Additionally, the CWC requires suppliers to implement certain efficient water management practices (EWMPs).

The main resources used to develop this 2015 Plan were the CWC itself, the 2012 Guidebook, the updated 2015 Guidebook (when it became available in early August 2015), the relevant sections of the CCR, and the Governor's April 2015 Executive Order. A cross-reference identifying the location(s) in the AWMP within which each of the applicable requirements of SBx7-7 and the corresponding sections of the CWC and CCR is addressed is provided on the following pages. This cross-reference is intended to support efficient review of the AWMP to verify compliance with the Law.

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Cross-Reference of Relevant Sections of the California Water Code to Turlock Irrigation District 2012 Agricultural Water Management Plan

California Water Code, Division 6, Part 2.55. Sustainable Water Use and Demand Reduction

Chapter 4. Agricultural Water Suppliers

Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
10608.48	(a)		On or before July 31, 2012, an agricultural water supplier shall implement efficient water management practices pursuant to subdivisions (b) and (c).	**6**
	(b)		Agricultural water suppliers shall implement all of the following critical efficient management practices:	(see below)
		(1)	Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement paragraph (2)	**2.6, 6.2, App. F**
		(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	**2.7, 6.3**
	(c)		Agricultural water suppliers shall implement additional efficient management practices, including, but not limited to, practices to accomplish all of the following, if the measures are locally cost effective and technically feasible:	(see below)
		(1)	Facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including drainage.	**6.4.1, 6.5, 6.6**
		(2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils.	**3.3, 6.4.2, 6.5, 6.6**
		(3)	Facilitate the financing of capital improvements for on-farm irrigation systems.	**6.4.3, 6.5, 6.6**
		(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at the farm level. (B) Conjunctive use of groundwater. (C) Appropriate increase of groundwater recharge. (D) Reduction in problem drainage. (E) Improved management of environmental resources. (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	**2.7, 6.4.4, 6.5, 6.6**
		(5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance, and reduce seepage.	**2.2, 6.4.5, 6.5, 6.6**
		(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	**2.2, 6.4.6, 6.5, 6.6**
		(7)	Construct and operate supplier spill and tailwater recovery systems.	**2.2, 6.4.7, 6.5, 6.6**
		(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	**2.7, 3, 4, 5, 6.4.8, 6.5, 6.6, App. B**
		(9)	Automate canal control structures.	**6.4.9, 6.5, 6.6**
		(10)	Facilitate or promote customer pump testing and evaluation.	**6.4.10, 6.5, 6.6**
		(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress reports.	**6.4.11, 6.5, 6.6**
		(12)	Provide for the availability of water management services to water users. These services may include, but are not limited to, all of the following: (A) On-farm irrigation and drainage system evaluations. (B) Normal year and real-time irrigation scheduling and crop evapotranspiration information. (C) Surface water, groundwater, and drainage water quantity and quality data. (D) Agricultural water management educational programs and materials for farmers, staff, and the public.	**6.4.12, 6.5, 6.6, App. C**
		(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	**6.4.13, 6.5, 6.6**
		(14)	Evaluate and improve the efficiencies of the supplier's pumps.	**6.4.13, 6.5, 6.6**
10608.48	(d)		Agricultural water suppliers shall include in the agricultural water management plans required pursuant to Part 2.8 (commencing with Section 10800) a report on which efficient water management practices have been implemented and are planned to be implemented, an estimate of the water use efficiency improvements that have occurred since the last report, and an estimate of the water use efficiency improvements estimated to occur five and 10 years in the future. If an agricultural water supplier determines that an efficient water management practice is not locally cost effective or technically feasible, the supplier shall submit information documenting that determination.	**6**

California Water Code, Division 6, Part 2.8. Agricultural Water Management Planning

Chapter 3. Agricultural Water Management Plans

Article 1. General Provisions

Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
10820	(a)		An agricultural water supplier shall prepare and adopt an agricultural water management plan in the manner set forth in this chapter on or before December 31, 2012, and shall update that plan on December 31, 2015, and on or before December 31 every five years thereafter.	**1, App. A**
10821	(a)		An agricultural water supplier required to prepare a plan pursuant to this part shall notify each city or county within which the supplier provides water supplies that the agricultural water supplier will be preparing the plan or reviewing the plan and considering amendments or changes to the plan. The agricultural water supplier may consult with, and obtain comments from, each city or county that receives notice pursuant to this subdivision.	**1, App. A**
	(b)		The amendments to, or changes in, the plan shall be adopted and submitted in the manner set forth in Article 3 (commencing with Section 10840).	**1, App. A**

Article 2. Contents of Plans

Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
10826			An agricultural water management plan shall be adopted in accordance with this chapter. The plan shall do all of the following:	(see below)
	(a)		Describe the agricultural water supplier and the service area, including all of the following:	(see below)
		(1)	Size of the service area.	**2.1**
		(2)	Location of the service area and its water management facilities.	**2.2, App. D**
		(3)	Terrain and soils.	**2.3**
		(4)	Climate.	**2.4**
		(5)	Operating rules and regulations.	**2.5, App. D**
		(6)	Water delivery measurements or calculations.	**2.6, 6.2, App. F**
		(7)	Water rate schedules and billing.	**2.7, 6.3**
		(8)	Water shortage allocation policies.	**2.5, 2.8**
10826	(b)		Describe the quantity and quality of water resources of the agricultural water supplier, including all of the following:	(see below)
		(1)	Surface water supply.	**2.2, 3, 4**
		(2)	Groundwater supply.	**2.2, 3, 4, App. B**
		(3)	Other water supplies.	**3, 4**
		(4)	Source water quality monitoring practices.	**3.4**
		(5)	Water uses within the agricultural water supplier's service area, including all of the following: (A) Agricultural. (B) Environmental. (C) Recreational. (D) Municipal and industrial. (E) Groundwater recharge. (F) Transfers and exchanges. (G) Other water uses.	**3, 4**
		(6)	Drainage from the water supplier's service area.	**4**
10826	(b)	(7)	Water accounting, including all of the following: (A) Quantifying the water supplier's water supplies. (B) Tabulating water uses. (C) Overall water budget.	**4**
		(8)	Water supply reliability.	**3, 4**
	(c)		Include an analysis, based on available information, of the effect of climate change on future water supplies.	**5**
	(d)		Describe previous water management activities.	**1.1, 2, 3, 6**
	(e)		Include in the plan the water use efficiency information required pursuant to Section 10608.48.	**6**

Article 3. Adoption and Implementation of Plans				
Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
10841			Prior to adopting a plan, the agricultural water supplier shall make the proposed plan available for public inspection, and shall hold a public hearing on the plan. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned agricultural water supplier pursuant to Section 6066 of the Government Code. A privately owned agricultural water supplier shall provide an equivalent notice within its service area and shall provide a reasonably equivalent opportunity that would otherwise be afforded through a public hearing process for interested parties to provide input on the plan. After the hearing, the plan shall be adopted as prepared or as modified during or after the hearing.	**1, App. A**
10842			An agricultural water supplier shall implement the plan adopted pursuant to this chapter in accordance with the schedule set forth in its plan, as determined by the governing body of the agricultural water supplier.	**1.3.1, 7, 8**
10843	(a)		An agricultural water supplier shall submit to the entities identified in subdivision (b) a copy of its plan no later than 30 days after the adoption of the plan. Copies of amendments or changes to the plans shall be submitted to the entities identified in subdivision (b) within 30 days after the adoption of the amendments or changes.	**1, App. A**
	(b)		An agricultural water supplier shall submit a copy of its plan and amendments or changes to the plan to each of the following entities:	(see below)
		(1)	The Department of Water Resources (DWR).	**1, App. A**
		(2)	Any city, county, or city and county within which the agricultural water supplier provides water supplies.	**1, App. A**
		(3)	Any groundwater management entity within which jurisdiction the agricultural water supplier extracts or provides water supplies.	**1, App. A**
		(4)	Any urban water supplier within which jurisdiction the agricultural water supplier provides water supplies.	**1, App. A**
		(5)	Any city or county library within which jurisdiction the agricultural water supplier provides water supplies.	**1, App. A**
		(6)	The California State Library.	**1, App. A**
		(7)	Any local agency formation commission serving a county within which the agricultural water supplier provides water supplies.	**1, App. A**
10844	(a)		Not later than 30 days after the date of adopting its plan, the agricultural water supplier shall make the plan available for public review on the agricultural water supplier's Internet Web site.	**1, App. A**
	(b)		An agricultural water supplier that does not have an Internet Web site shall submit to DWR, not later than 30 days after the date of adopting its plan, a copy of the adopted plan in an electronic format. DWR shall make the plan available for public review on DWR's Internet Web site.	**Not Applicable**

Executive Order B-29-15 (April 1, 2015).				
Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
		12	Agricultural water suppliers that supply water to more than 25,000 acres shall include in their required 2015 Agricultural Water Management Plans a detailed drought management plan that describes the actions and measures the supplier will take to manage water demand during drought. The Department shall require those plans to include quantification of water supplies and demands for 2013, 2014, and 2015 to the extent data is available. The Department will provide technical assistance to water suppliers in preparing the plans.	**2.8, App. G**

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List of Acronyms

ACOE ..... Army Corps of Engineers

ACWA ..... Association of California Water Agencies

Ac ..... acre

AF ..... acre-feet

ASCE ..... American Society of Civil Engineers

AWMC ..... Agricultural Water Management Council

AWMP ..... Agricultural Water Management Plan

BCSD ..... Bias Comparison and Spatial Disaggregation

CASGEM ..... California Statewide Groundwater Elevation Monitoring

CDEC ..... California Data Exchange Center

cfs ..... cubic feet per second

CIMIS ..... California Irrigation Management Information System

CMIP3 ..... Coupled Model Intercomparison Project Phase 3

CMUA ..... California Municipal Utilities Association

CWC ..... California Water Code

CCR ..... California Code of Regulations

CCUF ..... Crop Consumptive Use Fraction

DF ..... Delivery Fraction

DMP ..... Drought Management Plan

DO ..... Dissolved Oxygen

DWR ..... Department of Water Resources

EC ..... Electrical Conductivity

ESJWQC ..... East San Joaquin Water Quality Coalition

ESRIRWMP ..... East Stanislaus Region Integrated Regional Water Management Plan

ET ..... Evapotranspiration

ET_a ..... Actual Evapotranspiration

ET_{aw} ..... Evapotranspiration of applied water

LIST OF ABBREVIATIONS

ET_c ..... Crop evapotranspiration

ET_o ..... Reference evapotranspiration

ET_{pr} ..... Evapotranspiration of precipitation

EWMP ..... Efficient Water Management Practice

FAO ..... Food and Agriculture Organization

FERC ..... Federal Energy Regulatory Commission

GAR ..... Groundwater Assessment Report

GCMs ..... Global Climate Models

GDD ..... growing degree day

GSA ..... Groundwater Sustainability Agency

GSP ..... Groundwater Sustainability Plan

GWMP ..... Groundwater Management Plan

ID ..... Improvement District

IDC ..... Integrated Water Flow Model Demand Calculator

ILRP ..... Irrigated Lands Regulatory Program

ITRC ..... Irrigation Training and Research Center

LGA ..... Local Groundwater Assistance

M&I ..... Municipal and Industrial

METRIC ..... Mapping Evapotranspiration at High Resolution using Internalized Calibration

MID ..... Modesto Irrigation District

MOU ..... Memorandum of Understanding

NIST ..... National Institute of Standards and Technology

NIWR ..... Net Irrigation Water Requirements

NMP ..... Nitrogen Management Plan

NOAA ..... National Oceanic and Atmospheric Administration

NPDES ..... National Pollutant Discharge Elimination System

NRCS ..... Natural Resources Conservation Service

ppm ..... parts per million

PU608 ..... Planning Unit 608

RWQCB ..... Regional Water Quality Control Board

SBx7-7 ..... Water Conservation Act of 2009

SCADA ..... Supervisory Control and Data Acquisition

SEBAL ..... Surface Energy Balance Algorithm for Land

SGMA ..... Sustainable Groundwater Management Act

SJTA ..... San Joaquin Tributaries Authority

SRWA ..... Stanislaus Regional Water Authority

SWRCB ..... State Water Resources Control Board

TCC ..... Total Channel Control

TDS ..... Total Dissolved Solids

TGBA ..... Turlock Groundwater Basin Association

TID ..... Turlock Irrigation District

TKN ..... Total Kjeldahl Nitrogen

TOC ..... Total Organic Carbon

USBR ..... United States Bureau of Reclamation

USCID ..... United States Committee for Irrigation and Drainage

VAMP ..... Vernalis Adaptive Management Plan

WCRP ..... World Climate Research Program

WDO ..... Water Distribution Operator

WDR ..... Waste Discharge Requirements

WMF ..... Water Management Fraction

WMP ..... Water Master Plan

WUE ..... Water Use Efficiency

WWCRA ..... West-Wide Climate Risk Assessment

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Glossary of Terms

Acre-Foot……The volume of water required to cover one acre of land one foot deep. Equal to 325,900 gallons.

Assessed Acres……...Total acres, as determined by the county assessor's office, for parcels that receive irrigation water. This acreage includes developed (non-irrigated) portions of the parcels such as roads, buildings and ditches.

Conjunctive Use ……Using a combination of surface water and groundwater supplies to meet water demands.

Conjunctive Management ……Coordinating operation and monitoring of surface water and groundwater supplies to meet defined objectives.

Evapotranspiration……The loss of water, to the atmosphere, by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues).

Garden Head……..A parcel of land that is five acres or less in size and receives irrigation water.

Gross Acres ……All lands within the irrigation service boundary such as cities, agricultural lands, roads and lake acreage.

Improvement District…….……...An Improvement District (ID) is a mechanism that allows a group of growers to pool resources to construct irrigation facilities. IDs can be formed for a variety of reasons, such as constructing, operating, and maintaining ditches, pipes, and wells, as well as surface and subsurface drains. TID administers the improvement districts.

Irrigable Acres……...All lands that could be irrigated within the irrigation service boundary. This designation includes both lands that are currently irrigated and lands that are not currently being irrigated but have access to irrigation water through an active irrigation service connection.

Irrigated Acres……...An estimate of the actual amount of land surface to which irrigation water is being applied. A survey performed in the 1990's found that approximately six percent of assessed acres are non-productive lands such as roads, buildings and ditches. Therefore, the Assessed Acres have been reduced by six percent to arrive at the Irrigated Acres.

Supplemental Pumping……Private groundwater pumping by growers used to supplement irrigation water supplied by TID.

Turlock Groundwater Basin……The groundwater basin underlying the eastern portion of the San Joaquin Valley bounded by the Tuolumne River to the north and the Merced River to the south. The western and eastern boundaries of the groundwater basin are the San Joaquin River and the Sierra Nevada foothills, respectively. (California Department of Water Resources, 2006).

Executive Summary

INTRODUCTION

The Turlock Irrigation District's (TID, or District) Agricultural Water Management Plan (AWMP or Plan) has been prepared to fulfill the requirements of the Water Conservation Act of 2009 (SBx7-7). In developing the Plan, TID has devoted considerable effort to evaluating water management and to developing a program aimed at sustaining sound water management practices where they are already in place and improving practices that can be strengthened.

TID understands that the intent of SBx7-7 is to encourage water suppliers to evaluate their water management operations and to implement locally cost-effective efficient water management practices (EWMPs) that improve the efficient use of irrigation water.

TID'S CONJUNCTIVE MANAGEMENT PERSPECTIVE

A key point highlighted by this AWMP is the District's reliance on both surface water and groundwater as sources of supply. The water balance developed as part of the AWMP shows that, on average, 82 to 88 percent (depending on water year type) of TID's water supply comes from surface sources with the remainder coming from groundwater[1]. The computations performed for the water balance and presented throughout the Plan are based on water usage during the period from 1991 through 2014. This period encompasses 13 years of normal water supplies and 11 years of reduced water supplies (as characterized based on annual water supplies available to growers), and illustrates how TID shifts between groundwater and surface water supply sources in response to hydrologic conditions. The District encourages the use of surface water for crop production when it is available to reduce reliance on groundwater and maintain long-term water supply reliability. As an example, during 2005, an above normal water year, 90 percent of the water delivered to irrigators came from surface supplies. By contrast, in the dry year of 2014, surface water utilization declined to 78 percent as a result of increased groundwater pumping by TID to supplement diminished inflow and storage in Don Pedro Reservoir.

TID's conjunctive management provides a significant amount of recharge to the Turlock Groundwater Basin. The water balance, as described in Section 4, quantifies the various inflows and outflows within the District's service area, and estimates that between 1991-2014 the average net recharge to the subbasin from TID's conjunctive management practices ranged from approximately 136,000 acre-feet (AF) in dry years to 237,000 AF in normal years.[2] This recharge has helped TID and its customers to achieve a generally consistent and reliable water supply in all but the most severe droughts, to meet crop requirements by enabling pumping in drier years to make up for reduced surface water supplies.

[1] The TID water supply includes Turlock Lake releases for irrigation, TID drainage well pumping, and TID rented well pumping. Other water supplies such as tailwater and recycled water are not included as they are minor sources and to avoid double counting of surface water supplies that are reused.

[2] These values are calculated for the TID system downstream of Turlock Lake, and as such, do not include recharge from Turlock Lake or seepage from the canal system upstream of Turlock Lake.

Recent drought conditions reemphasize the importance of recharge from surface water supplies for the Turlock Groundwater Basin to achieve sustainability, as envisioned by the recent enactment of the Sustainable Groundwater Management Act of 2014 (SGMA). Analysis shows that seepage and deep percolation of a portion of TID's surface water supply serves as the primary source of recharge to the groundwater system. Thus, while groundwater provides a significant portion of the water used by the District and others within the Turlock Groundwater Basin, much of this groundwater is derived from management of surface water resources by TID and its irrigation customers. Because of the flexibility offered by access to both surface water and groundwater as sources of supply, TID will continue to pursue a deliberate course of conjunctive management.

While TID does not have spreading basins and other facilities dedicated to direct groundwater recharge, conjunctive management is promoted through its pricing policies and operating practices. These actions help support sustainable agricultural production within TID. In addition, the benefits of TID's conjunctive management policies extend to municipal users within the District and to agricultural users outside of TID's boundaries for whom groundwater is the only source of supply. Even with these measures, groundwater levels continue to decline on the eastern side of the Turlock Groundwater Basin, where surface water supplies are not available. Extended drought or other circumstances which limit surface water supplies are likely to exacerbate this condition.

TID will continue to work with others within the Turlock Groundwater Basin to comply with SGMA. In addition to its own water management practices, TID will work with local interests to develop the tools needed to achieve long-term groundwater sustainability by identifying additional ways to maximize local water supplies, enhance conjunctive management practices, and recharge the groundwater system.

IMPLEMENTATION OF EFFICIENT WATER MANAGEMENT PRACTICES

The specific mechanisms for promoting improved water management under SBx7-7 are sixteen EWMPs. Of this total, two are critical or mandatory practices that are required of all water suppliers submitting AWMPs; the remaining fourteen are conditionally applicable practices subject to technical feasibility and local cost effectiveness. These conditionally applicable EWMPs must be implemented if they are found to be technically feasible and locally cost effective based on conditions within TID.

The TID AWMP evaluates and describes the extent to which TID currently implements each of the EWMPs and discusses how the EWMPs could be better implemented. Table ES.1 of this Executive Summary summarizes the status of EWMP implementation for each of the EWMPs. TID has implemented and continues to implement all technically feasible EWMPs at a locally cost-effective level.

CONCLUSION

The update of this AWMP has provided TID with an opportunity to reexamine its water management practices and to evaluate how these practices support the District's goal of providing a reliable, high quality, affordable water supply for its irrigation customers. The Plan demonstrates the critical importance of TID's overall conjunctive management strategy to

provide a reliable and adequate water supply to its customers. As demonstrated in this Plan, the District is committed to ongoing evaluation and implementation of EWMPs at locally cost effective levels to support TID goals while complying with SBx7-7.

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Table ES.1. Summary of TID Implementation Status for EWMPs Listed Under CWC 10608.48(b) & (c).

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
Critical EWMPs – Mandatory				
10608.48.b(1)	Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement 10608.48.b(2).	Implementing	Measuring the volume of water delivered to customers by: (1) installing 132 new measurement devices delivering water to about 3,000 parcels covering about half of the TID service area, and (2) calibrating flow rates for more than 1,700 sidegate-parcel combinations delivering water to an additional 35 percent of the TID service area.	In 2016, complete calibration of sidegate-parcel combinations not calibrated due to 2014 and 2015 drought conditions. By 2017, implement new, or modified ordering and delivery measurement recording software using new measured flows.
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Implementing	Completed the Proposition 218 process and adopted a new pricing structure based in part on quantity delivered in June 2012. The pricing structure consists of separate tiered-pricing structures for normal and dry years and includes four water rate tiers for each year type with an increasing cost per acre-foot delivered as growers move from lower to higher tiers defined based on the amount of water delivered per acre. A fixed charge per acre is also included. A price increase, using the same general structure was implemented in 2015.	Continue implementing a volumetric pricing structure, although the price will likely change over time. Evaluate billing system and implement improvement by 2017.
Additional (Conditional) EWMPs – To be Implemented if Locally Cost Effective and Technically Feasible				
10608.48.c(1)	Facilitate alternative land use for lands with exception-ally high water duties or whose irrigation contributes to significant problems, including drainage.	Not Technically Feasible	Lands with exceptionally high water duties or whose irrigation contributes to significant problems are not found within the District boundaries. Furthermore, TID's rules and regulations prohibit wasteful use of water, preventing exceptional water duties or significant problems from occurring.	
10608.48.c(2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils	Implementing	1. M&I wastewater used for cooling at TID's Walnut Energy Center. 2. M&I wastewater applied directly to TID irrigated lands. 3. Dairy nutrient water used by TID improvement districts for irrigation.	1. Continue existing use of recycled water within TID. 2. Consider requests from all qualifying permitted dischargers for additional use of recycled water. 3. Actively working with the City of Turlock to gain access to 2,000 AF of recycled water for agriculture needs. .
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems	Implementing	1. Financing of on-farm improvement district irrigation facilities. 2. Engineering design and construction oversight for on-farm improvement district irrigation facilities. 3. At-cost maintenance and repair of on-farm improvement district irrigation facilities. 4. Interest-free deferral of maintenance, repair, and electrical charges. 5. Pursuit of grant funding for on-farm improvements. 6. TID has hired an assistant engineer whose primary work assignment is to provide on-farm technical support and design assistance to TID customers. Services include support of micro/drip conversion and on-farm reservoir sizing.	1. Continue various financing activities to support development, operation, maintenance, and repair of on-farm irrigation systems.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Implementing	1. Pricing structure promotes more efficient water use at the farm level, conjunctive use of groundwater, appropriate increase of groundwater recharge, prevention of problem drainage, and effective management of all water sources throughout the year.	1. Continue to implement tiered pricing structure to promote TID's water management goals.
10608.48.c(5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage	Implementing	1. Lined or converted to pipelines over 90 percent of its distribution system. 2. Between 2010 and 2014, TID resurfaced approximately 5 miles of lining per year. 3. In 2014, TID converted the Lower Stevinson Flume to a pipeline. 4. Lateral 1 has been converted to a pipeline in developed areas. 5. Improvement district pipelines are actively maintained and replaced as necessary. 6. In 2015, TID completed the Lateral 8 Reservoir, 29 acre-feet of storage, integrated with TCC on Lateral 8 with objectives to a) reduce spill at the Highline and Lateral 8 Spills and b) improve service to about 4,300 acres served by Lateral 8.	1. Continue to resurface lining each year to maintain effectiveness. 2. Install new lining as appropriate based on local cost-effectiveness. 3. Continue active maintenance and repair of improvement district pipelines. 4. Increase Lateral 8 regulating reservoir capacity in 2016. 5. Continue to evaluate and implement other locally cost effective regulating reservoirs. A regulating reservoir along the Ceres Main Canal is proposed, and has been included in the current draft capital planning budget for 2016.
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Implementing	1. Implemented arranged-frequency demand delivery, providing a wide range of flexibility in irrigation frequency and duration, providing water with a lead time of approximately 2 days. 2. Moved its call center in 2008 to improve customer service and in 2014 implemented online ordering. 3. Provides water use information to irrigators for their fields upon request, online and in an annual report. 4. Worked over time to accommodate changes in demand characteristics for micro irrigation systems. 5. TID WDO's monitor the distribution system in real time using tablets at over 340 SCADA sites to enhance operational flexibility, including real time monitoring of Rubicon SlipMeters and permanent FlumeGates. 6. TID provides customers with access to real time monitoring of Rubicon SlipMeters and permanent FlumeGates. 7. Intermediate system flows at several locations are monitored to better meet customer demands and prevent operational spillage. 8. In 2015, TID completed the Lateral 8 Reservoir, 29 acre-feet of storage integrated with TCC on Lateral 8 with objectives to a) reduce spill at the Highline and Lateral 8 Spills and b) improve service to about 4,300 acres served by Lateral 8.	1. Continue to provide high levels of delivery flexibility and evaluate locally cost effective flexibility improvements. 2. Continue to offer online delivery ordering and online availability of water use information. 3. Increase Lateral 8 regulating reservoir capacity in 2016. 4. Evaluate the cost effectiveness of the Lateral 8 reservoir/TCC pilot project and consider implementing in other areas where found to be locally cost effective. 5. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems	Implementing	1. Intercepts spillage from upper laterals into the Ceres Main Canal. 2. Recovers operational spillage from Harding Drain. 3. Recovers and reuses tailwater and tilewater re-entering the distribution system. 4. Implemented real time SCADA monitoring of all spill sites. 5. Intermediate system flows at several locations are monitored to better meet customer demands and prevent operational spillage. 6. Operates drainage wells throughout the system, providing added operational flexibility and localized supply that enables spillage prevention. 7. TID provided WDOs with tablets to monitor the distribution system in real time at spillage sites and over 340 SCADA sites to enhance operational flexibility while reducing SlipMeters and permanent FlumeGates. 8. Drainage pump remote operation has been provided to WDOs. WDOs are able to turn on and shut down pumps using portable tablets to prevent operational spillage. 9. In 2015, TID completed the Lateral 8 Reservoir, 29 acre-feet of storage, integrated with TCC on Lateral 8 with objectives to a) reduce spill at the Highline and Lateral 8 Spills and b) improve service to about 4,300 acres served by Lateral 8.	1. Continue various strategies and actions to recover and prevent spillage and tailwater. 2. Consider implementation of recovery and pumpback systems, subject to evaluation of local cost-effectiveness. 3. Improve accounting for drain pump operation and pumped volumes. 4. Continue to evaluate and implement locally cost effective improvements to recover and prevent spillage and tailwater. 5. Increase Lateral 8 regulating reservoir capacity in 2016. 6. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Implementing	1. TID has implemented a comprehensive conjunctive management program. 2. TID operates over 100 drainage wells to increase water supply. 3. TID rents up to 100 or more privately-owned wells to supplement the available surface water supply. 4. TID's pricing promotes the following conjunctive management goals: (1) encourages use of available surface water supplies, (2) encourages conservation of limited surface water supplies in dry years, and (3) provides revenue required to operate drainage wells and rental wells in dry years. 5. When surplus water is available in some wet years. TID promotes direct and in-lieu recharge through surplus water sales within the subbasin but outside of the TID service area. 6. Substitution of M&I wastewater for groundwater to provide cooling at Walnut Energy Center. 7. Active participation in local groundwater entities and initiatives, including SGMA. 8. Implementation of groundwater monitoring as part of CASGEM. 9. Development of sophisticated groundwater and surface water models to support long term planning and management.	1. Continue various ongoing conjunctive management strategies and actions as part of TID's comprehensive conjunctive management program. 2. Continue to evaluate and implement locally cost effective actions. 3. Evaluate the cost effectiveness of the Lateral 8 reservoir/TCC pilot project and consider implementing in other areas where found to be locally cost effective. 4. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(9)	Automate canal control structures	Implementing	1. TID operates more than 330 automatic canal control structures. 2. TID monitors over 340 SCADA sites providing real time flow and water level information. 3. Drainage pump remote operation has been provided to WDOs. WDOs are able to turn on and shut down pumps using portable tablets to prevent operational spillage and conserve groundwater. 4. TID monitors additional slipgates at lateral headings. 5. In 2015, TID completed the Lateral 8 Reservoir, 29 acre-feet of storage, integrated with TCC on Lateral 8 with objectives to a) reduce spill at the Highline and Lateral 8 Spills and b) improve service to about 4,300 acres served by Lateral 8.	1. Continue to operate and maintain automatic control structures. 2. Continue real time SCADA monitoring. 3. Continue to evaluate and implement locally cost effective actions. 4. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation	Implementing	1. TID provides testing of private pumps upon request within its irrigation and electrical service areas. 2. TID tests all rented private wells once per year. 3. TID has trained employees in pump efficiency testing. 4. TID has obtained five additional portable flow meters available to test customer wells upon request. Two staff members are available for water level testing and twelve WDOs plus additional staff are available for flow testing. 5. Pump testing is additionally available for growers outside of TID's water service area but within its electrical service area (approximately 40,000 acres).	1. Continue to provide testing of private pumps and to maintain in-house pump testing capability.
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implementing	1. Designated a Water Conservation Coordinator in June 1997.	1. Continue to employ a designated Water Conservation Coordinator.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(12)	Provide for the availability of water management services to water users.	Implementing	1. TID provides engineering design services for improvement district facilities. 2. TID provides private pump testing upon request. 3. TID installed, rents land for, and maintains the Denair CIMIS site and provides a link to CIMIS on its web site. 4. TID provides detailed water use information for individual fields to irrigators online, upon request, and through a year-end water use report that is mailed to all irrigators. 5. TID provides detailed information on the suitability of surface, ground, and drain water quality for irrigation upon request. 6. TID provides real time hydrologic information on its website. 7. TID distributes a grower newsletter multiple times per year, holds annual grower meetings, and organizes occasional seminars on various water management topics. 8. TID has hired an assistant engineer whose primary work assignment is to provide on-farm technical support and design assistance to TID customers. Services include support of micro/drip conversion and on-farm reservoir sizing. 9. TID has developed a drought information page with extensive information to support on-farm water management during drought. 10. TID provides remote data access describing delivery flows for sidegates with SlipMeters and permanent FlumeGates. 11. TID has developed training videos for operation of Rubicon sidegates and posted them on its website.	1. Continue to provide various water management services. 2. Continue to evaluate and implement locally cost effective services.
10608.48.c(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Implementing	1. TID cooperates with the Modesto Irrigation District (MID), who co-owns Don Pedro Reservoir. 2. TID coordinates with other agencies that have the potential to impact the District's flexibility in delivery and storage. 3. TID is a member of the Turlock Basin Groundwater Association (TGBA). 4. TID is active in implementation of SGMA. 5. TID is preparing a Water Master Plan that will include an evaluation of agency policies.	1. Continue cooperation with MID and others to allow more flexible deliveries and storage. 2. Continue to evaluate and implement locally cost effective opportunities. 3. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implementing	1. TID tests all District owned and rented wells. 2. TID has trained employees in pump efficiency testing. 3. TID has established an ongoing capital improvement program to rehabilitate and replace pumps as necessary. 4. Drainage pump remote operation has been provided to WDOs. WDOs are able to turn on and shut down pumps using portable tablets to prevent operation al spillage. This also reduces wear and tear, prolonging pump life and improving efficiency.	1. Continue to test TID pumps and to maintain in-house pump testing and SCADA capabilities. 2. Continue ongoing rehabilitation and replacement of TID pumps as necessary.

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1. Plan Preparation

A critical component in the development of an Agricultural Water Management Plan (AWMP or Plan) is the solicitation of feedback from interested parties. This section describes TID's coordination with other agencies in the development of this AWMP, as well as TID's past water management activities.

1.1 PAST WATER MANAGEMENT ACTIVITIES

The Turlock Irrigation District (TID or District) was the first irrigation district formed in California under the Wright Act in June 1887. Although the current Agricultural Water Management Planning requirements were recently established, water management planning is not a new concept for TID. The District continues to evaluate and implement new cost effective approaches and technologies as they become available, to ensure the District's water resources are managed to meet local water supply needs and environmental stewardship requirements now, and in the future.

TID was one of the first agencies in California to adopt a Groundwater Management Plan pursuant to Assembly Bill 3030, to sign on to the Memorandum of Understanding (MOU) establishing the Agricultural Water Management Council (AWMC), and to prepare an Agricultural Water Management Plan (AWMP) approved by the AWMC. TID's first AWMP was adopted in July 1999 and approved by the Ag Water Management Council in May 2001. TID was also one of the first agencies in California to comply with SBx7-7, and submit their plan to DWR in 2012. Since that time, TID has implemented all locally cost effective and technically feasible Efficient Water Management Practices (EWMPs). Some of the most recent implementation efforts include:

- Automation of canal control structures,
- Improved measurement of canal and delivery flows and the access to real-time data by field crews,
- Installation of water quality monitoring telemetry,
- Additional lining of canals and other facility modifications to improve delivery reliability and operational flexibility,
- Improved water balance accounting,
- Installation and maintenance of a CIMIS station to provide more accurate local crop ET information to growers,
- Seepage testing to refine seepage calculations,
- Adoption of a volumetric pricing structure,
- Implementing a plan to bring the District into compliance with delivery measurement requirements (pursuant to 23 CCR §597),
- Hired an assistant engineer to provide on-farm technical support,
- Improved access to water delivery information available to customers,
- Implemented remote operation of District owned pumps,
- Implemented improvements along Lateral 8 to test the pairing of regulating reservoirs and automation to provide Total Channel Control (TCC)features on TIDs open channel system, and

- Continued implementation of numerous other measures to provide information to growers and to ensure water delivery reliability and flexibility.

1.2 AGENCY COORDINATION AND PUBLIC PARTICIPATION

Coordination with other agencies and public participation are critical components of the agricultural water management planning process. The following section describes the on-going coordination efforts between TID and the various local agencies in this region that manage water resources. Additionally, this section provides information on the public participation process used during the development, adoption, and implementation phases of the planning process.

1.2.1 Agency Coordination

TID holds joint water rights and ownership of Don Pedro Reservoir with the Modesto Irrigation District (MID). As such, the districts (TID and MID) continuously work together to coordinate and manage the shared resource. Additionally, TID maintains close relationships with irrigation districts on other tributaries of the San Joaquin River, and through those relationships is able to share information regarding successes and challenges to help shape irrigation programs. TID works and coordinates with the City and County of San Francisco, San Joaquin Tributaries Authority (SJTA), the East San Joaquin Water Quality Coalition (ESJWQC), as well as the various water committees and groups that are forming at the county level. Each authority and association is involved in activities that relate to different aspects of the District's water management activities. Additionally, TID coordinates with various local, state and federal agencies as outlined in the Drought Management Plan (Appendix G).

TID adopted its first Groundwater Management Plan (GWMP) in 1993. After that time, other agencies within the Turlock Groundwater Basin (also referred to as the Basin or Turlock Basin in this document) became interested in groundwater management. As a result, the Turlock Groundwater Basin Association (TGBA) was formed in 1995 to develop a basin-wide GWMP. The first plan was adopted in 1997 by the majority of the water agencies within the Basin. Since that time the TGBA has continued to coordinate groundwater management activities, completed several studies, and updated the basin-wide GWMP. TID adopted the updated plan on March 18, 2008.

The TGBA continues to meet on a monthly basis to coordinate groundwater management activities, and pursue projects and studies to better understand and manage the shared groundwater resource. The TGBA is working together to implement groundwater monitoring, and submit the data required to comply with the California Statewide Groundwater Elevation Monitoring (CASGEM) program, as required by SBx7-6. Additionally, the TGBA is completing a Local Groundwater Assistance (LGA) grant to study the hydrologic conditions on the far eastern side of the Turlock Basin where additional agricultural development continues to occur in an area where groundwater pumping, in excess of recharge, has caused a cone of depression which extends west into the TID's service area. (See Section 3 below for more information on groundwater conditions.) The LGA grant provides funding to characterize aquifer parameters on the eastern side of the basin, update the groundwater model, and provide information to help focus future TGBA groundwater management efforts.

Agencies within the Turlock Groundwater Basin are also working together to determine the best approach to complying with the Sustainable Groundwater Management Act of 2014 (SGMA). A Memorandum of Understanding (MOU) has been developed and is being adopted by local agencies to demonstrate their intent to work together to comply with SGMA requirements including: (1) identifying the best approach to forming Groundwater Sustainability Agencies (GSAs) within the subbasin; (2) working together to develop a single Groundwater Sustainability Plan (GSP) for the subbasin; and (3) compiling data and developing tools that will be needed for SGMA related activities.

1.2.2 Plan Participation

TID has prepared this AWMP in accordance with the requirements of the Water Conservation Act of 2009, also known as SBx7-7, enacted November 9, 2009. The legislation itself and the guidebook provide limited guidance regarding the outreach process to be followed while developing and adopting an AWMP, providing flexibility for agencies to implement an outreach process focused on the needs of the local area.

TID patterned the agency coordination and public participation process in reference to the Department of Water Resources (DWR) guidebook for agencies and after similar planning efforts implemented by local urban water suppliers, as well as past efforts for developing and implementing the Basin-wide Groundwater Management Plan, and the 2012 AWMP. The process made use of existing communication programs, association memberships and coordination to help to streamline the effort. Table 1.1, below, describes public outreach activities, which included informal discussions with and notices to interested parties, newsletter articles, public meetings, newspaper notices, in addition to making documents available for review and comment.

Table 1.1. AWMP Public Participation Process.

Activity	Date(s)
Turlock Groundwater Basin Association Meeting coordination and discussion	September 17, 2015
TID Website – AWMP update information added	June 5, 2015
Letter notice to local water agencies – Plan to update AWMP	June 8, 2015
Newsletter to TID growers – Status of AWMP update	August 2015
Board Workshop – Review of draft AWMP and adoption process	October 13, 2015
TID Board – Sets Hearing for November 10 and directs staff to publish notice in newspaper, and make draft Plan available for public comment at TID office, on-line, and at local library	October 13, 2015
Copies of draft AWMP available for review at local library, on-line, and at TID office	October 14, 2015
Letters to local water agencies – Draft AWMP available for comment	October 14, 2015
Newspaper Notice – per Government Code Section 6066	October 2015
Public Hearing & AWMP adoption	November 10, 2015
Copies of approved AWMP distributed as required by SBx7-7	December 2015

Copies of the information circulated in the public outreach effort are included in Appendix A.

Ongoing coordination and implementation of the Plan will be facilitated by continuing interactions with other local water agencies and TID customers. Examples of these programs include:

- Coordination with the MID through their partnership in management of Don Pedro Reservoir.
- Coordination with other local public agencies, including the counties and agricultural and urban water supply agencies, through meetings of the TGBA; an association that was formed to coordinate groundwater management activities within the Turlock Groundwater Basin. A copy of the TGBA Groundwater Management Plan is included and the internet address where the plan can be downloaded is provided in Appendix B.
- Stanislaus County has established a Water Advisory Committee and a Technical Advisory Committee to coordinate water issues within the County. TID has representatives on both committees. TIDs involvement in these efforts will assist with outreach and coordination efforts.
- Growers in TID are kept informed of various TID activities and irrigation-related issues through grower meetings held at the start of each irrigation season and periodic newsletters mailed out throughout the year. Copies of past newsletters are available on TID's website at http://tid.com/news-resources/publications/the-grower. An example newsletter is included in Appendix C.
- TID's Board of Directors meets weekly. Board meetings provide an opportunity to educate and obtain feedback from the Board and the public regarding a wide range of water management related topics. The media and the public regularly attend these meetings. During each meeting, time is set aside to update the Board on District activities, and receive comments from the public.
- The District's public information staff regularly communicates with the media regarding a variety of topics, issuing press releases as needed regarding District activities. The media also regularly reports on the issues, policies and projects discussed at TID Board meetings.
- The TID website is updated regularly. It includes a variety of information regarding TID's water management programs and practices. Information regarding the AWMP update is available at: www.tid.org/AWMP. Once adopted, the updated AWMP, will be posted on the TID website.

A Drought Task Force has been established by Stanislaus County involving various agencies and interested parties within the County. TID's drought management program includes involvement with this and other processes as needed to provide education and outreach and coordinate water management efforts.

2. Agricultural Water Supplier and Service Area

This section contains a description of the physical and operational organization of the Turlock Irrigation District, including TID's history, geographic and environmental settings, operations, and policies.

2.1 HISTORY AND SIZE

TID provides irrigation water to agricultural lands in Stanislaus and Merced counties in the Central Valley of California. TID was formed on June 6, 1887 and was the first irrigation district formed in California under the Wright Act. At the time of its formation, TID covered 179,527 acres. TID presently covers a service area of 197,261 gross acres, with 157,800 acres that can currently be irrigated with surface water (i.e. the acreage that could be served by active irrigation service connections). The average assessed acreage from 2010-2014 was 146,750 acres. The actual number of acres that irrigate each year varies depending on the decisions of the individual property owners. These and other key aspects of TID are summarized in Table 2.1. The increase in gross acreage from the time of District formation is attributed to the annexation of adjacent lands including Turlock Lake, the community of Delhi, and a portion of Don Pedro Reservoir.

Table 2.1. Water Supplier History and Size.

Date of formation	June 6, 1887
Local surface water source	Tuolumne River
Local groundwater source	Turlock Groundwater Basin
Gross acreage at time of formation	179,527 acres
Present irrigable acreage[1]	157,800 acres

[1] Acreage that could be served by active irrigation service connections.

2.2 LOCATION AND FACILITIES

TID's irrigation service area is generally bounded on the north by the Tuolumne River, on the south by the Merced River and on the west by the San Joaquin River (see map included as Appendix D). The communities of Turlock, Ceres, Keyes, Denair, Hughson, Delhi, South Modesto, Hickman, and Hilmar are within the boundaries of the TID irrigation service area. This section of the AWMP describes TID irrigation facilities and operations within its service area. A summary of TID's irrigation facilities and operations is provided in Table 2.2.

The Tuolumne River provides the principal water supply for TID. Don Pedro Reservoir is located on the Tuolumne River and is TID's principal storage reservoir, with a total capacity of 2,030,000 acre-feet (AF). Don Pedro Reservoir is jointly owned by TID and MID (68.46 % TID and 31.54 percent MID). TID operates the reservoir for the districts.

It is important to note that a portion of Don Pedro Reservoir's storage capacity is reserved for flood control purposes each year and operated in compliance with the Army Corps of Engineers (ACOE) requirements. To vacate the 340,000 acre-foot flood control space, reservoir levels are lowered each fall to a specified elevation (801.9 feet above mean sea level) by October 7th. Levels are allowed to gradually increase again after April 27th.

Table 2.2. TID Water Conveyance and Delivery System.

Facility/System	Description
Storage facilities	
Don Pedro Reservoir capacity[1]	1,178,197 AF
Turlock Lake capacity	45,600 AF
Conveyance facilities and other Infrastructure	
Unlined Canals	18.5 miles[2]
Lined Canals	222 miles[2]
Number of Canal Turnouts	1,259 operational sidegates
TID-owned Drains	18 miles
Drainage Wells	165
Rented Wells	48 to 175, depending on water year type and weather conditions
Tailwater/Spill Recovery Facilities	
TID-operated	Operational spills[3]
Grower-operated Tailwater/Spill Recovery	Individual grower tailwater systems[4]
Supplier Delivery System	
Order type/scheduling	Arranged-frequency demand (ASCE, 1991)
Operational constraints	Canal capacity flow limitations
Expected changes to service area	None

NOTES:

1 TID's useable capacity in Don Pedro is 68.46 percent of overall 2,030,000 AF reservoir capacity minus 68.46 percent of the 309,000 AF (the minimum operating pool).

2 Miles of lined and unlined canals downstream of La Grange Diversion Dam.

3 TID accepts a minor amount of tailwater into its canals that is blended with surface water supplies for deliveries; spills from upper canals are intercepted by the Ceres Main Canal and utilized to the greatest extent possible for delivery to downstream canals. TID also recaptures spills from the Harding Drain.

4 Grower operated tailwater systems are installed to make use of water and to comply with relevant water quality requirements.

Flood control operations, combined with variable hydrology and operation of reservoirs upstream on the Tuolumne River, influence Don Pedro Reservoir storage levels and the available surface water supplies each year.

La Grange Diversion Dam was constructed in 1893 and is located on the Tuolumne River, downstream of Don Pedro Reservoir near the community of La Grange. Water released from Don Pedro Reservoir is diverted from the river into the TID Upper Main Canal at the La Grange Diversion Dam.

TID's distribution system begins at La Grange Diversion Dam where water, released from Don Pedro Reservoir for irrigation purposes, is diverted into the TID Upper Main Canal for conveyance to Turlock Lake. Turlock Lake is an important component of the TID's irrigation system with a maximum capacity of 45,600 AF. TID operates Turlock Lake to store and release irrigation water supplies, to balance irrigation deliveries with irrigation demand, and to minimize flow fluctuations in the District's irrigation canals and laterals.

From Turlock Lake, water is released into the Main Canal for distribution to downstream growers for irrigation purposes. TID's conveyance and distribution system consists of

approximately 241 miles of canals, of which 222 miles are fully or partially lined (92%). (Lining information is reported through 2014 for consistency with the irrigation season water budget presented in Section 4 of this Plan.) The unlined canals are located primarily in upland areas underlain with hard clay soils with very low infiltration rates. TID has an active gunite and lining replacement maintenance program and resurfaces an average of 2 miles of canal lining each year (based on the 1991-2014 period). During the winters 2006-2007 and 2007-2008, TID lined approximately 4.5 miles of existing earthen canals for operational purposes.

Three main delivery canals run north to south with laterals running east to west from the canals. Upper laterals terminate into the lower canals, allowing any excess water in the upper laterals to be utilized for deliveries from the lower canals. Several interconnections between canals provide additional operational flexibility, enabling the District to capture water that may otherwise spill. Additionally, a small volume of tailwater flows to agricultural drains and is intercepted by the TID distribution system and blended with surface water supplies for delivery to TID growers. Additional information on tailwater in the TID irrigation service area is described in Sections 2.3, “Terrain and Soils” and 2.5, “Operating Rules and Regulations.”

TID owns and maintains the distribution system from Turlock Lake down to the sidegate; the point at which water is delivered from the District to the individual fields. Growers are responsible for building, operating and maintaining the distribution facilities from the sidegate to the field. A variety of private and improvement district facilities have been designed and built over time to meet this need. (See Section 2.2.1 for more information regarding Improvement Districts.)

TID’s canal distribution system is a gravity flow system. Water in the canals not utilized for irrigation purposes flows through the canals and is released into drains or downstream rivers. These locations are called spills. There are a total of 15 spill locations from the distribution system. Six of the spills flow directly to rivers and the remaining nine are consolidated into three drains that flow to the river system.

TID supplements surface water releases by pumping groundwater from drainage and rented wells. Drainage wells are owned by TID and are used to lower groundwater levels in localized, high groundwater areas and to supplement other irrigation water supplies. Rented wells are private or Improvement District wells that are rented by TID to supplement irrigation supplies, particularly in drier years when surface water supplies are limited. The actual wells rented each year vary depending upon a variety of factors including the anticipated amount of rented pumping needed, pumping costs, condition of the well and the quality and quantity of the water pumped. Water pumped from drainage and rented wells either discharges directly into the canal, into a pipeline that flows back to the canal, or into a pipeline from which it is utilized for irrigation purposes.

TID also utilizes supplemental groundwater pumping to help conserve water by reducing canal spillage. This is done by purposely releasing less than the needed amount of surface water into the head of each canal and pumping groundwater into the lower sections of canal to make up the difference. Utilization of available groundwater supplies in this manner provides greater flexibility to system operators to meet irrigation demand, while reducing distribution system spills. Recent pump automation has further facilitated this process, enabling pumps to be turned on and off remotely.

2.2.1 Improvement Districts

TID's responsibility for water delivery stops at the canal or lateral sidegate. The Growers are responsible for the construction and maintenance of facilities to transport the water from the TID canal to their land. Improvement Districts (IDs) are formed to allow groups of growers to pool resources to construct, operate and maintain irrigation facilities including ditches, pipes, wells, drip/micro systems, and surface and subsurface drainage facilities. TID offers low interest financing to IDs, generally with a 10-year loan term.

TID is the trustee and administrator for 1,043 IDs that deliver water from the TID canals and laterals to individual growers. ID facilities comprise approximately 700 miles of lined delivery ditches and pipelines serving 128,400 acres. Generally the District continues to work with IDs to pipe facilities whenever possible. An average ID is comprised of 13 parcels with an average parcel size of 18 acres. The average parcel size receiving surface water within TID's irrigation service area is 28 acres. Parcels not belonging to IDs receive water through private pipelines and ditches served directly by sidegates on TID canals and laterals.

2.2.2 System Operational Constraints

There are a few capacity constraints in the canal delivery system that can cause delays in delivering ordered water. These capacity constraints are due, in part, to changes in cropping patterns over the years that have led to a demand for more frequent and time sensitive irrigation (e.g., a shift from irrigated pasture to corn and alfalfa). To reduce delays in water deliveries and to improve customer service, TID created a central call center in 1991 to process irrigation orders. In most of the service areas with capacity constraints, TID rents pumps to supplement surface water supplies downstream of the capacity constraint. Pumps are used as needed to ensure that the customer is not affected by system constraints and receives the full ordered flow with as much flexibility in timing as practical. The rented pumps that are turned on for this purpose can run up to several days continuously per week during the summer peak demand time, until demand has diminished.

2.2.3 Changes to Service Area

An increase in urbanization has occurred within TID's irrigated service area in the last decade. Urban land uses occupy approximately 20,000 acres within the irrigation service area. A recent evaluation of land use patterns in the TID irrigation boundaries completed in 2006 shows that idle cropland has been converted to urban land uses, rather than land in active agricultural production. The economic downturn that began in about 2008 also influenced urban development in the region, a condition from which this area is just starting to recover from. Hence, land use changes within the irrigation service area have not resulted in significant reductions in active irrigated acreage since about 2008.

Several local community water systems, including those found in Ceres, Turlock and the portion of Modesto south of the Tuolumne River have for a number of years been studying the possibility of using TID surface water from the Tuolumne River to supplement groundwater supplies. (See Section 4.5.4 regarding municipal and industrial water supplies for more information.) While such a project would restore surface water service to land within TID's current irrigation boundaries.

2.3 TERRAIN AND SOILS

Soils within TID vary from loam on the eastern edge of the irrigation service area to loamy sands on the western side. On average, land in TID is flat with an average fall of about 1 foot per 1,000 feet. Most irrigated lands in the TID irrigation service area are laser leveled, with the annual crop areas re-leveled every few years. The majority of land is flood irrigated using basin-check systems that generate little or no tailwater. Private tailwater return systems are not permitted to discharge to the distribution system. Even on the eastern side of TID, where the land is somewhat steeper and more tailwater occurs, the majority of growers have control structures to prevent tailwater from flowing directly back into the distribution system.

A small quantity of tailwater is generated in the TID irrigation service area. Tailwater production is limited to approximately 10,900 acres (less than 7% of TID irrigable lands). The tailwater first flows to agricultural drains that collect a mixture of tailwater, shallow groundwater, and occasionally rainfall runoff. Several of these drains are intercepted by the distribution system enabling recovery and reuse of drain flows, including tailwater from approximately 2,700 acres (less than 2% of TID irrigable lands). The remainder of drains flow to local rivers. During the irrigation season, the intercepted water is blended with surface water supplies in the canals and used for irrigation. Approximately 8,200 additional acres within TID can also produce tailwater, but this water does not enter the TID distribution system. (See Section 2.5.4 for additional information regarding tailwater policies.)

On the western side of TID extensive clay lenses lying between 5 and 20 feet beneath the ground surface result in localized perched water tables. TID drainage wells in these areas are run to help lower groundwater levels to maintain aerated root zones for crop production. TID makes monthly shallow groundwater elevation maps to guide the operation of the drainage pumps. These perched water tables developed soon after water was delivered into these areas in the early 1900's and led TID to begin installing drainage wells as electricity became available in the 1920's. TID currently owns 165 drainage wells and generally operates 105 to 130 of them each year depending on rainfall and need for drainage. The pumped drainage water can contain elevated concentrations of Total Dissolved Solids (TDS) and nitrates and is therefore blended with surface water and used for irrigation to the fullest extent possible.

The spatial variation in soils from east to west has resulted in the majority of the orchard crops being located on the east side of TID while the bulk of the field crops supporting the dairy industry are found on the west side. Micro sprinkler and drip irrigation systems are concentrated on the east side in the areas with lighter soils, and tend to use less water and produce less deep percolation (recharge) than surface irrigation methods. However, it should be noted that, where feasible, most new installations of drip irrigation and micro sprinkler systems use surface water and also maintain access to their historic flood irrigation facilities. The east side of TID is the area where recharge is most needed to overcome local groundwater level declines, presenting a challenge to groundwater management in the Basin. Conversely, subsurface drainage systems have been installed in the western areas with higher groundwater levels.

2.4 CLIMATE

TID's service area is characterized by a Mediterranean-type climate. Summers are hot and dry, with average high temperatures of approximately 90°F and temperatures exceeding 100°F at

times. Winters are cool and wet, with the majority of precipitation falling between November and March. The coldest month of the year is January, which has an average minimum temperature of 38°F. These characteristics are widely representative of the climate throughout the irrigation service area. Microclimates within TID do not vary greatly and, therefore, have little impact on TID operations or on-farm water demands. Average climate data for the period 1991 to 2014 are presented in Table 2.3. The twenty-four year period from 1991 to 2014 period provides a reasonable depiction of long-term climatic conditions within TID. Potential climate change effects are discussed in Section 5.

Natural precipitation generally meets the water needs of winter annuals, pasture and winter cover crops in the orchards; however, dry winters may require irrigation deliveries for these crops between November and February. In the past, early irrigations have typically occurred within a two week period in either January or February. Water delivered during the winter is typically not counted towards a grower's available water supplies (referred to as the "allotment" prior to 2013 and known as available water since then) for the irrigation season and is charged on a volumetric basis.

Table 2.3. Average Climate Characteristics (1991-2014).

Climate Characteristic	Average Value[1]
Average Annual Precipitation	12.3 inches
Average Minimum Temperature	38°F January)
Average Maximum Temperature	92°F (July)
Average Annual Reference Evapotranspiration (ET_o)	52.3inches
Average Minimum Monthly Reference Evapotranspiration (ET_o)	1.0 inches (January)
Average Maximum Monthly Reference Evapotranspiration (ET_o)	8.1 inches (July)

[1]Average precipitation values are from 1991 - 2002 records from the National Oceanic & Atmospheric Administration (NOAA) Station #49073 (Turlock #2), from California Irrigation Management Information System (CIMIS) Station #168 (Denair) for 2003 - April 2009, and from CIMIS Station #206 (Denair) for April 2009 to December 2014.

Temperature values are from CIMIS Station #71 (Modesto) for 1991 - 2002, from CIMIS Station #168 for 2003 - April 2009, and from CIMIS Station #206 (Denair) for April 2009 to December 2014.

ETo values are from CIMIS Station #71 (Modesto) for 1991 - 2002, from CIMIS Station #168 for 2003 - April 2009, and from CIMIS Station #206 (Denair) for April 2009 to December 2014.

Although freezing temperatures do occur during the winter months at times, water is not delivered for frost protection. However, TID does allow growers to use the canals to convey the grower's own deep well water to other parcels owned or rented by the pump owner. A condition of this use is that such activities cannot interfere with operation and maintenance of the canal or lateral.

TID has been providing growers with local weather information for on-farm water management for over 10 years. TID installed a California Irrigation Management Information System (CIMIS) Station #168 (Denair) in early 2002. The station was installed in a central location in the TID irrigation service area, providing data for a previously underrepresented area in the CIMIS network. The station provides area-specific climate and reference evapotranspiration data to growers to allow them to effectively schedule irrigation events based on current and projected crop water usage. TID provides the Department of Water Resources (DWR) CIMIS website information and a web link to CIMIS tutorials and station data on the TID webpage.

Growers can also access the data directly from the DWR website. (http://www.tid.org/water/water-management/california-irrigation-management-information-system-cimis) In April 2009, CIMIS Station #168 (Denair) was relocated approximately two miles to the southeast and assigned a new station number (#206). The station is located on an irrigated pasture with adequate fetch to provide reliable reference evapotranspiration estimates. TID continues to sponsor and maintain the station.

2.5 OPERATING RULES AND REGULATIONS

The current TID "Irrigation Rules" are provided in Appendix E, including rules for the distribution and use of irrigation water, governing rules for IDs, pump IDs, and subsurface drainage IDs, and the TID Drainage Policy. Updates to the irrigation rules occur from time to time as needed. The current rules are expected to be updated, prior to the 2016 irrigation season, to reflect changes in the water pricing structure, and to reflect current practices and procedures. Any changes to the irrigation rules are communicated to customers and readily available at TID offices, or via the internet at www.tid.com.

2.5.1 Water Allocation Policies

Historically, the TID Board of Directors has established the baseline water allotment each year depending on projected runoff including the possibility of the occurrence of consecutive dry years, desired carryover storage, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps. This baseline allotment was part of a three-tiered increasing block rate schedule, which is discussed in greater detail in Section 2.7, "Water Rate Schedules and Billing." The baseline allotment was the quantity of water available equally to each acre of land within the TID service area. Additional water could be purchased, if available, and was charged on a volumetric basis. In average rainfall years, the baseline allotment was as high as 48 inches (4 AF per acre).

On June 12, 2012, the TID Board of Directors adopted a new volumetric pricing structure to comply with SBx7-7 water pricing requirements. As described in Section 2.7, the new structure is an increasing block rate structure combined with a fixed charge. Additionally, the structure includes two different fee schedules, one for "normal" water years and one for "dry" years. The new rate structure took effect in 2013. With the new structure, instead of establishing an "allotment," the Board of Directors determine the amount of water available for purchase each year, and the fee schedule to be used (e.g. normal or dry year), based on projected runoff including the possibility of the occurrence of consecutive dry years, desired carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps.

In establishing water available in a dry year, the District evaluates water supplies as if it is the first dry year of a multiple year dry cycle. For these analyses, the dry period from 1987 to 1992, the longest dry cycle in recent history, is often used as the drought of record for planning purposes. Another significantly dry period was 1976 through 1977. These dry periods, and their impacts on water supply availability, are often utilized for reference in water supply planning. In the future, experience gained during the most recent 2012 through 2015 dry period will be incorporated into these water supply evaluations.

Additionally, in most normal or above normal precipitation years, depending on carry-over storage, the TID Board of Directors may allow the sale of "surplus water" to lands outside of, but adjacent to TID. This block of water is not always available. The bulk of the "surplus water" goes to lands to the east of TID as a substitute for groundwater pumping or in lieu groundwater recharge. These lands have no surface water supply and groundwater pumping has caused a cone of depression to form on the eastern portion of the Turlock Groundwater Basin. TID promotes in-lieu groundwater recharge during most years with normal or above normal precipitation by selling surplus water at rates that are competitive with the cost to pump groundwater. The last time surplus water was made available (2011) the cost was $20 per AF.

2.5.2 Water Orders

TID uses an arranged-frequency demand system of water ordering and delivery. Under this system, the irrigation frequency (water delivery date) is arranged, flow rates are arranged subject to a maximum limit, and the delivery duration is under user control as growers are allowed to keep the water until they finish irrigating (ASCE, 1991). Cropping patterns in TID's irrigation service area are very diverse, with trees, vines, alfalfa, and field crops often served by the same ID pipeline. An individual grower may adjust the duration and frequency of delivery and, less commonly the flow rate to meet crop needs. For surface irrigation, flow rates are typically held constant from one irrigation event to the next to achieve consistent system performance.

Growers place orders for water with a Central Call Center where the computer system tracks current water use by parcel. In addition, TID began implementing an online ordering system in 2011, with full implementation reached in 2014. The District has also made historical customer information available to growers online. Use of the new online system has been gradually increasing over time. In 2014 and early 2015, about 15 to 20% of orders were completed online.

Growers receive water 50 hours after they place an order. Growers are allowed to keep the water until the irrigation is complete. Growers are billed for the total volume of water used, computed from the actual time of use rather than the time estimate given when the water order was placed. As described under "Irrigation Deliveries" below, most growers take a full flow (or "head") of water. The TID Water Distribution Operator (WDO) notifies each irrigator with the name and contact information for the grower they will receive the water from and the grower they will pass the water to when finished.

Growers on micro systems or sprinklers using non-standard flow rates (less than full surface irrigation heads) set up weekly orders in the Central Call Center and then communicate directly with the WDO to coordinate delivery. The WDO has the discretion to adjust the grower sequence from the Central Call Center water requests. This is done to minimize flow fluctuations in long pipelines by sequencing in continuous 24-hour blocks rather than making multiple flow adjustment throughout the day. Fixed two week rotation deliveries are established for 604 "garden heads," blocks of parcels 5 acres or smaller of non-commercial agriculture that are irrigated as a unit.

Wait times for water delivery are variable within a reasonable range, due to the discretion WDOs have to adjust delivery sequences. The WDO must call the irrigator within 24 hours of receiving the irrigation request to give an estimate of the delivery time. The WDO then will attempt to

contact the irrigator at least 12 hours in advance to notify the irrigator of any change in time of delivery. The mean wait time for deliveries is 50 hours from the time of the water request. The grower is responsible for contacting the next irrigator in the sequence to let him know when the water will be available. The lead time, or notice, for the next irrigator is typically ½ hour to 1 hour before the preceding irrigation finishes.

The software system currently used by the Central Call Center to track water orders and irrigation deliveries, and to bill customers is a proprietary system created by TID software engineers in the early 1990's. The system has been updated as needed over time. TID is currently evaluating commercially available software and other options, with the intent of migrating to another platform, or updating the existing proprietary system for water ordering, tracking and billing purposes. TID is currently evaluating one commercial system in a pilot test. To ensure a smooth transition, TID plans to operate the current system and the new system in parallel for at least a portion of the irrigation season. This will allow time for TID staff and customers to become familiar with the new system, and confident in its performance before making the final transition.

2.5.3 Irrigation Deliveries

The predominant irrigation practice in the TID service area is a basin-check flood irrigation system. TID supplies water by gravity to a grower at the ID or private sidegate. The standard head of water delivered is 15 cubic feet per second (cfs) or 20 cfs, depending on the grower or ID system capacity. Growers served through private pipelines or ditches receive a full standard head. In most instances, growers served from an ID pipeline or ditch also receive the entire flow in their sidegate in the order the water is scheduled. Growers are responsible for controlling their water while irrigating and passing the entire flow on to the next grower, as instructed by the WDO. These large delivery rates enable high application distribution uniformity using surface irrigation of the light textured soils found in the majority of the TID service area.

2.5.4 Drainage and Tailwater Policies

As a general rule, direct tailwater discharges are not permitted in the TID distribution system. The basin-check system of irrigation used most commonly in TID's irrigation service area produces little or no tailwater. Overall, approximately 10,900 acres (less than 7% of TID's irrigable acreage) generates tailwater. A small portion is collected in drains and discharged into the distribution system where it blends with surface water and is reused for irrigation. The remainder flows to local drains which in turn discharge to nearby rivers.

In 2000, TID began a systematic program to inventory the tailwater and storm drains that discharge to TID facilities. In 2004 TID received grant funding which allowed TID to inventory the entire District, provide financial assistance to growers to install positive shut-off devices on their drains and to install real-time water quality monitoring equipment. As part of this program, TID issues growers with drainage discharges a "Drainage Permit" which requires that a positive shut-off device be installed on each field drain, establishes a size limit on the drain and spells out the grower's responsibilities with respect to the quality of their drainage water. An annual fee is also charged for each field drain to offset a portion of the maintenance costs.

The inventory shows that drain water that, eventually enters TID canals, comes from a small percentage of lands within TID (approximately 2,700 acres, or less than 2%). This drain water includes tailwater mixed with other source water such as groundwater and natural runoff from precipitation. The drain water is blended with surface water supplies for delivery to TID growers. Some tailwater is generated on approximately 8,200 additional acres within TID, but is not intercepted by the TID distribution system.

2.6 WATER DELIVERY MEASUREMENTS OR CALCULATIONS

2.6.1 Conveyance System Measurements

TID began installing a Supervisory Control and Data Acquisition (SCADA) system in 1997, with data collection beginning in 1998. Through its agricultural management planning process, TID improved upon its SCADA system to better monitor flows by adding additional SCADA sites throughout the canal system. Today, a total of 342 sites have been outfitted with SCADA equipment to monitor and measure flow. Approximately 18 SCADA sites provide real-time water quality information. In 2007 TID began upgrading the pressure transducers originally installed with the SCADA equipment to maintain data accuracy, and has completed the upgrade at all sites.

These improvements have increased TID's ability to monitor system operations. Staff routinely monitor flows at the heads of most laterals, main diversion points, 18 intermediate points in the distribution system and at 14 operational spills[3], 3 drains, and 2 creeks.

Further, WDOs have remote access to the real time flow data through a program installed on their TID tablet computers, allowing them to rapidly check conditions throughout their service area. The installation of SCADA technology has increased the accuracy of flow measurements throughout the TID distribution system. In addition to providing flow measurements at previously ungaged sites in the distribution system, the telemetry equipment replaced the Stevens chart recorders. The SCADA sites produce more accurate flow estimates because flows are recorded in real time and averaged for the daily flow volume. These flow data have improved the estimates of water use throughout the irrigation service area.

The measurement structures within the conveyance system are maintained annually to ensure the accuracy of recorded measurements. The calibration of the sensors at the SCADA sites is periodically checked throughout the year.

2.6.2 Delivery Measurements

The delivery point at which water is delivered from a TID canal or lateral to a grower's parcel or an improvement district facility is called a *sidegate*. Sidegates are typically operated for measurement by setting the valve stem opening as needed to deliver the standard surface irrigation flow rate of either 15 or 20 cfs based on the hydraulic conditions and grower preference at the sidegate. The valve opening is determined by measuring the height of the gate

[3] There are 15 operational spills. However, only 14 are used. The 15th site can spill, but is very rarely used, and therefore is not included in the SCADA system at this time.

stem above a standard reference point on the gate frame. Historically, the gate opening has been set such that the end (downstream-most) user receives at least the standard flow for that pipeline.

The gate opening required to deliver the standard flow has been determined from flow measurements made by trained TID employees using portable electromagnetic velocity meters, which measure velocity in the irrigation pipeline or ditch, downstream of the sidegate. Flow is calculated by multiplying the measured velocity by the cross-sectional area of the pipe. The required gate openings (providing a standard 15 or 20 cfs head) have been provided to the WDOs, the field staff who deliver the water and to the, growers served by each gate. A gate opening and associated flow rate is assigned to each parcel in the database record used to compute water use.

TID also provides an increasing number of non-standard delivery rates, mainly to parcels served by pressurized systems. Deliveries to these parcels are assigned a unique flow based on the individual irrigation system configuration.

Growers are billed for the volume of water delivered. When a grower completes an irrigation event, they contact the WDO to give the start and stop times for the irrigation, and the WDO records the times on a water receipt. The volume delivered is calculated by multiplying the flow rate by the duration of the delivery.

Using TID sidegates to measure individual customer deliveries in this manner is complicated by a number of factors that make using this method, in some locations, potentially problematic for achieving accuracy standards specified in the California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (23 CCR §597). Therefore, pursuant to 23 CCR §597.4(e) (4), a corrective action plan to be fully compliant with the new regulation by December 31, 2015 was developed, and included in Appendix F of the 2012 TID AWMP.

The corrective action plan includes a two-pronged approach to delivery measurement pursuant to which TID is in the process of establishing parcel specific calibrated flows, or installing new measurement devices to directly measure the volume of water delivered to each parcel. As of August 31, 2015, TID has installed 137 new continuous flow measurement devices on 132 sidegates, and five branches below these gates, serving large areas and many parcels, which together account for roughly half the irrigated acreage. At existing sidegates without access vents in suitable locations for measurement, TID developed a system for temporarily installing Rubicon FlumeMeters at gates to calibrate parcel-specific flow rates. Approximately 50 FlumeMeters are used in this program and parcel specific calibrated average flow rates have been developed for 1,027 parcels, representing 22,304 acres, or 70% of the 31,996 acres to be calibrated. Additionally, 209 parcel flow rate calibrations have been completed with Hach FH950 meters, representing 7,675 acres, or 36 percent of the 21,480 acres to be calibrated. Finally, 474 parcel flow rate calibrations have been completed with Fuji Portaflow meters, representing 18,078 acres, or 69 percent of the 26,190 acres to be calibrated. In total, 1,710 parcel flow rate calibrations have been completed, representing 48,057 acres, or 60 percent of the 80,572 acres served by existing sidegates. More information about TID's delivery measurement accuracy improvement program is provided in Appendix F.

2.6.3 Private Pumping Measurements

Private pumping is estimated using a conversion factor that correlates the quantity of water pumped based to electrical energy use. In TID's first AWMP, TID identified an overestimation of the amount of pumping from private irrigation wells. Because the land uses and irrigation practices over large portions of TID have changed since then, the conversion factor that had previously been developed was no longer accurate. A survey of private facilities showed that there were many instances where the electricity measured by the electric meter was being used to power more than just the deep well pump, resulting in an overestimation of private pumping. A new conversion factor was developed to address this by accounting for the use of pressurized irrigation systems and multiple pumps connected to a single electric meter (e.g., a deep well pump and separate booster pump on the same meter). Use of several conversion factors has allowed TID to develop a better estimate of private groundwater use over time. In 2014, initial water balance results indicated an implausibly high average crop consumptive use fraction of 0.86 triggering a new review of private pumping. This review revealed that when the total electrical usage for pumping increased in 2014 the methodology assumed the increase was shared proportionally between groundwater pumps and other pumps sharing the same meter. Assuming that all of the energy increase in extremely dry years is used primarily to pump groundwater from deep wells resulted in higher estimates of private pumping and a reasonable average crop consumptive use fraction of 0.76.

2.7 WATER RATE SCHEDULES AND BILLING

TID has historically used a three-tiered, increasing block rate schedule based on three classes of water deliveries. The first block was the annual allotment which was available equally to each acre of land. The volume of the allotment varied depending upon the available surface water supply. The actual allotment, as well as any additional water available above the allotment, was set each year based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps.

The TID water rate basis and structure in effect from 2010-2012 are presented in Table 2.4. During that period, the allotment charge was $26 per acre, which is equivalent to $6.50 per acre-foot for a 48-inch allotment. However, because the allotment was assessed at a flat rate per acre, when the volume of the allotment declined, the effective cost per acre-foot increased. The next two blocks of water, when available, were charged on a volumetric basis. The charge for available (Tier 2) water was $15 per acre-foot for the first 12 inches of water over the allotment and any remaining water (Tier 3) was charged at $20 per acre-foot. During certain dry years, TID also placed caps on the amount of Tier 2 and Tier 3 water available above the allotment as part of its conjunctive management strategy and conservation efforts.

Table 2.4. Description of Historical Water Rates (2010-2012).

Water Charge Basis	
Acreage-based[1]	Allotment up to 48 inches per acre, set each year
Quantity-based	Use above allotment charge on an AF basis
Type of Billing	Increasing block rate
Allotment Charge	$26/acre[1]
2nd & 3rd Tier Water Rates (if available)	▪ **Tier 2:** $15/AF for up to 12 inches of water per acre[1] ▪ **Tier 3:** $20/AF
Frequency of Billing	Semi-annually

[1]Acreage based on assessed acres.

TID's historic pricing and water management practices have enabled TID to conjunctively manage its surface water and groundwater resources. In normal and above normal water years, allotments (up to 48 inches) encouraged growers to use surface water rather than pump groundwater. The majority of surface water applied but not consumed by the crop recharged the groundwater system. The recharge maintained groundwater storage that is pumped in dry years to supplement reduced surface water supplies. Additionally, the allotment was reduced in dry years, increasing the cost to the grower by moving deliveries into the higher tiered water prices sooner. This not only encouraged conservation in dry years, but also provided additional revenue to cover costs associated with additional pumping needed to supplement reduced surface water supplies.

In June of 2012, TID adopted a new volumetric pricing structure that became effective in 2013 (Table 2.5). The new structure is designed to continue to support the District's critically important conjunctive management objectives, but also to comply with the requirements of SBx7-7. The new structure includes a fixed (per acre) charge, combined with a four-tiered increasing block rate schedule. The new rate structure also includes a split schedule, with one schedule established for dry years, and another for normal or above normal years. As with the previous pricing structure described above, the new "dry" schedule is at a higher rate, to help recover the additional pumping costs incurred in dry years. With the new pricing structure in place, the TID Board of Directors will no longer determine the allotment each year. Instead, the Board will determine the type of water year (and therefore the water pricing schedule to be used for the given year) as well as the amount of water available for purchase, based on projected runoff, including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River and the availability of rented pumps. The process now used to determine the volume of available water is similar to that used previously to establish the annual "allotment."

In early 2015 TID implemented another water rate increase to help generate revenues to fund revenue shortfalls, canal improvement projects, development of a Water Master Plan (WMP), the SBx7-7 water measurement program and other various projects. At that time, the District evaluated several different means of revising the rate structure and determined that a more reliable revenue stream could be generated by increasing the fixed charge. As a result, the District revised the fixed charge as illustrated in Table 2.6. The new rates took effect at the start of the 2015 irrigation season.

Table 2.5. Description of 2013-2014 Water Rates.

Water Charge Basis	Each year, based on water supplies available, the Board determines amount of water available, and if the normal or dry schedule is to be used.	
Acreage-based[1]	Fixed Charge, varies by normal or dry year	
Quantity- based	Water charged on a per acre-foot (AF) basis, varies by normal or dry year	
Type of Billing	Water costs include a fixed charge, plus volumetric charges for the water used. Charges are established in normal or dry year schedules. Volumetric charges are based on a four-tiered, increasing block rate structure.	
	Normal Year Rate Schedule[1]	**Dry Year Rate Schedule[1]**
Fixed Charge	$23 per acre	$26 per acre
1st Tier Water Rate	$2 per AF, up to 2 AF per acre	$2 per AF, up to 1 AF per acre
2nd Tier Water Rate	$3 per AF, up to 2 AF per acre	$3 per AF, up to 1.5 AF per acre
3rd Tier Water Rate	$15 per AF, up to 1 AF per acre	$15 per AF, up to 1 AF per acre
4th Tier Water Rate	$20 per AF, additional available	$20 per AF, additional available
Frequency of Billing	Semi-annually	

[1]Acreage based on assessed acres.

Table 2.6. Description of 2015 Water Rates.

Water Charge Basis	Each year, based on water supplies available, the Board determines amount of water available, and if the normal or dry schedule is to be used.	
Acreage-based[1]	Fixed Charge, varies by normal or dry year	
Quantity- based	Water charged on a per acre-foot (AF) basis, varies by normal or dry year	
Type of Billing	Water costs include a fixed charge, plus volumetric charges for the water used. Charges are established in normal or dry year schedules. Volumetric charges are based on a four-tiered, increasing block rate structure.	
	Normal Year Rate Schedule[1]	**Dry Year Rate Schedule[1]**
Fixed Charge	$60 per acre	$68 per acre
1st Tier Water Rate	$2 per AF, up to 2 AF per acre	$2 per AF, up to 1 AF per acre
2nd Tier Water Rate	$3 per AF, up to 2 AF per acre	$3 per AF, up to 1.5 AF per acre
3rd Tier Water Rate	$15 per AF, up to 1 AF per acre	$15 per AF, up to 1 AF per acre
4th Tier Water Rate	$20 per AF, additional available	$20 per AF, additional available
Frequency of Billing	Semi-annually	

[1]Acreage based on assessed acres.

In addition to the cost of water, the growers are responsible for the cost of the facilities to convey water from the TID canal sidegates to their fields.

TID also promotes in-lieu recharge in most years with normal and above normal precipitation. In these years, depending on carry-over storage, the TID Board of Directors may allow the sale of "surplus water" to lands outside of, but adjacent to TID. This block of water is not always available. The bulk of these sales go to lands to the east of TID as a substitute for groundwater pumping for irrigation. These lands have no surface water supply, and groundwater pumping significantly impacts available groundwater supplies in the Basin. The District promotes groundwater recharge in those areas in years when surplus water is made available by selling the water at rates comparable to the cost to pump groundwater. The last year this occurred was in 2011, when surplus water was available at the cost of $20 per acre-foot.

2.8 WATER SHORTAGE ALLOCATION POLICIES

TID's water allocation guidelines were developed in response to the 1987-1992 drought and are described in greater detail in TID's Drought Management Plan (Appendix G). The guidelines rely on TID's groundwater pumping capacity and management of carryover storage in Don Pedro Reservoir. Prudent water supply planning requires TID to consider that the first dry year encountered may just be the first year in a series of dry years similar to the 1987 to 1992 period.

Prior to 2013, the following process was used. Each year, the decision to set the water available at normal levels or to reduce surface water diversions correspondingly lower the water available was made based on runoff projections and carryover storage. Groundwater pumping was increased progressively in the first years of a drought, while water available was progressively reduced. The gradual increase in groundwater use and corresponding decrease in water available to the grower in the allotment allowed for a more uniform increase in groundwater pumping balanced against annual reductions in the carryover storage reserve. Additional pumping and other operational changes help to reduce spills, further extending limited supplies. However, there is a limit to the amount of pumping the District is able provide. As a drought extends, growers that have access to private wells are able to use them to offset reduced District supplies.

Prior to 2013, the reduction in the amount of water available to growers and carryover storage in the first year were determined based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, availability of groundwater and rented pumps, and instream flow requirements. Reducing the allotment size caused growers to go into higher priced water tiers more quickly, and was intended to promote water conservation at the farm and supplier scales[4]. For subsequent years of drought, the same process was used to make further adjustments in the water available and carryover storage. In critically dry or consecutive dry years, TID could cap water deliveries to lands receiving surface water. The one exception was that growers that rented pumps to TID, were typically given access to an additional 12 inches of water, up to a maximum of 48 inches, on those lands able to be served by the pump. This was done to encourage growers to rent pumps to TID. Without this option, many rental pumps might not have been available, significantly reducing TID's ability to supplement reduced surface water supplies in dry years.

[4] To develop a methodology to quantify Water Use Efficiency (WUE), DWR considered the components of a water balance at three spatial scales—basin, water supplier, and field (DWR, 2012). Similarly, spatial scale must be considered when evaluating the influence of the amount of water available to growers.

Beginning in 2013, the new water rate structure changed the process described above. However, a similar type of water shortage allocation process has been implemented. In water short years, the Board of Directors determines whether to use the dry year rate schedule, and the amount of water available on a per acre basis, based on projected runoff including the possibility of the occurrence of consecutive dry years, carryover storage, flows required to be delivered to the lower Tuolumne River, and the availability of rented pumps.

As with past years, the decision to reduce surface water diversions in the future will be made based on available water supplies. Information including runoff and carryover storage projections, the availability of rented pumps, and instream flow requirements will be used to assist in making that determination. Similarly, groundwater pumping is expected to increase progressively in each drought year as supplies allow, and water available to the growers may be progressively reduced, as needed to balance supplies available with carryover storage requirements.

However, even with TID's conjunctive water management, groundwater is not an unlimited supply. In an extended drought, the availability of groundwater will likely decline over time, due to declining water levels and increased groundwater demand by TID and others.

Water availability is treated equally for all crop types because a large proportion of field crop production occurs in conjunction with local dairy operations. This demand is as stable as the water demands for orchard crops. Payment of the water charge (in the past), provided the grower with access to the amount of water established as the allotment, regardless of crop type. The new rate schedule is designed to act in a similar manner. In future years, payment of the fixed charge will provide growers with access to purchase the amount of water available that year, regardless of crop type. All water delivered will be charged on a volumetric (or per acre-foot) basis.

Increased groundwater pumping during dry years also allows TID to increase water delivery efficiency by reducing operational spills. The use of extensive pumping allows a WDO to more closely match water supplies to demands in the downstream portion of a service area. This flexibility was utilized during the 1987-1992 drought, resulting in a substantial decrease in operational spills. TID has continued to rely on the practice of increased groundwater pumping to reduce spills in the dry years since the 1987-1992 drought most notably 2007 through 2009 when operational spills were decreased to an average of five percent. Similarly, from 2012 through 2014 operational spills have progressively decreased each year to approximately five percent in 2014, with a comparable value expected for 2015.

2.8.1 Wasteful Use

TID's Irrigation Rules (Appendix E) require that all water be applied efficiently and used in a reasonable and beneficial manner. During an irrigation delivery, the irrigator is responsible for the water at all times after it leaves the TID distribution system. Irrigators who waste water intentionally or as a result of carelessness, improper field preparation, or neglected facility maintenance may be refused TID water until the cause of the condition is remedied.

The predominant irrigation method in TID (basin-check flood irrigation system) promotes beneficial use of water. Deep percolation that does occur from the basin-check systems provides recharge for the groundwater basin that is put to beneficial use by neighboring agencies as well

as by TID and its customers. As noted in the introduction to this AWMP, even with the recharge provided by irrigation, the groundwater levels in the eastern portion of TID and in the eastern portion of the Turlock Groundwater Basin have steadily declined (see Section 3.2.1), largely due to groundwater usage outside the eastern boundary of TID.

It is important to note that in areas where groundwater levels are higher, and groundwater is pumped for drainage, the drainage water is blended with canal water and used as a part of the irrigation supply. Drawdown of groundwater levels due to the cone of depression on the eastern side of the groundwater basin limits the amount of groundwater that can be pumped on the eastern side of the District in dry years. As a result, groundwater pumping in recent dry years has relied more heavily on drainage wells for supply, enabling the District to maximize the use of higher groundwater levels on the western side of the basin for beneficial use.

2.8.2 Enforcement of Irrigation Rules and Regulations

Failure or refusal to comply with the TID rules and regulations by a landowner or irrigator may lead to termination of water delivery. Once terminated water delivery cannot be resumed to the landowner or irrigator until the issue is resolved.

The Water Distribution Department Manager is authorized to issue a Notice and Order or oral or written warning to any irrigator or landowner in violation of a TID rule or regulation. The landowner or irrigator has 10 calendar days from the date of service (of the Notice and Order)to file a written appeal to the General Manager or Board of Directors, depending on the type of notice, after which all rights to a hearing are waived. Water deliveries may be terminated immediately in certain circumstances. These violations and the appeal process are described in detail in the TID Irrigation Rules in Part I, Section 10 (Appendix E).

Once an order or decision has become final, the irrigator or landowner has 7 calendar days to commence corrective action or repair and must pursue the action with sufficient diligence to meet the time established for compliance. When the landowner or irrigator re-establishes full compliance with all regulations, the eligibility to receive water deliveries is restored.

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3 Inventory of Water Supplies

This section of the AWMP describes the quantity and quality of the water resources available to TID. Over the last five years, total TID water supply averaged about 604,000 AF (Table 3.1). Usage patterns within the TID irrigation service area as depicted by the water balance analysis, a central component of this AWMP, are described in Section 4.

Table 3.1. Summary of Water Supply Volumes within TID.

Year	Available Water (inches)[1]	Surface Water Supply (AF)	Groundwater Supply (AF)[2]	Other Water Supply (AF)[3]	Total Supply (AF)
2010	48	531,107	80,983	16,109	628,199
2011	48	537,685	85,757	18,003	641,445
2012	30	445,579	139,027	13,726	598,332
2013	34	460,420	155,679	13,108	629,207
2014	20	320,862	191,632	11,316	523,810
2010-2014	Average	459,131	130,615	14,452	604,198
	Minimum	320,862	80,983	11,316	523,810
	Maximum	537,685	191,632	18,003	641,445
1991-2014	Overall Average	491,475	107,917	12,132	611,794
	Normal Year Average	520,225	90,749	12,605	623,579
	Dry Year Average	458,086	128,207	11,574	597,867

[1]Depth of water in inches available equally to each acre of land. For 2010-1012 this was the allotment.
[2]Includes supplemental private pumping on surface water irrigated lands.
[3]Includes reused tailwater and subsurface drainage, measured drain pumping at TID Pump 152, and treated Municipal and Industrial (M&I) effluent delivered to farms.

In this Sections 3 (Water Supplies) and in the following Section 4 (Water Balance). The following periods are used for the presentation and interpretation of data:

1. 2010 to 2014 Period (Near-Term Historical)
    a. 2010-2014 average, which is an average of the last five years of operation. The 2010-2014 data are reflective of current TID operations and weather conditions. During this period, three of the years are considered dry and two are considered normal. The last three years of this period plus 2015 are the driest four-year period in TID's 128 year history.
    b. 2010-2014 minimum and maximum annual values. The minimum and maximum depict the range of values under recent historical conditions.
2. 1991 to 2014 Period (Long-Term Historical)
    a. Normal year average, which is an average of the historical data from years in which water supplies were sufficient to allow for 48 inches or more of water available (between 1991 and 2012, this was equivalent to the allotment). From a

hydrological perspective, these years could be characterized as anywhere between normal and wet. Over the 24 year period from 1991 to 2014, 13 of the years fall into this category.

b. Dry year average, which is an average of the historical data from years in which supplies were reduced, and the water available equally to each acre of land (also referred to as the allotment from 1991-2012) was less than 48 inches. Eleven years between 1991 and 2014 are considered dry. The water available during these years ranged from a low of 20 inches to a high of 42 inches.

c. Overall average for the 24-year period from 1991 to 2014.

TID practices conjunctive water management, the coordinated operation and monitoring of surface water and groundwater supplies to meet defined objectives. In TID's case, the main objective is to provide a firm, reliable water supply to the TID service area. As discussed in this AWMP, given the nature of the crops grown in the TID service area, the water demand in TID varies little from year to year. TID has been able to meet this firm demand in both normal and dry years by using more groundwater in dry years when the surface water supply is reduced (Table 3.2).

Table 3.2. Summary of Water Supplies within TID as a Percentage of Total Supply.

Year	Available Water (inches)[1]	Surface Water Supply	Groundwater Supply[2]	Other Water Supply[3]	Total Supply
2010	48	85%	13%	3%	100%
2011	48	84%	13%	3%	100%
2012	30	74%	23%	2%	100%
2013	34	73%	25%	2%	100%
2014	20	61%	37%	2%	100%
2010-2014	Average	75%	22%	2%	100%
	Minimum	61%	13%	2%	NA
	Maximum	85%	37%	3%	NA
1991-2014	Overall Average	80%	18%	2%	100%
	Normal Year Average[4]	83%	15%	2%	100%
	Dry Year Average	77%	21%	2%	100%

[1]Depth of water in inches available equally to each acre of land. For 2010-2012 this was the allotment.
[2]Includes supplemental private pumping on surface water irrigated lands.
[3]Includes reused tailwater and subsurface drainage, measured drain pumping at TID Pump 152, and treated M&I effluent delivered to farms.
[4]Percentages do not add up to 100 percent when reported to the nearest whole percentage point due to rounding error. To the nearest 0.1 percent, the averages are 83.5 percent, 14.5 percent and 2.0 percent for surface water, groundwater, and other supplies, respectively.

However, even with TID's conjunctive water management, groundwater is not an unlimited supply. In an extended drought, the availability of groundwater will likely decline over time, due to declining water levels and increased groundwater demand by TID and others.

The facilities referred to in this section are described in greater detail in Section 2 of the AWMP, and are shown in the map provided in Appendix D.

3.1 SURFACE WATER SUPPLY

The Tuolumne River is the source of TID's surface water supply. TID diverts water according to a series of pre- and post-1914 flow and storage water rights recognized by the State of California. TID's surface water supply is dependent upon annual hydrologic and reservoir storage conditions. Irrigation water from Don Pedro Reservoir is diverted into the TID Upper Main Canal at La Grange Diversion Dam. Diversions flow via gravity through the Upper Main Canal to Turlock Lake for temporary storage and re-regulation for irrigation deliveries. Hydrology can vary widely but is somewhat mitigated by storage capacity at the Don Pedro Reservoir. While Don Pedro Reservoir is large, TID's share is only 68.46 percent of the reservoir's available storage, above the minimum operating pool.

Table 3.3 summarizes annual TID releases from Turlock Lake for irrigation purposes. Annual volumes are provided along with surface water supply as a percentage of total TID water supplies[5]. This table also illustrates the portion of the total irrigation supply from surface water for lands that receive TID deliveries. Sources of groundwater to these lands include TID drainage wells, wells rented by TID, and supplemental pumping by individual growers or Improvement Districts. Supplemental pumping includes groundwater pumped from private or Improvement District wells by the grower at the grower's expense. There are approximately 4,000 acres within the TID irrigation service area that are capable of receiving surface water but utilize groundwater as their sole source of irrigation supply. The water use for these lands is not included in Table 3.3 because they do not receive surface water deliveries.

The monthly distribution of surface water releases as a percentage of total annual releases into the TID distribution system is summarized in Table 3.4. Note that these values represent the typical irrigation season of March through October. In special circumstances, such as very dry conditions, TID can provide a limited amount of water for irrigation during the winter months or, as was the case in 2011, the irrigation season could extend into November.

3.2 GROUNDWATER SUPPLY

The Turlock Groundwater Basin (also referred to in this document as the Basin) lies on the eastern side of the San Joaquin Valley and underlies TID. This groundwater basin is a subunit or sub-basin of the San Joaquin Valley Groundwater Basin. The Turlock Groundwater Basin lies in the eastern portions of Stanislaus and Merced counties and has an area extent of approximately 347,000 acres (542 mi^2). The Basin is bounded by the Tuolumne River on the north, the Merced River on the south, the San Joaquin River on the west, and the Sierra Nevada foothills to the east (California Department of Water Resources, 2006).

[5] The TID water supply includes Turlock Lake releases for irrigation, TID drainage well pumping, and TID rented well pumping. Other water supplies such as tailwater and recycled water are not included as they are minor sources and to avoid double counting of surface water supplies that are reused.

Table 3.3. Summary of Surface Water Supply Relative to Total TID Water Supply.

Year	Available Water (inches)[1]	Surface Water Supply	
		Acre-Feet	Percent of TID Water Supply[2]
2010	48	531,107	89%
2011	48	537,685	89%
2012	30	445,579	80%
2013	34	460,420	81%
2014	20	320,862	78%
2010-2014	Average	459,131	83%
	Minimum	320,862	78%
	Maximum	537,685	89%
1991-2014	Overall Average	491,745	85%
	Normal Year Average	520,225	88%
	Dry Year Average	458,086	82%

[1]Depth of water in inches available equally to each acre of land. For 2010-2012 this was the allotment.
[2]The TID water supply includes Turlock Lake releases for irrigation, TID drainage well pumping, and TID rented well pumping. Other water supplies such as tailwater and recycled water are not included as they are minor sources and to avoid double counting of surface water supplies that are reused.

Table 3.4. Average Monthly Percentage Distribution of Turlock Lake Releases[1].

Period	Statistic	Month[2]							
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
2010-2014	Average	5%	8%	13%	17%	21%	18%	11%	7%
	Minimum	0%	7%	13%	14%	20%	16%	9%	5%
	Maximum	11%	11%	15%	18%	24%	19%	12%	9%
1991-2014	Overall Average	5%	10%	13%	16%	21%	17%	10%	7%
	Normal Year Average	4%	10%	13%	16%	20%	17%	11%	8%
	Dry Year Average	6%	10%	14%	17%	21%	17%	10%	6%

[1]Irrigation season values only.
[2] Represents the minimum, maximum or average distribution for that month over the given timeframe. The total of the monthly percentages do not equal 100%, nor were they intended to.

A variety of water agencies (both agricultural and urban entities) overlie the Turlock Groundwater Basin (Figure 3.1). Ballico-Cortez Water District and Eastside Water District located east of TID do not have surface water supplies. They were formed to represent growers and private domestic water users in their areas, who rely entirely upon groundwater for their water supply.

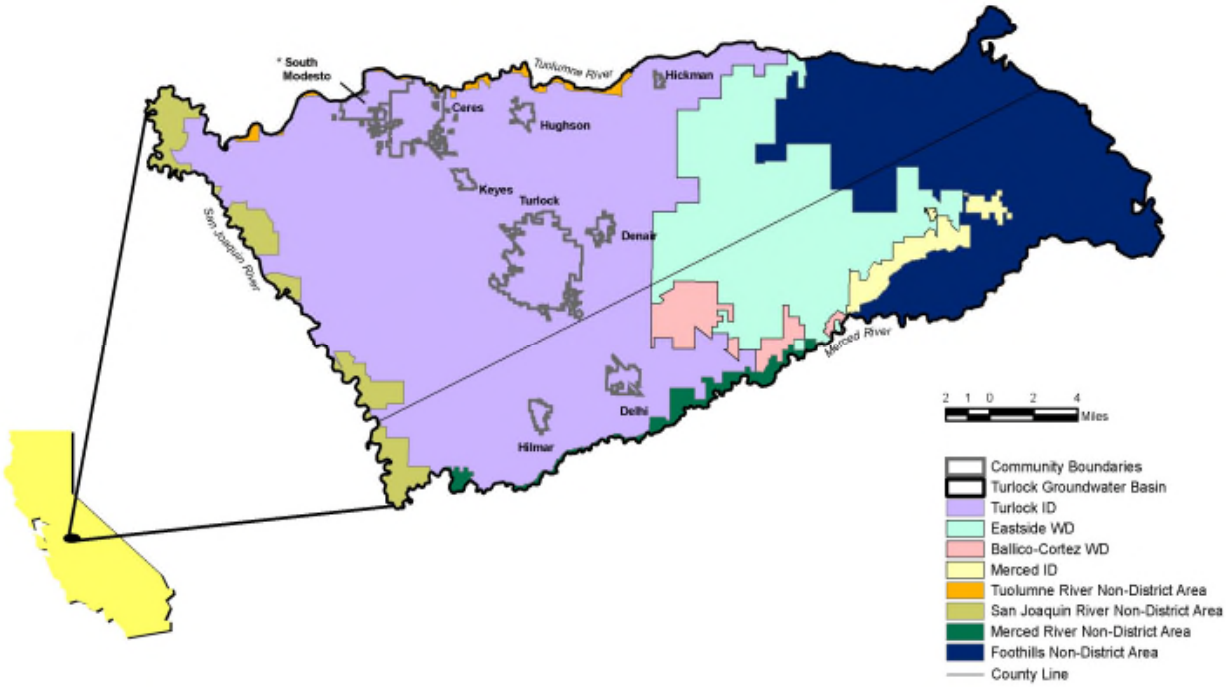

Figure 3.1. Turlock Groundwater Basin and Local Agency Boundaries (TGBA, 2008).

Groundwater within the Basin occurs under unconfined and confined conditions. A portion of the Basin is underlain by the Corcoran Clay, which separates the groundwater into two zones: an upper, unconfined aquifer and a lower, confined aquifer. There is also a deeply buried confined aquifer containing saline brine that extends upward into the unconsolidated sediments (Figure 3.2).

The unconfined aquifer occurs in unconsolidated deposits above and east of the Corcoran Clay. In the area underlain by the Corcoran Clay, the top of the clay is the base of the aquifer. To the east of the clay, the top of the consolidated rocks is the base of the aquifer. The unconfined aquifer is generally 150 feet in thickness. The unconfined aquifer is used for both agricultural and domestic supply in the western part of the Turlock Groundwater Basin. Wells less than 200 feet in depth draw from this aquifer. The general direction of regional groundwater flow in the unconfined aquifer would normally be westward and southward towards the valley trough. However, private agricultural pumping to irrigate approximately 89,000 acres in 2014 (Todd Groundwater, 2014) east of the TID has created a large cone of depression that results in portions of the groundwater flow reversing direction and moving to the east, out from under TID. Agricultural development that began in the 1950's in the eastern area continues to expand, increasing by about 8,800 acres from 2010 to 2014. All of which has no source of surface water supply. As a result, the areas east of TID rely entirely on groundwater for their water supply.

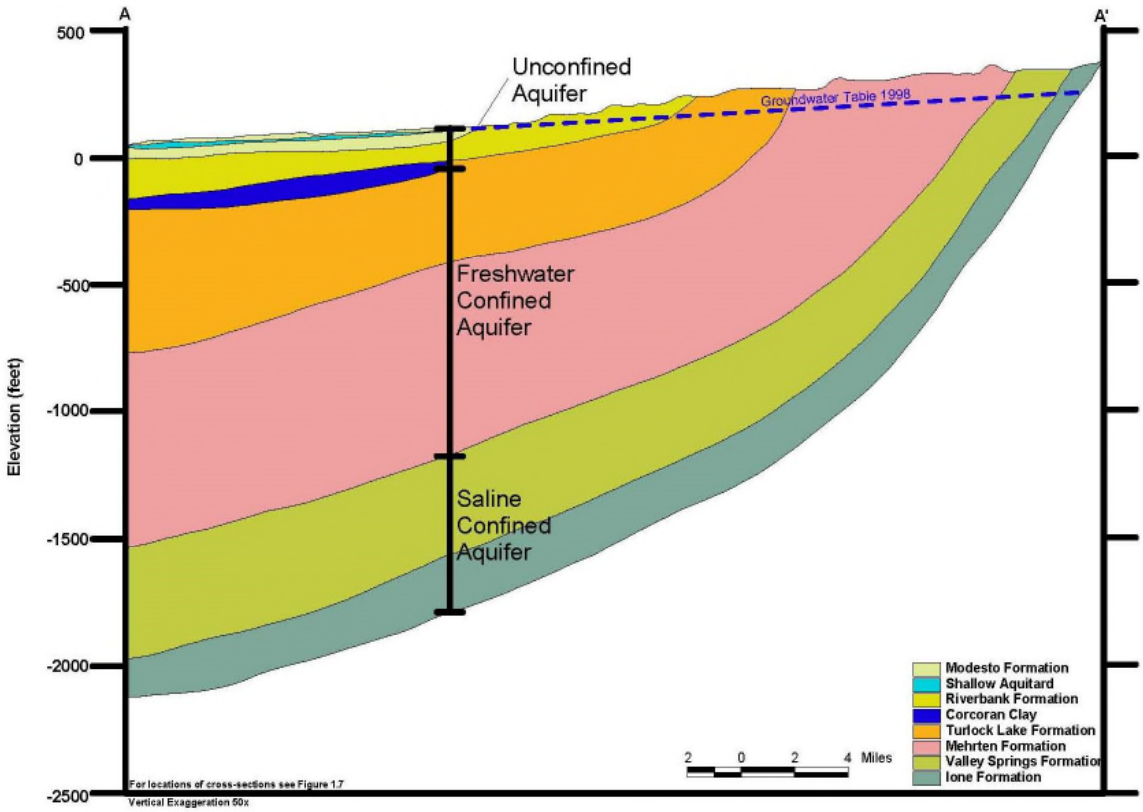

Figure 3.2. East-West Cross Section Showing Hydrogeologic Units within the Turlock Groundwater Basin (TGBA, 2008).

The confined aquifer within the Turlock Groundwater Basin occurs in the unconsolidated deposits that underlie the Corcoran Clay. Accordingly, the areal extent of the confined aquifer is limited to the extent of the Corcoran Clay. In the eastern part of the Basin, the confined aquifer is only semi-confined. The confined aquifer provides extensive municipal and agricultural supplies to the Basin. Wells greater than 200 feet deep draw from the confined aquifer, but may also receive flow from the unconfined aquifer. Based on general groundwater hydrologic considerations, the direction of groundwater flow in the confined aquifer is probably similar to that in the unconfined aquifer, westward and southward. Under historical conditions, the hydraulic head in the confined aquifer was greater than that of the unconfined aquifer, which caused water to flow upwards through the Corcoran Clay from the confined to the unconfined system. Under present conditions, the pumping that has occurred in the unconfined aquifer would tend to maintain or possibly increase the upward gradient (head differential) between the aquifers. Historically, the Corcoran Clay served as an “impermeable” barrier but with wells perforated above and below the clay in both aquifers, the effectiveness of the barrier is now greatly reduced.

At the present time the urban and private, rural domestic water systems within TID rely exclusively on groundwater for their source of water supply[6]. Municipal groundwater use averaged approximately 41,000 AF per year from 2008-2012, all of which is drawn from the confined aquifer. In addition, rural and small private residential groundwater use is estimated at 5,500 AF per year. If groundwater remains the sole source of municipal water supply, it is expected that municipal groundwater use will increase over time. However, several communities are considering the use of surface water from the Tuolumne River in conjunction with existing groundwater supplies. A variety of work has been done over the years on this project, including preliminary design and environmental review work, and the purchase of a parcel to locate the plant near the Fox Grove Fishing Access along the Tuolumne River. Most recently, the Stanislaus Regional Water Authority (SRWA) was formed in 2011 by the cities of Turlock, Ceres and Modesto and entered into renewed negotiations with TID over the drinking water project. On July 28, 2015 the TID Board of Directors approved the final negotiated Water Sales Agreement for the transfer of water to the SRWA. Multiple actions still need to take place before construction and operation of a SRWA water treatment plant to serve domestic water. However, the recent Water Sales Agreement is a historic step toward the future delivery of surface water for drinking water purposes to several of the communities within the Turlock Groundwater Basin.

The volume of groundwater utilized during the irrigation season on lands that receive surface water from TID is summarized in Table 3.5. The total volume includes groundwater pumped from TID-owned drainage wells, Improvement District and private wells rented by TID, and from Improvement District and private wells used by growers to supplement surface water deliveries. The total TID pumping is greater in dry years reflecting TID's conjunctive management approach to managing water supplies to achieve high water supply reliability. Except for extreme dry years (like 2014), supplemental pumping on surface water irrigated land volumes are small relative to TID pumping and vary little from normal to dry years. Prior to the 2012-2014 drought, the small supplemental pumping volumes indicated that growers do not increase private groundwater pumping in dry years illustrating the effectiveness of TID's conjunctive management policies. However, the year 2014 indicates that, when required by extreme drought, recharge resulting from TID's conjunctive management policies supports pumping of significant groundwater volumes by growers.

[6] TID and Modesto ID jointly provide surface water to the small community of La Grange located along the Tuolumne River, east of the TID service area. As the volume of water used is relatively small (average of 36 AF/year from 2010-2014) and does not directly impact agricultural water management within TID, it is not described in detail herein.

Table 3.5. Summary of Groundwater Use for Irrigation within TID [1].

Year	Available Water (inches)[2]	TID Drainage Pumping (AF)[3]	TID Rented Well Pumping (AF)[3]	Supplemental Pumping on Surface Water Irrigated Lands (AF)[4]	Total Groundwater Supply	
					Acre-Feet	Percent of Total Supplies within TID[5]
2010	48	42,669	20,073	18,241	80,983	13%
2011	48	51,166	16,638	17,953	85,757	13%
2012	30	47,279	65,525	26,223	139,027	23%
2013	34	42,711	68,687	44,281	155,679	25%
2014	20	31,007	57,420	103,205	191,632	37%
2010-2014	Average	42,966	45,669	41,980	103,615	22%
	Minimum	31,007	16,638	17,953	80,983	13%
	Maximum	51,166	68,687	103,205	191,632	37%
1991-2014	Overall Average	49,776	32,492	25,651	107,919	18%
	Normal Year Average	54,168	15,990	20,875	91.033	15%
	Dry Year Average	44,585	51,995	31,296	127,876	22%

[1] Irrigation season values only.
[2] Depth of water in inches available equally to each acre of land. For 2010-2012 this was the allotment.
[3] TID pumping values are based on recent or annual pump tests and power consumption data.
[4] Supplemental private pumping volumes estimated from power consumption data and private pumping survey.
[5] The total volume includes all supplies available to growers: including Turlock Lake Releases, groundwater pumped from TID-owned drainage wells, Improvement District and private wells rented by TID, and from Improvement District and private wells used by growers to supplement surface water deliveries and other water supplies.

Note that estimates of supplemental groundwater pumping are not taken from direct measurement, but are derived from data describing power consumption. The water budget results of TID's first AWMP indicated that private pumping estimates needed refinement. Data from private well evaluations together with a survey of 33 private pumps conducted in 2002 were used to refine the computation of private pumping within TID. An additional action item from the AWMP was a survey of parcels not receiving surface water to collect information to estimate the areal extent of private pumping within TID. The results of this survey indicate that there are approximately between 4,000 and 5,000 acres within the TID service area that use groundwater exclusively. There are other lands that irrigate with private pumping but also take some surface water in some years. In the years they do not take surface water, these acres are not included in the TID irrigated acreage. Based on the survey of private pumps and parcels, an improved method of estimating private and supplemental groundwater pumping was developed and used in the TID water balance. In 2014, implausible initial water balance results for the irrigated lands accounting center (average crop consumptive use fraction of 0.86) led to a new

review of private pumping. This review revealed that when the total electrical usage for pumping increased in 2014 the methodology assumed the increase was shared proportionally between the deep wells and other pumps sharing the same meter. Assuming that all of the energy increase in extremely dry years went to pump groundwater from deep wells resulted in plausible water balance results for the irrigated lands accounting center (average crop consumptive use fraction of 0.76).

3.2.1 Groundwater Conditions

A map of TID and the surrounding vicinity showing groundwater elevations in 1960, before the majority of land east of TID was converted to irrigated agriculture, is provided in Figure 3.3. Figure 3.4 shows groundwater elevations taken in the spring 1986, after more than 25 years of groundwater extraction to the east of TID. These figures illustrate the development of a pumping depression in the eastern portion of the Turlock Groundwater Basin. Figures 3.5, 3.6, 3.7 and 3.8 provide groundwater elevations for spring 1998, spring 2005, spring 2011, and spring 2015 respectively. These figures illustrate that the cone of depression continued to expand after 1986. The pumping depression generally stabilized between 1998 and 2005, with additional decline by 2011 and 2015. Figure 3.7 also provides some land use information, illustrating the extent of the agricultural development (in green) east of the TID in 2011, all of which relies entirely on groundwater for irrigation water supply. Localized groundwater declines are most concentrated east of TID and in some municipalities. As a result, the flow of groundwater on the eastern side of TID is generally from the TID service area to the east.

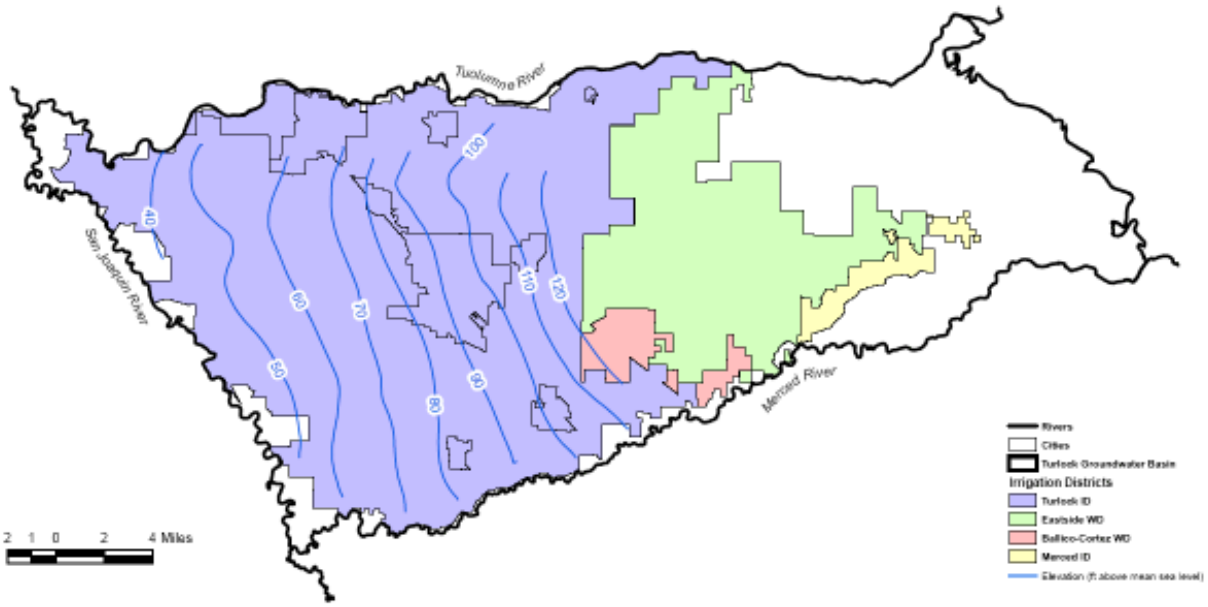

Figure 3.3. Groundwater Elevations - Spring 1960 (TGBA, 2008).

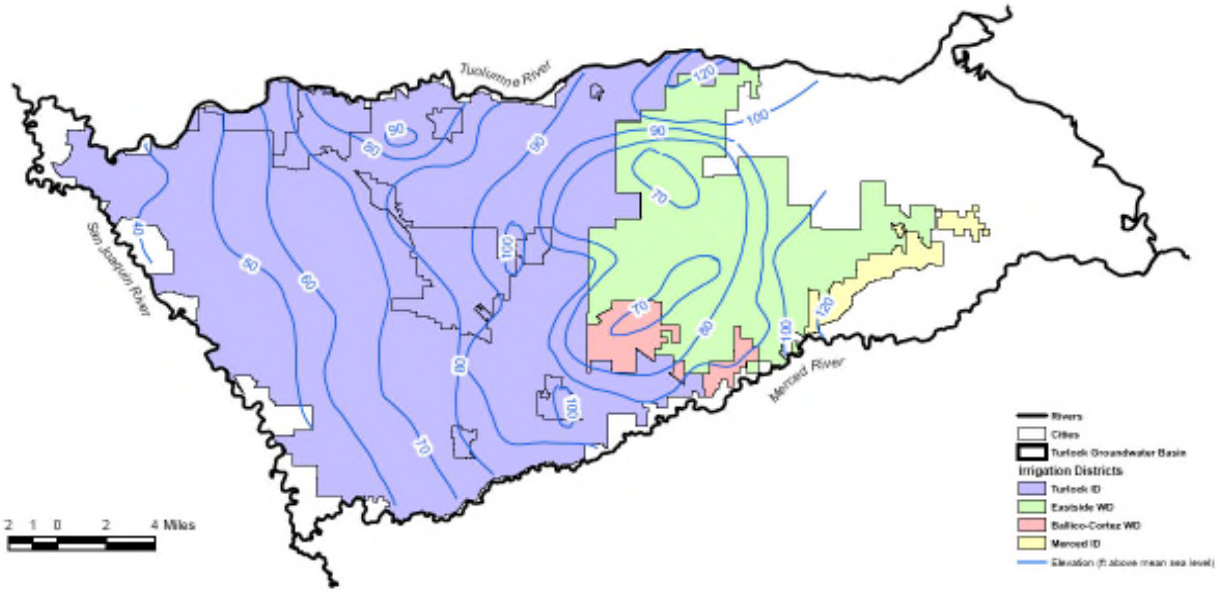

Figure 3.4. Groundwater Elevations - Spring 1986 (TGBA, 2008).

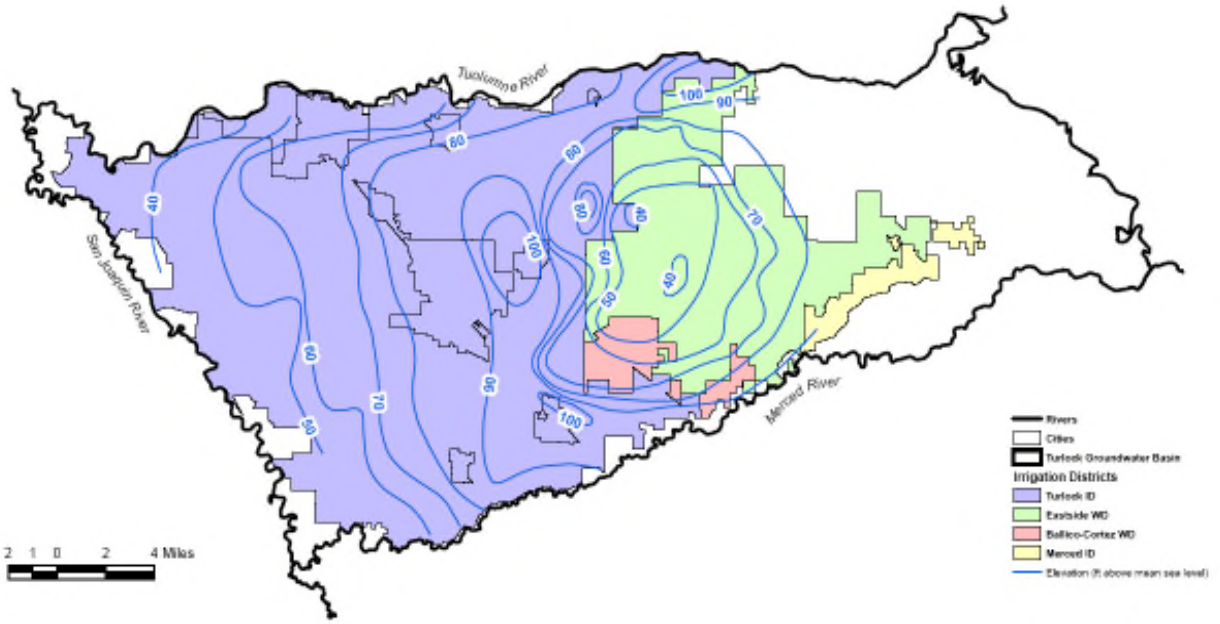

Figure 3.5. Groundwater Elevations - Spring 1998 (TGBA, 2008).

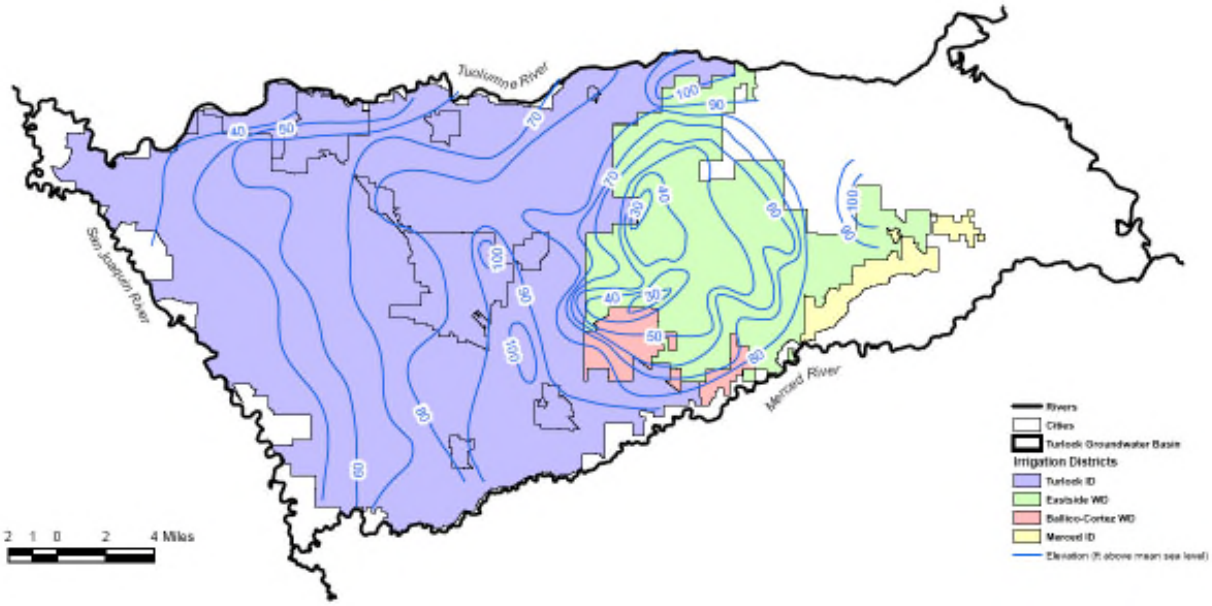

Figure 3.6. Groundwater Elevations - Spring 2005 (TGBA, 2008).

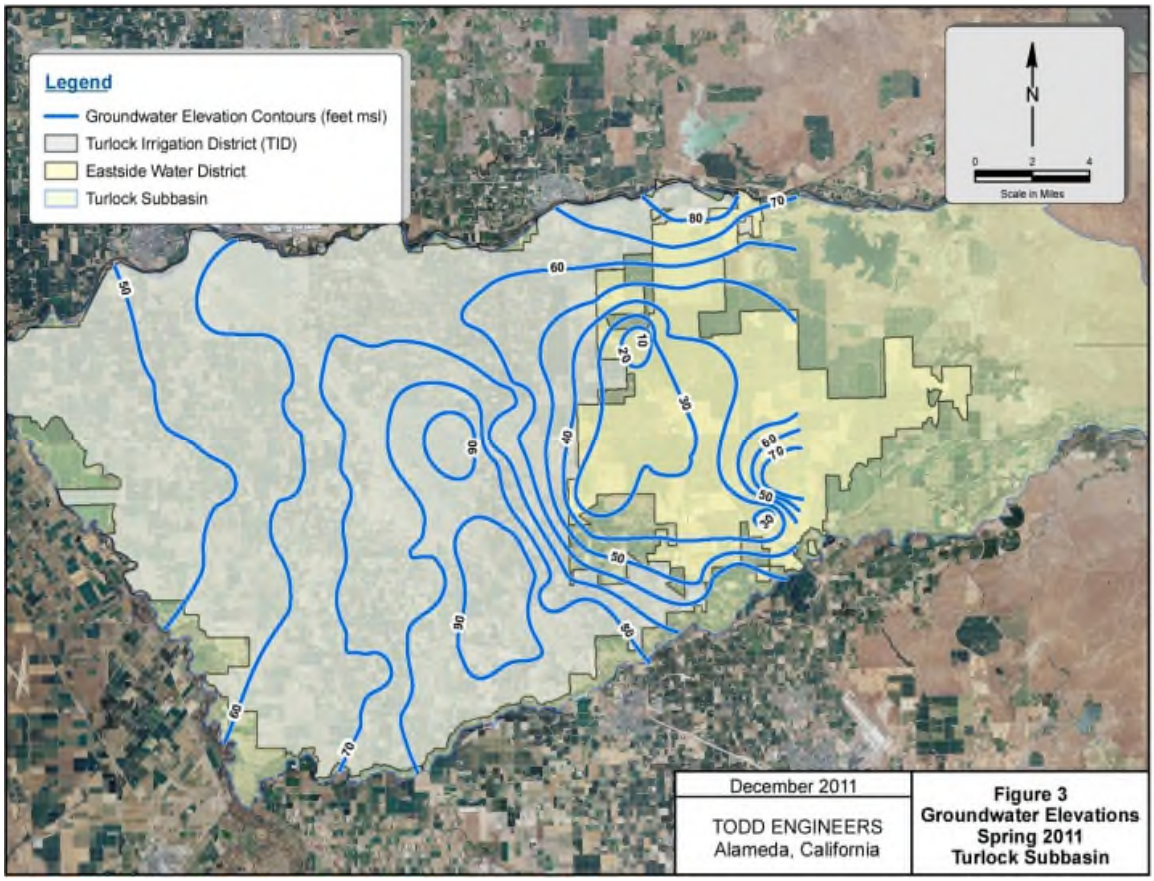

Figure 3.7. Groundwater Elevations - Spring 2011 (Todd Engineers, 2011).

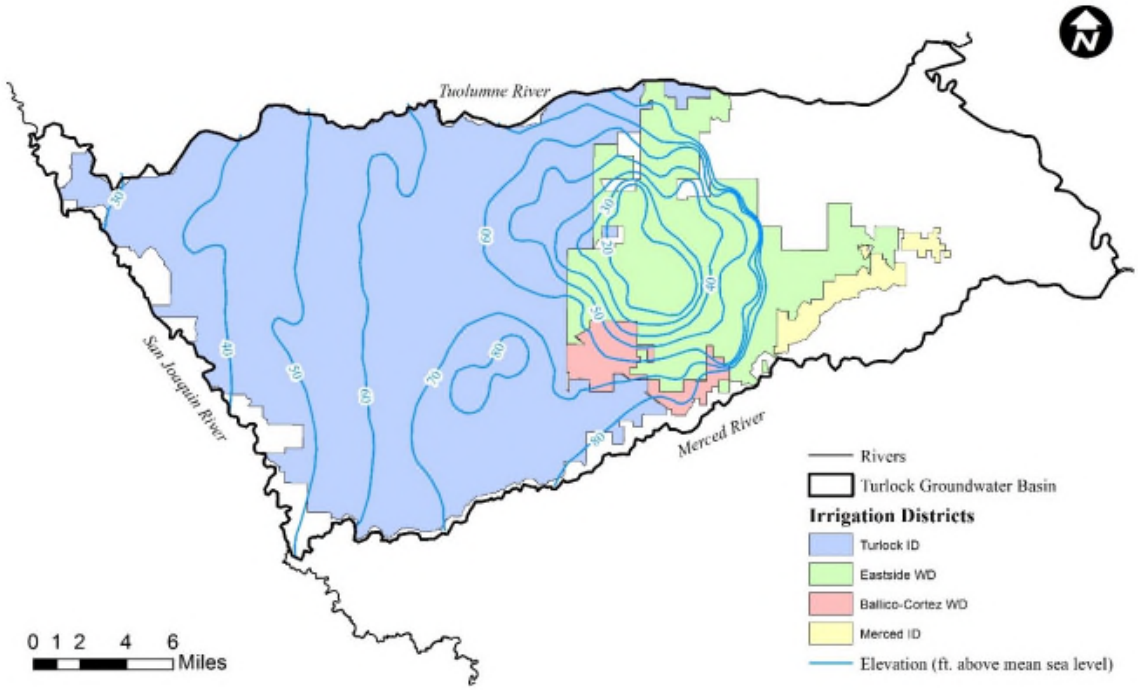

Figure 3.8. Groundwater Elevations – Spring 2015 (Durbin, 2015).

TID adopted the updated Turlock Groundwater Basin Groundwater Management Plan on March 18, 2008, representing the lands in its service area that are outside of the boundaries of the local municipalities. The Groundwater Management Plan is provided on CD in Appendix B.

Following the update of the Groundwater Management Plan in 2008 by TID and other local public agencies, efforts have been continued to monitor and evaluate groundwater conditions and to determine whether additional management actions should be considered.

Studies, completed with limited data from the eastern side of the basin, suggest that additional agricultural development on the eastern side of the basin has the potential to significantly impact groundwater availability. In the study, even if some community water systems began to use surface water supplies from the Tuolumne River (as described in Section 4.5.4), groundwater levels would decline, particularly in dry years (Timothy J. Durbin, Inc. 2008).

In 2012, the TGBA was awarded a Local Groundwater Assistance grant by DWR to compile existing available data, and evaluate groundwater conditions on the eastern side of the Turlock Groundwater Basin. When completed, the grant project is expected to provide an updated understanding of the geology and groundwater conditions on the eastern side of the Basin, which is dependent entirely on groundwater for its supply and where limited information has been available historically. The grant work is expected to be completed by the end of 2015.

The Sustainable Groundwater Management Act (SGMA) was signed into law on September 16, 2014. The new law requires local agencies within groundwater management plans to work together to achieve sustainability within a defined period of time. SGMA requires a series of intermediate steps be achieved to demonstrate SGMA compliance, including formation of

Groundwater Sustainability Agencies (GSAs) by June 30, 2017 to manage groundwater supplies, Groundwater Sustainability Plans (GSPs) be developed by January 2022 to identify actions needed to achieve groundwater sustainability. An additional MOU has been developed and is being signed by agencies within the Turlock Groundwater Basin recognizing these new requirements, and agreeing to work cooperatively together toward developing GSA(s), a GSP, and the technical data and/or tools needed to comply with SGMA.

3.2.1.1 Conjunctive Management

TID's conjunctive management program is designed to encourage irrigators to draw from surface water supplies during periods of normal and above normal reservoir storage. Surface water from the Tuolumne River, applied within the TID via flood irrigation, is the primary source of groundwater recharge within the Basin. Use of surface water during normal and wetter years recharges the aquifer, enabling TID to rely more heavily on groundwater during years when surface supplies are below normal. During dry years TID increases the volume of groundwater pumped into the distribution system from rented and drainage wells to supplement surface water supplies. For example, in the 1976-1977 and 1987-1992 droughts, TID rented large numbers of Improvement District (ID) and private wells to supplement supplies from TID-owned wells. Table 3.5 shows that, on average, TID pumped approximately 26,000 more acre-feet of groundwater through rented wells and drainage pumping in dry years than in normal years between 1991 and 2014.

Sustained use of surface water for irrigation is a key component of TID's conjunctive management of surface water and groundwater supplies. The TID water balance indicates that over the period from 1991 to 2014 net groundwater recharge, including deep percolation of precipitation, ranged from a low of 1.0 AF per acre on average during dry years to a high of 1.7 AF per acre on average during normal years. Table 3.6 provides a summary of net recharge within TID. These results show the importance of continuing irrigation with surface water to maintain groundwater storage and water supplies in drier years. TID's tiered volumetric pricing structure for surface water (described in Section 2.7) is designed to encourage growers to use available surface water supplies to provide appropriate in-lieu and direct groundwater recharge. Having two rate schedules, one for normal or wetter years and one for dry years, provides different pricing signals between normal and dry water year types. This pricing encourages the use of available surface water supplies in normal and wetter years. In dry years, the pricing encourages conservation of limited surface water supplies, and provides additional revenue to recover increased pumping costs. However, even in dry years, surface water is priced competitively compared to private groundwater pumping. An important aspect of TID's conjunctive management strategy includes setting the price of TID water appropriately to discourage growers from becoming permanently reliant on groundwater.

During the period from 1991 to 2014, the TID water balance, described in Section 4, shows that for lands receiving TID deliveries, on average 80 percent of the water supply was surface water from the Tuolumne River with 18 percent coming from groundwater and 2 percent from other sources (Table 3.2). In normal and wet years, when more surface water was available, these percentages, on average, were 83 percent surface water, 15 percent groundwater, and 2 percent other supplies. In dry years, the average percentages were 77 percent surface water, 21 percent groundwater, and 2 percent other supplies.

Table 3.6. Summary of TID Net Recharge.

Period	Statistic	Net Recharge (AF/acre)		
		Seepage and Irrigation*	Precipitation	Total
2010		1.2	0.6	1.8
2011		1.3	0.5	1.8
2012		0.6	0.2	0.8
2013		0.4	0.1	0.5
2014		-0.4	0.4	0.0
2010-2014	Average	0.6	0.4	1.0
	Minimum	-0.4	0.1	0.0
	Maximum	1.3	0.6	1.8
1991-2014	Overall Average	0.9	0.5	1.4
	Normal Year Average	1.1	0.6	1.7
	Dry Year Average	0.6	0.4	1.0

*Values for system downstream of Turlock Lake. Does not include seepage losses from Turlock Lake or the Upper Main Canal system.

In 2014, an extremely dry year, the percentage of water supplied by pumping was even greater (37 %). TID pumped even more in past dry cycles (1976-1977) and (1987-1988). Unfortunately, the high rates of groundwater extraction in 1977 (67 %) and 1988 (56 %) can no longer be achieved because of the decline in groundwater levels, particularly along TID's eastern boundary.

In response to increased volumes of groundwater used in the 1976-1977 and the 1987-1992 droughts, TID developed a drought conjunctive management plan. One outcome of the plan is improved management of groundwater pumping within TID. Despite improved management of water resources within TID, the ability to sustain groundwater supplies beneath the TID service area is hindered by substantial groundwater pumping for irrigation of approximately 89,000 acres of crops east of TID with no available surface water supply. This pumping, along with the small area of groundwater-only irrigation within TID, continues to contribute to the decline in water levels of the aquifers underlying TID, particularly during periods of drought. More efficient irrigation techniques being used in the groundwater-irrigated areas has helped lessen the impact of agricultural expansion on groundwater levels; however, this may be counteracted by the additional agricultural development continuing to expand eastward within the Basin, and to a lesser extent, by the increasing use of pressurized irrigation systems in the eastern portion of TID, which tend to produce less deep percolation than traditional surface irrigation methods.

3.3 OTHER WATER SUPPLIES

There is growing use of recycled water within TID. Categories of recycled water identified within TID are subsurface drainage (tilewater), tailwater, spill recovery, and recycled wastewater (Table 3.7). For the period of 1998 through 2014, an average of approximately 4,800 AF per year of recycled wastewater from the City of Modesto, City of Turlock and Hilmar Cheese has

been utilized on approximately 1,900 acres within the TID boundaries to irrigate forage crops. Over the period 2010 to 2014, the average volume of recycled water used for irrigation was 5,000 AF per year.

Table 3.7. Summary of TID Other Water Supplies[1].

Year	Available Water (inches)[2]	Subsurface Drainage (Tilewater) (AF)[3]	Tailwater to Canals (AF)[4]	Spill Recovery (AF)[5]	Treated Wastewater Delivered to Farms (AF)[6]
2010	48	7,689	850	2,020	5,550
2011	48	9,978	951	2,659	4,415
2012	30	5,022	833	2,909	4,962
2013	34	3,618	903	3,166	5,421
2014	20	3,634	762	2,294	4,626
2010-2014	Average	5,988	860	2,610	4,995
	Minimum	3,618	762	2,020	4,415
	Maximum	9,978	951	3,166	5,550
1991-2014	Overage Average	5,888	1,418	702	3,887
	Wet Year Average	6,485	1,443	547	3,705
	Dry Year Average	5,183	1,389	885	4,102

[1] Irrigation season values only.
[2] Depth of water in inches available equally to each acre of land. For 2010-2012 this was the allotment.
[3] Subsurface drainage is estimated based on flow meters and power records.
[4] Estimated based on survey of tailwater producing lands.
[5] Estimated based on flow measurements.
[6] City of Modesto, Hilmar Cheese, City of Turlock, and Treated Wastewater prorated based on days in the irrigation season

The Harding Drain is a multi-use facility; transporting treated effluent from the City of Turlock (until the end of 2014), urban runoff, drainage from lands adjacent to the drain, groundwater accretions and spilled canal water, however the percentages of each are unknown. Historically, TID utilized water from the Harding Drain to supplement supplies in Lateral 5½. However, water reuse regulations restricted TID's ability to recapture those flows for a period of time until the City of Turlock implemented tertiary treatment. TID was able to resume the reuse from the Harding Drain in July 2008. For the period from 2010 to 2014, an average of 2,600 AF of water per year was reused.

Some tailwater enters TID canals indirectly through drainage channels that are intercepted by the distribution system. This recovered tailwater is blended with water in the canals and utilized to the greatest extent possible. Based on the TID water balance, it is estimated that an average of approximately 900 AF of tailwater flows into the TID distribution system each year (2010-2014).

In the 1990's growers began installing subsurface drainage systems (or tile drains) to help control shallow groundwater. These drains discharge into the TID canals where the water is blended with water in the canals and utilized to the greatest extent possible. Based on the TID water balance, it is estimated that subsurface drainage systems pump an average of 6,000 AF of tilewater per year into TID canals (2010-2014).

Additionally, some long improvement district pipelines were designed and constructed so they terminate at a TID canal in order to recover undelivered irrigation water where it can be used for irrigation delivery downstream. This undelivered water originates from fill up and run down water, or when growers choose to not take a delivery. The volume of water that is recovered in this manner has not been quantified independently due to its intermittent nature, but is reflected in the water balance closure to determine deliveries to farms.

Another component of recycled water use is recycling of dairy nutrient water through land application. TID assists growers who wish to receive nutrient water by allowing dairies to transport nutrient water through improvement district conveyance structures. This recycling of dairy runoff reduces discharge, enables growers to utilize the nutrient water as fertilizer for forage crops, and provides water for irrigation. This component is difficult to estimate independently and is not currently included in the water balance.

Similarly, TID supports the practice of reusing industrial process water from Hilmar Cheese Company by allowing Hilmar Cheese to transport the process water through improvement district conveyance structures. Using the existing improvement district facilities in this manner enables Hilmar Cheese to apply the process water for agricultural use, and the growers on those facilities to benefit from the water supply year-round, including the non-irrigation season when TID supplied irrigation water isn't available. This type of reuse has increased over time as the Hilmar Cheese facility has diversified and expanded. Between 2010 and 2014, approximately 1,000 AF of process water was recycled per year, on average.

At the end of 2014 the City of Turlock moved the wastewater that historically flowed through the Harding Drain and began discharging directly to the San Joaquin River. As a result, starting in 2015 the spill recovery data for water pumped from the Harding Drain does not include tertiary treated wastewater as a component of the supply. TID does, however, continue to recover spill water and other flows in the Harding Drain for reuse. Additionally, as a part of the SRWA drinking water project, the City of Turlock has agreed to provide TID 2,000 AF of tertiary treated wastewater for agricultural use which will help to offset the loss of surface water supplies provided through the project for municipal use. TID is actively working with the City of Turlock to obtain access to this additional supply as quickly as possible.

3.4 SOURCE WATER QUALITY MONITORING PRACTICES

TID actively monitors water quality of both canal and well waters through samples collected under several different water quality programs. Some of these programs, such as the quarterly agricultural suitability monitoring are voluntary and self-directed while other programs, such as the Aquatic Pesticide Permit are required regulatory programs.

3.4.1 Agricultural Suitability Monitoring

Quarterly agricultural suitability (Ag Suitability) monitoring is performed at Turlock Lake and all spill locations during the irrigation season to monitor long-term water quality trends in the TID system. Samples at spill locations are not representative of source water; however since they are at the bottom end of the canal system they do represent a possible worst case scenario of quality of waters delivered to growers. The data is provided to growers upon request. The quarterly agricultural suitability monitoring includes analysis for a standard "ag panel" (sodium, calcium, magnesium, carbonate, bicarbonate, chloride, phosphorus, potassium, nitrate, sulfate, boron, (TDS, pH, Electrical Conductivity (EC) and adjusted sodium adsorption ratio {adj. SAR}).

3.4.2 Well Quality Monitoring

TID has sampled most TID owned wells plus the rented wells used for irrigation supply. The samples are analyzed for the same "ag panel" listed above. Data gathered over the years shows that the water quality from the wells does vary, but not significantly from year to year. As funds allow, District drainage and rented wells are sampled for water quality to maintain a good understanding of the quality of groundwater entering the canal system. Additionally, if there are concerns regarding water quality in an area, or from a particular well, samples are taken to confirm the current conditions. During droughts, one of the objectives of TID's conjunctive management program is to provide a water supply that satisfies irrigation demands in terms of quantity, timing of deliveries, and water quality. To this end, the selection process for wells used to supplement water supplies includes consideration of well salinity levels. WDOs are provided pump salinity levels, and utilize that information to provide the growers with the best water quality possible, including minimizing the use of wells with elevated salinity levels when it could affect germination of crops.

TID also collects an "ag panel" sample during the formation of a pump Improvement District. As a general policy, if the electroconductivity of the new well is above 1.5 dS/m (or about 1,000 ppm TDS), TID staff recommends that the Improvement District not be formed.

3.4.3 Tile Drain Monitoring

Starting in the 1990s, growers began installing subsurface drainage systems (tile drains) to help control shallow water table levels. Discharge from these subsurface drains enters the TID canal system and becomes a part of the overall water supply. TID samples 32 tile drain discharges on a quarterly basis. The samples are analyzed for the same "ag panel" listed under *Agricultural Suitability Monitoring* above. The data are provided to the Improvement Districts and growers are encouraged to implement on-farm measures to improve water quality should it not meet TID's water quality standards.

3.4.4 Real-time Canal Monitoring

In 2005 TID began installing water quality telemetry to better understand the quality of water within the canal/drainage system. TID has installed YSI 600XL multi-parameter water quality sondes at 18 canal and drain spill locations. These sondes measure EC, and temperature on a real-time basis. The data is uploaded into TID's SCADA system where it can be viewed by

staff. The data is useful in determining how canal water quality changes as a result of different operational scenarios.

3.4.5 Irrigated Lands Regulatory Program Monitoring

Between 2004 and 2010 TID performed additional water quality sampling and reporting in compliance with the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Irrigated Lands Regulatory Program). During that time, TID sampled three spill locations twice during the irrigation season and two spill locations twice during a storm event. Samples were collected and analyzed for general water quality parameters (pH, EC, Dissolved Oxygen (DO), temperature, turbidity, TDS, Total Organic Carbon (TOC), Total Kjeldahl Nitrogen (TKN), phosphorus and potassium) as well as the active ingredients of any pesticides or herbicides utilized by TID along the canals, which included up to eleven active ingredients from herbicides used for terrestrial weed control purposes.

Beginning in 2011, TID joined the East San Joaquin Water Quality Coalition (ESJWQC) for coverage under the Irrigated Lands Regulatory Program (ILRP). The ESJWQC represents growers throughout TID service area as well as other areas on the eastern side of the San Joaquin River. The ESJWQC has an elaborate monitoring program which includes a wide variety of constituents, sampled in a number of local drains and canals. The program is designed to rotate throughout the watershed, and as a result, the sampling locations and constituents are subject to change.

A new Waste Discharge Requirements (WDR) order for the ESJWQC was approved by the RWQCB in December 2012 which brought groundwater into the regulatory framework of the ILRP. While surface water monitoring continues under the new WDR, the new program is focused more on a management approach with an emphasis on managing inputs of various pollutants (e.g. nutrients and sediment) rather than strictly focusing on water quality monitoring. Toward this effort, the ESJWQC developed and is implementing a Nitrogen Management Plan (NMP) which requires growers to document how much nitrogen is added and removed from their lands. This information is then submitted to the Coalition once per year which summarizes and reports it to the RWQCB. A Sediment and Erosion Control Plan was also developed. A template for the plan is still being considered by RWQCB staff. Once approved, it will be sent to growers primarily in areas with hilly terrain.

Under the new WDR the ESJWQC also completed a Groundwater Assessment Report (GAR) and submitted it to the RWQCB in 2014. The GAR compiled all available groundwater data (both level and quality) in an effort to identify high and low vulnerability areas within the Coalition. These designations will then be used while implementing the plans described above. In addition, the ESJWQC must develop and implement a groundwater trend monitoring program. The specifics of which are still being determined.

As members of the ESJWQC, TID continues to coordinate with ESJWQC staff regarding water quality issues. To facilitate this process, a TID staff member serves on the ESJWQC Board of Directors. Information from the new WDR will provide additional information regarding surface and groundwater quality in the TID service area.

3.4.6 Aquatic Pesticide Permit

TID maintains coverage for its applications of Magnacide-H and endothall-based herbicides under the Statewide General NPDES Permit for Aquatic Pesticides. Both the Magnacide-H and endothall products are aquatic herbicides for the control of submerged aquatic weeds and algae. These products are used in the District's canals, along with mechanical removal and other practices necessary to maintain the flow of water in the canal system. As part of the permit, monitoring is required for general water quality parameters (pH, EC, DO, temperature and turbidity) as well as the active ingredient of the permitted herbicide (in this case, acrolein or endothall). .

3.4.7 Water Quality Monitoring Results

The surface water supply for TID originates as snowmelt from the Sierra Nevada Mountains and is of very high quality. Quarterly water quality monitoring performed at Turlock Lake as part of TID's Ag Suitability Monitoring shows that water diverted from the Tuolumne River has an average TDS measurement of 38 parts per million (ppm), nitrates at less than1 ppm, phosphorus less than 0.04 ppm and potassium of 1 ppm. This high quality water poses no restrictions for irrigation. However, some growers do need to add gypsum to heavier soils to overcome infiltration problems associated with such low TDS water.

Sampling of TID owned drainage wells and the rented wells show that some wells provide water with elevated TDS levels. A few wells show TDS levels that exceed 2,000 ppm. The average of all of the groundwater TDS measurements made by TID is 738 ppm. The pumped groundwater is mixed with surface water in the distribution system, resulting in irrigation water of acceptable quality. Groundwater salinity generally increases from east to west across TID and with depth so that in the western third of TID, wells that go below the Corcoran Clay can be too salty for normal use.

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4. Water Balance

4.1 INTRODUCTION

This section describes the various uses of water within TID, followed by a detailed description of TID's water balances for key accounting centers within the District. The water balance presented in this AWMP covers the most recent 5 year period from 2010 through 2014. This period was selected to utilize the highest quality data available and to support the development of useful conclusions regarding TID's current operations. To understand TID's conjunctive management approach to water resources management, it is useful to take a longer view to identify differences between wet and dry years. Consequently, averages from 1991 through 2014 are referenced as well. The water balance quantifies all significant inflows and outflows of water to and from the TID service area during the irrigation season. The irrigation season varies from year to year based on water needs, but approximately covers the period from March through October.

The water uses and water balances are discussed in relation to hydrologic conditions within TID, which vary from year to year. Key hydrologic drivers of water management in a given year include available surface water supply based on Don Pedro Reservoir inflows; precipitation within the TID service area, and evaporative demand.

4.2 WATER BALANCE OVERVIEW

The TID water balance includes separate accounting centers for the TID distribution system and the surface water irrigated lands served by TID. A total of twenty-one individual flow paths are quantified as part of the water balance. A schematic of the water balance structure is provided in Figure 4.1.

In general, flow paths are quantified on a monthly basis for the irrigation season (March – October). For each accounting center, all but one flow path is determined independently based on measured data or calculated estimates, and the remaining flow path is then calculated based on the principal of conservation of mass (Equation 4-1), which states that the difference between total inflows and outflows to an accounting center for a given period of time is equivalent to the change in stored water within that accounting center. Over the course of a year, it is assumed that the change in storage is zero (Equation 4-2).

$$\text{Inflows} - \text{Outflows} = \text{Change in Storage (monthly time step)} \qquad [4\text{-}1]$$

$$\text{Inflows} - \text{Outflows} = 0 \text{ (annual time step)} \qquad [4\text{-}2]$$

The flow path that is calculated using Equation 4-2 is referred to as the "closure term" because the mass balance equation is solved or "closed" for the unknown quantity. The closure term is selected based on consideration of the availability of data or other information to support an independent estimate as well as the volume of water representing the flow path relative to the size of other flow paths. Generally speaking, the largest, most uncertain flow path is selected as the closure term.

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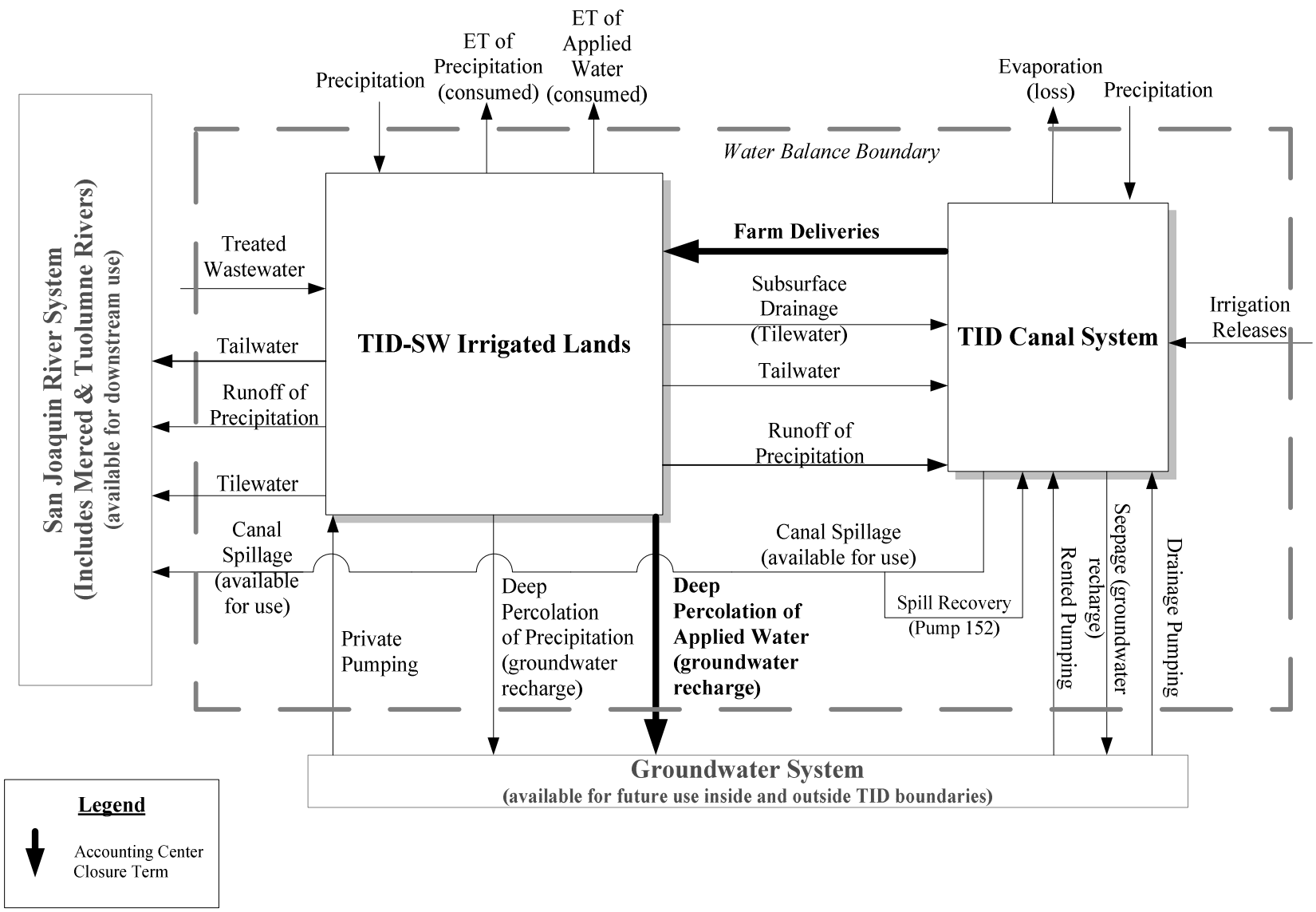

Figure 4.1. TID Water Balance Structure.

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4.3 FLOW PATH ESTIMATION AND UNCERTAINTY

Individual flow paths were estimated based on direct measurements or based on calculations using measurements and other data. As described previously, those flow paths not estimated independently were calculated as the closure term of each accounting center.

For the TID distribution system accounting center, farm deliveries were calculated as the closure term. Farm deliveries were selected because of inaccuracies inherent in TID delivery measurement devices (see the water delivery measurement discussion in Section 2.6), and because farm deliveries represent the largest outflow from the distribution system, a highly accurate aggregated value can be obtained from the water balance.

For the farmed lands (or TID-SW Irrigated Lands) accounting center, deep percolation of applied water was calculated as the closure term. Deep percolation of applied water was selected because it is a relatively large flow path and nearly impossible to estimate otherwise.

The results of the water balance for each flow path are reported with a high level of precision (nearest whole acre-foot) that implies a higher degree of accuracy in the values than is actually justified. While a detailed uncertainty analysis has not been conducted to assess potential error in the data and computed values, an estimated percent uncertainty (approximately equivalent to a 95 % confidence interval) in each measured or calculated flow path has been estimated. Then, based on the relative magnitude of each flow path, the resulting uncertainty in each closure term can be estimated by assuming that errors in estimates are random (Clemmens and Burt 1997). Errors in estimates for individual flow paths may cancel each other out to some degree, but the net error due to uncertainty in the various estimated flow paths is ultimately expressed in the closure term.

Table 4.1 lists each flow path included in the water balance, indicating which accounting center(s) it belongs to, whether it is an inflow or an outflow, whether it was measured or calculated, the supporting data used to determine it, and the estimated uncertainty, expressed as a percent. As indicated, estimated uncertainties vary by flow path from 3 percent to 35 percent of the estimated value, with uncertainties generally being less for measured flow paths and greater for calculated flow paths. The estimated uncertainty of each closure term, calculated based on the concept of propagation of random errors as described above, is also shown for each closure term.

As indicated, the estimated uncertainty in farm deliveries is four percent. This uncertainty is relatively small due to the relatively low uncertainty in system inflows from Turlock, which represent the largest flow path in the distribution system balance. The estimated uncertainty in deep percolation of applied water is 24 percent. Despite appreciable uncertainty in some flow path quantities, the water balance provides useful insights into TID's water management.

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Table 4.1. TID Water Balance Flow Paths, Supporting Data, and Estimated Uncertainty.

Accounting Center	Flowpath Type	Flowpath	Source	Supporting Data	Typical Volume (AF)[1]	Estimated Uncertainty (percent)[1]
Distribution System	Inflows	Irrigation Releases	Measurement	Broad-crested weir measurement site just downstream of Turlock Lake	459,000	3%
		TID Drainage Pumping	Measurement	TID drainage well pump power use measurements	43,000	20%
		TID Rented Pumping	Measurement	TID rented well pump power use measurements	46,000	20%
		Subsurface Drainage Reuse	Measurement	Flow meter where reliable records available, remainder based on power use	6,000	7%
		Tailwater to Canals	Calculation	Estimated as a percentage of deliveries to the specific parcels identified as draining to canals for 2009-2011.	900	35%
		Spill Recovery	Measurement	Pump 152 power use	2,600	20%
	Outflows	**TID Farm Deliveries**	**Closure (Distribution System)**	**Difference of total inflows and measured/estimated outflows for Distribution System accounting center**	**463,000**	**4%**
		Canal Seepage	Calculation	NRCS soils data, published seepage rates by soil type, estimated wetted area, estimated wetted duration, representative ponding tests.	37,000	35%
		Operational Spillage	Measurement	TID operational spill measurements, predominately Cipoletti weirs	56,000	9%
		Canal Evaporation	Calculation	CIMIS reference ET (Denair CIMIS station), estimated evaporation coefficient, estimated wetted surface area	1,500	30%
Irrigated Lands	Inflows	**TID Farm Deliveries**	**Closure (Distribution System)**	**Difference of total inflows and measured/estimated outflows for Distribution System accounting center**	**463,000**	**4%**
		Private Groundwater Pumping	Calculation	Power use of power accounts with deep wells within the TID service area, estimated groundwater only area, average TID ET_{aw} and CCUF	42,000	20%
		Treated Wastewater	Measurement	Measurements received from City of Modesto, Hilmar Cheese, City of Turlock, and Treated Wastewater prorated based on days in the irrigation season	5,000	10%
		Precipitation	Calculation	Quality-controlled precipitation from Denair CIMIS station, TID cropped area	48,000	20%
	Outflows	Crop ET of Applied Water (ET_{aw})	Calculation	CIMIS reference ET, estimated crop coefficients from METRIC and SEBAL analysis, cropped area by crop, root zone simulation model (IDC) to divide total ET into applied water and precipitation components	324,000	10%
		Tailwater to Reuse and to Rivers	Calculation	Estimated as a percentage of deliveries to the specific parcels identified as draining to canals for 2009-2011.	3,600	35%
		Deep Percolation of Applied Water	**Closure (Farmed Lands)**	**Difference of total inflows and measured/estimated outflows for Farmed Lands accounting center applied water balance**	**176,000**	**24%**
		TID Subsurface Drainage (tilewater) Reuse and to Rivers	Measurement	Flow meter where reliable records available, remainder based on power use	7,100	7%
		Crop ET of Precipitation (ET_{pr})	Calculation	CIMIS reference ET, estimated crop coefficients from METRIC and SEBAL analysis, cropped area by crop, root zone simulation model (IDC) to divide total ET into applied water and precipitation components	48,000	10%
		Deep Percolation of Precipitation	Calculation	Root zone simulation model, NRCS soils characteristics, CIMIS precipitation data	27,000	25%
		Runoff of Precipitation	Calculation	Root zone simulation model, CIMIS precipitation data, NRCS curve number method	100	35%
		Change in Storage of Precipitation	Calculation	Root zone simulation model, negative values indicate a net decrease in stored precipitation due to consumption or deep percolation	-28,000	30%

[1] Typical Annual Volume and Closure Uncertainty Estimated based on 2010-2014 average irrigation season volume. Due to rounding inflows and outflows may not be exactly equal (see Tables 4.8 and 4.9 for detailed water balance results).

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4.4 HYDROLOGIC YEAR TYPES FOR EVALUATION OF WATER MANAGEMENT

Development of a multi-year water balance allows for evaluation of water management impacts of surface water supply variability, precipitation variability, and other changes in the hydrology of TID and its surrounding area over time. Specifically, a multi-year water balance that includes both dry and normal years is essential to evaluate and plan for conjunctive management as practiced by TID. This multi-year water balance also supports the EWMP "planned conjunctive use of surface water and groundwater", that is discussed in Section 6. To support review and interpretation of water uses and overall water balance results over time, TID surface water available, total calendar year precipitation, and total water year reference evapotranspiration (ET_o) are presented, and year types are assigned.

As discussed previously, TID has a reliable source of water from Don Pedro Reservoir through a variety of water rights on the Tuolumne River. TID growers have received full water supplies available in 13 of the last 24 years.[7] During the 2010 to 2014 period, reduced supplies were available in 2012, 2013 and 2014, with full water supplies available in 2010 and 2011.

Reduced inflows into Don Pedro Reservoir due to reduced precipitation in the watershed typically correspond to years with reduced precipitation and increased evaporative demand in the TID service area. Based on the available water provided to growers, the years 1991 to 2014 have been assigned to normal or dry year types for purposes of discussion of water uses in TID over time and the corresponding water balances. As described in Section 3, "dry" years are those years when the water available was less than 48 inches, and "normal" years are those years with a 48 inch available. These year type classifications are for this analysis only, and not meant to correspond with water year classifications used for regulatory or other purposes. The water available, calendar year precipitation, reference ET and the year types by year, from 2010 to 2014, are listed in Table 4.2.

Over the 1991 to 2014 time period, March to October (irrigation season) ET_o was lowest for normal years, averaging approximately 44 inches. In the 5-year period from 2010 to 2014, average irrigation season ET_o has been approximately 44 inches. The years of 2010 and 2011 had 48 inches available, while 2012, 2013 and 2014 were dry and had less than 48 inches available. Water year precipitation (October through September) in the TID service area tends to be less in dry years as compared to normal years, with an average between 1991 and 2014 of approximately 9 inches and 15 inches for dry and normal years, respectively. For comparison, the most recent dry years (2012-2014) have been exceptionally dry, with an average of only 7.1 inches of precipitation per year.

[7] Between 1991 and 2012, water available, for purposes of comparing water year types for this report, was considered the "allotment" or "allocation." In wetter years, additional water may have been purchased above the allotment. The volume of which is included in the water supply values presented. Starting in 2013, implementation of a volumetric pricing system eliminated the "allocation" system. Therefore, starting in 2013, available water for the purposes of this report is considered the amount of water available equally to each acre of land.

Table 4.2. 2010 to 2014 TID Available Water, Water Year Precipitation, and Irrigation Season ET_o, and Hydrologic Year Type.

Year	Irrigation Season		Number of Days	Available Water (inches)[1]	Year Type	Precipitation (inches)	ET_o (inches)
	Start Date	End Date					
2010	18-Mar	31-Oct	228	48	Normal	14.7	44.4
2011	17-Mar	2-Nov	231	48	Normal	17.2	44.0
2012	08-Mar	10-Oct	217	30	Dry	7.5	43.1
2013	07-Mar	09-Oct	217	34	Dry	6.7	46.6
2014	10-Apr	09-Oct	182	20	Dry	7.2	43.3
					2010 – 2014 Average	10.6	43.1
					2010 – 2014 Minimum	6.7	46.6
					2010 – 2014 Maximum	17.2	46.9
					1991 – 2014 Overall Average	12.1	43.7
					1991 – 2014 Normal Year Average	14.6	42.9
					1991 – 2014 Dry Year Average	9.2	44.6

[1]Depth of water in inches available equally to each acre of land. For 2010-2012 this was the allotment.

In addition to having reduced surface water supplies and below normal precipitation, dry years also tend to have higher evaporative demand compared to normal years, resulting in increased crop irrigation requirements. Thus, in dry years TID faces increased irrigation demands while surface water supplies are reduced. As a result, in dry years groundwater use is increased to supplement reduced surface water supplies reflecting TID's conjunctive management approach.

4.5 WATER USES

As described in Sections 2 and 3, the District co-owns Don Pedro Reservoir with MID. The reservoir is outside of TID's service area and is managed by TID and MID for water storage, power generation, and recreation (including water sports). TID supplies irrigation water for agriculture. TID also provides domestic drinking water (in conjunction with MID) for the community of La Grange. These and other water uses within TID's service area, as well as uses related to TID's operations are described in greater detail in the remainder of this section.

4.5.1 Agricultural

The TID service area covers a gross area of 197,261 acres with approximately 157,800 irrigable acres that have the ability to receive the TID surface water. Between 2010 and 2014 an average of 146,750 assessed acres received surface water from TID. This translates to an average of 135,832 irrigated acres when an estimate of field roads and other small non-irrigated areas are accounted for.

The TID service area climate and soils are suitable for a wide variety of crops (more than 40 different crops were grown during the 24 years from 1991 through 2014). Table 4.3 lists the types of crops grown in the TID irrigation service area, along with a summary of acreages planted in each crop between 2010 and 2014 and over the 1991 to 2014 period for both normal years[8] and dry years. The minor differences in average acreages for normal and dry years reflect the high water supply reliability achieved by TID's conjunctive management approach to water resources management. This high water supply reliability is also reflected in the large areas of permanent crops and crops supplying local dairies that require a steady water supply year after year. The values in Table 4.3 represent irrigated acreages with double cropping included as a specific crop type. Thus, double counting of acres is avoided.

Improved crop coefficients that reflect water use reductions due to crop stressors were developed for the water balance update. These crop coefficients were derived from actual ET (ET_a) estimates from remotely sensed surface energy balance results from Mapping EvapoTranspiration at high Resolution with Internalized Calibration (METRIC) and Surface Energy Balance Algorithm for Land (SEBAL) for nine recent years. METRIC and SEBAL results account for effects of salinity, deficit irrigation, disease, poor plant stands, and any other stress factors on crop ET. Studies by Bastiaanssen, et al. (2005), Allen, et al. (2007), (Allen, et al. 2011) and Thoreson, et al. (2009) and others have found that when performed by an expert analyst, seasonal ET_a estimates by these models are expected to be within plus or minus five percent of actual ET. For crops grown in the TID service area, growing season ET computed using the CIMIS reported reference evapotranspiration (ET_o) and crop coefficients are provided in Table 4.4.

The resulting ET_a is input to the Integrated Water Flow Model Demand Calculator (IDC) version 2015.0.0036 (DWR, 2015) to parse the ET_a into ET from applied water (ET_{aw}) and ET from precipitation (ET_{pr}). This approach ensures the most accurate and consistent calculation of historical crop ET (ET_c) and ET_{aw} possible, and improving the reliability of the water balance and related performance indicators.

Other uses of applied irrigation water include leaching of salts and frost protection for orchards and vineyards. These uses are limited. Due to the generally low salinity of TID irrigation water, the required leaching fraction is small for the crops grown in the District**.** Growers using groundwater of relatively higher salinity for irrigation could require leaching to maintain production for sensitive crops. Should the use of groundwater increase, leaching requirements would also be expected to increase, to the extent that groundwater salinity is greater than surface water salinity. Leaching requirements have not been estimated at this time. Similarly, frost protection may be necessary in certain circumstances. Frost protection is typically applied outside of the irrigation season and, although not provided by TID, growers may use private or ID wells as water sources for frost protection. Frost protection has not been estimated at this time.

[8] Note that "normal" years, as described herein may include relatively wet years with respect to overall hydrology. As noted previously, for purposes of discussion, normal years refer to those years with 48-inches allotted, or available.

Table 4.3. Irrigated Area[1] of Crops Grown on Lands Receiving TID Surface Water.

Crop	Wet Year Average	Dry Year Average	1991-2014 Average	2010-2014 Average
Alfalfa	13,405	14,051	13,701	9,839
Almonds	43,280	43,451	43,358	46,513
Apples	781	683	736	434
Apricots	28	27	28	2
Beans	621	545	586	258
Beets	6	0	6	0
Berries	31	43	38	25
Carrots	6	71	39	0
Cherries	365	352	359	431
Christmas Trees	5	5	5	0
Citrus	9	9	9	8
Clover	475	404	443	79
Corn	9,256	9,623	9,424	11,866
Double - Other	10,041	8,232	9,211	7,322
Eggplant	10	13	12	9
Garden	76	71	74	70
Grain	194	165	180	106
Gypsophilia	76	120	92	0
Kiwi	29	46	36	16
Lawn	1,130	1,142	1,135	1,389
Melons	212	248	229	118
Oats	2,303	3,451	2,829	3,358
Oats/Corn	16,111	19,257	17,553	18,232
Olive	90	87	88	108
Onions	23	35	28	17
Other Crops	380	393	386	352
Other Trees	342	376	358	368
Pasture	10,109	9,633	9,891	6,433
Peaches	5,218	4,926	5,084	3,305
Pears	8	14	11	7
Peas	0	7	7	8
Plums	34	28	31	3
Pumpkins	93	87	90	76
Squash	33	26	30	30
Sudan	819	718	773	764
Sunflowers	8	59	42	8
Sweet Potatoes	1,977	1,638	1,821	1,638
Tomatoes	12	11	11	11
Unirrigated Forage/Corn[2]	11,161	9,620	10,454	15,794
Vineyard	2,992	2,592	2,809	1,575
Walnuts	4,765	5,068	4,904	5,264
Totals	136,513	137,324	136,901	135,832

[1] Irrigated area estimated as 94 percent of assessed area (to account for farm roads and non-irrigated areas). Due to rounding of individual crop acres, totals may differ slightly from 94 percent of assessed area.

[2] Unirrigated (rainfed) forage followed by irrigated corn in a double cropped sequence.

Table 4.4. Growing Season (March through October) ET[1] in Inches for Crops Receiving TID Surface Water.

Crop	Wet Year Average	Dry Year Average	1991-2014 Average	2010-2014 Average
Alfalfa[2]	36.86	39.02	37.85	38.40
Almonds	31.83	33.67	32.67	33.14
Corn[3]	31.44	33.12	32.21	32.62
Other Crops[4]	30.58	32.30	31.37	31.81
Other Trees[5]	29.54	31.18	30.29	30.72
Pasture[6]	32.98	34.86	33.85	34.31
Sweet Potatoes	19.96	20.92	20.40	20.69
Vineyard	19.10	20.16	19.59	19.89

[1] Total ET derived from applied water and precipitation calculated with crop coefficients derived from a remotely sensed surface energy balance inherently account for "bare spots and reduced vigor" to represent the total water consumed.
[2]Alfalfa also includes clover
[3]Corn also includes grain, oats corn, oats, sunflowers, beans, unirrigated forage corn, and double--other
[4]Other Crops include carrots, berries, beets, eggplant, garden, gypsophilia, melons, pumpkins, onions, tomatoes, sudan, squash and peas
[5]Other Trees include apples, apricots, cherries, Christmas, plums, olives, pears, peaches, kiwi, walnuts, and citrus
[6]Pasture includes lawn

4.5.2 Environmental

There are no natural environmental resource delineations within the irrigation service area that are supported by TID diversions. However, the Federal Energy Regulatory Commission (FERC) license requirements for Don Pedro Reservoir include an extensive set of minimum instream flow release requirements that vary with the water year type. Instream flows and irrigation releases come from the Don Pedro Reservoir supplies. Releases to the Tuolumne River for environmental purposes therefore reduce the remaining supplies available for irrigation. In 1996, instream flow requirements were significantly increased. The annual volume of these flows ranges from 94,000 acre-feet in dry years to 301,000 acre-feet in wet years, up from 64,000 acre-feet and 123,000 acre-feet under the previous license requirements for dry and wet years, respectively. The TID contributes approximately 68 percent of these releases. Diversions for irrigation are made after the instream requirements are met. (Note: The FERC dry and wet year distinctions described in this paragraph are based on regulatory requirements and are different than other hydrologic water year descriptions referenced in this AWMP.)

During a 45-day period between October 15 and December 1 (e.g., October 17 through November 30), flow fluctuations in the Tuolumne River are minimized to protect fall-run Chinook salmon. For the period extending from October 15 through March 15, river flow changes are also subject to certain ramping rates to protect salmon, which can require additional flows.

Between 2000 and 2011, a portion of the years analyzed by this AWMP, TID also participated in the Vernalis Adaptive Management Plan (VAMP). VAMP was designed to test the effects of various 30-day pulse flows (as measured at Vernalis on the main stem of San Joaquin River) on out-migrating salmon smolts while the state and federal export pumps were operated at specified

levels. Under the division agreement among the VAMP participants, TID contributed up to an additional 11,000 acre-feet of water each year depending upon the basin hydrology and designated targets.

4.5.3 Recreational

While there are recreational uses of TID diversions, there is no mandated supply dedicated to recreational use nor are the current recreational uses consumptive in nature.

The State of California contracts with a concessionaire to operate a park at Turlock Lake (www.parks.ca.gov/?page_id=555). The park is managed by American Land and Leisure. During the irrigation season, the water level in the lake is generally kept between water levels corresponding to 28,000 and 32,000 acre-feet of water to allow recreation along the shoreline and to assure steady deliveries to the distribution system. During consecutive dry years, in order to reduce seepage, TID may lower the operating lake level range corresponding to 22,000 to 27,000 acre-feet of water. By the end of the irrigation season, the lake is drawn down to provide stormwater capacity for the McDonald Creek watershed which drains into the Upper Main Canal and to allow for maintenance. The lake is used for duck hunting and other recreational uses conducive to the lower reservoir levels typical of the non-irrigation season.

4.5.4 Municipal and Industrial

TID, in conjunction with MID, operates the La Grange Domestic Water System serving 66 connections. Total water use is approximately 36 acre-feet per year, based on 2010 through 2014 data after the installation of water meters. This use is not included in the TID water balance as it occurs upstream of Turlock Lake. All other municipalities, industries, and small domestic uses of water in the TID service area rely on groundwater for their supply.

If groundwater remains the sole source of municipal water supply, it is expected that municipal groundwater use will increase over time. However, some of the local community water systems including those found in Ceres, Turlock, and that portion of Modesto south of the Tuolumne River have for a number of years been studying the possibility of using TID surface water from the Tuolumne River in conjunction with existing groundwater supplies.

In July 2015, the TID and the SRWA completed a water sales agreement which represents a significant step forward toward TID providing surface water for municipal uses. Pursuant to the agreement, TID will provide up to a combined 30,000 AF of surface water to the SRWA communities. Tuolumne River water will be withdrawn from the river through an existing infiltration gallery near Geer Road. After which the water will be treated, and distributed to the communities through facilities to be designed and built by the SRWA. The agreement also stipulates that during less than normal irrigation years, the SRWA will provide offset water to TID to reduce the impact of the project on TID irrigation supplies. Once implemented, the project will reduce municipal reliance on groundwater supplies and result in in-lieu recharge of the Turlock Groundwater Basin.

The uses of groundwater described in this section are not directly included in the Water Balance as they are not a part of the TID system. However, the municipal, industrial and small domestic use of groundwater does have a potential to influence the groundwater supplies available for irrigation purposes in the future.

4.5.5 Groundwater Recharge

Groundwater recharge is an important component of TID's conjunctive management strategy to achieve water supply reliability. As described in Section 3, TID is a leader in groundwater management. The majority of groundwater recharge within the basin occurs indirectly as a result of agricultural practices in the irrigation service area. The discussion of conjunctive management in Section 3 demonstrates how TID encourages the use of surface water supplies resulting in significant in-lieu groundwater recharge. Groundwater recharge that occurs within TID consists of passive seepage from TID canals and deep percolation of precipitation and applied irrigation water. This distributed, passive recharge provides a means to replenish the groundwater basin to the benefit of TID water users, communities within TID, and surrounding areas that share the groundwater resource. Estimates of indirect groundwater recharge of irrigation water from these sources were derived from the water balance analysis. Canal seepage was calculated based on soil characteristics along with estimated canal wetted perimeters, overall lengths, and wetting frequency. Deep percolation of irrigation water was calculated as the closure term of the TID-SW irrigated lands water balance accounting center. Seepage and deep percolation volumes for 2010 to 2014 are provided in Table 4.5, along with total recharge expressed as a volume and as a depth of water relative to the cropped area in each year.

Total recharge between 2010 and 2014 ranged from approximately 195,000 AF to 323,000 AF per year, or from 1.4 AF to 2.4 AF per irrigated acre per year. On average, total recharge was estimated to be approximately 262,000 AF per year (1.9 AF/acre) for the period 2010 to 2014 and 299,000 AF per year (2.2 AF/acre) for the period 1991 to 2014. In the long term, total recharge is approximately 65,000 AF greater in normal years than dry years, on average. Approximately 12 percent of recharge originates from canal seepage, 65 percent of recharge originates from deep percolation of applied water, and 23 percent of recharge originates from deep percolation of precipitation.

TID relies on local groundwater supplies to supplement surface water deliveries, particularly in dry years. Additionally, urban areas, industrial, and private (both domestic and agricultural) pumpers within TID and the rest of the basin rely upon groundwater in all years to some extent. To enhance groundwater recharge within the basin, TID has been participating in a small, ten-year pilot groundwater recharge project with the Eastside Water District (see the EWMP section for a detailed description). These deliveries and subsequent recharge are not accounted for separately within the water balance, due to the small nature of the pilot project, but are included in the overall recharge estimates.

Net groundwater recharge was calculated by subtracting pumping volumes from total recharge volumes. Total pumping volumes include TID drainage pumping, TID rented well pumping, and private pumping volumes. Total recharge volumes include deep percolation of applied water and precipitation from farms as well as seepage from TID canals and from drains. Net recharge provides a measure of the net impact of TID's operations on groundwater storage volumes. Net recharge estimates for the study period are provided in Table 4.6.

Table 4.5. TID Total Groundwater Recharge.

Year	Year Type	Canal Seepage (AF)	Deep Percolation of Applied Water (AF)	Deep Percolation of Precipitation (AF)	Total Recharge	
					(AF)	(AF/ac)
2010	Normal	39,210	201,650	76,118	316,978	2.4
2011	Normal	39,340	219,446	63,892	322,678	2.4
2012	Dry	36,890	177,879	31,532	246,301	1.8
2013	Dry	36,890	170,903	18,707	226,500	1.6
2014	Dry	31,000	105,416	58,762	195,178	1.4
2010-2014	Average	36,666	175,059	49,802	261,527	1.9
	Minimum	31,000	105,416	18,707	195,178	1.4
	Maximum	39,340	219,446	76,118	322,678	2.4
1991-2014	Average	36,049	193,521	69,078	298,649	2.2
	Normal Year	36,542	205,202	86,493	328,237	2.4
	Dry Year	35,467	179,716	48,498	263,681	1.9

Table 4.6. TID Net Groundwater Recharge.

Year	Hydrologic Year Type	Total Recharge (AF)	Groundwater Pumping (AF)	Net Recharge	
				(AF)	(AF/ac)
2010	Normal	316,978	80,983	235,995	1.8
2011	Normal	322,678	85,757	236,921	1.8
2012	Dry	246,301	139,027	107,274	0.8
2013	Dry	226,500	155,679	70,821	0.5
2014	Dry	195,178	191,632	3,546	0.0
2010-2014	Average	261,527	130,615	130,912	1.0
	Minimum	195,178	80,983	3,546	0.0
	Maximum	322,678	191,632	236,921	1.8
1991-2014	Average	298,649	107,919	190,729	1.4
	Normal Year	328,237	91,033	237,203	1.7
	Dry Year	263,681	127,876	135,805	1.0

Net recharge ranged from approximately 3,500 AF to 237,000 AF per year between 2010 and 2014, or from 0.0 AF to 1.8 AF per irrigated acre per year. On average, net recharge was estimated to be approximately 131,000 AF per year (1.0 AF/acre) for the period 2010 to 2014 and 191,000 AF per year (1.4 AF/acre) for the period 1991 to 2014. In the long term, net recharge is approximately 101,000 AF greater in normal years than dry years, on average, or about 0.7 AF/acre. The computed net recharge is for the area within the water balance boundaries. Thus, seepage from Turlock Lake or the Upper Main Canal are not included in these net recharge values.

4.5.6 Transfers and Exchanges

During normal water supply years, surface water may be sold to lands outside but adjacent to the TID irrigation service boundary to reduce demands on groundwater supplies, providing in-lieu and direct groundwater recharge in the area of the cone of depression east of TID. Approximately 3,400 acres adjacent to, but outside, TID can purchase “surplus” water from TID.

On average only 1,200 acres use about 2,100 acre-feet of water in years when surplus water is sold. No water is transferred into the TID service area from external sources.

During periods of surface water shortage, growers use internal water transfers to balance individual crop irrigation needs within the District. These types of transfers enable growers to make use of water unused on one parcel for the benefit of another parcel so long as both parcels are either owned by the same grower or under long-term lease.

4.5.7 Other Water Uses

Other incidental uses of water within TID include watering of roads for dust abatement, agricultural spraying, and stock watering by TID water users. TID also supplies water for flood irrigation of church yards and school fields. The volume of water used for such purposes is small relative to other uses and has not been quantified as part of this AWMP.

4.6 DRAINAGE

4.6.1 Spillage Recovery and Tailwater and Subsurface Drainage Reuse within TID

In TID's distribution system, operational canal spillage can occur at 15 locations (called canal spills) typically located at or near the terminal ends of the lateral canals. Six of the 15 canal spills terminate directly to local rivers. The remaining nine canal spills are to drains which are consolidated into three drains which spill to the local rivers. The drains carry a mixture of canal spillage, groundwater, tailwater, runoff from precipitation and urban runoff. Some of this drain water is captured for reuse.

The Ceres Main Canal runs north to south across approximately the center of the TID service area serving as an interceptor canal for spillage from the upper laterals that originate from the Turlock Main Canal (see the District Map in Appendix D). Additionally, some of the spill water from the Ceres Main Canal that is received by the Harding Drain is pumped from the drain and reused.

Historically, the City of Turlock also discharge treated municipal wastewater to the Harding Drain. TID would supplement surface water supplies in Lateral 5½ with water pumped from the Harding Drain. Due to the effluent discharges to the drain, the Regional Water Quality Control Board (RWQCB) established regulatory restrictions and extensive reporting requirements for the reuse of any water taken from the Harding Drain, making it impractical for TID to recover spillage from the drain. Therefore, TID discontinued the practice. However, in 2006, the City of Turlock began putting their wastewater through a tertiary treatment process which removed the restrictions on reuse. TID resumed the reuse of Harding Drain water in July of 2008, pumping a blend of recovered spillage and recycled M&I water from the Harding Drain totaling 1,370 acre-feet between July and October of that year. From 2010 to 2014, TID reused an average of 2,610 acre-feet per year from the Harding Drain. As noted earlier, beginning in 2015, the Harding Drain no longer conveys recycled wastewater. Nevertheless, TID will continue to utilize operational spill water recovered from the Harding Drain.

As described in Section 2.5, direct tailwater discharges from a field are not permitted into the TID distribution system. Some lands, mainly on the eastern side of TID, generate tailwater during irrigation. The majority of growers in this region have control structures to prevent

irrigation tailwater from flowing back into the distribution system. Some tailwater is allowed to enter TID canals indirectly through the drainage channels into the distribution system. An inventory of TID lands begun in 2004 and last updated in early 2009 demonstrates that drain water, which includes tailwater mixed with other sources such as storm water, only comes from a small percentage of lands within TID (approximately 2,700 acres, or less than 2% of assessed acres). This water is blended with surface water supplies for delivery to TID growers. The amount of water generated from these lands is estimated and included in the water balance.

Tailwater can also be generated on an additional 8,200 acres within TID; however, this water is not intercepted by the distribution system and ultimately drains to natural waterways adjoining TID. TID growers have also installed recovery pumps which draw from local drains, to supplement irrigation supplies. These grower recovery pumps are not included under the TID facilities in Section 2 or in the water balance calculations.

Starting in the 1990s, growers began installing subsurface drainage (or tile drain) systems to provide more uniform drainage. Discharge from these subsurface drains enters the TID distribution system and becomes a part of the water supply mix. During the irrigation season, this discharge is blended with canal water and utilized to the greatest extent possible as irrigation supply. During the non-irrigation season the subsurface drain water is passed through the distribution system and enters the rivers. Estimates of the subsurface drainage being reused or flowing to the rivers are included in the water balance.

In the non-irrigation season, the TID canals are drained of Tuolumne River surface water supplies. However, they are still used to convey subsurface drainage, drainage pumping, urban runoff from local communities, and storm water flows from east of the irrigation service area to the rivers. During the off-season, TID works with growers who wish to capture these flows, by boarding up drops, so long as it does not conflict with maintenance or other activities. This type of use is not significant, and is not considered a TID irrigation delivery. As such, it is not included specifically in the water balance.

4.6.2 TID Boundary Outflows

As previously discussed, TID owns only 18 miles of drains, and only a small percentage of TID irrigated land generates tailwater. TID has conducted a systematic inventory of the tailwater and storm drains that discharge to TID facilities. As described in more detail in Section 2.5, the inventory showed that the area with the ability to discharge tailwater is small. As described above, a portion of this water may be recovered, with the remainder flowing to the river system. Between 2010 and 2014, tailwater discharge from the TID service area is estimated to have ranged between 2,400 and 3,100 AF per year with an average of 2,800 AF for the irrigation season[9].

[9] Tailwater to rivers was not estimated prior to 2009 due to lack of available data.

Operational spillage from the TID distribution system is summarized in Table 4.7. Operational spillage ranged from approximately 19,000 AF to 87,000 AF per year between 2010 and 2014. On average, operational spillage was estimated to be approximately 56,000 AF per year (10% of total inflows to the distribution system) for the period 2010 to 2014 and 57,000 AF per year (10% of total inflows) between 1991 and 2014. In the long term, operational spillage is approximately 39,000 AF less in dry years than in normal years.

All surface water outflows from the TID service area are available for beneficial use by downstream users.

Table 4.7. Summary of TID Operational Spillage.

Year	Year Type	Operational Spillage (AF)
2010	Normal	81,968
2011	Normal	87,229
2012	Dry	46,211
2013	Dry	46,865
2014	Dry	19,207
2010-2014	Average	56,296
	Minimum	19,207
	Maximum	87,229
1991-2014	Overall Average	57,204
	Normal Year Average	74,963
	Dry Year Average	36,216

4.7 WATER ACCOUNTING (SUMMARY OF WATER BALANCE RESULTS)

The TID water balance structure was shown previously in Figure 4.1. The water balance was prepared for two accounting centers: (1) the TID distribution system and (2) TID-SW irrigated lands. An accounting center representing the groundwater system is also included in Figure 4.1 to account for exchanges between the vadose zone and the aquifers underlying TID; however, a complete balance for the underlying aquifer is not calculated because not all subsurface inflows and outflows have been estimated. Tabulated water balance results for each accounting center are provided in Tables 4.8 and 4.9.

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Table 4.8. TID Distribution System Irrigation Season Water Balance Results.

Year	Available Water (inches)[1]	Irrigation Season		Number of Days	Inflows (AF)								Outflows (AF)			Closure (AF)	Performance Indicators		
					Surface Supply	Groundwater Supply		Other Supply											
		Start Date	End Date		Irrigation Releases	TID Drainage Pumps	TID Rented Wells	Tilewater	Tailwater to Canals	Spill Recovery (Pump 152)	Runoff off Precipitation to Canals	Total Supply	Operational Spillage	Net Evaporation[2]	Irrigation Season Seepage	Farm Deliveries	Surface Water Supply Fraction[3]	Delivery Fraction[4]	Water Management Fraction[5]
2010	48	18-Mar	31-Oct	228	531,107	42,669	20,073	7,689	850	2,020	2	604,410	81,968	1,452	39,210	481,780	0.89	0.80	0.998
2011	48	17-Mar	2-Nov	231	537,685	51,166	16,638	9,978	951	2,659	43	619,120	87,229	1,436	39,340	491,115	0.89	0.80	0.998
2012	30	8-Mar	10-Oct	217	445,579	47,279	65,525	5,022	833	2,909	8	567,155	46,211	1,461	36,890	482,593	0.80	0.86	0.997
2013	34	7-Mar	9-Oct	217	460,420	42,711	68,687	3,618	903	3,166	3	579,508	46,865	1,648	36,890	494,105	0.81	0.86	0.997
2014	20	10-Apr	8Oct	182	320,862	31,007	57,420	3,634	762	2,294	4	415,983	19,207	1,530	31,000	364,246	0.78	0.88	0.996
2010-2014	Average			215	459,131	42,966	45,669	5,988	860	2,610	12	557,235	56,296	1,505	36,666	462,768	0.83	0.84	0.997
	Minimum			182	320,862	31,007	16,638	3,618	762	2,020	2	415,983	19,207	1,436	31,000	364,246	0.78	0.80	0.996
	Maximum			231	537,685	51,166	68,687	9,978	951	3,166	43	619,120	87,229	1,648	39,340	494,105	0.89	0.88	0.998
1991-2014	Overall Average			216	491,745	49,776	32,492	5,888	1,418	702	6	582,028	57,204	1,508	36,049	487,274	0.85	0.84	0.997
	Normal Year Average			218	520,225	54,168	15,990	6,485	1,443	547	10	598,868	74,963	1,456	36,542	485,908	0.88	0.81	0.998
	Dry Year Average			212	458,086	44,585	51,995	5,183	1,389	885	1	562,125	36,216	1,570	35,467	488,888	0.82	0.87	0.997

[1]Depth of water in inches available equally to each acre of land. For 2010-2012 this was the allotment.
[2]Evaporation minus precipitation that falls on the canal water surface.
[3]Irrigation Releases divided by the sum of Irrigation Releases, TID Drainage Pumping and TID Rented Well Pumping.
[4]Deliveries divided by Total Supply.
[5]Outflows available for beneficial use (Farm Deliveries, Irrigation Season Seepage, and Operational Spillage) divided by Total Supply.

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Table 4.9. TID Irrigated Lands Irrigation Season Water Balance Results.

Year	Available Water (inches)[1]	Applied Water Balance										Precipitation Balance					Net Recharge (AF/ac)[3]	Crop Consumptive Use Fraction[4]
		Inflows (AF)				Outflows (AF)					Closure	Inflow (AF)	Outflows (AF)					
		Deliveries	Private Pumping with Surface Water	Treated Wastewater	Total Irrigation Supply	ET of Applied Water	Tailwater to Canals	Tailwater to Rivers[2]	Tilewater to Canals	Tilewater to Rivers	Deep Percolation of Applied Water	Precipitation	Deep Percolation of Precipitation	ET of Precipitation	Uncollected Runoff	Change in Storage of Precipitation		
2010	48	481,780	18,241	5,550	505,571	291,230	850	2,760	7,689	1,392	201,650	61,343	32,312	65,534	12	(36,515)	1.8	0.58
2011	48	491,115	17,953	4,415	513,483	278,797	951	2,589	9,978	1,722	219,446	78,086	46,936	73,872	218	(42,939)	1.8	0.54
2012	30	482,593	26,223	4,962	513,778	326,004	833	2,941	5,022	1,099	177,879	44,803	25,127	36,362	47	(16,733)	0.8	0.63
2013	34	494,105	44,281	5,421	543,807	364,811	903	3,106	3,618	466	170,903	17,533	12,346	26,892	17	(21,723)	0.5	0.67
2014	20	364,246	103,205	4,626	472,077	358,919	762	2,395	3,634	950	105,416	38,995	19,769	38,994	19	(19,787)	0.0	0.76
2010-2014	Average	462,768	41,980	4,995	509,743	323,952	860	2,758	5,988	1,126	175,059	48,152	27,298	48,331	63	(27,540)	1.0	0.64
	Minimum	364,246	17,953	4,415	472,077	278,797	762	2,395	3,618	466	105,416	17,533	12,346	26,892	12	(42,939)	0.0	0.54
	Maximum	494,105	103,205	5,550	543,807	364,811	951	3,106	9,978	1,722	219,446	78,086	46,936	73,872	218	(16,733)	1.8	0.76
1991-2014	Overall Average	487,274	25,651	3,887	516,812	314,702	1,418	2,852	5,888	570	193,521	47,017	27,691	55,237	2,858	(38,770)	1.4	0.61
	Normal Year Average	485,908	20,875	3,705	510,488	296,119	1,443	2,889	6,485	573	205,202	56,671	32,797	63,397	3,626	(43,149)	1.7	0.58
	Dry Year Average	488,888	31,296	4,102	524,285	336,663	1,389	2,814	5,183	567	179,716	35,607	21,656	45,595	1,951	(33,594)	1.0	0.64

[1]Depth of water in inches available equally to each acre of land. For 2010-2012 this was the allotment.
[2] Tailwater to rivers was not estimated prior to 2009, so the average flows are from 2009-2014.
[3]The calculation of net recharge includes deep percolation of precipitation during the off-season. Total deep percolation of precipitation during the irrigation season and off season is presented in Table 4.5.
[4] The Crop Consumptive Use Fraction (CCUF) is calculated as ET of Applied Water divided by the Total Irrigation Supply.

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As depicted in Figure 4.1, extensive interconnection exists between the two accounting centers due to in part recapture and reuse of water by TID. Additional reuse occurs directly by the water users that is not accounted for in the water balance due to lack of data. These methods of water recovery and reuse result in higher levels of aggregate performance than would otherwise occur.

The water balance is presented on an annual time step for the irrigation season (approximately March through October) for the years 2010 through 2014. Summary results are provided for the 2010 to 2014 period as well as for the 1991 to 2014 period. Underlying the annual time step is a more detailed water balance in which all flow paths are determined on a monthly or more frequent basis. The winter months are excluded because the non-irrigation season water balance is influenced by unmeasured intercepted stormwater, and the information provided does not pertain to TID water management activities.

4.7.1 Distribution System Water Balance

Over the 2010 to 2014 period, the District distribution system (also referred to as the canal system) had total inflows from Turlock Lake ranging from 321,000 AF to 538,000 AF for the irrigation season with an average of 459,000 AF. For the 1991 to 2014 period, normal year irrigation releases averaged 520,000 AF, and dry year releases averaged 458,000 AF, with an overall average of 492,000 AF. Releases are greater in normal years due to the greater availability of surface water.

Other sources of supply include TID drainage and rented well groundwater pumping, subsurface drainage and tailwater reuse directly entering the distribution system, and recycled water discharged to TID irrigated lands. As indicated in Table 4.8, TID drainage well pumping ranged from 31,000 AF to 51,000 AF between 2010 and 2014. The overall average for the five year period was 43,000 AF. The 1991-2014 normal and dry year averages were 54,000 AF and 45,000 AF, respectively, with an overall average of 50,000 AF. Drainage pumping is about the same in normal and dry years due to the use of drainage pumps to lower the water table and to provide flexible supply in the distribution system.

TID rented well pumping ranged from 17,000 AF to 69,000 AF between 2010 and 2014. The overall average for the five year period was 46,000 AF. The normal and dry year averages over the 1991 to 2014 period were 16,000 AF and 52,000 AF, respectively, with an overall average of 32,000 AF. Rented well pumping is increased in dry years because rented wells are used as an additional groundwater supply to meet increased irrigation demands and to compensate for reduced surface water availability.

For TID, the fraction of supply from surface water provides a means of evaluating variability in TID's reliance on surface water supplies over time. The surface water supply fraction is calculated according to Equation 4-3:

$$\text{Surface Water Supply Fraction} = \text{Irrigation Releases} / (\text{Irrigation Releases} + \text{TID Drainage Pumping} + \text{TID Rented Well Pumping}) \quad [4\text{-}3]$$

The surface water supply fraction ranged from 0.78 to 0.89 between 2010 and 2014 with an average of 0.83. Over the 24-year period from 1991 to 2014, the fraction of supply from surface

water averaged 0.88 and 0.82 in normal and dry years, respectively, with an overall average of 0.85. The reduction in the fraction of TID's water supply from surface water in dry years demonstrates TID's conjunctive management of surface water and groundwater supplies to maintain overall water supply reliability.

TID subsurface drainage water reuse ranged from 3,600 AF to 10,000 AF between 2010 and 2014. The overall average for the five year period was 6,000 AF. For the 1991 to 2014 period, subsurface drainage reuse averaged 6,500 AF in normal years and 5,200 AF in dry years, with an overall average of 5,900 AF. Subsurface drainage water reuse is about the same in normal and dry years, as the need to lower the water table in the areas with subsurface drains varies little from year to year.

TID tailwater reuse ranged from 760 AF to 950 AF between 2010 and 2014. The overall average for the five year period was 860 AF. For the 1991 to 2014 period, tailwater reuse averaged 1,400 AF in normal years and 1,400 AF in dry years, and also had and overall average of 1,400 AF. Tailwater reuse is about the same in normal and dry years.

TID spillage recovery from Harding Drain (Pump 152) averaged 2,610 AF between 2010 and 2014. Spillage recovery through interception by the Ceres Main Canal (an internal flow path not included in the water balance) is estimated to be on the order of 15,000 AF per year. In addition, spillage is recovered from 34 ID pipelines that spill into canals. Spillage recovery is greater in dry years in order to maximize the use of available water supplies.

When comparing total deliveries to meet irrigation demand to the total water supply, a Delivery Fraction (DF) may be calculated to provide an indicator of distribution system performance. The DF is calculated on an annual (i.e., irrigation season) basis by dividing total deliveries by total irrigation supply according to Equation 4-4:

$$DF = \text{Farm Deliveries} / \text{Total Supply} \qquad [4\text{-}4]$$

For TID, the DF ranged from 0.80 to 0.88 between 2010 and 2014 with an average of 0.84. The DF over the 1991 to 2014 period averaged 0.81 and 0.87 in normal and dry years, respectively, with an overall average of 0.84.

Losses from the distribution system at the water supplier scale include seepage, spillage, and evaporation. Of the three loss types, only evaporation losses are non-recoverable as seepage recharges the underlying groundwater system and spillage is available by downstream water users. Between 2010 and 2014, seepage ranged between 31,000 and 39,000 AF with an average of 37,000 AF for the irrigation season. For the 1991 to 2014 period, seepage averaged 37,000 AF in normal years and 35,000 AF in dry years, with an overall average of 36,000 AF. The primary driver of seepage is the irrigation season length. TID continually evaluates lining condition and rehabilitation and relining is completed as necessary; however, seepage reduction to increase the available water supply for farm deliveries does result in a decrease in beneficial groundwater recharge.

Spillage losses varied from 19,000 AF to 87,000 AF between 2010 and 2014 with an average of 56,000 AF per year. Spillage losses for the 1991 to 2014 period averaged 75,000 AF and 36,000 AF in normal and dry years, respectively, with an overall average of 57,000 AF. In dry years, spillage losses are reduced through increased use of rented wells in the lower reaches of the

distribution system, which enable operators to reduce spills by turning on and off pumps to manage spills and meet irrigation demands, while diverting less water from Turlock Lake and conveying it through the distribution system.

Evaporation losses are relatively small and constant over time. Variations from irrigation season to irrigation season result primarily from differences in season length and evaporative demand (i.e., weather) over time. Between 2010 and 2014, evaporation losses varied from 1,400 AF to 1,600 AF, with an average of 1,500 AF in losses per year. The 1991-2014 averages reflect a similar range.

Comparing total inflows to the TID distribution system available to meet irrigation demands (i.e., total supply) to total outflows to meet irrigation demands plus recoverable losses to seepage and spillage, a Water Management Fraction (WMF) may be calculated at the water supplier scale. This fraction is calculated on an annual basis for the irrigation season as the ratio of farm deliveries, operational spillage, and seepage to total irrigation supply according to Equation 4-5:

$$\text{WMF} = (\text{Farm Deliveries} + \text{Operational Spillage} + \text{Seepage}) / \text{Total Supply} \qquad [4\text{-}5]$$

Over the period from 2010 to 2014, the WMF varied from 0.996 to 0.998, indicating that essentially all of TID's water supply is used to meet irrigation demands or is recoverable for beneficial use by down gradient surface water and groundwater users.

4.7.2 Farmed Lands Water Balance

Over the 2010 to 2014 period, TID farm deliveries ranged from 364,000 AF to 494,000 AF for the irrigation season. The overall average for the five year period was 463,000 AF. For the 1991 to 2014 period, farm deliveries averaged 486,000 AF for normal years and 489,000 AF for dry years with an overall average of 487,000 AF. Deliveries are greater in most dry years (except for extreme dry years) due to the fact that less precipitation is available to support crop water demands in TID and evaporative demands tend to be greater. As a result, additional irrigation deliveries are needed to maintain crop production.

Other sources of farm irrigation supply include private groundwater pumping and recycled water delivered directly to farms. As indicated in Table 4.9, private groundwater pumping ranged from 18,000 AF to 103,000 AF between 2010 and 2014. The overall average for the five year period was 42,000 AF. Private pumping varied little between normal and dry years except for years with the water available less than 30 inches and in the second and third year of a consecutive dry year period. TID's conjunctive management strategy provides a reliable district supply in all but the driest of years, so that the extra groundwater pumped by growers in dry years tends to be negligible. This is confirmed by the average normal and dry year private groundwater pumping over the 1991 to 2014 period, which vary by approximately 2,000 AF for normal years and dry years with at least 30 inches of water available.

Recycled water reuse is relatively steady over time due to steady generation of wastewater by the dischargers. Recycled wastewater applied directly to TID irrigated lands averaged 5,000 AF over the five year period of 2010 through 2014. Reuse of recycled water within TID has increased over time. The overall average for the 1991 to 2014 period is 3,900 AF, which has been similar in normal and dry years.

The objective of irrigation is to meet crop consumptive demand (ET_{aw}) along with any other agronomic on-farm water needs. Comparing total applied irrigation water to ET_{aw}, a Crop Consumptive Use Fraction (CCUF) may be calculated to provide an indicator of on-farm irrigation performance. The CCUF is calculated on an annual (i.e., irrigation season) basis by dividing total ET_{aw} by total applied irrigation water according to Equation 4-6:

$$\text{CCUF} = \text{ET of Applied Water} / \text{Total Irrigation Supply} \qquad [4\text{-}6]$$

For TID, the CCUF ranged from 0.54 to 0.76 between 2010 and 2014 with an average of 0.64. For the 1991 to 2014 period, the CCUF is lower in normal years, averaging 0.58 as compared to 0.64 in dry years. The overall average for the 1991 to 2014 period is 0.61.

Losses from the farmed lands include tailwater (flowing to drains that either discharge to canals or to rivers) and deep percolation of applied water. All of the losses are recoverable, as tailwater may be used by downstream water users for irrigation or other purposes, and deep percolation of applied water recharges the underlying groundwater system. Between 2010 and 2014[10], tailwater discharged to rivers was estimated to range between 2,400 and 3,100 AF with an average of 2,800 AF for the irrigation season. For the 2010 to 2014 period, tailwater returning to the distribution system was estimated to range from 750 AF to 950 AF with an average of 850 AF for the irrigation season. For the period from 1991 to 2014, tailwater returning to the distribution system was approximately 1,400 AF per year.

Deep percolation of applied water varied from 105,000 AF to 219,000 AF between 2010 and 2014 with an average of 175,000 AF per year. Deep percolation for the 1991 to 2014 period averaged 205,000 AF in normal years compared to 180,000 AF in dry years, with an overall average of 194,000 AF. Annual fluctuations in deep percolation estimates result from differences in rainfall patterns and resulting applied water demands, as well as from uncertainty in the flow paths used to calculate the deep percolation amount. Due to the uncertainty in the estimated deep percolation of applied water, it is difficult to identify clear trends resulting from changes in hydrology or other factors over time; however, deep percolation of applied water tends to be less in dry years than normal years.

4.8 WATER SUPPLY RELIABILITY

TID requires a firm water supply to meet crop irrigation demand. The primary crop grown in TID is almonds requiring a large initial investment and a reliable water supply. The second most dominant cropping group is forage crops required as a food supply to sustain dairy herds in the District. Trees, vines and dairy related acreages (i.e. corn, oats, alfalfa, etc.) combined account for over 110,000 acres of irrigated crops within TID. This firm irrigation demand drives TID's conjunctive management strategy, which is designed to provide a relatively consistent water supply.

Reliability of water supplies is dependent upon the availability of surface water and groundwater supplies. As discussed in detail in Sections 3 and 4, TID's programs and practices assist in improving water supply reliability by conjunctively managing surface water and groundwater

[10] Tailwater to rivers was not estimated prior to 2009 due to lack of available data.

resources. However, the overall availability of irrigation surface water supplies relies upon numerous factors including future hydrology, water rights and instream flow requirements. Similarly, while Tuolumne River water imported by the TID provides the majority of recharge within the Turlock Basin, the groundwater is relied upon by various irrigation, domestic, industrial and municipal water users within the Basin, both within and outside TID boundaries. As a result, the reliability of groundwater resources is dependent upon continued recharge of the groundwater basin, and the ability for the various groundwater users to work cooperatively to manage the water supply. TID works with the other agencies within the Turlock Basin to facilitate that effort. Although water supply reliability is not within TID's sole discretion, TID will continue to manage the resources available to it, and adjust its programs and practices as needed to provide the most reliable water supplies for its customers today, and into the future.

In addition to supplies themselves, water supply reliability is dependent upon the ability to transport the water to where it is used for irrigation. TID owns and maintains its distribution system, up to and including the sidegate. TID regularly inspects the distribution system, with an emphasis on identifying and fixing potential problems before they occur. The majority of the canal maintenance and system improvements are performed in the non-irrigation season (typically November through February) to avoid impacts to irrigation deliveries.

Distribution facilities from the canal to irrigated parcels are owned and maintained by the individual growers or groups of growers who have formed IDs. TID assists IDs in maintaining the facilities, and recovers the costs from the growers. Administering IDs in this way, enables quick responses when maintenance issues arise, and improves system reliability by reducing the downtime associated with repairs.

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5. Climate Change

5.1 INTRODUCTION

Climate change has the potential to directly impact the District's surface water supply and to indirectly impact groundwater supplies. The District is committed to adapting to climate change in a manner that continues to maximize water supply reliability for TID customers through conjunctive management, while satisfying Tuolumne River downstream release obligations. This section includes a discussion of the potential effects of climate change on the District and its water supplies, followed by a description of the resulting potential impacts on water supply and quality and on water demand. Finally, actions currently underway or that could be implemented to help mitigate future impacts are identified.

5.2 POTENTIAL CLIMATE CHANGE EFFECTS

Several potential effects of climate change have been identified by the scientific community, including reduced winter snowpack, more variable and extreme weather conditions, shorter winters, and increased evaporative demand. Additionally, climate change could affect water quality through increased flooding and erosion; greater concentration of contaminants, if any, in the water supply; and warmer water which could lead to increased growth of algae and other aquatic plants. Rising sea level and increased flooding are also potential effects of climate change. The District is required to follow the flood management criteria established by the Army Corps of Engineers at Don Pedro Reservoir. In addition, the District conveys some stormwater from adjacent urban areas through its distribution system. Stormwater management, however, is the responsibility of the communities. TID's irrigation facilities merely provide a conveyance to the river system. Additionally, TID is not located within the Sacramento-San Joaquin River Delta. As a result, this discussion of climate change focuses on climate change effects and impacts related to the District's water supply and demand and does not discuss potential effects of rising sea level and increased flooding.

5.2.1 Sources of Information Describing Potential Climate Change Effects

Existing historical data and projections of future hydrology can be used to evaluate potential climate change effects. For this AWMP, historical full natural flow in the Tuolumne River at La Grange is evaluated, along with projected changes to Tuolumne River hydrology over the next 100 years. In order to better understand potential climate change effects on the District's surface water supply, TID, in cooperation with the San Francisco Public Utilities Commission, conducted a study completed in January 2012 to estimate the sensitivity of upper Tuolumne River flow to climate change scenarios (Hydrocomp et al. 2012). The study evaluated changes in streamflow and watershed hydrologic response to potential temperature and precipitation changes for the years 2040, 2070, and 2100, as compared to the base year of 2010. Hydrologic processes were simulated using a physically-based conceptual model. The results of this study have been summarized as part of this section.

To provide additional information describing potential future changes in the hydrology of the Tuolumne River watershed, projected future flows in the Stanislaus River at New Melones Dam (north of the Tuolumne) and in the Merced River at Pohono Bridge near Yosemite National Park

(south of the Tuolumne) are also presented. Projected future flows were obtained from recent projections developed using Global Climate Models (GCMs) reported by the United States Bureau of Reclamation (USBR) (Gangopadhyay and Pruitt, 2011). Projected future flows for the Tuolumne River are not available as part of the information reported by USBR; however projected hydrologic trends in the Stanislaus River to the north and the Merced River to the south are likely similar to those that will occur in the Tuolumne River watershed and can be compared to the results of the Hydrocomp et al. (2012) study to provide greater confidence in future climate change trends affecting surface water supply.

Finally, the study, West-Wide Climate Risk Assessment: Irrigation Demand and Reservoir Evaporation Projections (USBR 2015), developed by the USBR is presented to evaluate the potential effects of climate change on crop evapotranspiration (ET).

5.2.2 Summary of Potential Climate Change Effects

Changes in Timing of Runoff. Based on available historical data and projected future streamflow, the amount of annual runoff occurring during the spring-summer period from April through July has decreased over the past century and will continue to decrease in the next century.

Tuolumne River unimpaired flow (i.e., full natural flow) from 1900 to 2014 at La Grange shows a decreasing trend in April to July runoff as a percentage of total water year runoff over the past century (Figure 5.1), demonstrating that increasingly more runoff has occurred during the fall-winter period, outside of the irrigation season.

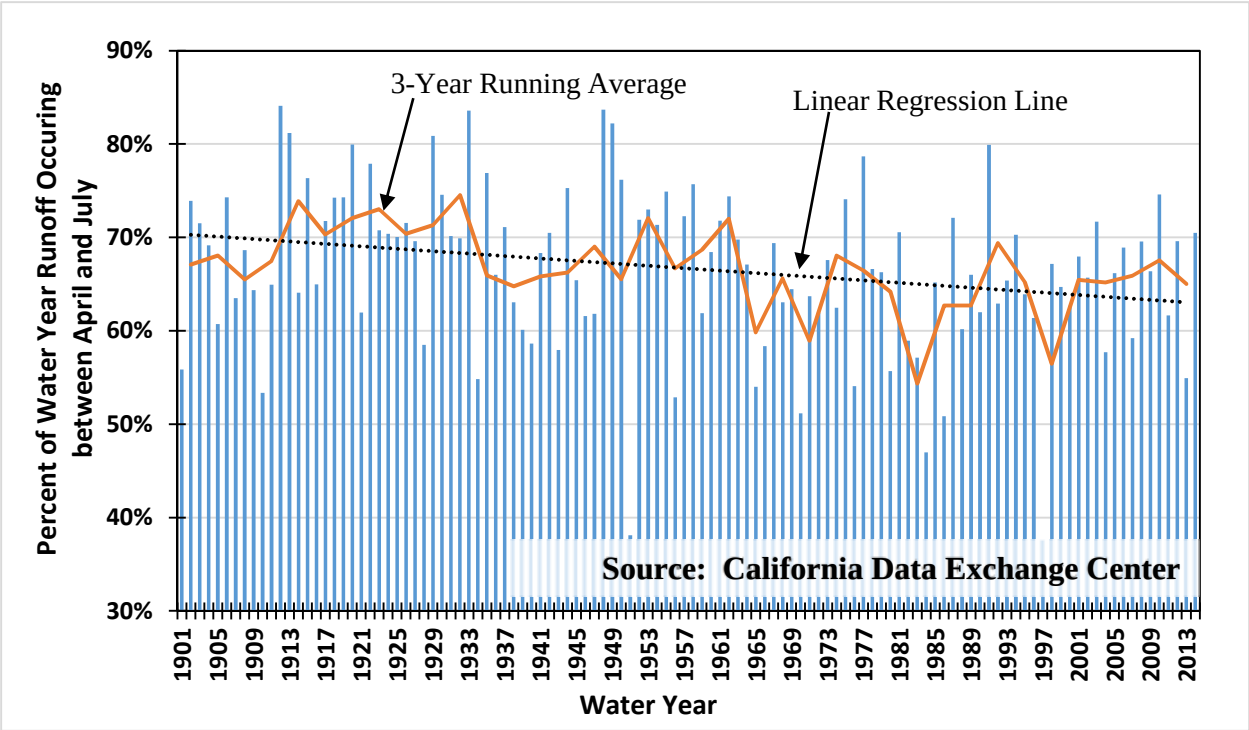

Figure 5.1. Annual April through July Unimpaired Runoff for Tuolumne River at La Grange (Source: CDEC, 2012).

The percentage of total runoff occurring during the April-July period is expected to continue to decline over the next century, as demonstrated by the results of the study conducted by Hydrocomp (2012), which projected monthly unimpaired runoff volumes for 2040, 2070, and 2100 for two alternative climate scenarios representing moderate temperature increase with no precipitation change (Scenario 2A) and moderate temperature increase with a decrease in precipitation (Scenario 2B)[11]. The projections suggest that Tuolumne River runoff at Don Pedro Reservoir occurring during the April to July period could decrease from around 60 percent of total runoff in 2010 to only 30 to 40 percent of total runoff in 2100 (Figure 5.2). In the Figure, projected changes in April to July runoff for the Stanislaus River at New Melones Reservoir and the Merced River at Pohono Bridge (Gangopadhyay and Pruitt, 2011) are also provided for comparison. Projected trends are similar for each of the three rivers.

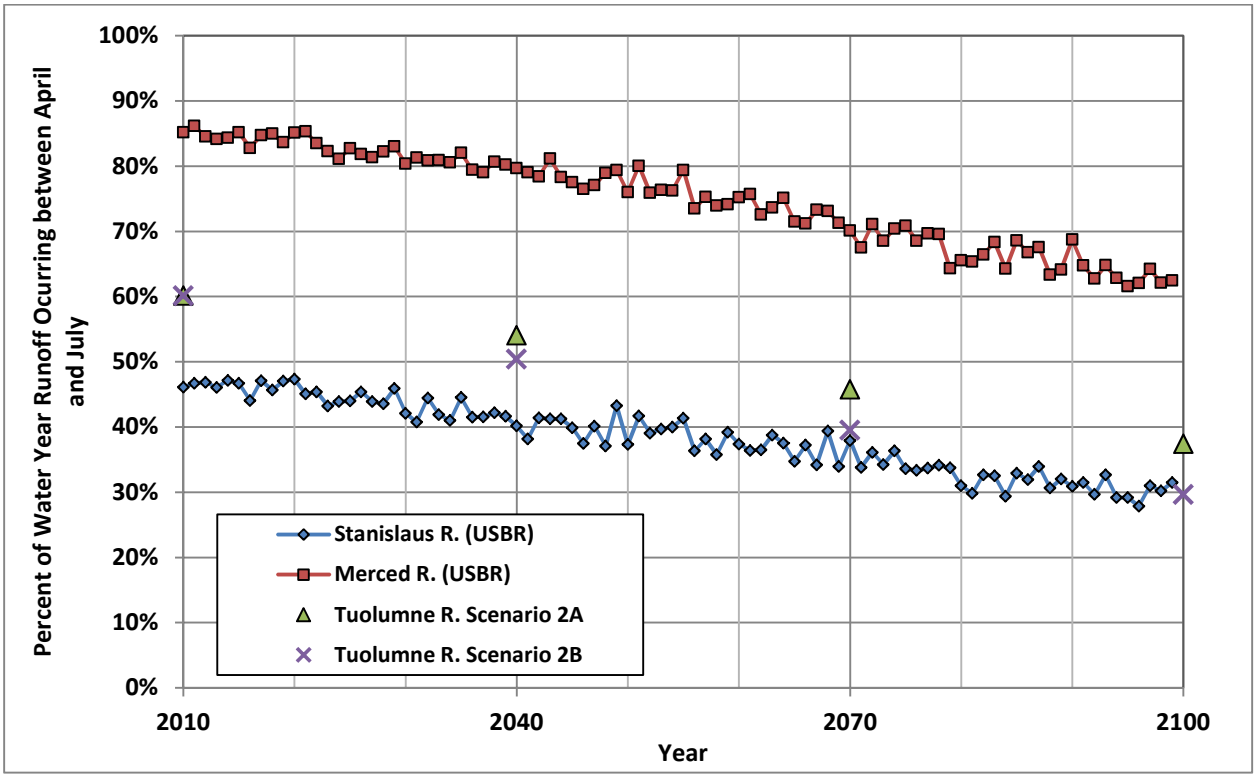

Figure 5.2. Annual April through July Unimpaired Runoff Projected for Tuolumne River Climate change Scenarios 2A and 2B (Hydrocomp et al. 2012) and Stanislaus and Merced Rivers (Gangopadhyay and Pruitt, 2011).

[11] Scenario 2A corresponds to a 6.1°F increase in mean annual temperature by 2100 as compared to 2010 with no change in mean annual precipitation. Scenario 2B corresponds to a 6.1°F increase in mean annual temperature by 2100 as compared to 2010 with a 15 inch decrease in mean annual precipitation in the watershed.

Changes in Total Runoff. Total water year runoff has not decreased substantially during the last century; however projections reported by Hydrocomp et al. (2012) and Gangopadhyay and Pruitt, (2011) suggest that total runoff could decrease over the next 100 years. The Hydrocomp et al. study provides estimates of Tuolumne River total annual runoff as a percentage of 2010 total runoff for 2040, 2070, and 2100 for the following six alternative climate change scenarios and corresponding changes in mean annual temperature and precipitation in the Tuolumne River watershed by 2100:

- 1A – low temperature increase (+3.6°F by 2100); no precipitation change
- 2A – moderate temperature increase (+6.1°F by 2100); no precipitation change
- 2B – moderate temperature increase (+6.1°F by 2100); precipitation decrease (-15 in by 2100)
- 2C – moderate temperature increase (+6.1°F by 2100); precipitation increase (+6 in by 2100)
- 3A – high temperature increase (+9.7°F by 2100); no precipitation change
- 3B – high temperature increase (+9.7°F by 2100); precipitation decrease (-15 in by 2100)

As shown in Figure 5.3, total runoff in the Tuolumne River at Don Pedro Reservoir could decrease to as little as 70 percent of the 2010 total by 2100, with a median projection that total runoff in 2100 will be approximately 87 percent of the 2010 total.

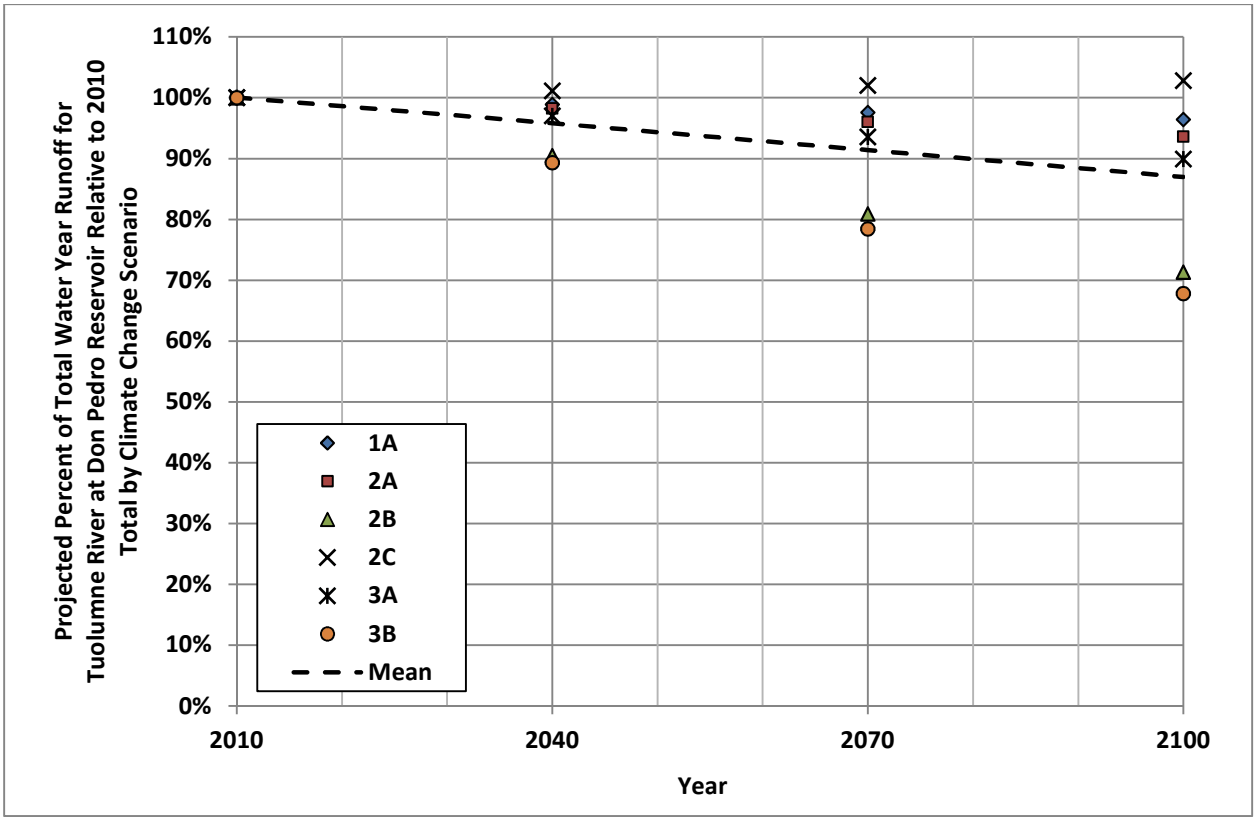

Figure 5.3. Total Projected Tuolumne River Runoff as a Percent of 2010 Runoff by Climate Change Scenario (Sources: Hydrocomp et al., 2012 and Gangopadhyay and Pruitt, 2011).

Projections of total runoff over the next century reported by USBR (2011) for the Stanislaus River to the north and in the Merced River to the south also suggest a decrease in total runoff (Figures 5.4 and 5.5). The figures show the 5th percentile, median, and 95th percentile annual runoff for 2010 to 2100 based on 112 separate hydrologic projections. The percent of total water year runoff in 2100 for the Stanislaus River and Merced River is similar to the projected decrease for the Tuolumne River.

Changes in Crop Evapotranspiration. Climate change has the potential to affect crop evapotranspiration and resulting irrigation water demands within TID. Changes in precipitation, temperature, and atmospheric CO_2 affect crop evapotranspiration (ET) and net irrigation water requirements (NIWR). GCMs have been used to project future climate change and impacts on crop water demands. In particular, the Bureau of Reclamation released a report entitled West-Wide Climate Risk Assessment: Irrigation Demand and Reservoir Evaporation Projections (WWCRA) (USBR 2015) in February 2015. The study uses climate change projections to calculate future ET and NIWR throughout the Western U.S., including California's Central Valley. Projections for the Central Valley were developed for DWR planning units used to evaluate statewide water supplies and demands as part of the California Water Plan. TID's service area falls within Planning Unit 608 (PU608), as shown in Figure 5.6. This section describes potential changes in crop ET, a climate change effect, while impacts on NIWR are described in Section 5.4, below.

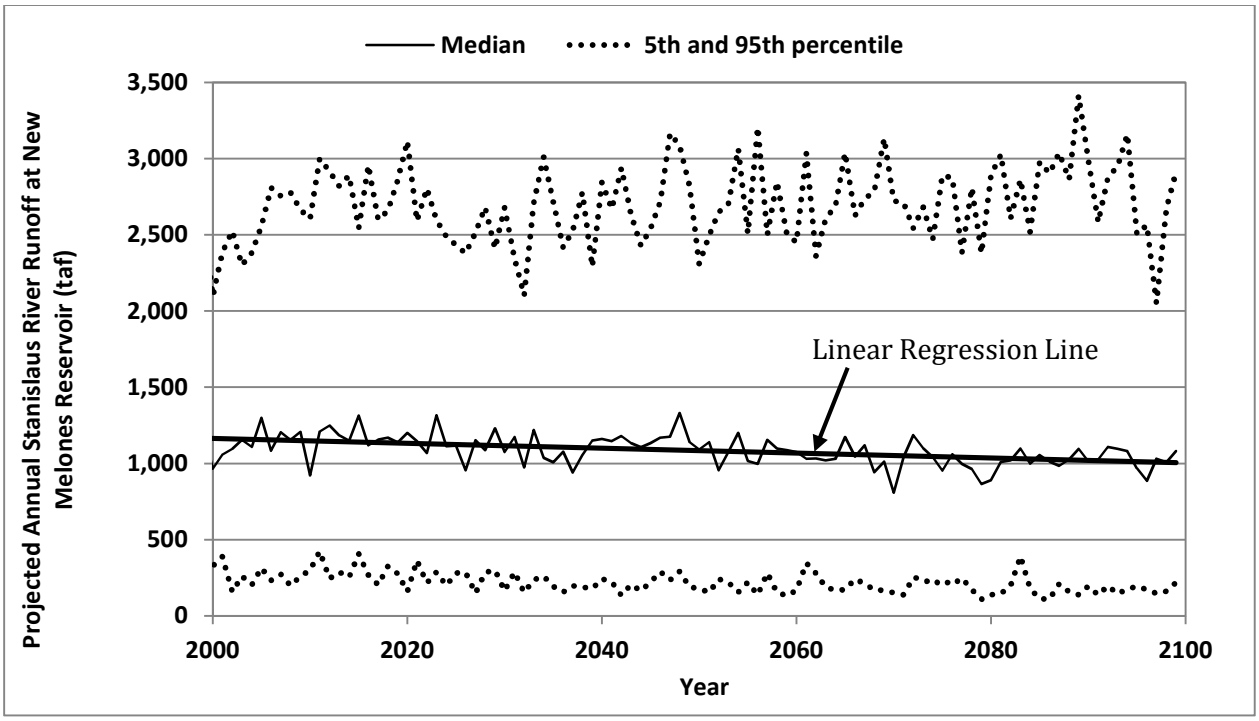

Figure 5.4. Annual Stanislaus River Runoff at New Melones Reservoir Based on 112 Hydrologic Projections (Gangopadhyay and Pruitt, 2011).

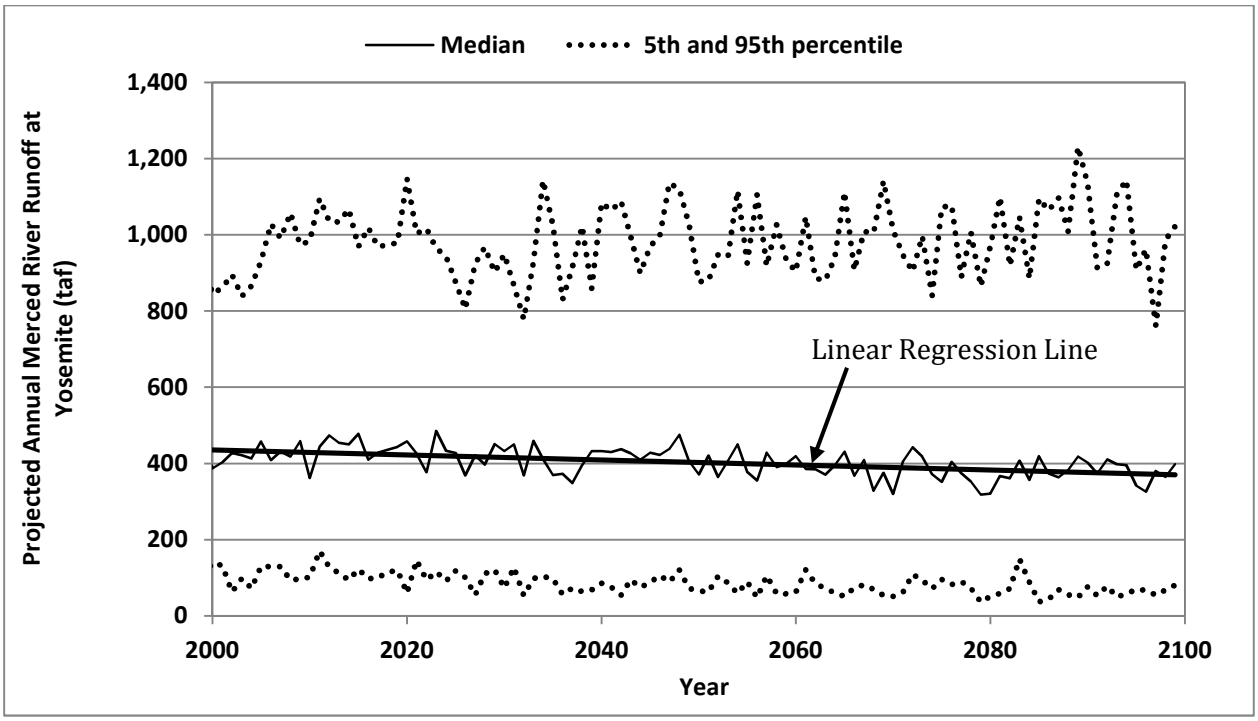

Figure 5.5. Annual Merced River Runoff at Yosemite Based on 112 Hydrologic Projections (Gangopadhyay and Pruitt, 2011).

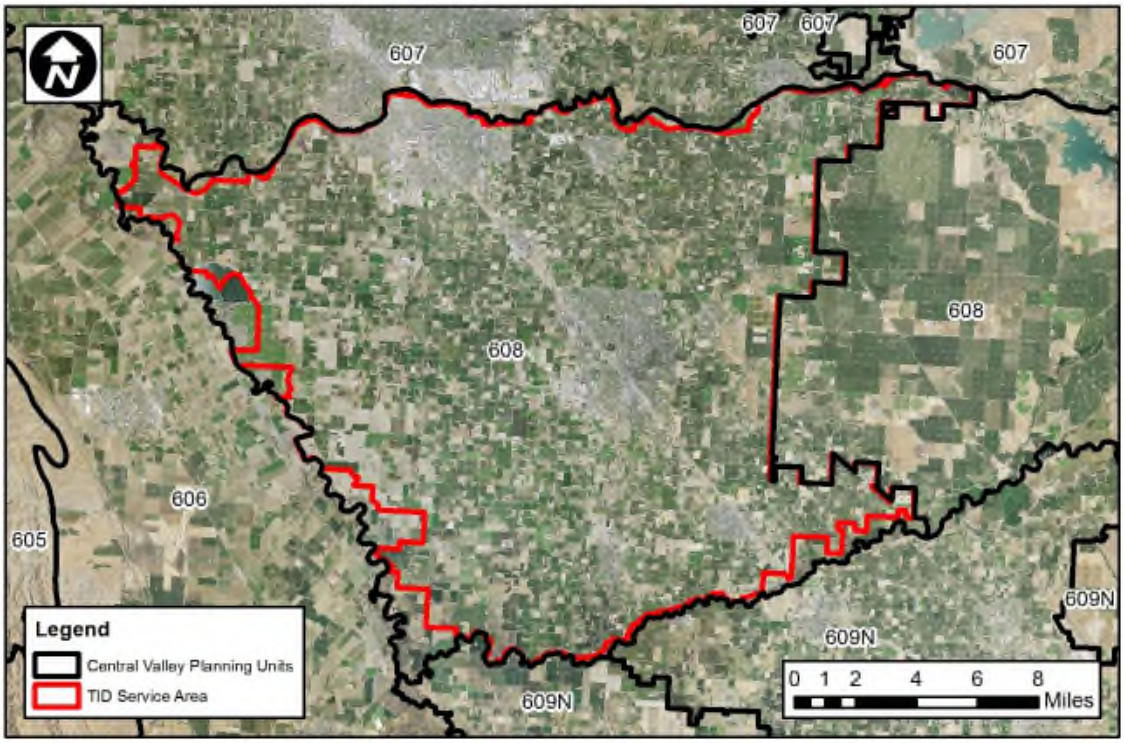

Figure 5.6. CMIP3 Planning Unit 608.

The Bureau of Reclamation's study utilizes future climate projections from GCMs to simulate crop evapotranspiration under climate change and to estimate resulting net irrigation requirements. The specific dataset selected for predicting future irrigation demands was the World Climate Research Program (WCRP) Coupled Model Intercomparison Project Phase 3 (CMIP3). Original GCM projections are developed at a spatial resolution of 100 to 250 km. In order to develop data on a usable scale to support local and regional planning, CMIP3 projections were downscaled to 12 km square sections using the statistical algorithm known as bias comparison and spatial disaggregation (BCSD). One hundred and twelve BCSD-CMIP3 projections were created based on combinations of GCM and potential future greenhouse gas emission scenarios.

Crop ET and NIWR were estimated using a model simulating crop growth and irrigation demands over time under baseline and modified climate scenarios. Specifically, the ET Demands model, a daily root zone water balance simulation applying the FAO-56 dual crop coefficient approach, was used to estimate crop ET and NIWR. Reference ET was calculated based on climate projections for each of the five modeled climate scenarios using the Food and Agricultural Organization (FAO) Report56 reference ET approach. The GCMs climatic conditions were limited to only daily maximum and minimum temperature and daily precipitation. Therefore, other climate parameters needed to estimate reference ET, such as solar radiation, humidity, and wind speed, were approximated for baseline and future time periods using empirical equations (USBR 2015). In order to evaluate potential impacts of changes in temperature on the timing of crop growth and overall season length, simulations were conducted assuming both static and dynamic crop phenology. To simulate dynamic phenology, growing degree day (GDD) based crop curves were used. By incorporating GDD into the analysis, projected changes in temperature influence the timing and speed of crop growth. Increased temperatures result in earlier, shorter growing seasons for annual crops. Crop evapotranspiration is projected to increase in areas where perennial crops are grown and smaller increases are projected for areas where annual crops are grown.

Potentially, each of the 112 climate projections could be simulated in the ET Demands model to develop projections of future ET and NIWR; however, due to the wide variety of crop types and agricultural practices in the West this would create enormous computation and data handling requirements. Instead, five different climate change scenarios were created using the ensemble hybrid formed delta method. The future conditions of warm-dry, warm-wet, hot-dry, hot-wet and central tendency were used. Three future periods for these five conditions were selected to project climate change, including the 2020's (2010-2039), 2050's (2040-2069) and 2080's (2070-2099).

Average air temperature in PU608 is projected to increase for each of the five scenarios for each future period as shown in Figure 5.7. Projected temperature increases range from 1.3 to 2.6 deg. F during the 2020's period, 2.7 to 4.5 deg. F during the 2050's period, and 3.9 to 6.9 deg. F during the 2080's period.

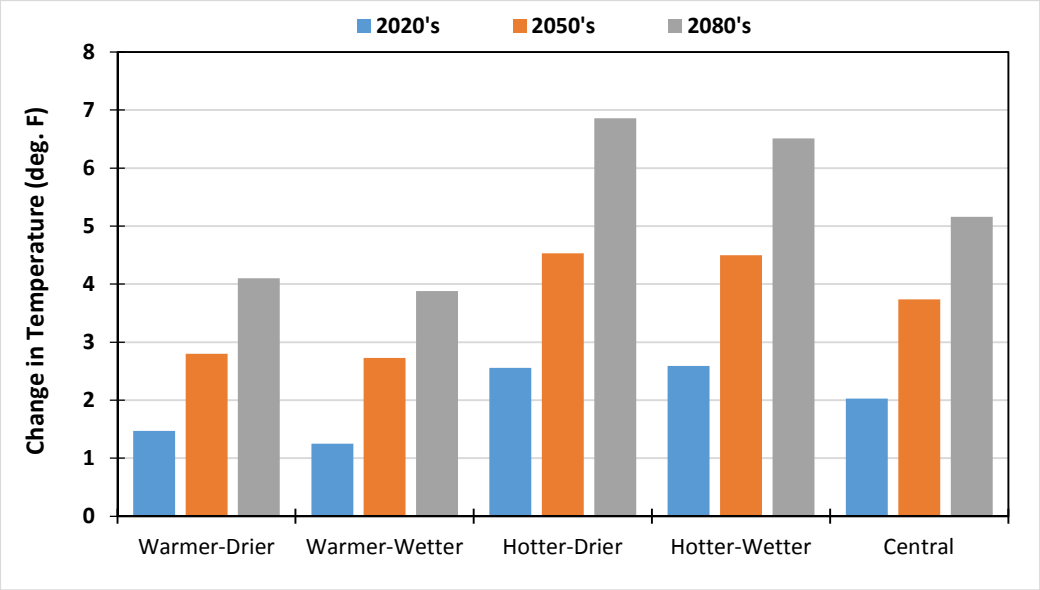

Figure 5.7. WWCRA Projected Temperature Change

Potential changes in precipitation resulting from climate change are relatively uncertain for California's Central Valley due to uncertainty in the future position of the jet stream. As a result, some GCMs and emission scenario combinations predict increased precipitation under climate change, while other combinations predict decreased precipitation. Percent changes in projected average annual precipitation for PU608 are shown in Figure 5.8. Under wetter conditions increases in precipitation of 3.8 to 10.0 percent between the 2020's and the 2080's are predicted, while under drier conditions, decreases in precipitation of 4.7 to 16.2 percent between the 2020's and the 2080's are predicted. The central tendency results in a predicted slight decrease in precipitation of 2.1 to 3.9 percent during the 2080's period.

From the projected temperature and precipitation results, WWCRA used impact models to develop projected reference ET and actual ET estimates. The results are shown below in Figures 5.9 and 5.10, respectively. Increases in both reference ET and actual ET are projected. Projected reference ET increases range from 1.77 to 3.66 percent during the 2020's period, 3.8 to 6.4 percent during the 2050's period, and 5.3 to 9.5 percent during the 2080's period. Projected actual ET increases range from 0.5 to 1.2 percent during the 2020's period, 0.9 to 1.3 percent during the 2050's period, and 0.9 to 1.2 percent during the 2080's period. Reference ET is expected to increase significantly more than actual ET due to changes in phenology of annual crops, discussed in the following paragraph.

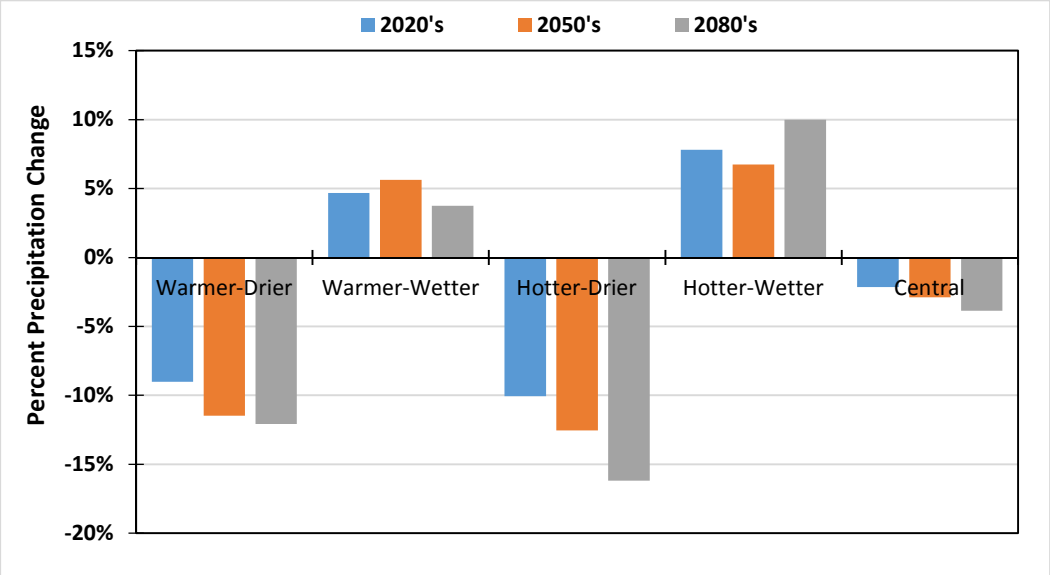

Figure 5.8. WWCRA Projected Precipitation Change.

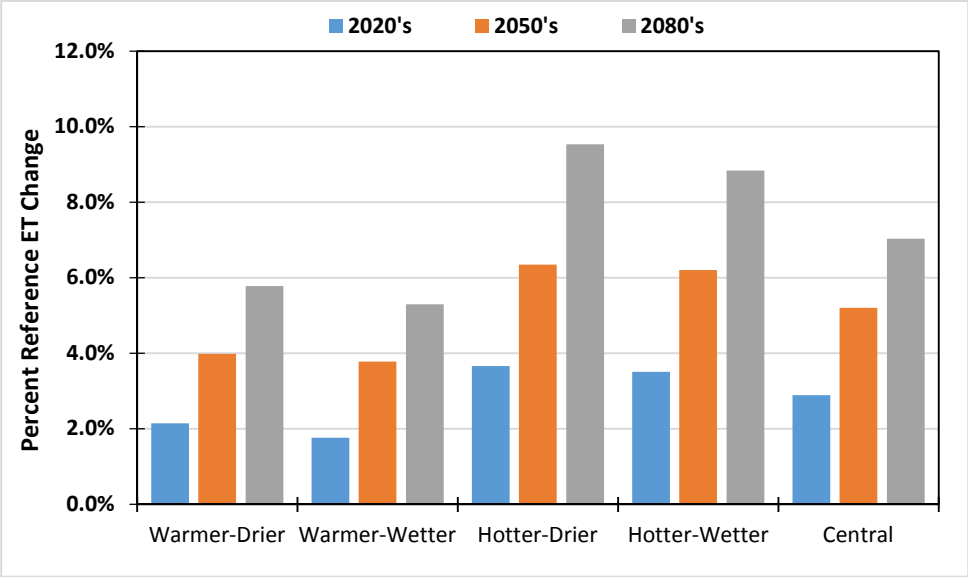

Figure 5.9. WWCRA Projected Reference ET Change.

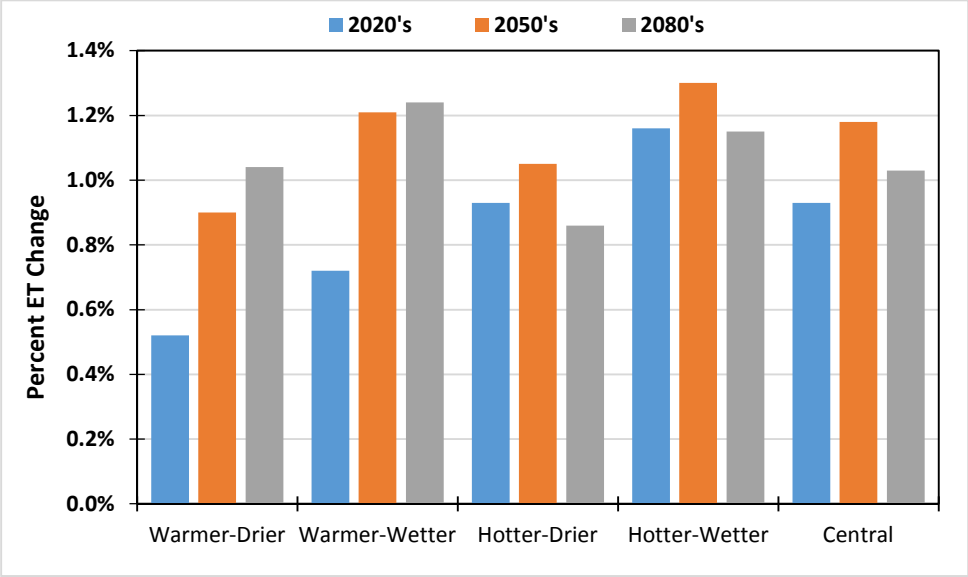

Figure 5.10. WWCRA Projected ET Change Assuming Non-Static Phenology.

Projected actual ET estimates assume non-static phenology for annual crops rather than static phenology. Non-static phenology is believed to be more accurate as plant growth depends heavily on temperature. With temperature expected to increase, crop growing seasons are expected to be shorter, which is accounted for in non-static phenology by using growing degree days. There is less projected impact on actual ET with non-static phenology than when static phenology is assumed. If static crop phenology is assumed, percent changes in actual ET would be similar to the projected changes in reference ET. Reference ET is expected to increase significantly more due to the projected temperature increases.

5.3 POTENTIAL IMPACTS ON WATER SUPPLY AND QUALITY

The shift in runoff to the winter period and projected reduction in total runoff have the potential to impact surface water supply in the future if sufficient storage is not available to retain winter runoff until it is needed to meet irrigation demands and to provide additional carryover storage from wet years to dry years.

Increased erosion and turbidity under climate change, if it occurred, would likely not significantly affect the water quality of the Tuolumne River as it affects agricultural irrigation. Additionally, there are no known contaminants that could be concentrated to levels that would affect agricultural irrigation if spring runoff were to decrease, particularly due to the dilution of such contaminants in reservoirs upstream of the District. Increased water temperature could result in additional challenges in controlling aquatic plants in TID's distribution system to maintain capacity, to the extent that the increase is great enough to result in substantially increased plant growth. Increased turbidity and algae growth, if substantial, could pose challenges to filtering canal water for micro irrigation.

According to the East Stanislaus Region Integrated Regional Water Management Plan (ESRIRWMP 2013) and other sources, climate change is expected to bring more frequent and more severe droughts in the future. With changing rainfall patterns, groundwater basins may experience less recharge in the long term. Groundwater pumping volumes are at their greatest during droughts because there is less surface water to meet water demands. This increases the difficulty of sustainably managing groundwater basins and preventing negative impacts to water quality. TID utilizes shallow groundwater wells and private and rented deep wells to supplement surface water supply. TID has developed and implemented methods to monitor and model groundwater extractions and recharge and is actively involved in groundwater management within the region to promote sustainability of the underlying groundwater basin.

5.4 POTENTIAL IMPACTS ON WATER DEMAND

The USBR publication, West-Wide Climate Risk Assessment: Irrigation Demand and Reservoir Evaporation Projections, showed crop ET is expected to increase, as discussed previously, due to effects of climate change, such as temperature increase and other climate factors (USBR 2015). NIWR is expected to increase for all climate scenarios presented in the USBR report, shown in Figure 5.11. Additionally, changes in precipitation timing and amounts could result in greater irrigation requirements to meet ET demands. Changes in the timing of crop planting, development, and harvest could also result in changes to the timing of irrigation demands during the year; all impacting the NIWR. Projected NIWR increases range from 0.7 to 2.4 percent during the 2020's period, 0.9 to 2.9 percent during the 2050's period, and 0.15 to 3.2 percent during the 2080's period. Projected NIWR are based on non-static crop phenology for annual crops.

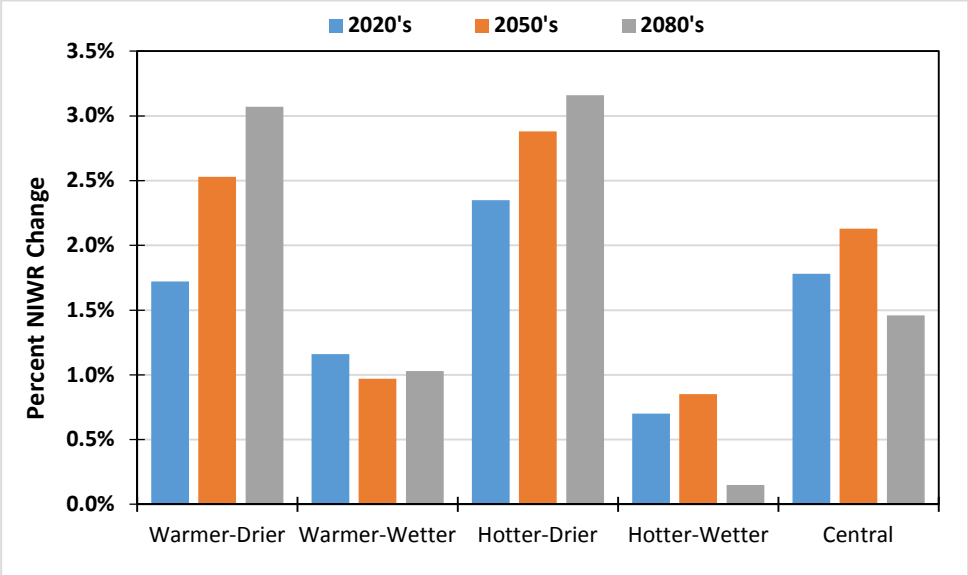

Figure 5.11. WWCRA Projected Net Irrigation Water Requirement Change Assuming Non-Static Phenology.

When interpreting results, several uncertainties must be accounted for. Estimating the effects of carbon dioxide (CO_2) on irrigation demand requires the use of physiological crop growth models and was not included in the WWCRA. In general, increased atmospheric CO_2 is expected to reduce stomatal conductance and transpiration, which would lead to reduced ET, all else equal. Changes in the types of crop grown, irrigated area, and irrigation efficiencies also affect the amount of irrigation water requirements. For further information, please refer to the West-Wide Climate Risk Assessment: Irrigation Demand and Reservoir Evaporation Projections (USBR 2015).

5.5 POTENTIAL STRATEGIES TO MITIGATE CLIMATE CHANGE IMPACTS

Although there is a growing consensus that climate change is occurring, and many scientists believe the effects of climate change are already being observed, the timing and magnitude of climate change impacts remains uncertain. The District will mitigate climate change impacts with this uncertainty in mind through an adaptive management approach in cooperation with other regional stakeholders, including municipalities within the District, neighboring irrigation districts, and other interested parties. Under adaptive management, key metrics uncertainties will be identified and monitored (e.g., April – July runoff as a percentage of annual runoff, total runoff, average temperature, and reference evapotranspiration), and strategies will be developed to address the related climate change impacts. As the impacts are observed to occur, the strategies will be prioritized, modified as needed, and implemented.

Additionally, the TID is currently developing a Water Master Plan for the District. The plan will further consider the potential impacts of climate change. The findings and recommendations from the Water Master Plan, when completed, will be incorporated into future AWMPs.

Several strategies for agricultural water providers and other water resources entities to mitigate climate change impacts have been identified (DWR 2008, CDM 2011). These strategies include those identified as part of the California Water Plan 2009 and 2013 Update (DWR 2010a and 2013) as well as strategies identified as part of the California Climate Adaptation Strategy (CNRA 2009). Many of these strategies applicable to irrigation districts are already being implemented by the District in an appropriate form and level to meet local water management objectives and will continue to serve the District well as climate change impacts occur.

Resource strategies that are being implemented or could be implemented by the District to adapt to climate change are summarized in Table 5.1.

Table 5.1. District Strategies to Mitigate Climate Change Impacts.

Source	Strategy	Status
California Water Plan (DWR 2010a and 2013)	Reduce water demand	The District is implementing all technically feasible and locally cost-effective EWMPs identified by SBx7-7 to achieve water use efficiency improvements in District operations and to encourage on-farm improvements. Additional actions to reduce water demand are considered on an ongoing basis as part of TID's water management activities.
	Improve operational efficiency and transfers	As described above and elsewhere in this AWMP, the District has and continues to implement improvements to increase operational efficiency.
	Increase water supply	The District has increased its available water supply through conjunctive management of available groundwater supplies and through reuse of drainage water. TID, in conjunction with MID, implements a cloud seeding program to maximize surface water supplies available from Tuolumne River. Additionally, irrigators within TID recycle treated municipal wastewater, reuse dairy nutrient water, and recapture drain water. In the future, the District will seek additional opportunities to increase available water supply, including increased conjunctive management through consideration of opportunities to increase groundwater recharge to increase available groundwater supply to compensate for reduced April through July runoff.
	Improve water quality	The District will continue to monitor surface water and groundwater quality as part of its active water quality monitoring program, and the coordination with monitoring programs conducted by others, including: quarterly ag suitability monitoring at Turlock Lake and spills, sampling and analysis of TID-owned and rented wells, quarterly ag suitability monitoring of subsurface drain discharges to the TID distribution system, real-time monitoring of canal and drain spill locations, analysis of water quality at various locations under the Irrigated Lands Program, and monitoring required as part of TID's use of aquatic herbicides.
	Practice resource stewardship	The District intrinsically supports the stewardship of agricultural lands within and surrounding its service area through its irrigation operations and resulting groundwater recharge. The District will participate in studies of aquatic life and habitat to better understand potential impacts of climate change.
	Improve flood management	The District is required to follow the flood management criteria established by the Army Corps of Engineers at Don Pedro Reservoir. In addition, its irrigation and drainage systems provide a passive system to collect and convey winter runoff. If runoff characteristics change substantially within the District in the future, modifications to the irrigation and/or drainage system to increase capacity or mitigate other impacts will be considered.
	Other strategies	Other strategies include crop idling, irrigated land retirement, and rainfed agriculture. Under severely reduced water supplies, growers could consider these strategies; however, it is anticipated that climate change impacts will be mitigated through the other strategies described.
California Climate Adaptation Strategy (CNRA 2009)	Aggressively increase water use efficiency	Described above under "Reduced water demand" and "Improve operational efficiency and transfers."
	Practice and promote integrated flood management	Described above under "Improve flood management."
	Enhance and sustain ecosystems	Described above under "Practice resource stewardship."
	Expand water storage and conjunctive management	Described above under "Increase water supply."
	Fix Delta water supply	Not applicable to the District.
	Preserve, upgrade, and increase monitoring, data analysis, and management	The amount of information and analysis available to support the District's water management is extensive and continues to increase substantially. For example, TID staff monitors the quantity and quality of water in the distribution system on a real-time basis to support operations and conjunctive management. Additionally, TID's water balance analysis is updated on an annual basis to inform near- and long-term water management decisions.
	Plan for and adapt to sea level rise	Projections indicate that sea levels could rise by 2 to 5 feet by 2100. Direct impacts on the District are not anticipated.

5.6 ADDITIONAL RESOURCES FOR WATER RESOURCES PLANNING FOR CLIMATE CHANGE

In addition to the study completed by Hydrocomp et al. (2012) to evaluate potential effects of climate change on the Tuolumne River watershed, much work has been done at State and regional levels to evaluate the effects and impacts of climate change and to develop strategies to manage available water resources effectively under climate change. The following list of resources provides additional information describing water resources planning for climate change:

- Sensitivity of Upper Tuolumne River Flow to Climate Change Scenarios. Hydrocomp, Inc.; San Francisco Public Utilities Commission; and Turlock Irrigation District. January 2012. (Hydrocomp et al. 2012)
- Progress on Incorporating Climate Change into Planning and Management of California's Water Resources. California Department of Water Resources Technical Memorandum. July 2006. (DWR 2006)
- Climate Change and Water. Intergovernmental Panel on Climate Change. June 2008. (IPC 2008)
- Managing An Uncertain Future: Climate Change Adaptation Strategies for California's Water. California Department of Water Resources Report. October 2008. (DWR 2008)
- 2009 California Climate Change Adaptation Strategy. California Natural Resources Agency Report to the Governor. December 2009. (CNRA 2009)
- Climate Change and Water Resources Management: A Federal Perspective. U.S. Geological Survey. (USGS 2009)
- Managing an Uncertain Future. California Water Plan Update 2009. Volume 1, Chapter 5. March 2010. (DWR 2010a)
- Managing an Uncertain Future. California Water Plan Update 2013. Volume 1, Chapter 5. 2013. (DWR 2013)
- Climate Change Characterization and Analysis in California Water Resources Planning Studies. California Department of Water Resources Final Report. December 2010. (DWR 2010b)
- Climate Change Handbook for Regional Water Planning. Prepared for U.S. Environmental Protection Agency and California Department of Water Resources by CDM. November 2011. (CDM 2011)
- Climate Action Plan—Phase 1: Greenhouse Gas Emissions Reduction Plan. California Department of Water Resources. May 2012. (DWR 2012)
- Climate Change and Integrated Regional Water Management in California: A Preliminary Assessment of Regional Perspectives. Department of Environmental Science, Policy and Management. University of California at Berkeley. June 2012. (UCB 2012)
- U.S. Bureau of Reclamation (USBR). 2015. West-Wide Climate Risk Assessments: Irrigation Demand and Reservoir Evaporation Projections. Technical Memorandum No. 86-68210-2014-01. Available at http://www.usbr.gov/watersmart/wcra/index.html. (USBR 2015)
- East Stanislaus Region Integrated Regional Water Management Plan. 2013. Available at http://www.eaststanirwm.org/. (ES IRWMP 2015)

- California Climate Adaption Planning Guide. 2012. California Natural Resources Agency. Available at http://resources.ca.gov/climate/.
- Perspectives and Guidance for Climate Change Analysis. August 2015. California Department of Water Resources Climate Change Technical Advisory Group.

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6. Efficient Water Management Practices

6.1 INTRODUCTION

This section describes the actions that TID has taken and is planning to take to accomplish improved and more efficient water management. These actions are organized with respect to the Efficient Water Management Practices (EWMPs) described in California Water Code §10608.48. The Code lists two types of EWMPs: critical EWMPs that are mandatory for all agricultural water suppliers subject to the Code and additional EWMPs that are mandatory if found to be technically feasible and locally cost effective.

The two mandatory EWMPs are measurement of the volume of water delivered to customers with sufficient accuracy for aggregate reporting and adoption of a pricing structure based at least in part on the quantity delivered. TID has implemented the delivery measurement accuracy EWMP by implementing the plan to comply with the agricultural water delivery measurement regulation California Code of Regulations (CCR) Title 23 §597 included in the 2012 AWMP. The implementation status of the corrective plan is described in Attachment F. The TID Board adopted a volumetric pricing structure in June 2012 to be implemented beginning with the 2013 irrigation season. The volumetric rate structure is described in Section 2 of this AWMP. TID has implemented and plans to continue implementing all additional (i.e., conditional) EWMPs that are technically feasible and locally cost effective. Table 6.1 describes each EWMP and summarizes TID's implementation status.

6.2 DELIVERY MEASUREMENT ACCURACY (10608.48.B(1))

STATUS: IMPLEMENTING

Sidegates[12] are the delivery points through which water is delivered from TID canals and laterals to customers. TID customers are the individual landowners (or land tenants) to whom TID delivers water, served either directly from the TID distribution system or through facilities owned by groups of landowners organized under IDs. TID measures water deliveries at the sidegate, where responsibility for water control and management is passed from TID to its customers.

TID has developed two approaches to comply with California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (23 CCR §597) consisting of: (1) the installation of 132 new permanent measurement devices that replace TID's largest existing sidegates to accurately measure deliveries to nearly 3,000 parcels comprising 49 percent of the District's service area, and (2) the development of more than 3,000 parcel-specific calibrated flow rates at the approximately 800 remaining active existing sidegates comprising the remaining 51 percent of the District's service area. Together, these approaches ensure that TID will comply with 23 CCR §597 while minimizing capital and ongoing operation and maintenance costs.

[12]"Sidegate" is the term that is used in TID for the "delivery point" defined in 23 CCR§597 as "…the location at which the agricultural water supplier transfers control of delivered water to a customer or group of customers…." (23 CCR §597.2(a)(6))

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Table 6.1. Summary of Critical and Conditional EWMPs (Water Code Sections 10608.48 b & c)

Water Code Reference No.	EWMP Description	Implementation Status	AWMP Section
Critical EWMPs – Mandatory			
10608.48.b(1)	Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement 10608.48.b(2).	Implementing	6.2
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Implementing	6.3
Additional (Conditional) EWMPs – To be Implemented if Locally Cost Effective and Technically Feasible			
10608.48.c(1)	Facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including drainage.	Not Technically Feasible	6.4.1
10608.48.c(2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils	Implementing	6.4.2
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems	Implementing	6.4.3
10608.48.c(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Implementing	6.4.4
10608.48.c(5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage	Implementing	6.4.5
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Implementing	6.4.6
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems	Implementing	6.4.7
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Implementing	6.4.8
10608.48.c(9)	Automate canal control structures	Implementing	6.4.9

Water Code Reference No.	EWMP Description	Implementation Status	AWMP Section
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation	Implementing	6.4.10
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implementing	6.4.11
10608.48.c(12)	Provide for the availability of water management services to water users.	Implementing	6.4.12
10608.48.c(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Implementing	6.4.13
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implementing	6.4.14

As of August 31, 2015, all 132 of the new permanent measurement devices have been installed along with an addition five new permanent measurement devices at branch points in large IDs. Development of parcel-specific calibrated flow rates at existing sidegates is 80% complete but could not be finished in 2015. This is because some parcels were infrequently irrigated or transferred surface water to another parcel and irrigated with groundwater in 2015 due to insufficient water supplies stemming from the ongoing drought. The corrective action plan included in the 2012 AWMP was developed based on an historic average number of irrigations per parcel per year. However, the drought has changed the timing and frequency of irrigations significantly, resulting in additional time needed to complete this work. Currently, about 1,300 parcels comprising 32,000 acres remain to be calibrated. TID plans to complete the remaining calibrations in 2016 and either implement new water ordering and delivery measurement software or modify existing software to accurately track and manage volumetric delivery data in 2017. As new devices have been installed and existing sidegates are being calibrated, TID has performed preliminary field testing to ensure that the two approaches will provide volumetric measurement accuracy that exceeds the standards of 23 CCR §597. Appendix F provides a status report on the corrective action initiated in 2013 and the plans for prompt completion of this action.

TID selected and installed 119 Rubicon SlipMeters and 18 FlumeMeters for the new permanent measurement devices (includes five FlumeMeters installed at branches in large IDs). Both of these devices use Rubicon's Sonaray measurement technology, and are laboratory certified to ±2.5 percent flow rate accuracy (Judge, 2011). Field tests in California irrigation district conditions found that the Sonaray measurement was within ±2.0 percent of a National Institute of Standards and Technology (NIST) certified magnetic flow meter (Hopkins and Johansen, 2011). TID has trained WDOs and irrigators to use the gates, and made training videos in English and Spanish available on the TID web site. A SlipMeter completely replaces an existing sidegate and will automatically adjust its opening to deliver a desired flow, hold a specified water level, or maintain a specified gate opening. FlumeMeters are installed in front of existing sidegates, so the sidegates in these cases are still manually adjusted to control delivery flow rate. Both SlipMeters and FlumeMeters send digital data to TID in real time via TID's SCADA system. The installation of new permanent flow measurement is complete.

TID is employing three techniques to develop parcel-specific flow rate calibrations at existing sidegates, depending on conditions at each sidegate. At sidegates without access vents in suitable locations for measurement, Rubicon FlumeMeters are being temporarily installed, and the continuous record of flow rate averaged to develop calibration flow rates for each parcel. When at least one delivery event has been measured for all the actively irrigating parcels served by a sidegate, the Rubicon FlumeMeter is moved to another sidegate. FlumeMeters will be used at 453 sidegates serving 1,510 parcels totaling 31,996 assessed acres, or more than 21 percent of the district. At sidegates with access vents suitably located for measurement, a Hach FH950 magnetic Velocimeter is being used for spot measurements to determine parcel-specific flow rates. Hach FH950 meters will be used at 362 sidegates serving 839 parcels totaling 21,480 assessed acres, or nearly 15 percent of the district. For parcels with pressurized on-farm systems, Fuji Portaflow meters are being used for spot measurements to determine parcel-specific flow rates. Fuji Portaflow meters will be used at 738 parcels serving 26,190 assessed acres, or nearly 18 percent of the district.

TID plans to implement a new, or modified, irrigation water ordering, delivery, and billing system by 2017. For the 132 sidegates with new devices, this system will calculate delivery volumes based on actual measured flow rates and delivery durations recorded by WDOs. Total delivery durations for multiple parcels will be confirmed by delivery durations reported by the new devices through the TID SCADA system. For existing sidegates, the new software will calculate delivery volumes based on parcel-specific calibrated flow rates and delivery durations recorded by WDOs. Additionally, the new software will have the capability to track water conveyed through a sidegate and corresponding ID pipeline to another ID, or to a different TID canal or lateral. Growers will be billed for the volume of water delivered.

Once the parcel-specific calibrations have been completed at all sidegates and the software system changes are implemented, as described above, TID will conduct a formal certification of the volumetric measurement accuracy consistent with 23 CCR §597. This is planned for 2018 or 2019 and will be reported in TID's 2020 AWMP update.

Attachment F describes TID's measurement program and the 2015 status of the process in greater detail.

6.3 VOLUMETRIC PRICING (10608.48.B(2))

STATUS: IMPLEMENTING

TID adopted a volumetric pricing structure that has been in effect since the 2013 irrigation season. The Proposition 218 process was completed and the Board adopted the current pricing structure in 2014 for implementation starting during the 2015 irrigation season. The pricing structure consists of separate tiered-pricing structures for normal and dry years and includes four water rate tiers for each year type with an increasing cost per acre-foot delivered as growers move from lower to higher tiers defined based on the amount of water delivered per acre. A fixed charge per acre is also included. A detailed description of the volumetric pricing structure is included in Section 2 of this AWMP.

6.4 ADDITIONAL CONDITIONAL EWMPS

CWC §10608.48.c requires agricultural water suppliers to implement 14 additional EWMPs "if the measures are locally cost effective and technically feasible." As part of its ongoing water management activities, TID is implementing all of these measures, except one that is not technically feasible, as described in the following sections.

6.4.1 Alternative Land Use (10608.48.c(1))

STATUS: NOT TECHNICALLY FEASIBLE

Facilitating alternative land use, as envisioned through implementation of this EWMP is not technically feasible in TID. This EWMP was designed to focus on resolving problems for lands with exceptionally high water duties or lands where irrigation contributes to significant problems. TID has neither of these conditions within the District boundaries. Furthermore, TID's rules and regulations prohibit wasteful use of water, preventing exceptional water duties or significant problems from occurring (see Section 2.8.1).

Some areas within TID require drainage to sustain maximum agricultural production. Shallow groundwater in these areas is suitable for irrigation and is used as a source of supply by TID and individual growers. Considering these factors, drainage does not pose a significant problem within TID.

Due to the factors described above, this EWMP is not technically feasible, and is not currently being implemented. If, in the future, conditions change such that this is not the case, TID will re-evaluate the EWMP implementation.

6.4.2 Recycled Water Use (10608.48.c(2))

STATUS: IMPLEMENTING

TID is implementing this EWMP by facilitating the use of available recycled water. The District accepts recycled water from municipal and industrial users within its service area into its system provided that the dischargers have the appropriate NPDES permits, and are able to meet TID specific requirements.

The City of Turlock historically discharged treated municipal wastewater to the Harding Drain. Historically, TID would supplement surface water supplies in Lateral 5½ with water pumped from the Harding Drain. Due to the effluent discharges to the drain, the Regional Water Quality Control Board established regulatory restrictions and extensive reporting requirements for the reuse of any water taken from the Harding Drain, making it impractical for TID to recover spillage from the drain. As a result, TID discontinued the practice for a time. In 2006, the City of Turlock began putting their wastewater through a tertiary treatment process which removed the restrictions on reuse. TID resumed the reuse of Harding Drain water in July of 2008, pumping a blend of recovered spillage and recycled M&I water from the Harding Drain totaling 1,370 acre-feet between July and October of that year. The City of Turlock ceased discharge of treated municipal wastewater to Harding Drain at the end of 2014. From 2010 to 2014, TID reused an average of 2,610 acre-feet per year from the Harding Drain.

For 20 years, the City of Modesto, Hilmar Cheese, and City of Turlock have provided treated wastewater to irrigated lands within the TID service area, averaging 5,000 acre-feet over the last five years as described in Section 4 of this AWMP. Additionally, TID facilitates the reuse of dairy nutrient water by Improvement Districts. TID continues to work with the cities within its service area to gain access to recycled water for agricultural needs. For instance, a recent agreement between the City of Turlock and TID will provide 2,000 AF of recycled water for agricultural uses.

TID endeavors to use recycled wastewater where possible to meet non-irrigation needs as well. In May 2010, TID converted the water source for its cooling towers at the Walnut Energy Center in Turlock to tertiary treated wastewater effluent from the City of Turlock. Since that time, TID has used approximately 1,000 AF per year of effluent, reducing TID's non-irrigation pumping needs by an equivalent amount.

TID has been implementing and will continue to implement locally cost effective and technically feasible practices consistent with this EWMP. In the future, TID will continue to identify and evaluate opportunities for use of recycled water that conform to regulatory and agronomic water quality standards and resource requirements.

6.4.3 Capital Improvements for On-Farm Irrigation Systems (10608.48.c(3))

STATUS: IMPLEMENTING

TID is implementing the EWMP to facilitate capital improvements for on-farm irrigation systems through a variety of programs described below.

TID has an active financing program to support on-farm capital improvements of irrigation facilities through the formation of new Improvement Districts (IDs), and on-going maintenance and support of existing IDs. Improvement Districts are formed by groups of growers to build, operate and maintain on-farm water distribution systems, subsurface drain systems, deep wells, and micro irrigation systems. There are currently 1,043 IDs that deliver water from the TID canals and laterals to individual growers. IDs own approximately 700 miles of lined irrigation delivery ditches and pipelines, serving 128,400 acres within TID (92% of TID irrigated lands).

TID provides low interest financing, engineering design, and installation oversight for these facilities. In addition, TID provides at-cost maintenance and repair to ID facilities. Financial assistance is further provided to each ID on a short-term basis through TID's assessment process. Maintenance, electrical charges, and repairs for the year are carried by TID interest-free and billed to ID members in November of each year. ID members have the option of paying the assessment in two installments with no interest or penalties. For very large assessments, TID will work with an ID to establish a multiple-year assessment that distributes the costs over a longer period. Multiple-year assessments are also interest-free and typically last two to three years.

TID also seeks out grant funding to assist its growers with on-farm improvements. In 2002, TID was awarded a Proposition 13 grant to provide financial assistance to growers to install positive shutoff devices on field drains. Between 2004 and 2006 this program provided cost-sharing for the installation of 125 positive shutoff structures and removal of 152 field drains that were no longer required. In total, the grant provided direct financial assistance to growers of approximately $121,500. TID will continue to evaluate future external funding opportunities to assist growers with on-farm irrigation improvements.

TID has hired an assistant engineer whose primary work assignment is to provide on-farm technical support and design assistance to TID customers. Services include support of micro/drip conversion and on-farm reservoir sizing.

TID has been implementing and will continue to implement this EWMP. In the future, TID will continue to identify and evaluate opportunities to facilitate financial assistance for on-farm capital improvements.

6.4.4 Incentive Pricing Structures (10608.48.c(4))

STATUS: IMPLEMENTING

TID is implementing this EWMP by implementing a pricing structure that promotes the following goals identified in the CWC:

1. More efficient water use at the farm level
2. Conjunctive use of groundwater

3. Increase groundwater recharge
4. Reduction in problem drainage
5. Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.

By implementing a tiered pricing structure with water rates per acre-foot delivered increasing with each tier purchased, TID promotes efficient water use at the farm level (goal 1, above) while also discouraging excessive or "problem" drainage (goal 4, above).

TID's pricing structure also promotes conjunctive use of groundwater and appropriate increases in groundwater recharge (goals 2 and 3, above) as part of the District's overall conjunctive management strategy through the following mechanisms:

- Encouraging the use of available surface water supplies and groundwater recharge by keeping surface water rates low relative to the cost of groundwater pumping,
- Encouraging conservation of limited surface water supplies in dry years by increasing the cost per acre-foot delivered, and
- Implementing the dry year rate structure, enables the District to generate additional revenue to pay for increased groundwater pumping in dry years.

TID's pricing structure promotes effective management of all water sources throughout each year by adjusting its pricing structure in dry years as compared to normal years. TID's pricing structure is described in greater detail in Section 2 of this AWMP.

TID has been implementing and will continue to implement this EWMP. In the future, TID will periodically review the volumetric pricing structure and rates with respect to TID's water management objectives.

6.4.5 Lining or Piping of Distribution System and Construction of Regulating Reservoirs (10608.48.c(5))

STATUS: IMPLEMENTING

TID has implemented this EWMP through: lining or pipeline conversion of 90 percent of its conveyance and distribution system; maintaining the canal lining through its canal lining maintenance program; supporting Improvement Districts in their effort to maintain and improve ID owned water conveyance facilities; and evaluating the installation of and, when locally cost effective, or deemed necessary for other reasons, such as improved customer service, installing regulating reservoirs along its distribution system.

TID's conveyance and distribution system (includes Upper Main Canal from La Grange to Turlock Lake) consists of approximately 230 miles of canals, of which 207 miles are fully or partially lined (90%). Within the irrigation service area, TID has lined or piped 204 miles of the 222 miles of conveyance and distribution facilities. In total, 204 miles (92%) of TID's distribution system below Turlock Lake are fully or partially lined, with only 18 miles of unlined canals. The remaining areas of unlined canals are primarily in upland clay soils with low seepage rates. The relatively small volume of seepage from the remaining unlined and partially lined canals provides beneficial groundwater recharge as they occur near the area to the east of TID where groundwater levels have steadily declined (see Section 3.2.1).

Even though most of the conveyance and distribution system is lined and total losses from the TID distribution system are low, TID implemented a canal lining project in 2006 that continued into 2008. Reducing seepage was an incidental benefit as the main purpose of this project was to reduce maintenance requirements by preventing erosion, improving the hydraulic efficiency, and reducing aquatic weed growth. TID installed approximately 4.5 miles of full or partial canal lining between 2006 and 2008. In 2014, TID converted the Lower Stevinson Flume to a pipeline. Additionally, in developed areas, Lateral 1 has been converted to a pipeline.

An effective lining maintenance program is necessary to prevent seepage losses from increasing due to cracks as the concrete lining ages. TID has an active canal lining maintenance program to maintain the effectiveness of the concrete lining. TID inspects canal lining on a regular basis and rates the lining condition by canal reach. Each year, lining condition and reach ratings are reviewed and reaches selected for resurfacing with gunite primarily based on the reach condition. From 2010 to 2014, TID has resurfaced on average approximately 5 miles of canal lining each year. From time to time, TID conducts ponding tests to quantify seepage rates in lined reaches to better understand the relationship between the subjective canal reach rating system, underlying soils and seepage. This understanding improved the reach resurfacing selection process and lining maintenance program. This program helps maintain hydraulic efficiency, prevent canal failure, and reduce seepage from the lined portions of the distribution system.

A substantial portion of the 700 miles of Improvement District conveyance facilities have been replaced by pipeline systems. Aging or leaking pipelines are actively maintained and are replaced as necessary. TID provides low interest loans for these improvements.

In addition to canal lining and pipeline conversion, TID evaluated the construction of regulating reservoirs in 2010 in anticipation of updating its AWMP. Specifically, reservoirs on the Ceres Main Canal at the headings of Lower Lateral 3 and Lower Lateral 4 were evaluated. The reservoirs were evaluated as part of a phased project aimed at providing increased monitoring and control of the distribution system along with regulating storage to facilitate increased flexibility to growers and spillage reduction. Ultimately, the evaluation of the project resulted in a benefit-cost ratio of 0.23, denoting that local project benefits would provide only about one quarter of the cost required to implement the project. Relative costs and projected benefits have not changed substantially, resulting in the project remaining not locally cost-effective at the current time. Despite this, the TID is tentatively planning to move forward with a regulating reservoir along the Ceres Main and has included it in the draft capital planning budget for 2016. TID will continue to consider other opportunities in the future. TID's current effort to develop a Water Master Plan will help to focus those efforts.

During the 2014-2015 winter season, TID constructed a regulating reservoir, referred to as the Lateral 8 Reservoir. The reservoir with 29 acre-feet of storage began operations in 2015. The reservoir is located such that water that would have spilled at the Highline or Lateral 8 Spill can be routed to the new reservoir. TID is planning to expand the storage capacity to 135 acre-feet.

TID has implemented this EWMP by lining and maintaining the majority of its facilities and assisting IDs in doing the same. TID will continue these efforts in the future. Additionally, TID will continue to consider the construction of regulating reservoirs to increase distribution system flexibility and reduce operational spillage.

6.4.6 Increased Flexibility to Water Users (10608.48.c(6))

STATUS: IMPLEMENTING

TID is implementing this EWMP by providing arranged-frequency demand delivery allowing for a wide range of flexibility in the frequency and duration of irrigation deliveries to its customers.

TID has been a pioneer in implementing increased flexibility for water users. TID has implemented an arranged-frequency demand ordering and delivery system where the frequency and duration of delivery are highly flexible, and the rate of flow is standardized based on capacities of distribution system and improvement district facilities. The mean time between the Call Center receiving a grower's call and the start of the requested delivery is 50 hours, or about 2 days.

Additionally, prior to the start of the 2008 irrigation season, TID moved its Central Call Center to the Customer Service Department to provide an increased level of customer service in taking water orders. In 2014, TID implemented online ordering and made water use information available online to growers. Growers can plan and manage water use on each parcel by requesting a copy of their water use records when placing a water order or at any other time of the year. At the end of each irrigation season, growers are also mailed a water use statement that details the number of irrigations, the amount of water applied during each irrigation, and total water use for the season. Additionally, TID provides customers with access to real time monitoring of Rubicon SlipMeters and permanent FlumeGates.

Distribution system improvements and careful operation of the distribution system by TID allows growers adjacent to TID canals and laterals and on some improvement district pipelines to have non-standard heads of water for micro irrigation systems. Over time, TID continues to work to accommodate growers who have converted their fields to micro irrigation. Real time SCADA monitoring of distribution system flows, water levels, and spillage by Water Distribution Operators (WDOs) in recent years has allowed TID to improve flexibility to water users while maintaining distribution system efficiency. In 2014, TID provided tablets to all WDOs and provided realtime access to over 340 SCADA sites including Rubicon SlipMeters and permanent FlumeGates. Intermediate system flows at several locations are monitored to better meet customer demands and prevent operational spillage.

To improve customer service on Lateral 8, TID constructed a regulating reservoir, referred to as the Lateral 8 Reservoir, during the 2014-2015 winter season. The reservoir with 29 acre-feet of storage began operations in 2015. The reservoir is located such that water that would have spilled at the Highline or Lateral 8 Spill can be routed to the new reservoir. The reservoir has been so successful that TID is planning to expand the storage capacity to 135 acre-feet. TID has implemented numerous measures to increase flexibility in water ordering by, and delivery to, water users within operational limits, and will continue to implement locally cost effective improvements consistent with this EWMP in the future.

6.4.7 Supplier Spill and Tailwater Recovery Systems (10608.48.c(7))

STATUS: IMPLEMENTING

TID is implementing this EWMP through the interception of spillage from its upper laterals via the Ceres Main Canal, which can then be delivered to lower laterals to meet irrigation demands; through spillage recovery from the Harding Drain; through real time monitoring distribution system spills; and through operation of drainage wells and rented wells to provide a localized source of supply and reduce spillage.

The majority of lands in TID receiving surface water are irrigated with basin check systems that produce no tailwater. Some tailwater is generated on the heavier soils of the northeastern portion of TID. The majority of growers in this area have control structures to prevent irrigation tailwater from flowing back into the distribution system. A small quantity of tailwater generated in the irrigation service area is intercepted by agricultural drains that flow into the distribution system. This water is blended with the water in the canals and delivered as irrigation water to the greatest extent possible. A survey of lands indicates that tailwater generated on approximately 2,700 acres (less than 2% of TID lands) ultimately enters the distribution system. An additional 8,200 acres in TID can also produce tailwater, but this water does not enter the TID distribution system. Tailwater not entering the distribution system is available for recovery and reuse by growers within and outside of TID. TID also recovers and reuses tilewater that enters the District's distribution system.

The Ceres Main Canal intercepts spillage from upper laterals 2 through 4 (see the District map in Appendix D). Intercepted spillage is then used as a source of supply to help meet irrigation demands in lower laterals west of the canal. In 2011, approximately 15,000 AF of spillage was intercepted by the Ceres Main Canal.

Additionally, some long improvement district pipelines were designed and constructed so they terminate at a TID canal in order to recover undelivered irrigation water where it can be used for irrigation delivery downstream. This undelivered water originates from fill up and run down water, or when growers choose to not take a delivery. The volume of water that is recovered in this manner has not been quantified independently due to its intermittent nature, but is reflected in the water balance closure to determine deliveries to farms.

As described previously in Section 6.4.2, TID resumed the reuse of Harding Drain water in July of 2008, pumping a blend of recovered spillage and recycled M&I water from the Harding Drain totaling 1,370 acre-feet between July and October of that year. From 2010 to 2014, TID reused an average of 2,600 acre-feet per year from the Harding Drain. There are also several private, grower-operated systems that recover a mixture of drainage water and operational spills to meet irrigation demands. The extent to which this occurs is not quantified as it occurs downstream of the distribution system and outside of the water balance area.

TID has completed installation of SCADA monitoring equipment at its spillage sites. In 2010 TID began upgrading the pressure transducers originally installed with the SCADA equipment to improve calibration. All SCADA flow measurement sites have recently been upgraded with float-operated sensors to improve measurement accuracy.

As of August of 2015, the District has 342 SCADA sites that transmit to five master radios located at electrical substations. The serial data is collected at these two sites and transmitted over a fiber optic network to TID's SCADA system. The District has largely accomplished the three main goals of its master SCADA plan:

- Maintain and upgrade the SCADA system to meet current and future needs.
- Create a centralized repository for water records and increase accessibility to SCADA data.
- Expand SCADA capabilities to incorporate cost effective water operations and water delivery efficiency improvements.

TID is implementing the master SCADA plan, with recent upgrades resulting in mobile access to data, remote operation and monitoring of irrigation control structures, and improved system redundancy. Although much is done, the master plan will continue to be updated, and is expected to continue to provide a road map for the next 5-10 years.

TID provided WDOs with smart phones and tablets to monitor the distribution system in real time at spillage sites and over 340 SCADA sites to enhance operational flexibility while reducing spillage, including realtime monitoring of Rubicon SlipMeters and permanent FlumeGates.

The use of extensive pumping in the western portion of TID allows WDOs to tightly control the bottom end of the distribution system in response to irrigation demand. Under this operating regime, operational spills are reduced from what would otherwise occur if diversions from Turlock Lake were used exclusively to satisfy irrigation demands low in the system. This is because long travel times from Turlock Lake make it challenging to respond to changing irrigation demands in the lower parts of the system while keeping operational spills low. This operational strategy is enhanced in dry years due to the operation of additional pumps, resulting in even less spillage. By adding the capability to remotely operate the drainage pumps through the SCADA system, the SCADA system facilitates improved customer service and spillage controls while maximizing the efficient use of pump water. The WDOs can turn pumps on and off from their portable tablets, allowing them to respond much more quickly to changes in canal flows, and helping to further reduce spills.

During the 2014-2015 winter season, TID constructed a regulating reservoir, referred to as the Lateral 8 Reservoir, as part of a pilot installation of Total Channel Control (TCC) on Lateral 8. The reservoir with 29 acre-feet of storage and the TCC on Lateral 8 began operations in 2015. The reservoir is located such that water that would have spilled at the Highline Spill can be routed to the new reservoir. With TCC on Lateral 8, TID is better able to match supply and demand, and thus provide better service with increased flexibility to customers on Lateral 8 while simultaneously reducing spillage from Lateral 8. TID is planning to expand the storage capacity to 135 acre-feet.

TID has implemented and continues to operate spillage recovery, including spillage prevention measures at levels that are locally cost effective. TID has also studied regulating reservoirs as an approach to spillage prevention and recovery. To that end, TID is currently considering the purchase of 7 acres at the end of Lower Lateral 2 which would enable a future reservoir and pump back system. TID will continue to evaluate the cost effectiveness of spillage and tailwater reduction opportunities in the future.

6.4.8 Increase Planned Conjunctive Use (10608.48.c(8))

STATUS: IMPLEMENTING

The District is implementing increased planned conjunctive use through a combination of actions as part of the District's overall strategy for the conjunctive management of surface water and groundwater supplies. TID's conjunctive management objectives include: 1) maintaining water deliveries in dry years through increased groundwater pumping and 2) maintaining a sustainable groundwater system through continued use of surface water in normal and wet years. Key components of TID's conjunctive management program include the following:

- Operation of over 100 drainage wells to increase water supply and reduce spillage in the western service area;
- Rental wells to supplement available surface water supply, with an increase in the number of rented wells (up to 100 or more privately-owned wells) in dry years;
- Pricing to promote use of available surface water supplies;
- Pricing to promote conservation of limited surface water supplies in dry years;
- Pricing to provide revenue to operate drainage and rental wells required to pump additional groundwater in dry years;
- Direct and in-lieu recharge through surplus water sales to adjacent agricultural lands east of TID's irrigation service area;
- Use of treated wastewater for cooling at the Walnut Energy Center as a substitute for groundwater;
- Active participation in local groundwater management efforts; including the Turlock Groundwater Basin Association (TGBA) and the Sustainable Groundwater Management Act (SGMA);
- Adoption of a revised Groundwater Management Plan in March 2008;
- Partnership with the Eastside Water District for groundwater recharge projects;
- Implementation of groundwater monitoring as part of SBx7-6 (California Statewide Groundwater Elevation Monitoring or CASGEM); and
- Development of sophisticated groundwater and surface water models used as planning tools to aid conjunctive management, including a semi-automated water balance documenting surface water and groundwater use within the irrigation service area.

On average, groundwater makes up 15 percent of the TID water supply in normal water supply years. This compares to 22 percent of the TID water supply in dry years. As a result, the use and recharge of groundwater supplies are an essential part of TID's water management program.

Key components of TID's conjunctive management practices are described throughout this AWMP and have not been restated in detail within this section. TID has a long history of leadership and optimization of conjunctive management; the planned and coordinated use and monitoring of surface water and groundwater supplies to meet defined objectives. The objective of TID's conjunctive management is to provide a reliable long-term water supply to growers in both normal and dry years. TID has implemented numerous locally cost effective conjunctive management actions and will continue to evaluate and implement locally cost effective actions consistent with this EWMP in the future.

6.4.9 Automate Canal Control Structures (10608.48.c(9))

STATUS: IMPLEMENTING

TID is implementing this EWMP by: installing, operating, and maintaining more than 330 canal control structures that automatically control canal water levels or flows based on operator targets; monitoring 342 SCADA sites in real time; and ensuring that all structure modifications allow for future automation.

TID has utilized automated canal control structures for one hundred years or more. In particular, the District's 70 "Meikle"[13] automatic gates, a type of hydraulic automatic gate believed to be unique to TID, provide water level control at lateral headings and check structures throughout the distribution system (Scobey, 1914) (Figures 6.1 and 6.2). The gates provide excellent water level control across a range of flows and require no external power.

Another "passive" structure utilized by TID to provide automatic control of canal water levels across a wide range of flows is the long crested weir. TID operates 229 long crested weirs throughout its distribution system. The simplest form of water level control, the long crested weir typically consists simply of a triangular or rectangular weir (when viewed from above) that sits within the canal channel. Because of the relatively long crest over which water flows, relatively large fluctuations in flows over the weir result in relatively small fluctuations in the canal water level upstream of the weir. This allows for steady delivery of water to irrigation gates or lateral headings upstream of the weir.

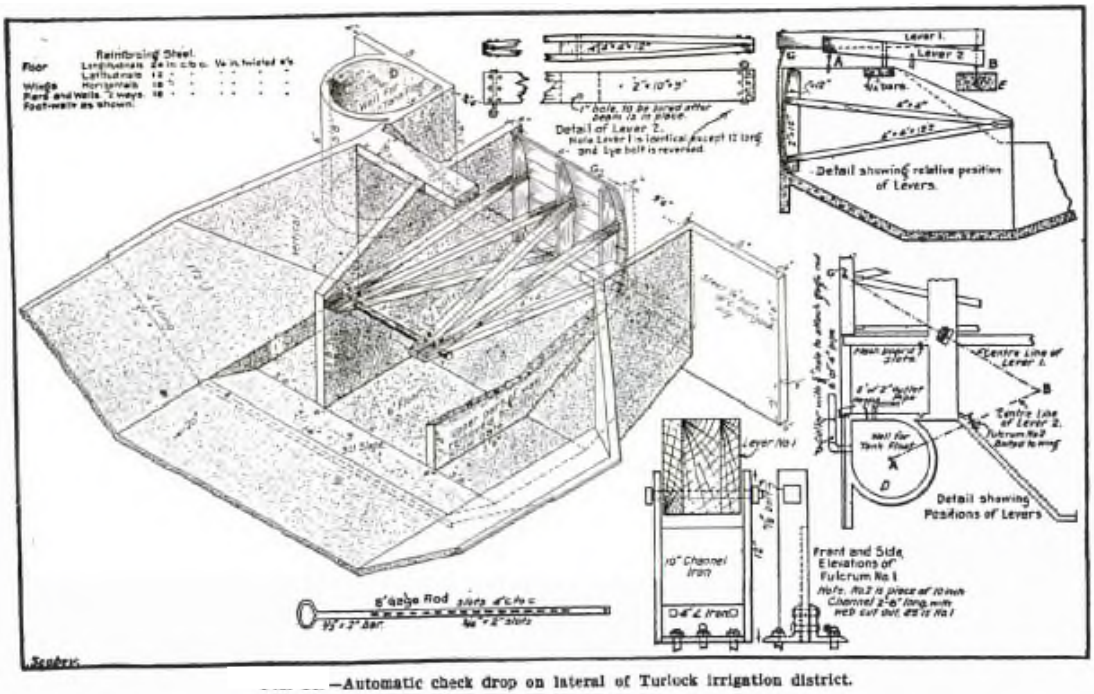
Flap gates developed by the Irrigation Training and Research Center (ITRC) at Cal Poly San Luis Obispo as a modified version of the Begemann gate are also used at 18 locations within TID's distribution system. The flap gate provides automated water level control, serving the same function as a Meikle gate or a long crested weir, but can be built and installed generally at a lesser cost. A disadvantage is that the flap gate requires a relatively large drop in water level across the control structure, limiting their applicability at many sites.

In addition to the automatic control structures described above, TID operates 18 permanent and 50 moveable Rubicon FlumeGates™. These gates are primarily for delivery measurement. One hundred and nineteen Rubicon SlipMeters™ have also been installed to provide automated flow control and improved measurement accuracy for irrigation deliveries. These gates also report water levels through the SCADA system that are available to WDOs on their tablets, providing intermediate canal water level measurement sites where these gates are located throughout the system.

[13] Named for Mr. Roy V. Meikle, who served the Turlock Irrigation District as chief engineer for over 50 years, beginning in 1912.

-AUTOMATIC CHECK GATE, TURLOCK IRRIGATION DISTRICT, CALIFORNIA.

Figure 6.1. Photo of Meikle Automatic Gate (Source: Scobey, 1914).



—Automatic check drop on lateral of Turlock irrigation district.

Figure 6.2. Schematic of Meikle Automatic Gate (Source: Scobey, 1914).

TID has provided drainage pump remote operation to WDOs. With their portable tablets, WDOs can turn drainage pumps off and on from a remote location.

In addition to the various automated structures used to operate the distribution system, TID has modernized its operations through the installation of 342 sites for real time water level and flow monitoring to support optimal operation of the system by WDOs. By providing real time information to the WDOs, more precise, timely decisions can be made to perform adjustments to gates and control structures, as needed. As described in Section 6.4.7, TID plans to upgrade and expand its SCADA and automation opportunities in the future and has developed and is following a SCADA master plan.

TID implements an ongoing maintenance program, designed to ensure these automatic structures continue to operate effectively throughout the irrigation season. Canal inspections and coordination with WDOs and other field crews identify maintenance issues and expedite speedy repairs to ensure the facilities continue to operate as designed, to provide the on-going, reliable water level control and operation.

During the 2014-2015 winter season, TID constructed a regulating reservoir, referred to as the Lateral 8 Reservoir, along with pilot installation of TCC on Lateral 8. The 29 acre-feet reservoir and the TCC system began operations in 2015. The reservoir is located such that water that would have spilled at the Highline Spill can be routed to the new reservoir. With TCC on Lateral 8, TID is better able to match supply and demand, and thus provide better service with increased flexibility to customers on Lateral 8 while simultaneously reducing spillage from Lateral 8. TID is planning to expand the regulating reservoir to a capacity of 135 acre-feet prior to the 2016 irrigation season.

TID has implemented and continues to operate the distribution system using automatic control of water levels and flows and real time monitoring by WDOs. TID will continue to study regulating reservoirs and other modernization improvements to improve distribution system operation to improve flexibility while maintaining distribution system efficiency and will implement those improvements that prove cost effective. TID will continue to evaluate the cost effectiveness of canal automation and other modernization opportunities in the future.

6.4.10 Facilitate Customer Pump Testing (10608.48.c(10))

STATUS: IMPLEMENTING

TID is implementing this EWMP by conducting a pump testing program that includes providing testing services for private pumps throughout its irrigation and electrical service areas.

As part of the pump testing program, TID trained employees in pump testing methods in 2014. Improvement district and other private pumps are generally tested once per year when they are rented by TID or upon request by the owner. The electrical service area includes approximately 40,000 additional cropped acres east of the irrigation service area that are irrigated almost exclusively with groundwater. Pump testing for this area is available through TID's electric department.

TID has obtained five additional portable Fuji flow meters for use with pressurized pipe. These five meters can be used to test customer wells on request. Two staff members are available for water level testing and 12 WDOs are available for flow testing.

TID will continue to implement this program in the future and continue to evaluate locally cost-effective opportunities to expand the program as part of the district's overall management of water and electrical resources.

6.4.11 Designate Water Conservation Coordinator (10608.48.c(11))

STATUS: IMPLEMENTING

TID is implementing this EWMP by continuing to have a designated Water Conservation Coordinator (to develop and implement the AWMP and encourage continued evaluation of efficient water management practices). This position was established in June 1997 and is currently filled by the District's Water Planning Department Manager.

6.4.12 Provide for Availability of Water Management Services (10608.48.c(12))

STATUS: IMPLEMENTING

TID is implementing this EWMP through a variety of actions. These actions are summarized in the following table (Table 6.2).

The link to CIMIS on the District's website is shown in Figure 6.3. The District also provides links to additional weather information including precipitation forecasts on a Weather page on the TID web site (Figure 6.4). Real time flows and storage for six surface water sites provided on TID website, as shown in Figure 6.5. A sample of the front page of "The Grower," TID's irrigation newsletter, is shown in Figure 6.6.

6.4.1 Evaluate Supplier Policies to Allow More Flexible Deliveries and Storage (10608.48.c(13))

STATUS: IMPLEMENTING

TID is implementing this EWMP through ongoing cooperation with Modesto Irrigation District, which co-owns Don Pedro Reservoir and by working with agencies that affect the flexibility with which TID can store and deliver water including the Federal Energy Regulatory Commission (FERC) and the Army Corps of Engineers.

TID coordinates with other agencies and entities in a variety of ways. For example, TID coordinates water releases in the Tuolumne River for fishery and other purposes with the Modesto Irrigation District and the City & County of San Francisco. TID is also coordinating with the SRWA to evaluate the feasibility of using surface water from the Tuolumne River in conjunction with existing groundwater supplies to satisfy municipal and industrial water demand within the communities of Ceres, Turlock and south Modesto. A recent Water Sales Agreement completed in July 2015 between the SRWA and the TID represents a significant step forward in this process.

Table 6.2. Summary of Water Management Services Provided to Irrigation Customers.

Water Management Service Category	TID Activities
On-farm irrigation and drainage system evaluations	Engineering design services for ID facilities
	Private and Improvement District pump testing upon request
Normal year and real-time irrigation scheduling and crop evapotranspiration information	Installation of CIMIS stations 168 (inactive) and 206 in Denair
	Rental of land and ongoing maintenance and support of Denair CIMIS station
	Link on TID web site to weather data from DWR CIMIS program (Figure 6.3) and weather forecasts (Figure 6.4)
Surface water, groundwater, and drainage water quantity and quality data	Private and Improvement District pump testing upon request
	Water use information by parcel available from TID at any time online, or upon grower's request, plus all growers receive a year-end water use report
	Information describing suitability of surface water, groundwater, and drain water quality for irrigation upon request
	Real time flows and storage for 6 surface water sites provided on TID website (Figure 6.5)
	TID participates in DWR's CASGEM groundwater level reporting program
Agricultural water management educational programs and materials for farmers, staff, and the public	Grower newsletter distributed three to four times per year
	TID has developed training videos for operation of Rubicon sidegates and posted them on its website.
	TID provides remote data access describing delivery flows for sidegates with SlipMeters and permanent FlumeGates.
	Drought information page with extensive information to support on-farm water management during drought.
	TID provides an agricultural engineer for providing on-farm technical support. Services include support of micro/drip conversion and on-farm reservoir sizing.
	Annual grower meetings
	Occasional seminars for growers on various water management topics

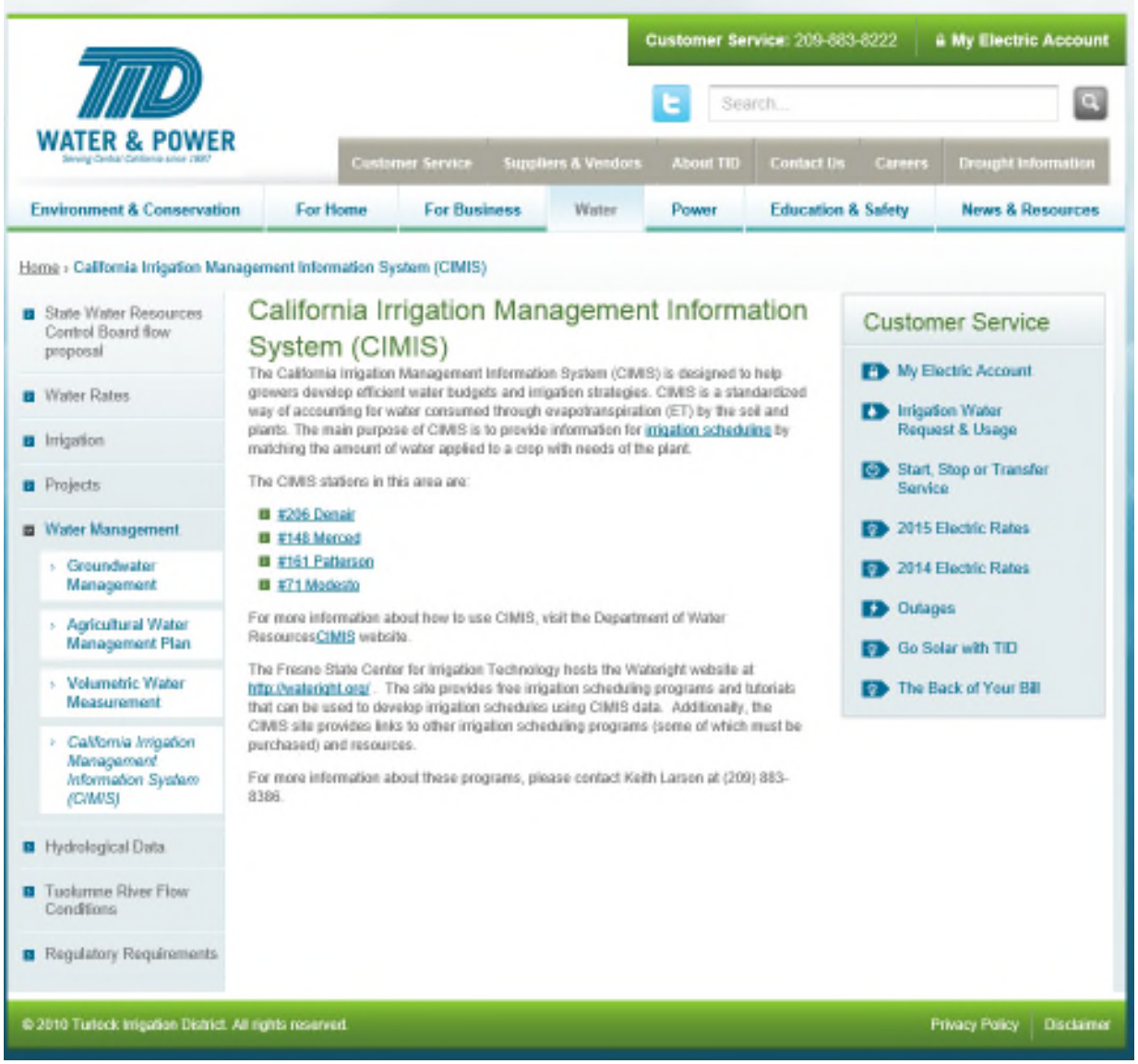


Figure 6.3. Link to CIMIS on TID Website.

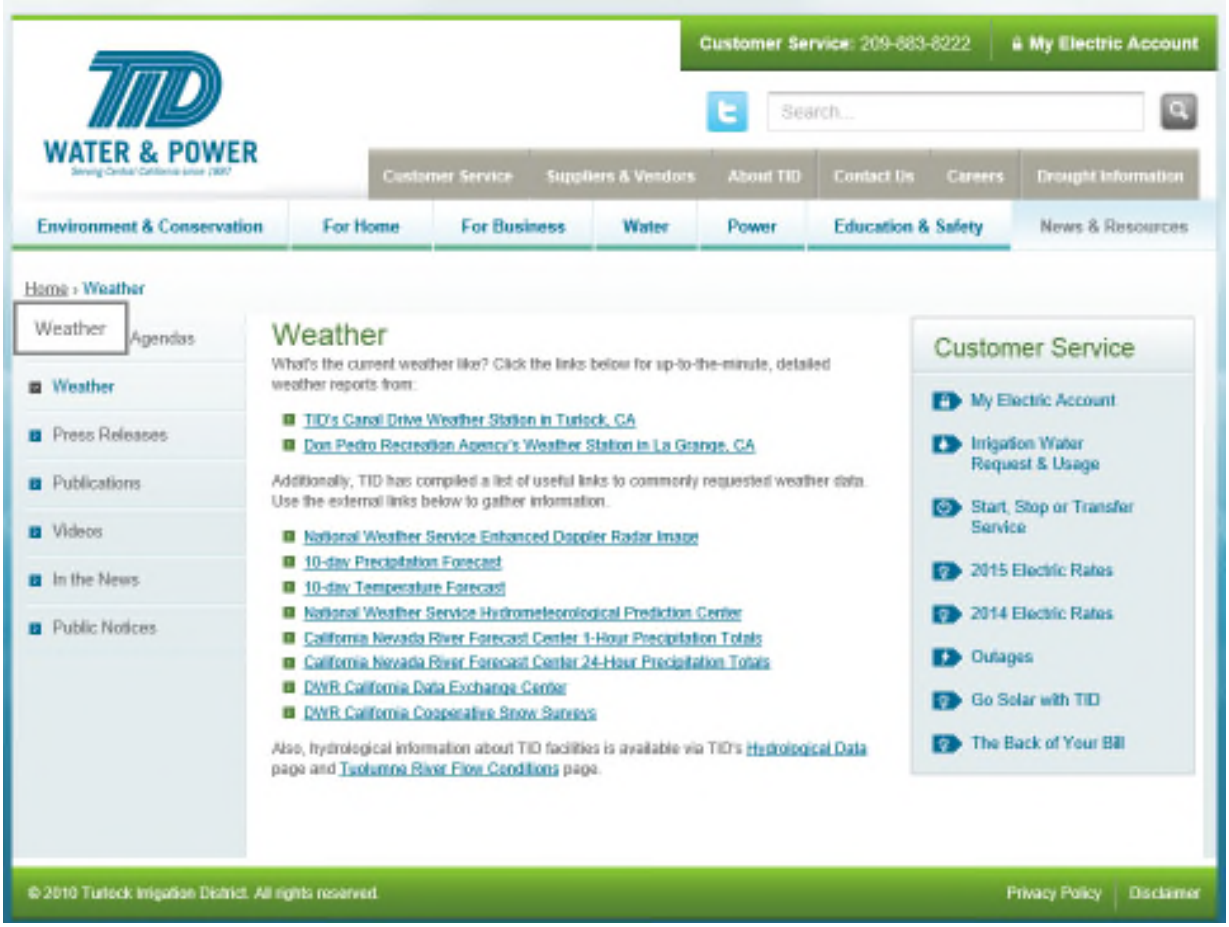


Figure 6.4. Additional Weather Information on TID Website

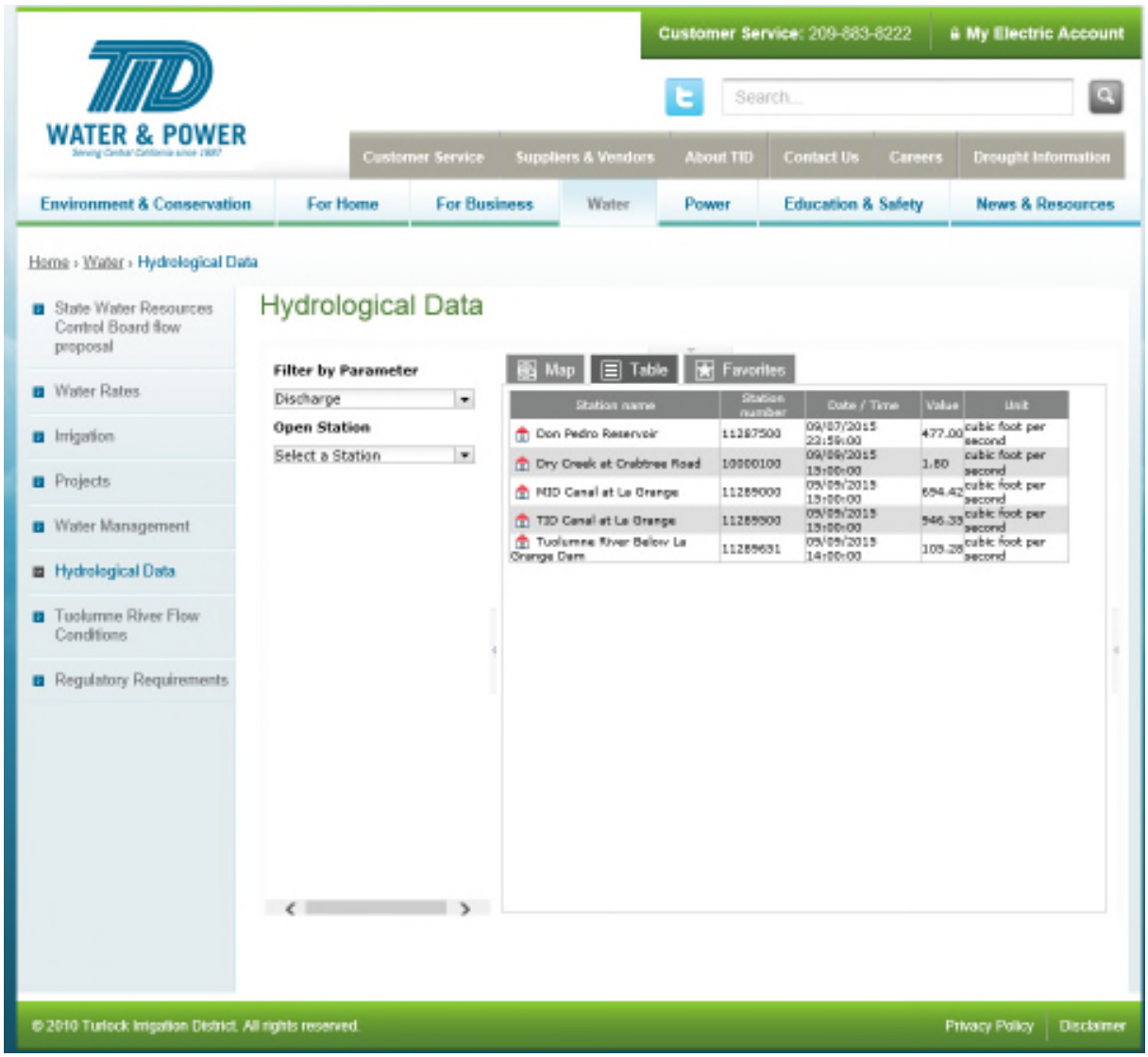


Figure 6.5. Real Time Hydrological Data on TID Website.

A Publication for Turlock Irrigation District Irrigation Water Users

the Grower

Vol. 27 • No. 1 | August 2015

Lateral 8 Project Completed

TID recently completed work on the Lateral 8 Total Channel Control (TCC) and Regulating Reservoir Project located just east of Hilmar where the Highline, Lateral 8 and Lateral 7 come together.

The purpose of the project is to support water conservation efforts by stabilizing flow rates in those canal systems and capturing water that is normally spilled as a result of operational fluctuations. It also improves the flexibility of water ordering as well as the supply reliability for TID customers on Lateral 8.

The District is proud to report that the project is now operational and was completed under-budget.

Projects like the Lateral 8 TCC and Reservoir are examples of TID's vision and preparation for the future by piloting new concepts to improve efficiency on our 127 year old system. The District is constantly evaluating concepts for future efficiency projects and will provide updates and opportunities for input as those projects are being considered.

For detailed information about Lateral 8 and the Regulating Reservoir Projects, visit tid.org/lateral8

As of July 15th, the Lateral 8 Project has captured

918 AF or,

299,131,610 gallons of water!

Important Dates

Sun., October 4
Last day to place irrigation orders

Wed., October 7
Final day of irrigation season

Throughout November
Water Use Statements mailed

December 20
Water transfers must be completed

Have Issues?

View this issue and past issues of The Grower online at www.tid.org/news-resources/publications

E-mail Sign-up

TID sends out e-mails to growers. E-mail us at info@tid.org if you would like to sign up

Inside

- Curtailment - What it means to you
- Ag Water Management Plan update
- SED
- Important Information about SB 854

ONLINE ORDERING REMINDER - When ordering water online, you will always receive a confirmation e-mail from TID if your online order was successfully placed. If you do not receive one of these e-mails within minutes of placing the order, go back and place the order again or call (209) 883-8456 for assistance.

TID WATER & POWER

Figure 6.6. FrontPage of August 2015 Issue of "The Grower."

Another example of coordination is TID's membership in the Turlock Groundwater Basin Association (TGBA), an association of local municipal water systems, agricultural water districts, and counties. The TGBA provides a mechanism to implement groundwater management activities and provide guidance for the management, preservation, protection and enhancement of the Turlock Groundwater Basin. To this end the TGBA developed a basin wide groundwater management plan and is working to develop a basin wide monitoring plan. TID coordinates groundwater management related activities with other agencies through this forum. TID is active in implementation of the SGMA.

TID is also preparing a Water Master Plan that will include an evaluation of agency policies. TID will continue to evaluate opportunities for more flexible deliveries and storage in the future and will pursue those opportunities found to be locally cost effective.

6.4.2 Evaluate and Improve Efficiencies of Supplier's Pumps (10608.48.c(14))

STATUS: IMPLEMENTING

TID is implementing this EWMP by actively testing and monitoring TID-owned and private wells that the District rents.

In order to develop in-house pump testing capabilities, TID trained employees in pump testing methods during the 2014 irrigation season. Pumps owned by TID are tested as needed to evaluate operational changes, and reliably calculate flows. The test results are used by staff to evaluate repair and replacement options. TID has an ongoing pump capital improvement program designed to maintain the efficiency of TID owned pumps through rehabilitation or replacement when necessary.

Improvement district or other private wells that are rented by TID are tested annually. The information is utilized by TID to evaluate which pumps to rent, to accurately calculate the amount of water pumped, and the information is provided to the owner to assist with maintenance decisions.

Drainage pump remote operation has been provided to WDOs. WDOs are able to turn on and shut down pumps using portable tablets to prevent operational spillage. This also reduces wear and tear, prolonging the pump life and improving efficiency.

TID will continue to implement this program in the future and continue to evaluate locally cost-effective opportunities to expand the program as part of the district's overall management of water and electrical resources.

6.5 SUMMARY OF EWMP IMPLEMENTATION STATUS

TID has taken many actions throughout its more than 125-year history to promote efficient and sustainable water management and continues to review and plan additional measures to accomplish improved and more efficient water management. Conjunctive management of local surface water and groundwater resources is foundational to TID's overall water management strategy. For purposes of this AWMP, TID actions have been organized and are reported with respect to the Efficient Water Management Practices (EWMPs) listed in Water Code §10608.48. A summary of the implementation status of each listed EWMP is provided in Table 6.3.

TID and its staff has long been active in, and affiliated with organizations supporting excellence in water management, including the Association of California Water Agencies (ACWA), the United States Committee for Irrigation and Drainage (USCID), the Irrigation Technology and Research Center (ITRC), the American Society of Civil Engineers (ASCE), the California Irrigation Institute, the California Municipal Utilities Association (CMUA) and others. One of the benefits that TID's active participation in these organizations brings is continuing exposure to water management innovations through conferences, trainings and networking with water management professionals. Additionally TID occasionally sends staff to water management trainings to enhance skill sets and increase basic understanding of efficient water management.

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Table 6.3. Summary of TID Implementation Status for EWMPs Listed Under CWC 10608.48(b) & (c).

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
Critical EWMPs – Mandatory				
10608.48.b(1)	Measure the volume of water delivered to customers with sufficient accuracy to comply with subdivision (a) of Section 531.10 and to implement 10608.48.b(2).	Implementing	Measuring the volume of water delivered to customers by: (1) installing 132 new measurement devices delivering water to about 3,000 parcels covering about half of the TID service area, and (2) calibrating flow rates for more than 1,700 sidegate-parcel combinations delivering water to an additional 35 percent of the TID service area.	In 2016, complete calibration of sidegate-parcel combinations not calibrated due to 2014 and 2015 drought conditions. By 2017, implement new, or modified ordering and delivery measurement recording software using new measured flows.
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Implementing	Completed the Proposition 218 process and adopted a new pricing structure based in part on quantity delivered in June 2012. The pricing structure consists of separate tiered-pricing structures for normal and dry years and includes four water rate tiers for each year type with an increasing cost per acre-foot delivered as growers move from lower to higher tiers defined based on the amount of water delivered per acre. A fixed charge per acre is also included. A price increase, using the same general structure was implemented in 2015.	Continue implementing a volumetric pricing structure, although the price will likely change over time. Evaluate billing system and implement improvement by 2017.
Additional (Conditional) EWMPs – To be Implemented if Locally Cost Effective and Technically Feasible				
10608.48.c(1)	Facilitate alternative land use for lands with exception-ally high water duties or whose irrigation contributes to significant problems, including drainage.	Not Technically Feasible	Lands with exceptionally high water duties or whose irrigation contributes to significant problems are not found within the District boundaries. Furthermore, TID's rules and regulations prohibit wasteful use of water, preventing exceptional water duties or significant problems from occurring.	
10608.48.c(2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils	Implementing	1. M&I wastewater used for cooling at TID's Walnut Energy Center. 2. M&I wastewater applied directly to TID irrigated lands. 3. Dairy nutrient water used by TID improvement districts for irrigation.	1. Continue existing use of recycled water within TID. 2. Consider requests from all qualifying permitted dischargers for additional use of recycled water. 3. Actively working with the City of Turlock to gain access to 2,000 AF of recycled water for agriculture needs. .
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems	Implementing	1. Financing of on-farm improvement district irrigation facilities. 2. Engineering design and construction oversight for on-farm improvement district irrigation facilities. 3. At-cost maintenance and repair of on-farm improvement district irrigation facilities. 4. Interest-free deferral of maintenance, repair, and electrical charges. 5. Pursuit of grant funding for on-farm improvements. 6. TID has hired an assistant engineer whose primary work assignment is to provide on-farm technical support and design assistance to TID customers. Services include support of micro/drip conversion and on-farm reservoir sizing.	1. Continue various financing activities to support development, operation, maintenance, and repair of on-farm irrigation systems.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Implementing	1. Pricing structure promotes more efficient water use at the farm level, conjunctive use of groundwater, appropriate increase of groundwater recharge, prevention of problem drainage, and effective management of all water sources throughout the year.	1. Continue to implement tiered pricing structure to promote TID's water management goals.
10608.48.c(5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage	Implementing	1. Lined or converted to pipelines over 90 percent of its distribution system. 2. Between 2010 and 2014, TID resurfaced approximately 5 miles of lining per year. 3. In 2014, TID converted the Lower Stevinson Flume to a pipeline. 4. Lateral 1 has been converted to a pipeline in developed areas. 5. Improvement district pipelines are actively maintained and replaced as necessary. 6. In 2015, TID completed the Lateral 8 Reservoir, 29 acre-feet of storage, integrated with TCC on Lateral 8 with objectives to a) reduce spill at the Highline and Lateral 8 Spills and b) improve service to about 4,300 acres served by Lateral 8.	1. Continue to resurface lining each year to maintain effectiveness. 2. Install new lining as appropriate based on local cost-effectiveness. 3. Continue active maintenance and repair of improvement district pipelines. 4. Increase Lateral 8 regulating reservoir capacity in 2016. 5. Continue to evaluate and implement other locally cost effective regulating reservoirs. A regulating reservoir along the Ceres Main Canal is proposed, and has been included in the current draft capital planning budget for 2016.
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Implementing	1. Implemented arranged-frequency demand delivery, providing a wide range of flexibility in irrigation frequency and duration, providing water with a lead time of approximately 2 days. 2. Moved its call center in 2008 to improve customer service and in 2014 implemented online ordering. 3. Provides water use information to irrigators for their fields upon request, online and in an annual report. 4. Worked over time to accommodate changes in demand characteristics for micro irrigation systems. 5. TID WDO's monitor the distribution system in real time using tablets at over 340 SCADA sites to enhance operational flexibility, including real time monitoring of Rubicon SlipMeters and permanent FlumeGates. 6. TID provides customers with access to real time monitoring of Rubicon SlipMeters and permanent FlumeGates. 7. Intermediate system flows at several locations are monitored to better meet customer demands and prevent operational spillage. 8. In 2015, TID completed the Lateral 8 Reservoir, 29 acre-feet of storage integrated with TCC on Lateral 8 with objectives to a) reduce spill at the Highline and Lateral 8 Spills and b) improve service to about 4,300 acres served by Lateral 8.	1. Continue to provide high levels of delivery flexibility and evaluate locally cost effective flexibility improvements. 2. Continue to offer online delivery ordering and online availability of water use information. 3. Increase Lateral 8 regulating reservoir capacity in 2016. 4. Evaluate the cost effectiveness of the Lateral 8 reservoir/TCC pilot project and consider implementing in other areas where found to be locally cost effective. 5. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems	Implementing	1. Intercepts spillage from upper laterals into the Ceres Main Canal. 2. Recovers operational spillage from Harding Drain. 3. Recovers and reuses tailwater and tilewater re-entering the distribution system. 4. Implemented real time SCADA monitoring of all spill sites. 5. Intermediate system flows at several locations are monitored to better meet customer demands and prevent operational spillage. 6. Operates drainage wells throughout the system, providing added operational flexibility and localized supply that enables spillage prevention. 7. TID provided WDOs with tablets to monitor the distribution system in real time at spillage sites and over 340 SCADA sites to enhance operational flexibility while reducing SlipMeters and permanent FlumeGates. 8. Drainage pump remote operation has been provided to WDOs. WDOs are able to turn on and shut down pumps using portable tablets to prevent operational spillage. 9. In 2015, TID completed the Lateral 8 Reservoir, 29 acre-feet of storage, integrated with TCC on Lateral 8 with objectives to a) reduce spill at the Highline and Lateral 8 Spills and b) improve service to about 4,300 acres served by Lateral 8.	1. Continue various strategies and actions to recover and prevent spillage and tailwater. 2. Consider implementation of recovery and pumpback systems, subject to evaluation of local cost-effectiveness. 3. Improve accounting for drain pump operation and pumped volumes. 4. Continue to evaluate and implement locally cost effective improvements to recover and prevent spillage and tailwater. 5. Increase Lateral 8 regulating reservoir capacity in 2016. 6. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Implementing	1. TID has implemented a comprehensive conjunctive management program. 2. TID operates over 100 drainage wells to increase water supply. 3. TID rents up to 100 or more privately-owned wells to supplement the available surface water supply. 4. TID's pricing promotes the following conjunctive management goals: (1) encourages use of available surface water supplies, (2) encourages conservation of limited surface water supplies in dry years, and (3) provides revenue required to operate drainage wells and rental wells in dry years. 5. When surplus water is available in some wet years. TID promotes direct and in-lieu recharge through surplus water sales within the subbasin but outside of the TID service area. 6. Substitution of M&I wastewater for groundwater to provide cooling at Walnut Energy Center. 7. Active participation in local groundwater entities and initiatives, including SGMA. 8. Implementation of groundwater monitoring as part of CASGEM. 9. Development of sophisticated groundwater and surface water models to support long term planning and management.	1. Continue various ongoing conjunctive management strategies and actions as part of TID's comprehensive conjunctive management program. 2. Continue to evaluate and implement locally cost effective actions. 3. Evaluate the cost effectiveness of the Lateral 8 reservoir/TCC pilot project and consider implementing in other areas where found to be locally cost effective. 4. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(9)	Automate canal control structures	Implementing	1. TID operates more than 330 automatic canal control structures. 2. TID monitors over 340 SCADA sites providing real time flow and water level information. 3. Drainage pump remote operation has been provided to WDOs. WDOs are able to turn on and shut down pumps using portable tablets to prevent operational spillage and conserve groundwater. 4. TID monitors additional slipgates at lateral headings. 5. In 2015, TID completed the Lateral 8 Reservoir, 29 acre-feet of storage, integrated with TCC on Lateral 8 with objectives to a) reduce spill at the Highline and Lateral 8 Spills and b) improve service to about 4,300 acres served by Lateral 8.	1. Continue to operate and maintain automatic control structures. 2. Continue real time SCADA monitoring. 3. Continue to evaluate and implement locally cost effective actions. 4. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation	Implementing	1. TID provides testing of private pumps upon request within its irrigation and electrical service areas. 2. TID tests all rented private wells once per year. 3. TID has trained employees in pump efficiency testing. 4. TID has obtained five additional portable flow meters available to test customer wells upon request. Two staff members are available for water level testing and twelve WDOs plus additional staff are available for flow testing. 5. Pump testing is additionally available for growers outside of TID's water service area but within its electrical service area (approximately 40,000 acres).	1. Continue to provide testing of private pumps and to maintain in-house pump testing capability.
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implementing	1. Designated a Water Conservation Coordinator in June 1997.	1. Continue to employ a designated Water Conservation Coordinator.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(12)	Provide for the availability of water management services to water users.	Implementing	1. TID provides engineering design services for improvement district facilities. 2. TID provides private pump testing upon request. 3. TID installed, rents land for, and maintains the Denair CIMIS site and provides a link to CIMIS on its web site. 4. TID provides detailed water use information for individual fields to irrigators online, upon request, and through a year-end water use report that is mailed to all irrigators. 5. TID provides detailed information on the suitability of surface, ground, and drain water quality for irrigation upon request. 6. TID provides real time hydrologic information on its website. 7. TID distributes a grower newsletter multiple times per year, holds annual grower meetings, and organizes occasional seminars on various water management topics. 8. TID has hired an assistant engineer who's primary work assignment is to provide on-farm technical support and design assistance to TID customers. Services include support of micro/drip conversion and on-farm reservoir sizing. 9. TID has developed a drought information page with extensive information to support on-farm water management during drought. 10. TID provides remote data access describing delivery flows for sidegates with SlipMeters and permanent FlumeGates. 11. TID has developed training videos for operation of Rubicon sidegates and posted them on its website.	1. Continue to provide various water management services. 2. Continue to evaluate and implement locally cost effective services.
10608.48.c(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Implementing	1. TID cooperates with the Modesto Irrigation District (MID), who co-owns Don Pedro Reservoir. 2. TID coordinates with other agencies that have the potential to impact the District's flexibility in delivery and storage. 3. TID is a member of the Turlock Basin Groundwater Association (TGBA). 4. TID is active in implementation of SGMA. 5. TID is preparing a Water Master Plan that will include an evaluation of agency policies.	1. Continue cooperation with MID and others to allow more flexible deliveries and storage. 2. Continue to evaluate and implement locally cost effective opportunities. 3. TID is developing a Water Master Plan (WMP) that will include the most cost effective EWMPs as part of an overall strategy for distribution system modernization and improvements.
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implementing	1. TID tests all District owned and rented wells. 2. TID has trained employees in pump efficiency testing. 3. TID has established an ongoing capital improvement program to rehabilitate and replace pumps as necessary. 4. Drainage pump remote operation has been provided to WDOs. WDOs are able to turn on and shut down pumps using portable tablets to prevent operation al spillage. This also reduces wear and tear, prolonging pump life and improving efficiency.	1. Continue to test TID pumps and to maintain in-house pump testing and SCADA capabilities. 2. Continue ongoing rehabilitation and replacement of TID pumps as necessary.

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6.6 EVALUATION OF WATER USE EFFICIENCY IMPROVEMENTS

CWC §10608.48(d) requires that AWMPs include:

> *… a report on which efficient water management practices have been implemented and are planned to be implemented, an estimate of the water use efficiency improvements that have occurred since the last report, and an estimate of the water use efficiency improvements estimated to occur five and 10 years in the future.*

A description of which EWMPs have been implemented has been provided previously in Section 6. This section provides an evaluation of EWMP implementation and an estimate of water use efficiency (WUE) improvements that have occurred in the past and are expected to occur in the future.

As described elsewhere in this document, TID has, over time, effectively implemented a variety of EWMPs designed to: develop and maintain reliable surface water and groundwater supplies; prevent or reduce system losses; promote the efficient use of water; seek alternative sources of supply; and maximize the flexibility with which the District can deliver and store water. The value of evaluating WUE improvements (and EWMP implementation in general), from TID's perspective, is to identify what the benefits of EWMP implementation are and to identify those additional actions that hold the potential to improve TID's ability to provide customers with a reliable water supply.

First and foremost among the issues that must be considered in any evaluation of the benefits of EWMP implementation and WUE improvements is how any proposed actions may impact the water balance, and overall water supply availability (Davenport and Hagan, 1982; Keller, et al., 1996; Burt, et al., 2008; Clemmens, et al., 2008; Canessa, et al., 2011). For example, flows to deep percolation and seepage that could be considered losses in some settings are critical to maintain the long-term sustainability of the underlying groundwater basin. Reduced seepage or on-farm WUE improvements could be considered beneficial in some areas, but would adversely impact local groundwater recharge. Similarly, spillage and tailwater are also recoverable flows. These flows are already being recovered locally, or have the potential to be put to beneficial use downstream. The only distribution system or on-farm losses that are not recoverable within TID, the underlying groundwater basin, or the San Joaquin River Basin as a whole are canal and reservoir water surface evaporation and evaporation from irrigation application. These components represent a small portion of TID's water supply (less than one percent as indicated in Table 4.8). An implication of this is that very little water can be made available through water conservation in TID to increase the State's overall water supply.

An essential first step in evaluating EWMP implementation and WUE improvements is a comprehensive, quantitative, multi-year water balance (see Section 4). The quantitative understanding of the water balance flow paths enables identification of targeted flow paths for TID water management objectives and WUE improvements, along with improved understanding of the beneficial impacts and consequential effects of EWMP implementation at varying spatial and temporal scales. The water balance enables evaluation of potential changes in flow path quantities and timing for any given change in water management.

Even where comprehensive, multi-year water balances have been developed, evaluating water balance impacts and WUE improvements is not a trivial task. Issues of spatial and temporal scale and the relatively small changes in annual flow path volumes (relative to year to year variation in water diversions and use) that result from most water management improvements coupled with the inaccuracies inherent in even the best water measurement greatly complicate the evaluation of WUE improvements. Additionally, the implications of recoverable and irrecoverable losses at varying scales complicate the evaluation of WUE improvements, and consequential, potentially unintended consequences must be considered (Burns et al. 2000, AWMC 2004).

Given the aforementioned complexities inherent in evaluating WUE improvements and the extremely limited potential for increase to the State's overall water supply, TID has developed a qualitative assessment of past WUE improvements and those expected to occur five and ten years in the future. The qualitative magnitude is expressed as None, Limited, Modest, or Substantial in order of increasing relative magnitude for each EWMP. Past WUE improvements are estimated relative to no historical implementation and relative to the time of the last plan (adopted in December 2012). Future WUE improvements are estimated for five years in the future (2020) relative to 2015 and for ten years in the future (2025) relative to 2015. The result of this evaluation is provided in Table 6.4.

TID will continue to seek out and implement water management actions that meet its overall water management objectives and result in WUE improvements. TID staff regularly attend water management conferences and evaluate technological advances in the context of TID's water management objectives and regional setting. The continuing review of water management within TID, coupled with exploration of innovative opportunities to improve water management will continue to result in future water management innovations and additional WUE improvements.

Table 6.4. Evaluation of Relative Magnitude of Past and Future WUE Improvements by EWMP.

Water Code Reference No.	EWMP	Implementation Status	Marginal WUE Improvements[1,2]			
			Past		Future	
			Relative to No Historical Implementation[3]	Since Last AWMP[4]	5 Years in Future[5]	10 Years in Future[5]
10608.48.b (1)	Measure the volume of water delivered to customers with sufficient accuracy	Being Implemented	No Direct WUE Improvements			
10608.48.b (2)	Adopt a pricing structure based at least in part on quantity delivered	Being Implemented	None	Limited	Limited	
10608.48.c (1)	Facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems, including drainage.	Not Technically Feasible	Not Applicable to TID			
10608.48.c (2)	Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria, and does not harm crops or soils.	Being Implemented	Modest (approx. 5,000 af annually)	None	None to Limited, Depending on Future Opportunities	
10608.48.c (3)	Facilitate financing of capital improvements for on-farm irrigation systems	Being Implemented	Substantial	Modest	None to Modest, Depending on Future Needs	
10608.48.c (4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Being Implemented	Substantial	None	Limited	
10608.48.c (5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance and reduce seepage	Being Implemented	Substantial (Limited Reduction in Irrecoverable Losses)	Modest	Modest	
10608.48.c (6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Being Implemented	Substantial	Modest	Modest	
10608.48.c (7)	Construct and operate supplier spill and tailwater recovery systems	Being Implemented	Substantial	Modest	Modest	
10608.48.c (8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Being Implemented	Substantial	None	None to Limited	
10608.48.c (9)	Automate canal control structures	Being Implemented	Substantial	Modest	Modest	
10608.48.c (10)	Facilitate or promote customer pump testing and evaluation	Being Implemented	Modest	None (Limited Energy Conservation)	None (Limited Energy Conservation)	
10608.48.c (11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Being Implemented	The activities of the Water Conservation Coordinator and other TID staff to achieve WUE improvements through implementation of the EWMPs are described individually by EWMP.			
10608.48.c (12)	Provide for the availability of water management services to water users.	Being Implemented	Substantial	Limited	None to Limited	
10608.48.c (13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Being Implemented	Substantial	None	None	
10608.48.c (14)	Evaluate and improve the efficiencies of the supplier's pumps.	Being Implemented	Substantial	None (Limited Energy Conservation)	None (Limited Energy Conservation)	

[1] As noted herein and throughout this analysis, reductions in losses that result in WUE improvements at the farm or district scale do not result in WUE improvements at the basin scale, except in the case of evaporation reduction. All losses to seepage, spillage, tailwater, and deep percolation are recoverable within TID or by downgradient water users within the basin.

[2] In most cases, quantitative estimates of improvements are not available. Rather, qualitative estimates are provided as follows, in increasing relative magnitude: None, Limited, Modest, and Substantial.

[3] WUE Improvements occurring in recent years relative to if they were not being implemented.

[4] WUE Improvements occurring in recent years relative to the level of implementation at time of last AWMP (2012).

[5] WUE Improvements expected in 2020 (five years in the future) and 2025 (ten years in the future), relative to level of implementation in recent years.

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Appendix A
PUBLIC OUTREACH AND RESOLUTION ADOPTING PLAN

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TID Website Information regarding Draft AWMP

http://www.tid.com/water/water-management/agricultural-water-management-plan

Customer Service: 209-883-8222 | My Electric Account

WATER & POWER
Serving Central California since 1887

Customer Service | Suppliers & Vendors | About TID | Contact Us | Careers | Drought Information

Environment & Conservation | For Home | For Business | Water | Power | Education & Safety | News & Resources

Home › Agricultural Water Management Plan

- State Water Resources Control Board flow proposal
- Water Rates
- Irrigation
- Projects
- Water Management
  - Groundwater Management
  - *Agricultural Water Management Plan*
  - Volumetric Water Measurement
  - California Irrigation Management Information System (CIMIS)
- Hydrological Data
- Tuolumne River Flow Conditions
- Regulatory Requirements

Agricultural Water Management Plan

TID has been actively involved in agricultural water management planning efforts since it joined the Agricultural Water Management Council (AWMC) in April 1997.

The District's current Agricultural Water Management Plan (AWMP) was adopted in 2012, and evaluates water use within the District and applicable management practices to make the best use of available resources.

Prior to 2012, a plan was developed under a voluntary AWMC process established in the 1990s. Legislation passed in 2009, commonly referred to as SBx7-7, made the once voluntary program mandatory. Under the new requirements, TID is required to update the plan in 2015, and then every five years thereafter.

TID is in the process of updating its AWMP pursuant to these requirements. The revised plan will also address the new AWMP requirements established by the Governor in Executive Order B-29-15 (April 1, 2015). Updates on the process will be posted here, on this webpage.

A Public Review Draft of the AWMP is expected to be available for review in October 2015. At that time, copies of the draft plan will be available at the TID main office (333 E. Canal Drive, Turlock, CA 95380), and at the Turlock Public Library (559 Minaret Ave., Turlock, CA 95380), and a link will be included below. Comments may be submitted in writing before that time to:

Debbie Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

The 2012 AWMP describes TID's water supplies and irrigation demand, local conditions, facilities and operations, rules and policies, and a variety of water management activities, including a series of efficient water management practices (EWMPs) designed to improve water use efficiency. The AWMP documents how TID is complying with current law, and proposes improvements, if needed, to meet new requirements. A link to the AWMP appears below, along with a report from the Natural Resources Defense Council (NRDC) praising TID's Ag Water Management Plan efforts.

- 2012 TID Agricultural Water Management Plan 6.7 MB (pdf)
- NRDC Issue Paper commends TID's Ag Water Management plan and its Efficient Water Management Practices (EWMPs).

Copies of the 2012 plan are also available at the TID main office (333 E. Canal Dr., Turlock, CA 95380), and at local public libraries throughout the TID service area.

Customer Service

- My Electric Account
- Irrigation Water Request & Usage
- Start, Stop or Transfer Service
- 2015 Electric Rates
- 2014 Electric Rates
- Outages
- Go Solar with TID
- The Back of Your Bill

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Table A.1. TID Ag Water Management Plan - Outreach/Distribution List

Agency	Department	Mailing Street Address	City	State	Zip	Zip +4	Notice of Intent Letter	Public Hearing Notice Letter	Draft Plan	Plan
Stanislaus County	Environmental Resources Dept	3800 Cornucopia Way, Suite C	Modesto	CA	95358	9494	X	X		X
Merced County	Environmental Health Dept	260 E 15th St	Merced	CA	95341	6216	X	X		X
City of Turlock	Municipal Services	156 S. Broadway, Suite 270	Turlock	CA	95380	5461	X	X		X
City of Modesto	Utility Planning & Projects Dept	PO Box 642	Modesto	CA	95354	0642	X	X		X
City of Hughson	Public Works	PO Box 9	Hughson	CA	95326	0009	X	X		X
City of Ceres		2220 Magnolia St	Ceres	CA	95307	3209	X	X		X
Monterey Tract CSD		PO Box 1301	Ceres	CA	95307	1301	X	X		X
Keyes CSD		PO Box 699	Keyes	CA	95328	0699	X	X		X
Denair CSD		PO Box 217	Denair	CA	95316	0217	X	X		X
Delhi CWD		PO Box 639	Delhi	CA	95315	639	X	X		X
Hilmar CWD		8319 Lander Ave	Hilmar	CA	95324	8324	X	X		X
Eastside WD		PO Box 280	Denair	CA	95316	0280	X	X		X
Ballico-Cortez WD		12724 Sunny Acres Ave	Turlock	CA	95380	9028	X	X		X
Merced Irrigation District		744 W 20th St.	Merced	CA	95340	3601	X	X		X
DWR	Ag WUE Statewide IWM - WUE Branch	PO Box 942836	Sacramento	CA	94236	0001				X
LAFCo – Stanislaus Co.		1010 10th St, 3rd Floor	Modesto	CA	95354	0859				X
LAFCo – Merced Co.		2222 M St	Merced	CA	95340	3729				X
California State Library	Gov't Publication Section	PO Box 942837	Sacramento	CA	94237	0001				X

Agency	Department	Mailing Street Address	City	State	Zip	Zip +4	Notice of Intent Letter	Public Hearing Notice Letter	Draft Plan	Plan
Turlock Public Library		550 Minaret Ave	Turlock	CA	95380	4137			X	X
Ceres Public Library		2250 Magnolia St	Ceres	CA	95307	3209				X
Denair Public Library		4801 Kersey Rd	Denair	CA	95316	9350				X
Hughson Public Library		2412 3rd St, Suite A	Hughson	CA	95326	9310				X
Keyes Public Library		1500 I Street	Modesto	CA	95354	1120				X
Delhi Educational Park Community Library		16881 W Schendel Ave	Delhi	CA	95315	9543				X
Irwin-Hilmar Public Library		20041 Falke St	Hilmar	CA	95324	9778				X
TID Website									X	X

CSD = Community Services District
CWD = County Water District
WUE = Water Use Efficiency
IWM = Integrated Water Management

Example Notice of Intent Letter to Local Public Agencies

WATER & POWER
Serving Central California since 1887
(209) 883.8300 • www.tid.com
333 East Canal Drive • P.O. Box 949 • Turlock, CA 95381-0949

June 8, 2015

Michael Brinton
City of Ceres
2220 Magnolia St
Ceres, CA 95307-3209

Dear Michael Brinton,

RE: Notice of Intent to Adopt Update to Agricultural Water Management Plan

This letter serves as notice that the Turlock Irrigation District (TID) intends to adopt an update to its current Agricultural Water Management Plan (AWMP). A hearing will be scheduled within the November/December timeframe for comments. Comments may be submitted in writing before that time to:

Debra Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

Please refer to our website www.tid.org/AWMP for updates and posting of the draft plan when it becomes available. The draft is expected to be available in October.

Following the public hearing, the TID Board of Directors will consider comments received, and may choose to consider adopting the plan on the day of the hearing.

Should you have any questions, please do not hesitate to contact me at (209) 883-8428, or dcliebersbach@tid.org. Thank you.

Sincerely,

Debra Liebersbach
Water Planning Department Manager

WATER & POWER
Serving Central California since 1887
(209) 883.8300 • www.tid.com
333 East Canal Drive • P.O. Box 949 • Turlock, CA 95381-0949

June 8, 2015

Michael Cooke
City of Turlock
Municipal Services
156 S. Broadway, Ste 270
Turlock, CA 95380-5461

Dear Michael Cooke,

RE: Notice of Intent to Adopt Update to Agricultural Water Management Plan

This letter serves as notice that the Turlock Irrigation District (TID) intends to adopt an update to its current Agricultural Water Management Plan (AWMP). A hearing will be scheduled within the November/December timeframe for comments. Comments may be submitted in writing before that time to:

Debra Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

Please refer to our website www.tid.org/AWMP for updates and posting of the draft plan when it becomes available. The draft is expected to be available in October.

Following the public hearing, the TID Board of Directors will consider comments received, and may choose to consider adopting the plan on the day of the hearing.

Should you have any questions, please do not hesitate to contact me at (209) 883-8428, or dcliebersbach@tid.org. Thank you.

Sincerely,

Debra Liebersbach
Water Planning Department Manager

Example of Public Hearing Notice Letter to Local Public Agencies

WATER & POWER
Serving Central California since 1887
(209) 883.8300 • www.tid.com
333 East Canal Drive • P.O. Box 949 • Turlock, CA 95381-0949

October 14, 2015

Michael Cooke
City of Turlock
156 S. Broadway, Ste 270
Turlock, CA 95380-5461

Dear Michael Cooke:

RE: Update to the TID Agricultural Water Management Plan - Public Hearing Notice

The Turlock Irrigation District (TID) is scheduled to hold a review and public comment period on the proposed update to the TID Agricultural Water Management Plan (AWMP) from October 14, 2015 through November 10, 2015. A public hearing is scheduled to be held at 9:00 AM on November 10, 2015 in the TID Board Room, located at 333 East Canal Drive, Turlock, CA. At the hearing, the TID Board will receive public comments on the draft AWMP, prior to consideration and possible adoption of the AWMP. All persons interested in this matter should appear at the public hearing to comment, or submit written comments as described below.

The AWMP includes a discussion of TID and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices being implemented now or planned in the coming years. Copies of the draft plan are available for review at the following locations:

- Turlock Public Library located at 550 Minaret Ave. in Turlock, CA
- Turlock Irrigation District office located at 333 E. Canal Dr. in Turlock, CA
- Turlock Irrigation District website: www.tid.com/AWMP

Any comments prior to the hearing should be submitted to:

Debbie Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

Should you have any questions or comments regarding the draft AWMP, or the adoption process, please do not hesitate to contact me at (209) 883-8428 or dcliebersbach@tid.org.

Sincerely,

Debra C. Liebersbach
Water Planning Department Manager

Public Hearing Notice

Notice of Public Hearing

Notice is hereby given that the Turlock Irrigation District (TID) will hold a public hearing
November 10, 2015 at 9:00AM

Regarding:
2015 Agricultural Water Management Plan

Agricultural water agencies in California are required to prepare Agricultural Water Management Plans (AWMP) in 2015. To meet the new requirements, TID is considering revisions to its existing AWMP. The AWMP includes a discussion of TID and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices being implemented now or planned in the coming years. The TID Board of Directors will hold a hearing to consider public comments on the proposed revisions to TID's AWMP.

A copy of the AWMP may be reviewed at the TID offices (333 E. Canal Dr., Turlock, CA); the Turlock Public Library (550 Minaret Ave., Turlock, CA); or on the TID website (www.tid.com/AWMP). Written comments, submitted prior to the hearing, should be directed to:

Debbie Liebersbach
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

Comments may also be provided at the hearing.
If you have questions regarding the AWMP, please contact Debbie Liebersbach at (209) 883-8428.

Copy of Hearing Notice – Turlock Journal

Affidavit of Publication

PUBLICE NOTICE

STATE OF CALIFORNIA,
County of Stanislaus

JENNIFER PARGA

Of the said County, being duly sworn, deposes and says:

I am a citizen of the United States and a resident of the county aforesaid; I am over the age of twenty-one years, and not a party to or interested in the above entitled matter. I am the principal clerk of THE TURLOCK DAILY JOURNAL, 138 South Center Street, Turlock, California, a newspaper of general circulation, published in Turlock, California in the City of Turlock, County of Stanislaus, and which newspaper has been adjudged a newspaper of general circulation, by the Superior Court of the County of Stanislaus, State of California. That the notice, of which the annexed is a printed copy (set in type not smaller than nonpareil), has been published in each regular and entire issue of said newspaper

OCT 17, 21, 24, 28, 31, 2015

I certify (or declare) under penalty of perjury that the foregoing is true and correct, this 31st day of Oct 2015

Principal Clerk of the Printer

Notice of Public Hearing

Notice is hereby given that the Turlock Irrigation District (TID) will hold a public hearing Tuesday, November 10, 2015 at 9:00AM Regarding: 2015 Agricultural Water Management Plan Agricultural water agencies in California are required to prepare Agricultural Water Management Plans (AWMP) in 2015. To meet the new requirements, TID is considering revisions to its existing AWMP. The AWMP includes a discussion of TID and its irrigation facilities, water supply and demand, and various programs, policies and efficient water management practices being implemented now or planned in the coming years. The TID Board of Directors will hold a hearing to consider public comments on the proposed revisions to TID's AWMP. A copy of the AWMP may be reviewed at the TID offices (333 E. Canal Dr., Turlock, CA); the Turlock Public Library (550 Minaret Ave., Turlock, CA); or on the TID website at www.tid.com/AWMP. Written comments, submitted prior to the hearing, should be directed to: Debbie Liebersbach, Turlock Irrigation District, P.O. Box 949, Turlock, CA 95381. Comments may also be provided at the hearing. If you have questions regarding the AWMP, please contact Debbie Liebersbach at (209) 883-8428.

DATED: October 13, 2015
Executive Secretary to the Board of Directors of the Turlock Irrigation District

10/17, 10/21, 10/24, 10/28, 10/31/2015

PUBLIC NOTICE

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Resolution Adopting AWMP – November 10, 2015

RESOLUTION NO. 2015 - 72

RESOLUTION ADOPTING THE AMENDED TURLOCK IRRIGATION DISTRICT'S AGRICULTURAL WATER MANAGEMENT PLAN AND SUPERSEDING THE EXISTING AGRICULTURAL WATER MANAGEMENT PLAN

WHEREAS, the Board of Directors of the Turlock Irrigation District adopted the existing Agricultural Water Management Plan in December 2012 pursuant to the Water Code Sections 10800, et. seq., 10900, et. seq. and 10608.48; and

WHEREAS, staff has prepared an update to the Plan, pursuant these same Water Code sections; and

WHEREAS, the California Water Code, as amended by Senate Bill x7-7 in 2009, requires agricultural water suppliers to update 2012 Agricultural Water Management Plans on or before December 31, 2015; and

WHEREAS, the District has held a properly noticed public hearing to receive comments on the adoption of the proposed revisions to the Agricultural Water Management Plan as required by Sections 10821 and 10841 of the Water Code and Section 6066 of the Government Code; and

WHEREAS, at the public hearing, there were no written or verbal objections to the plan.

NOW, THEREFORE, BE IT HEREBY RESOLVED by the Board of Directors of the Turlock Irrigation District that:

1. The Turlock Irrigation District Agricultural Water Management Plan as presented and prepared in accordance with Senate Bill x7-7 is adopted and supersedes all previous agricultural water management plans.

2. The General Manager or his designee is directed to submit copies of the plan, no later than 30 days from this date, to the various agencies and entities as specified in California Water Code Section 10843.

3. The Agricultural Water Management Plan shall be posted on the Turlock Irrigation District web site, and made available for public review, no later than 30 days from this date.

Moved by Director Fernandes, seconded by Director Santos, that the foregoing resolution be adopted.

Upon roll call the following vote was had:

Ayes:	Directors Fernandes, Santos, Alamo, Macedo
Noes:	Directors None
Absent:	Director Frantz

The President declared the resolution adopted.

I, Tami Wallenburg, Executive Secretary to the Board of Directors of the TURLOCK IRRIGATION DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a regular meeting of said Board of Directors held the 10th day of November, 2015.

Executive Secretary to the Board of
Directors of the Turlock Irrigation District

Appendix B
TURLOCK GROUNDWATER BASIN GROUNDWATER MANAGEMENT PLAN

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TURLOCK GROUNDWATER BASIN

Groundwater Management Plan

Prepared for.

Turlock Irrigation District

333 East Canal Drive/P.O. Box 949

Turlock, CA 95381

March 18, 2008

Prepared by.

Turlock Groundwater Basin Association

The Turlock Groundwater Basin Groundwater Management Plan (GWMP) can be found online at:

http://www.tid.com/sites/default/files/documents/tidweb_content/Groundwater%20Management%20Plan.pdf

A copy of the GWMP is also included with this AWMP on a CD.

Appendix C
EXAMPLE NEWSLETTER

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A Publication for Turlock Irrigation District Irrigation Water Users

the Grower

Vol. 27 • No. 1 | August 2015

Lateral 8 Project Completed

TID recently completed work on the Lateral 8 Total Channel Control (TCC) and Regulating Reservoir Project located just east of Hilmar where the Highline, Lateral 8 and Lateral 7 come together.

The purpose of the project is to support water conservation efforts by stabilizing flow rates in those canal systems and capturing water that is normally spilled as a result of operational fluctuations. It also improves the flexibility of water ordering as well as the supply reliability for TID customers on Lateral 8.

The District is proud to report that the project is now operational and was completed under-budget.

Projects like the Lateral 8 TCC and Reservoir are examples of TID's vision and preparation for the future by piloting new concepts to improve efficiency on our 127 year old system. The District is constantly evaluating concepts for future efficiency projects and will provide updates and opportunities for input as those projects are being considered.

For detailed information about Lateral 8 and the Regulating Reservoir Projects, visit tid.org/lateral8

As of July 15th, the Lateral 8 Project has captured

918 AF or,

299,131,610 gallons of water!

Important Dates

Sun., October 4
Last day to place irrigation orders

Wed., October 7
Final day of irrigation season

Throughout November
Water Use Statements mailed

December 20
Water transfers must be completed

Have Issues?

View this issue and past issues of The Grower online at www.tid.org/news-resources/publications

E-mail Sign-up

TID sends out e-mails to growers. E-mail us at info@tid.org if you would like to sign up

Inside

- Curtailment - What it means to you
- Ag Water Management Plan update
- SED
- Important Information about SB 854

ONLINE ORDERING REMINDER - When ordering water online, you will always receive a confirmation e-mail from TID if your online order was successfully placed. If you do not receive one of these e-mails within minutes of placing the order, go back and place the order again or call (209) 883-8456 for assistance.

TID WATER & POWER

Ag Water Management Plan Update

TID is in the process of updating its Agricultural Water Management Plan (AWMP) which was last updated in 2012. Legislation adopted in 2009 (also known as SBx7-7), requires that AWMPs be updated in 2015 and every five years thereafter.

The updated plan describes TID's water supplies and irrigation demand, local conditions, facilities and operations, rules and policies, and a variety of water management activities, including a series of efficient water management practices designed to improve water use efficiency. In addition, the update will address new requirements established by the Governor earlier this year in his Executive Order B-29-15 (April 1, 2015).

SBx7-7 also requires the new measurement program that has been implemented over the last several years. TID is required to complete an assessment of how the program is working as a part of the AWMP update. A study is on-going to meet those requirements.

A Public Review Draft of the AWMP is expected to be available for review in October 2015. At that time, copies of the draft plan will be available at the TID main office (333 E. Canal Drive, Turlock, CA 95380), and at the Turlock Public Library (559 Minaret Ave., Turlock, CA 95380), and on our website.

Additional information on the Agricultural Water Management Plan can be found on our website at www.tid.org/AWMP. If you have any questions regarding this process, please contact Debbie Liebersbach at (209) 883-8428.

Water Measurement Certification

As part of the SBX7-7 process TID has hired independent contractors to audit the measurement practices of the District. You may see people out in the field completing measurements as a part of this process. These independent contractors will be working on behalf of TID and may or may not be accompanied by a District employee.

If you have any questions concerning these contractors, please call 209-883-8356.

What you need to know about SB 854 *before* hiring a contractor

Senate Bill 854 passed by the California legislature affects the way the District awards all public works projects including every contractor and subcontractor performing work by changing the way the state monitors compliance of prevailing wage requirements. This includes work performed by customers utilizing District funds for reimbursement.
Here is what the bill does and, how it affects you.

SB 854

- Requires all public agencies to report every awarded public works project to the California Department of Industrial Relations (DIR).
- Contractors performing work or submitting bids must pay a fee and be registered with the DIR and only those contractors may be awarded bids for public works projects.
- Contractors must provide proof of Worker's Compensation Insurance.
- Contractors must pay prevailing wage for any projects over $1,000. (including labor and materials)

If you're contracting for work to be performed on your property and then requesting reimbursement from the District, you must comply with the provisions of SB 854 in order to receive reimbursement. This includes new facilities brought into TID without prior knowledge or input of the District.

For details about SB 854 visit our website at tid.org/SB854

TID WATER & POWER

Regulatory Update

Water Rights Curtailment

On June 12, the State Water Resources Control Board (SWRCB) issued curtailment 'courtesy notices' to certain pre-1914 water rights holders in the Sacramento and San Joaquin rivers and Delta Watersheds. These notices informed those in those in watersheds who exercise pre-1914 water rights dating after 1903 that there may be insufficient supplies in order for them to divert water.

The SWRCB had previously referred to these notices as enforceable and punishable by hefty fines. However, a July 10 decision in Sacramento County Superior Court found that the notices were, "coercive in nature and go beyond the 'informational' purpose the (SWRCB) claims." The result of the court's decision is that the SWRCB is barred from taking any action to enforce those specific curtailment orders; however the SWRCB still has the power to administer and enforce the water rights system under its existing authorities.

On the heels of the July 10 court action, the State Water Resources Control Board rescinded and reissued all appropriative water rights curtailments that it issued the past few months, both post-1914 and pre-1914 curtailments. This was done to clarify that the notices were indeed advisory and not mandatory orders to stop diverting. However, riparian diverters along rivers should ensure with the SWRCB that they are authorized to divert.

While TID is certainly sensitive to the hardships of the current drought, TID plans to fully defend its water rights within the context of water law on behalf of those we serve. Because of TID's mix of senior water rights, these curtailments have not affected the 2015 Irrigation Season.

SED

TID continues to monitor the State Water Resources Control Board as it updates its Bay-Delta Water Quality Control Plan. Specifically, TID is concerned with Phase 1 of the Plan, which is in the middle of its environmental review. Phase 1 looks to set flow objectives for the Tuolumne River by dedicating 35 percent of its flows from February through June annually to discharge into the San Joaquin River to improve fish populations and Delta salinity. These flows could be required in all water years, whether dry or wet.

The SWRCB expects to hold a vote on the SED and its objectives before the end of 2015, after a public comment period and public hearing. However, the SED's approval date has slipped consistently since late 2013.

A few rule reminders to ensure efficient operations

From time to time, it is important for the District to remind growers and others working near District canals and other facilities regarding a few selected rules set forth in TID's Irrigation Rules.

TID's Irrigation Rules exist pursuant to Water Code Section 22257 to ensure the orderly, efficient, and equitable distribution, use and conservation of the water resources of the District.

While it may seem that some of these rules are more serious than others, they are designed to allow the District to continue to meet the needs of all growers that rely on District irrigation water.

Irrigation Rule 2.4.1 states: "No diverting gates, weirs, structures, or pump intakes shall be constructed or placed in any District conduit until an application in writing has been made to the TID Board of Directors and permission granted therefore." ***Growers are not allowed to place structures in TID canals without written permission.***

Planting of trees above Improvement District pipelines. Irrigation Rule 2.3.1 states: "No trees, vines, shrubs, corrals, fences, or any other type of encroachment shall be planted, or placed in, on, over, or across any District or improvement district conduit or any District right-of-way unless the District has given specific written approval for such encroachment."

Fertilizer tanks on canal banks have also historically been a cause for concern, and are in conflict with Irrigation Rules. ***Please contact TID prior to placing encroachments in the District's rights-of-way.*** If in doubt, TID can also help to identify and mark the right-of-way.

The District endeavors to deliver irrigation water in a flexible, timely manner consistent with the physical and operational limits of the delivery system facilities. But in order to do this, TID needs to be able to conduct water distribution operations and maintenance in a manner free of obstructions.

A full copy of TID's Irrigation Rules is available online at **www.tid.org/water/irrigation**. Water Distribution Operators also have copies available for growers.

The District thanks its customers in advance for their continued compliance of these rules that will ensure timely delivery of water to growers.

Calling all growers: important offseason notices

- **Growers planning to convert to drip/micro/sprinkler irrigation** (i.e. land conversion), need to contact TID prior to performing any work so TID can verify a non-standard head can be delivered. Systems installed without prior approval may be denied water if the configuration is not compatible with the District's infrastructure and operations. Please keep in mind that this type of conversion can negatively impact groundwater recharge in your area.
- **Growers intending to use TID canals and laterals** or Improvement District facilities for irrigation purposes during the offseason must contact the Water Distribution Department (883-8356) to coordinate the use.

TID
WATER & POWER
333 East Canal Drive
P.O. Box 949
Turlock, CA 95381
(209) 883-8300
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FIRST CLASS
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PAID
PERMIT # 415
STOCKTON, CA
ONLINE ORDERING REMINDER -
When ordering water online, you will always receive a confirmation e-mail from TID if your online order was successfully placed.
If you do not receive one of these e-mails within minutes of placing the order, go back and place the order again or call (209) 883-8456 for assistance.
Water Statistics
Don Pedro Reservoir as of July 15, 2015
Elevation this week: 688 feet
Elevation last year: 722 feet
Average outflow: 1402 cfs
Average to TID canal: 866 cfs
Visit tid.org/drought for drought resources, water reports and updates
Visit tid.org/weather for up-to-the-minute forecasts

Appendix D
DISTRICT MAPS

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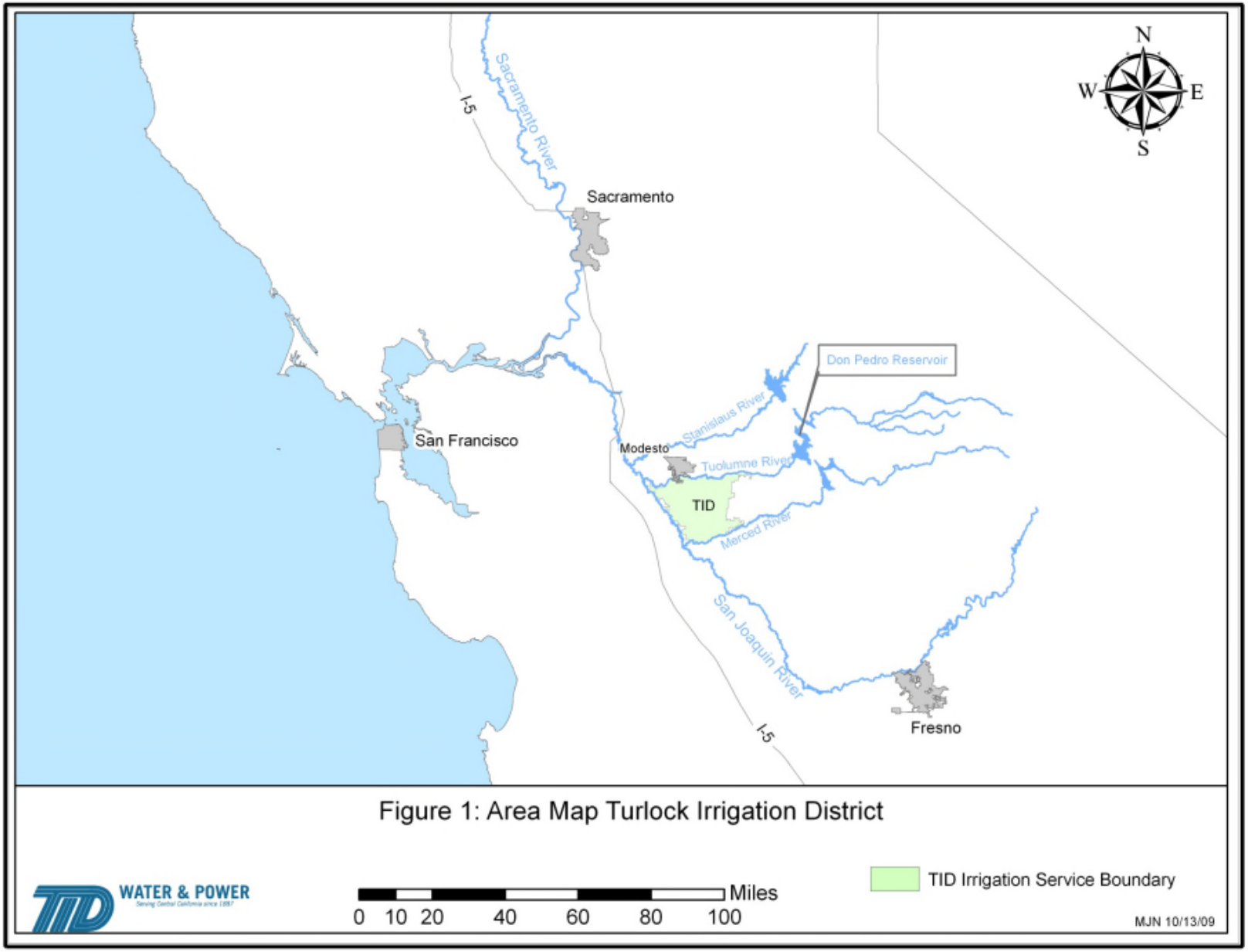
N
W
E
S
Sacramento River
I-5
Sacramento
Don Pedro Reservoir
Stanislaus River
San Francisco
Modesto
Tuolumne River
TID
Merced River
San Joaquin River
I-5
Fresno
Figure 1: Area Map Turlock Irrigation District
WATER & POWER
Miles
0 10 20 40 60 80 100
TID Irrigation Service Boundary
MJN 10/13/09

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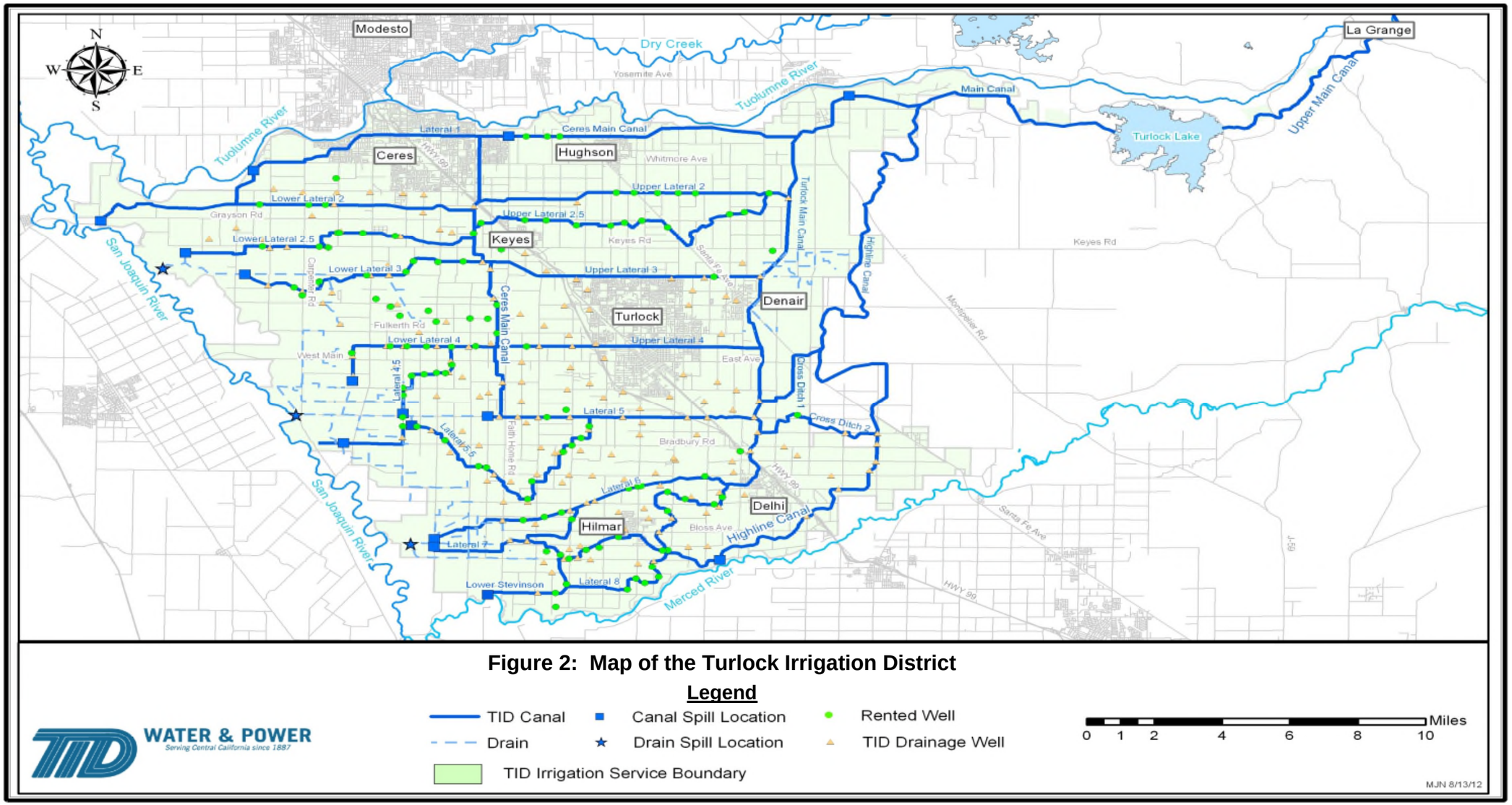

Figure 2: Map of the Turlock Irrigation District

Legend

TID Canal
Drain
Canal Spill Location
Drain Spill Location
Rented Well
TID Drainage Well
TID Irrigation Service Boundary

WATER & POWER
Serving Central California since 1887

0 1 2 4 6 8 10 Miles

MJN 8/13/12

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Appendix E
Turlock Irrigation District Irrigation Rules

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THE TURLOCK IRRIGATION DISTRICT IRRIGATION RULES

I. Rules for the Distribution and Use of Water Within the Turlock Irrigation District..... 2

II. Governing Rules of the Turlock Irrigation District Improvement Districts.....23

III. Rules for the Formation and Operation of Pump Improvement Districts.....35

IV. Rules for the Formation and Operation of Subsurface Drainage Improvement Districts.....42

V. Policies 46

A. Drainage Policy Within the Turlock Irrigation District.....47

EFFECTIVE, SEPTEMBER 30, 2003

REVISED, FEBRUARY 22, 2005

REVISED, JUNE 2, 2009

The Turlock Irrigation District Irrigation Rules can be found online at:

http://www.tid.org/sites/default/files/documents/tidweb_content/Irrigation%20Rules.pdf

A copy of the Turlock Irrigation District Irrigation Rules is also included with this AWMP on a CD

Appendix F
Agricultural Water Measurement Regulation Documentation

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Introduction

The Turlock Irrigation District (TID or District) recognizes the need for farm delivery measurement and uniform standards and procedures for measuring and recording farm water deliveries in order to: (1) provide cost-effective service to customers, and (2) generate improved operational records for planning and analysis. Regulations requiring a specified level of delivery measurement accuracy were incorporated into California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (23 CCR §597) in July 2012. Field investigations conducted between 2002 and 2012 indicated that TID's existing measurement devices, referred to as sidegates, and associated measurement methods are generally adequate for the aforementioned purposes, but that not all sidegates would satisfy the new accuracy standards required by 23 CCR §597. Thus, per regulation 23 CCR §597, TID developed a corrective action plan with a budget and schedule to achieve compliance by December 31, 2015 as described in Appendix F of its 2012 Agricultural Water Management Plan (AWMP).

TID has spent 6.5 million dollars to (1) install 132 new measurement devices to accurately measure deliveries to nearly 3,000 parcels covering about half of the District's service area, and (2) develop calibrated flow rates for more than 3,000 existing sidegate-parcel combinations. The result is delivery measurement satisfying 23 CCR §597 accuracy requirements to 80 percent of TID's assessed area (Figure F.1). However, due to reduced deliveries of surface water during the last two years of drought (i.e. 2014 and 2015), calibrated flow rates remain to be developed for about 20 percent of the TID assessed parcel area. The drought resulted in a reduced allocation to growers, which limited the number of water delivery events, and therefore made it impossible for TID to calibrate all of the nearly 3,000 single sidegate-parcel combinations according to the corrective action plan schedule contained in the 2012 AWMP. TID will continue to calibrate sidegate-parcel combinations in 2016 and plans to install a new, or modified, ordering and delivery measurement recording software for use in 2017.

Compliance Requirements (23 CCR §597.1)

Briefly summarized, 23 CCR §597 requires that on or before July 31, 2012 agricultural water suppliers providing water to 25,000 irrigated acres or more measure the volume of water delivered to customers. Existing measurement devices must be certified to be accurate to within ±12 percent by volume (23 CCR §597.3(a)(1)). New or replacement measurement devices must be certified to be accurate to within ±5 percent by volume in the laboratory if using a laboratory certification, or ±10 percent by volume in the field if using a non-laboratory certification (23 CCR §597.3(a)(2)). The regulation includes specific requirements for certifying and documenting accuracy for existing and new devices (23 CCR §597.4). Additionally, suppliers subject to the regulation are required to report certain information in their AWMP (23 CCR §597.4(e)). TID serves more than 25,000 irrigated acres and is therefore subject to these regulations.

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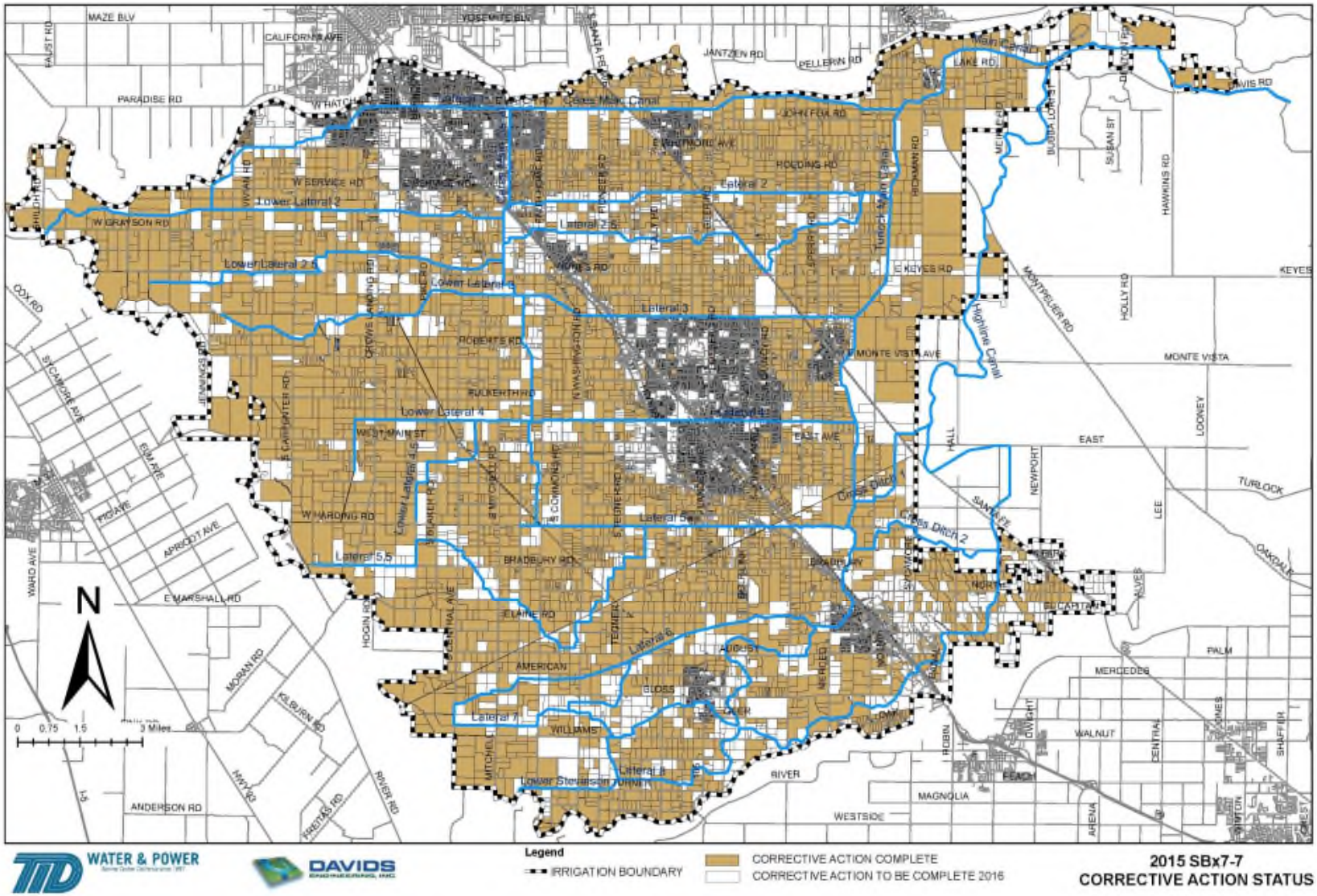

Figure F.1. Map of Parcels with Completed Delivery Measurement Improvements.

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Corrective Actions (23 CCR §597.4(e)(4))

To comply with CCR 23 §597, TID has been aggressively implementing the corrective action plan (plan) described in Appendix F of TID's 2012 AWMP. The following sections provide an overview of delivery facilities, the status of the corrective actions, a plan for calibrating flows at sidegates that were not active during the recent drought years (i.e. 2014 and 2015), a plan for recalibrating flows for parcels with changes to on-farm facilities, and a plan for integrating accurate delivery measurements into TID's volumetric billing process are described in the following sections.

TID FACILITIES FEATURES AFFECTING CORRECTIVE ACTIONS AND CERTIFICATION APPROACH

Sidegates[1] are the delivery points through which water is delivered from TID canals and laterals to customers. TID customers are the individual landowners (or land tenants) to whom TID delivers water, served either directly from the TID distribution system or through facilities owned by groups of landowners organized under IDs. TID measures water deliveries at the sidegate, where responsibility for water control and management is passed from TID to its customers.

Using TID's sidegates to measure delivery volumes at the parcel level (different from delivering a minimum flow rate) is complicated by two main factors:

- Downstream hydraulic conditions on sidegates can vary appreciably among parcels as the head is rotated among customers and, relatively infrequently, even within individual parcels as irrigation "sets" are changed, resulting in flow rate fluctuations.
- In some cases, where sidegates discharge into pipelines, access to vent pipes needed to observe downstream water levels and for conducting flow verification is limited or impossible, or the vents are not located in suitable places for measurement.

TID's corrective action plan addresses the two main factors for both flood heads and for drip and micro system booster pumps at the parcel level. TID installed new permanent measurement devices that are not affected by downstream conditions at 132 sidegates that deliver water to about 49 percent of the service area (Table F.1). For the approximately 800 active existing sidegates not replaced, TID is developing parcel-specific calibrated average flow rates under standard hydraulic conditions (i.e. upstream water level in canal or lateral and sidegate opening), thus accounting for varying downstream conditions at each parcel. TID has inventoried parcels irrigating with booster pumps and has developed parcel-specific flows for these parcels. TID also delivers water to about 600 gardenhead parcels. These parcels are five acres or less and grow small pastures, lawns, ornamentals or produce for self-consumption. These parcels are not subject to the regulation as indicated by DWR's response to comments on the regulation[2].

---

[1] "Sidegate" is the term that is used in TID for the "delivery point" defined in 23 CCR§597 as "…the location at which the agricultural water supplier transfers control of delivered water to a customer or group of customers…." (23 CCR §597.2(a)(6))

[2] Based on DWR's Final Statement of Reasons dated 5/31/12, response number G24.

Table F.1. Summary of Corrective Actions and Associated Certification Approaches and Accuracy Standards for Flood Deliveries at TID Sidegates.

Corrective Action	Delivery Measurement Certification Approach	Accuracy Required (23 CCR §597.3a)	Number of Sidegates	Active Assessed Area Served, acres	Active Assessed Area Served, %
New Device--Continuous Flow Measurement Device	Laboratory Certification of Flow Rate; Field Certification of Duration	Within +/- 10%	132	72,160	49%
Existing Device (sidegate)--Parcel Specific Average Flow Rate	Field Certification	Within +/- 12%	815	74,907	51%
Totals			947	147,067	100%

STATUS OF INSTALLATION OF NEW PERMANENT MEASUREMENT DEVICES

TID selected Rubicon SlipMeters and FlumeMeters for new permanent flow measurement at 132 sidegates representing 72,160 assessed acres, or roughly 49 percent of the District. Both of these devices use Rubicon's Sonaray measurement technology, and are laboratory certified to ±2.5 percent flow rate accuracy (Judge, 2011). Field tests in California irrigation district conditions found that the Sonaray measurement was within ±2.0 percent of an NIST certified magnetic flow meter (Hopkins and Johansen, 2011). TID has installed SlipMeters at 119 sidegates, FlumeMeters at an additional 13 sidegates, FlumeMeters at five branch points in IDs, trained WDOs and irrigators to use the gates, and made a training video available on the TID web site. A SlipMeter completely replaces an existing sidegate and will automatically adjust its opening to deliver a desired flow, hold a specified water level, or maintain a specified gate opening. FlumeMeters are installed in front of existing sidegates, so the sidegates in these cases are still manually adjusted to control delivery flow rate. Both SlipMeters and FlumeMeters send digital data to TID in real time via TID's Supervisory Control and Data Acquisition (SCADA) system. The installation of new permanent flow measurement has been completed.

STATUS OF PARCEL-SPECIFIC FLOW RATE CALIBRATION FOR EXISTING SIDEGATES

At existing sidegates without access vents in suitable locations for measurement, a Rubicon FlumeMeter was temporarily installed, and the continuous record of flow rate was used to develop average flow rates for each parcel. Once at least one delivery event was measured for all actively irrigating parcels served by a sidegate, the Rubicon FlumeMeter was moved to another sidegate. FlumeMeters were used for 1,510 parcels representing 31,996 assessed acres, or over 21 percent of the District. For sidegates with access vents in suitable locations for measurement, a Hach FH950 magnetic Velocimeter was used to determine parcel specific flow

rates. Hach FH950 meters were used at 839 parcels representing 21,480 assessed acres, or nearly 15 percent of the District. For parcels with pressurized on-farm systems served by existing sidegates, a Fuji Portaflow was used to determine parcel specific flow rates. Fuji Portaflow meters were used at 738 parcels representing 26,190 assessed acres, or nearly 18 percent of the District. See Section 5.3 for additional details on the flow rate calibration process for existing sidegates.

Through early September 2015, 1,027 parcel flow rate calibrations have been performed with Rubicon FlumeMeters, representing 22,304 acres, or 70% of the total acreage for this calibration methodology (Table F.2). Additionally, 209 parcel flow rate calibrations have been performed with Hach FH950 meters, representing 7,675 acres, or 36% of the total acreage for this calibration methodology. Finally, 474 parcel flow rate calibrations have been performed with Fuji Portaflow meters, representing 18,078 acres, or 69% of the total acreage for this calibration methodology. In total, 1,710 parcel flow rate calibrations have been performed, representing 48,057 acres, or 60% of the acreage served by existing sidegates.

Table F.2. Summary of Flow Rate Calibration Method and Parcels with Calibrated Flow Rates Completed at TID Existing Sidegates.

Existing Sidegate Calibration Method	Number of Sidegates	Number of Parcels	Assessed Area Served, acres	Number of Parcels Calibrated	Assessed Area Served by Parcels Calibrated, acres	Assessed Area Served by Parcels Calibrated, %
Temporary Continuous Flow Measurement Device (Rubicon Flume Meter)	453	1,510	31,996	1,027	22,304	70%
Spot Current Meter Measurement (Hach FH950)	362	839	21,480	209	7,675	36%
Flood Subtotals	815	2,349	53,476	1,236	29,979	56%
Spot Strap on Flow Meter Measurement (Fuji)	279	738	26,190	474	18,078	69%
Exempt--Non-Agriculture (Gardenheads)	NA	604	906	NA	NA	NA
Totals*	815	3,087	80,572	1,710	48,057	60%

* Totals exceed total number of sidegates and parcels and total area for the existing gates because many parcels that pump also take a few flood deliveries and are thus included in both totals.

PLAN, SCHEDULE AND BUDGET FOR COMPLETION OF CORRECTIVE ACTIONS

As indicated earlier, due to the drought and the resulting limited water availability, calibrated flow rates at approximately 1,300 parcels with a total assessed area of 32,500 acres (about 20 percent of the District's assessed area) remain to be developed. TID has spent $6.5 million on delivery measurement over the last three years and has budgeted $850,000 in 2016 to calibrate the remaining parcels and integrate calibrated flows into the billing process.

In the interest of fair and equitable treatment for all customers, TID does not intend to use any calibrated flow rates for billing purposes until all actively irrigating parcels have been rated. TID plans to inform growers of the calibrated flow rates for each of their parcels during the 2016 calendar year. Growers will also be notified that billing volumetrically based on the new calibrated flow rates rather than the standard ordered heads will begin during the 2017 irrigation season. TID is piloting a new water ordering, delivery, and billing software, and plans to have a new or modified system in place prior to the 2017 irrigation season. TID plans to formally certify the accuracy in 2018 or 2019 after a year or two of operation with the new or modified water ordering and delivery database software system and report the results in the 2020 AWMP.

PLAN FOR CALIBRATING FLOW RATES FOR NEW OR INACTIVE PARCELS

When new or reactivated parcels request water, TID will develop calibrated flow rates for these parcels by measuring the flow rate during an initial irrigation event. The new or reactivated parcel will be calibrated using the same method used to calibrate flows at the parcels served by the same sidegate or by the Fuji meter if the parcel uses a pump. TID will assign a parcel without a calibrated flow rate an initial calibrated flow rate based on an adjacent or nearby parcel (or parcels) served by the same sidegate until the actual calibration can be performed.

Best Professional Practices (23 CCR §597.4(e)(2 and 3))

As described previously in Section 3.1, sidegates are the delivery points through which water is delivered from the TID system to customers. Historically, sidegates are operated for measurement by setting the sidegate opening to deliver a standard flood head, based on the sidegate size and the difference between the water levels upstream and downstream of the sidegate. The sidegate openings are based on specific upstream water levels that are intended to, and generally do, remain steady during canal and lateral operations. The sidegate-specific openings were compiled and provided to WDOs tasked with delivering the water, as well as to growers so they can verify that sidegates openings are correct, and that they are receiving the standard flood head. With the new parcel specific calibrated flows the same standard water levels and gate openings will be maintained and the grower will be charged for the parcel-specific calibrated flow rate.

COLLECTION OF DELIVERY MEASUREMENT DATA

TID collects water measurement data from 342 SCADA sites. Upstream water levels, gate openings, and measured flows are collected through the TID SCADA system at regular intervals. These SCADA sites include all of the 132 new permanent delivery measurement installations and all of the 50 temporary flume meter measurement locations. TID also collects spot flow rate measurements with the Hach FH950 magnetic Velocimeter and Fuji Portaflow transit time flow

meter. The detailed data collected by these devices are stored in Excel and text files and average flows from each measurement are calculated and stored in Excel files summarizing the results.

TID also records ordered flow rates and durations in a water ordering and delivery database and plans to implement a new, or modified, irrigation water ordering, delivery, and billing system by 2017 that will:

1. Use SCADA reported measured flows and WDO recorded durations confirmed by SCADA delivery durations from the new, permanent measurement devices,
2. Use calibrated sidegate-parcel specific flow rates and WDO recorded durations for existing sidegates,
3. Track water that is measured through a sidegate, but not delivered to a grower, but rather passed to another ID or TID canal or lateral via an intertie at the end of the pipeline,
4. Track water to the sidegate if it is delivered to parcels that can be served by multiple sidegates, and
5. Allow WDOs to make adjustments to delivery volumes in the interest of fairness for the relatively rare situations when delivery service does not meet TID service standards.

FREQUENCY OF MEASUREMENTS

TID collects SCADA data on regular intervals. Spot flow rate measurements are collected when growers ask for validation measurements of flows and at other times as needed. Delivery start and end dates and times are collected and recorded by WDOs for each water delivery event.

METHOD FOR DETERMINING IRRIGATED ACRES

TID maintains a database of irrigated parcels that receive water deliveries. The assessed area of these parcels is reduced by six percent to account for roadways, buildings and other non-irrigated areas to determine irrigated acres.

QUALITY CONTROL AND QUALITY ASSURANCE PROCEDURES

TID regularly reviews all water measurement data collected. Growers are billed for the water volume they use, and will likely contact TID if there is an error in the water volume delivered. If an error is found, TID staff promptly correct the error. Much of the water data collected by TID is used in the District-wide water balance reported on Section 4 of the AWMP. Prior to using data in the water balance, the data is reviewed for out-of-range values and other possible errors. When assembled in the water balance, the data is again checked for consistency by comparing to other data in the water balance to ensure the highest possible data quality.

CONVERSION OF FLOW RATE TO VOLUME

TID's new, or modified, water ordering and delivery recording system will convert flow rates to volume for the new measurement devices by multiplying the measured flow rate by WDO recorded duration as confirmed by the SCADA recorded duration. For the existing sidegates, the calibrated flow rate will be multiplied by the WDO reported duration.

Preliminary Field Testing (23 CCR §597.4(b))

TID conducted preliminary field tests during the 2015 irrigation season to confirm that the new and calibrated existing measurement devices would satisfy the 23 CCR §597 accuracy requirements. Random samples of 100 delivery events for each device type were selected and analyzed, confirming that the device will meet the accuracy requirements. Additionally, these tests identified some challenges that will be addressed during design and implementation of the new, or modified, water order and delivery database software system. TID plans to formally certify the accuracy in 2018 or 2019 after a year or two of operation with the new or modified water ordering and delivery database software system and report the results in the 2020 AWMP.

References

Hopkins, J.D. and K.R. Johansen. 2011. In-Situ Testing of a 600 mm Rubicon SlipMeter™ in Oakdale Irrigation District, CA. Provost & Pritchard Consulting Group. Clovis CA.

Judge, A. 2011. Laboratory Testing of a 600 mm Rubicon SlipMeter™ February-March 2011. Manly Hydraulics Laboratory. Manly Vale, NSW. Australia.

Appendix G
Turlock Irrigation District Drought Management Plan

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Background and Overview

TID has historically faced variability in surface water supplies due to drought, which led to development of current water shortage allocation policies that date back to the 1976-1977 drought, the most severe two year historical drought, and the 1987 to 1992 drought, the most severe and longest drought in recorded history. Both of these droughts were the historic design drought until the current 2012-2015 observed drought. These policies evolved from water shortages experienced over the last 119 years. A key aspect of TID's drought management policy is to plan for the use of carryover storage in Don Pedro Reservoir and strategic, conjunctive management of surface water and groundwater supplies for a period of forecasted consecutive dry years. Prudent water supply planning requires TID to consider that the first dry year encountered may be the first year in a series of dry years, similar to the 1976-1977, 1987 to 1992, or 2012-2015 period.

On April 1, 2015 Governor Brown issued Executive Order B-29-15, mandating agricultural water suppliers include a detailed Drought Management Plan (DMP) describing actions and measures taken to manage water demand during drought. In response to the Governor's Executive Order, TID has developed a detailed description of existing policies and extraordinary actions undertaken in response to current drought conditions. This DMP describes a broad range of actions undertaken during drought to manage available water supplies and meet customer demands to the maximum extent possible.

The DMP builds upon existing shortage allocation policies adopted by TID for drought conditions. In addition, the DMP includes components recommended by DWR in its 2015 AWMP Guidebook for inclusion (DWR 2015). TID's DMP combines long-standing shortage allocation policies with more recent actions to address ongoing, historic drought conditions. The DMP describes actions taken under the following categories:

- Monitoring of Hydrologic Conditions to Assess Available Supply and Drought Severity
- Declaration of Water Shortage and Implementation of Drought Policies
- Operational Modifications to Increase Operational Efficiency
- Demand Management Actions
- Alternative and Additional Water Supplies
- Stages of Action
- Coordination and Collaboration
- Expenditures and Revenues

In addition to describing TID drought actions and activities as outlined above, the DMP includes a summary of 2015 supply and demand conditions available at the time of preparation of this DMP for the 2015 AWMP update.

Drought Actions and Activities

This section describes actions and activities undertaken by TID to address drought and incorporates the shortage allocation policies described in Section 2.8 of the District's AWMP.

MONITORING OF HYDROLOGIC CONDITIONS TO ASSESS AVAILABLE SUPPLY AND DROUGHT SEVERITY

Monitoring of hydrologic conditions to assess available water supply is at the core of TID's drought management strategy. In order to inform decisions related to available water supply, TID actively monitors forecasted precipitation and snow, accumulated precipitation and snow, runoff, reservoir storage, groundwater levels, availability of rented pumps, and instream flows to assess water supply availability. Other sources of information include DWR snow surveys and other available streamflow and groundwater level measurements. This data is incorporated into the District's real-time and firm yield models to forecast operations and inform decisions.

Water reports describing hydrologic conditions are prepared by staff and reported to the Board of Directors at each Board meeting. Sample reports for 1/13/2015, 4/7/2015, 6/30/2015, and 8/25/15 are provided in Attachment G.1.

DECLARATION OF WATER SHORTAGE AND IMPLEMENTATION OF DROUGHT POLICIES

The District's Board of Directors determines annual water availability, expressed as available water per acre served of up to 48 inches in average to wet years, based on staff recommendations. Staff develops and reviews runoff projections and projected carryover storage and considers past operations experience in developing recommendations to the Board. In dry (reduced water supply) years, less than 48 inches is available. For the drought years of 2012 to 2015, available water ranged from a maximum of 34 inches in 2013 (71% of a full supply year) to 18 inches in inches in 2015 (38% of a full supply year), as indicated in Table G.1.

Table G.1. Recent Historical TID Water Available.

Year	Available Water (inches)[1]	Percent of Full Supply
2011	48	100%
2012	30	63%
2013	34	71%
2014	20	42%
2015	18	38%

[1]Depth of water in inches available equally to each acre of land. For 2011-2012 this was the allotment.

OPERATIONAL MODIFICATIONS TO INCREASE OPERATIONAL EFFICIENCY

During drought, TID modifies operations to increase operational efficiency with the primary goal of reducing operational spillage from TID canals and laterals. This is accomplished through a combination of strategies. First, Water Distribution Operators (WDOs) increase effort to reduce spillage through spill monitoring and more frequent adjustments to water level control structures and lateral headings, and the use of pumps to more precisely match supply with demand.

In all but extreme drought years, TID is able to increase groundwater pumping to supplement surface water supplies in the canal system, providing increased flexibility for WDOs to more precisely match water supply to customer demands and further reduce spills. Using pumps in this manner, particularly in the lower distribution system (i.e. west of the Ceres Main Canal), allows WDOs more rapidly adjust canal flows to match demand and reduce spills that result from irrigation head changes and different delivery amounts that cause fluctuations in canal flows. This strategic use of groundwater supplies enables the District to maximize surface water supplies, reserving surface water in Don Pedro Reservoir that would otherwise have spilled and to make it available for delivery later in the season or in subsequent dry years.

During the 1987-1992 drought, these actions resulted in a substantial decrease in operational spills. TID has continued to rely on these extraordinary operational practices in subsequent drought years. Notably, during the dry period of 2007 through 2009 operational spills were decreased to an average of less than five percent of total supply. Similarly, during the onset of the current drought from 2012 through 2014 operational spills decreased each year to less than five percent of total supply. Comparable spillage percentages are expected for the 2015 irrigation season.

Another operational strategy employed by TID to increase operational efficiency in drought years is to modify targeted water levels in Turlock Lake. By operating the Lake at reduced water levels during drought, losses are reduced. In 2015, TID operated Turlock Lake at approximately 50% of capacity to reduce seepage and evaporation.

TID's internal water transfer policies allow growers to transfer water between parcels that they own or rent. This program enables growers to maximize available supplies for use in meeting crop water requirements and is facilitated by TID WDOs, who convey the transferred water using the TID distribution system as needed.

In addition to changes in operations during drought years, TID is taking long-term steps to improve infrastructure and institute updated operational strategies to further improve operational efficiency. Current efforts include a pilot project to automate Lateral 8 to provide additional operational flexibility and spill reduction. Also, as of 2015, TID's new Lateral 8 Reservoir became operational and captures water that would otherwise be spilled into the San Joaquin River. Another example is the District's recent improvements in SCADA-based flow monitoring and access to the data in the field, combined with pump automation. These improvements enable WDOs to more efficiently manage canal flows and maximizing deliveries to growers while minimizing spills.

Additionally, TID is developing a long-term Water Master Plan to identify and evaluate other options to increase water delivery flexibility and minimize system losses. TID continues to improve and upgrade flow measurement and monitoring along supply canals and at points of delivery to help WDOs more closely match diversions and District pumping to customer demands in order to reduce spills.

DEMAND MANAGEMENT ACTIONS

TID encourages on-farm water conservation and demand reduction during dry and drought years through several actions, including the following:

- Education and Outreach to Growers
- Enforcement of TID Rules and Regulations
- Reduction of Water Available
- Reduction in Season Length
- Increased Cost per Unit of Water Delivered

These actions are summarized in the remainder of this section.

Education and Outreach to Growers

TID regularly provides educational resources and conducts outreach activities to support efficient water management by its irrigation customers. During drought, TID increases these efforts to further encourage on-farm water conservation and to keep growers informed of changes to TID policies and practices to manage limited water supplies. An example of TID's extraordinary drought efforts is the Drought Information section of its web site which, in addition to TID resources, includes links to city and county resources and resources available from the State and other entities[16]. TID resources include those listed below and provided as Attachments to this DMP.

TID General Resources (Attachment G.2)

- TID Water Conservation FAQ's
- TID Drought Resolution, adopted by TID Board of Directors on Feb. 25, 2014
- TID Water Management page
- TID Irrigation Tips page
- TID Water Usage page for irrigators
- TID Water Measurement Project Presentation

Grower Resources (Attachment G.3)

- Drought Strategies for Orchards
- Strategies for Farming in a Drought
- University of California Drought Management page
- How NRCS can help?

Grower Meeting Information (Attachment G.4)

- January 2014
- February 2014
- January 2015
- February 2015

[16] http://www.tid.org/drought-information. Accessed September 10, 2015.

Enforcement of TID Rules and Regulations

TID's Irrigation Rules (Appendix E) require that all water be applied efficiently and used in a reasonable and beneficial manner. During an irrigation delivery, the irrigator is responsible for the water at all times after it leaves the TID distribution system. Irrigators who waste water intentionally or as a result of carelessness, improper field preparation, or neglected facility maintenance may be refused TID water until the cause of the waste is remedied.

In the face of drought, TID has increased enforcement of water regulations to prevent unauthorized use of water. Failure or refusal to comply with the TID rules and regulations by a landowner or irrigator may lead to suspension of water delivery and water delivery cannot be restored until the issue is resolved. The Water Distribution Department Manager is authorized to issue a Notice and Order or oral or written warning to any irrigator or landowner in violation of a TID rule or regulation. The landowner or irrigator has 10 calendar days from the date of service to file a written appeal to the General Manager or Board of Directors, depending on type of notice, after which all rights to a hearing are waived. Water deliveries may be terminated immediately in certain circumstances. These circumstances and the appeal process are described in detail in the TID Irrigation Rules in Part I, Section 10 (Appendix E).

Once an order or decision has become final, the irrigator or landowner has 7 calendar days to commence corrective action or repair and must pursue the action with sufficient diligence to meet the time established for compliance. When the landowner or irrigator returns to full compliance with all regulations, the individual will resume eligibility to receive water deliveries.

As part of the 2015 Irrigation Season Rules, the TID Board of Directors adopted the following penalties for unauthorized use of water:

- First offense - $1,000 fine and water taken will be billed at the highest tier amount.
- Second offense- Potential loss of water on all parcels owned or rented for the remainder of the season.

Reduction of Water Available

As described previously, the District's Board of Directors determines annual water availability, expressed as water available per acre served of up to 48 inches, based on staff recommendations. In dry (reduced water supply) years, less than 48 inches is available. Reducing available water supplies (as described under the water shortage policies) directly reduces customer demand. During the drought years of 2012 to 2015, available surface water supplies have ranged from 38% to 71% of full supply, with an average of 52%. Some growers have responded to the reduction in available water by switching to drought resistant sorghum. In 2014, a new crop code for sorghum was added at the request of TID's Call Center in response to growers reporting their crop as sorghum.

Reduction in Season Length

The District's Board of Directors determines the irrigation season start and end dates considering grower preferences and staff recommendations. In dry (reduced water supply) years, the season start and end dates are often adjusted to reduce the season length. In 2014, the irrigation season

was 182 days, the shortest in the last 24 years (1991-2014) and 34 days less than the 24-year average.

Increased Cost per Unit of Water Delivered

Beginning in 2013, a new water rate structure was implemented. In reduced supply years, the Board of Directors has the discretion to implement a dry year rate schedule, increasing the cost per acre-foot delivered, based on consideration of certain factors and staff recommendations. Each schedule includes a fixed charge per acre plus volumetric water charges.

Rates were updated in January 2015 for implementation starting in 2015. The updated water rates are as follows:

- Normal Year
  - $60 per acre fixed charge
  - Volumetric Charge
    - Tier 1: $2 per acre-foot, up to 2 acre-feet per acre
    - Tier 2: $3 per acre-foot, 2 to 4 acre-feet per acre
    - Tier 3: $15 per acre-foot, 4 to 5 acre-feet per acre
    - Tier 4: $20 per acre-foot, above 5 acre-feet, if available
- Dry Year
  - $68 per acre fixed charge
  - Volumetric Charge
    - Tier 1: $2 per acre-foot, up to 1 acre-feet per acre
    - Tier 2: $3 per acre-foot, 1 to 2.5 acre-feet per acre
    - Tier 3: $15 per acre-foot, 2.5 to 3.5 acre-feet per acre
    - Tier 4: $20 per acre-foot, above 3.5 acre-feet, if available

Total costs per acre irrigated as a function of usage are illustrated in Figure G.1. As indicated, during dry years the cost for a given amount of usage is increased, encouraging on-farm conservation or other grower decisions to reduce demand.

ALTERNATIVE AND ADDITIONAL WATER SUPPLIES

Generally, TID water supplies have been sufficient in all but the driest of years due to conjunctive management of surface water and groundwater supplies and drought management actions. Generally, the District has increased rented pumping during dry years. Under historic drought conditions such as experienced in 2015, TID limited rented pumping to areas without risk of negative impacts to surrounding water users. Specifically, TID avoided pumping in the area of its service territory bounded by Harding Road to the south, the Tuolumne River to the north and from Faith Home Road east to the irrigation service boundary.

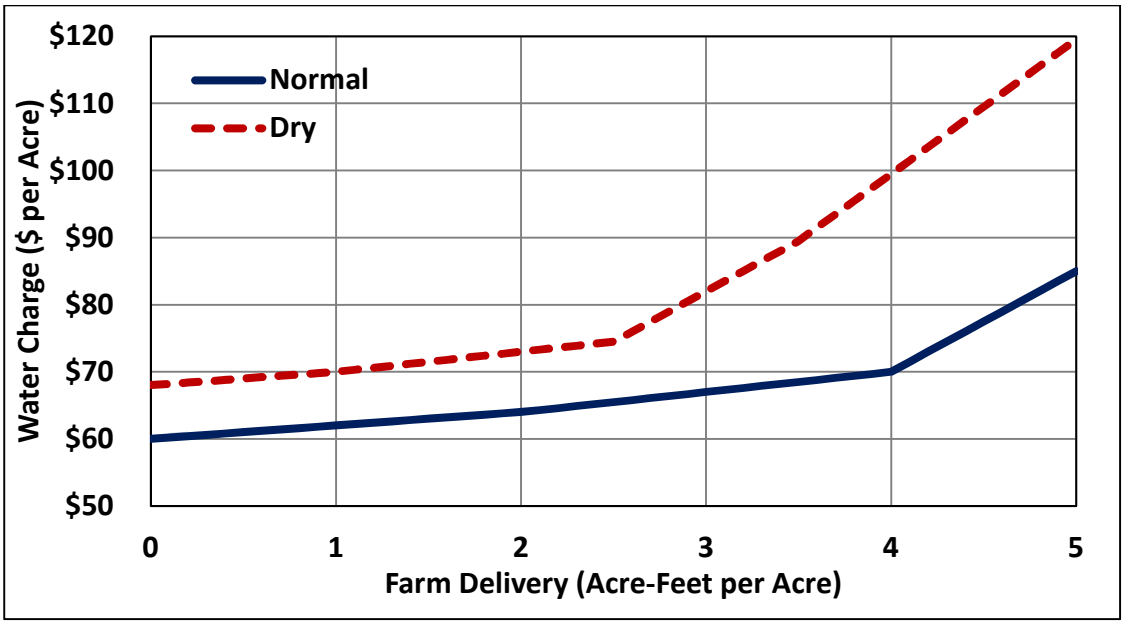

Figure G.1. TID Normal and Dry Year Per-Acre Water Costs as a Function of Usage.

TID considers potential water transfers from others on a case-by-case basis; however, availability of transfers is limited and, if available, costly. TID actively utilizes available recycled water and drainage water to supplement primary water supplies. The District is actively working with the City of Turlock to obtain access to 2,000 AF of tertiary treated surface water for irrigation purposes which might be available as early as the 2016 irrigation season. TID's pumping for credit program allows growers to optimize the use of additional groundwater supplies during drought.

In addition, TID has an active cloud seeding program in conjunction with the Modesto Irrigation District to help to increase available surface water supplies. TID will continue to evaluate the program, taking advantage of technological advances and/or increased cloud seeding opportunities to enable the Districts to maximize the water supply benefits of the program.

STAGES OF ACTION

TID does not rely on mechanistic, pre-determined triggers to implement drought management actions. Rather, the Board of Directors considers data that it receives on an ongoing basis as well as recommendations from TID staff based on assessment of current and projected water supply conditions on an annual basis to set an annual water available amount. Based on Board decisions influenced by the annual water available amount, water policies are modified, and drought management actions are implemented and adjusted as needed. This approach to managing water supplies and demands during allows TID maximum flexibility to maximize the long term reliability, quality, and affordability of irrigation water supplies.

COORDINATION AND COLLABORATION

TID coordinates and collaborates extensively with others to coordinate operations in all years. The District participates in and cooperates with the Stanislaus County Drought Task Force and the State Office of Emergency Services to respond to local drought emergencies. The District reports data to the California Energy Commission, the California Department of Water Resources, and other governmental entities as necessary. The District works with the City and County of San Francisco and the Modesto Irrigation District regarding Tuolumne River water supplies and demands including instream flows, snowpack, agricultural and urban demands, climate change, and other considerations.

The District participates in the Turlock Groundwater Basin Association (TGBA) and the Stanislaus County Groundwater Technical Advisory Committee regarding groundwater resources issues, such as groundwater level and quality monitoring, and public education and outreach. Additionally, the District meets with local cities and counties regarding groundwater resources, water conservation and recycling, and public education and outreach.

EXPENDITURES AND REVENUES

TID mitigates the decrease in available water supply for sale to customers during drought years in part by setting irrigation water rates with a large portion based on a fixed (per-acre) component and by increasing both fixed and volumetric water rates in dry years.

Increased expenditures required to implement extraordinary drought management actions are mitigated by reducing expenditures for capital improvements and maintenance. This allows for more emphasis on system operations and demand management. District staff members spend significantly more time providing irrigation customer service and outreach to the public through increased grower meetings, outreach programs, and drought workshops.

Water Supply and Demand during Drought

WATER SUPPLY DURING DROUGHT

TID's water supplies for 2011 to 2015 are discussed to illustrate the actions taken by TID and its customers to manage available water supplies during drought. The year 2011 represents a normal year with full supply, while the years 2012 through 2015 represent an historic, multi-year drought. All sources of supply are summarized, (to the extent available at the time of preparation of this DMP), including Turlock Lake releases, District pumping (including both rented pumping and drainage pumping), private pumping, and other supply sources (subsurface drainage reuse, tailwater to canals, and spill recovery).

Turlock Lake releases during the 2012 and 2013 were more than 100,000 acre-feet less than the supply in 2011 at slightly above 450,000 acre-feet (Figure G.2). These two years were within a few thousand acre-feet of the dry year average of about 458,000 acre-feet. In 2014, surface water releases from Turlock Lake were reduced to slightly more than 300,000 acre-feet. In 2015 through September 11, 2015, releases from Turlock Lake are slightly less than they were in 2014 and are likely to be around 300,000 acre-feet.

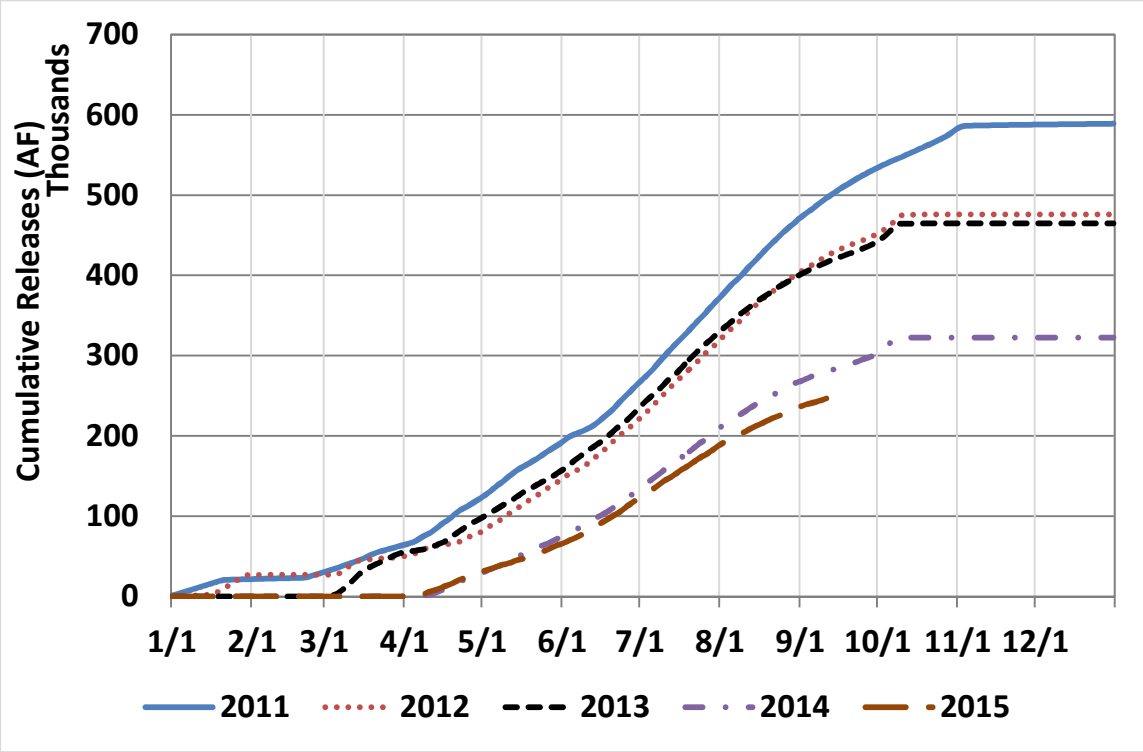

Figure G.2. Daily Cumulative Turlock Lake Releases for 2011 through September 11, 2015 (2015 data is preliminary).

TID total district pumping, the combined total of drainage and rented pumping, was lowest during 2011, the last full supply year and nearly doubled from just over 60,000 acre-feet to over 110,000 acre-feet in 2012 and 2013 (Figure G.3). In 2014, the total district pumping decreased to about 85,000 acre-feet, as TID reduced pumping in certain areas to reduce the potential impacts on local groundwater levels.

TID total private pumping was lowest during 2011, the last full supply year and more than doubled by 2013 to more than 44,000 acre-feet (Figure G.4). In response to the reduced District pumping in 2014, the private pumping increased to about 103,000 acre-feet. The 2015 private pumping volume is not currently available, as these volumes are compiled, summarized and reported after the irrigation season is complete.

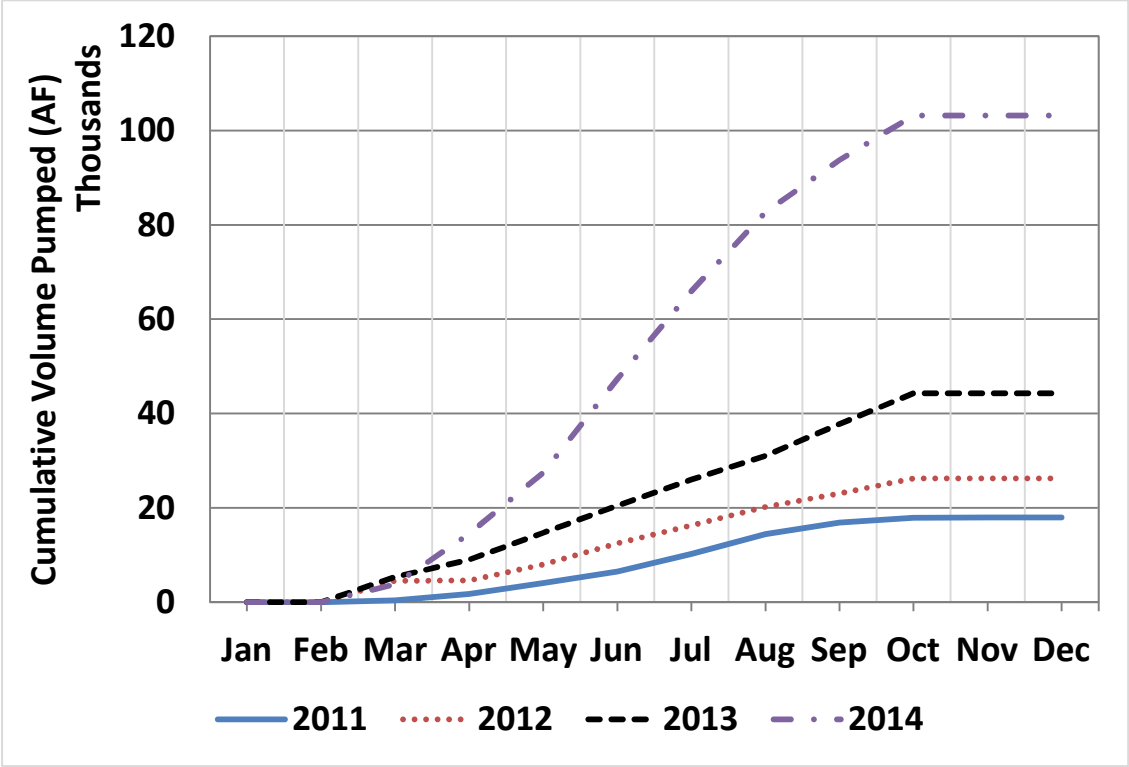

Figure G.3. Monthly Cumulative District Pumping for 2011 to 2014.

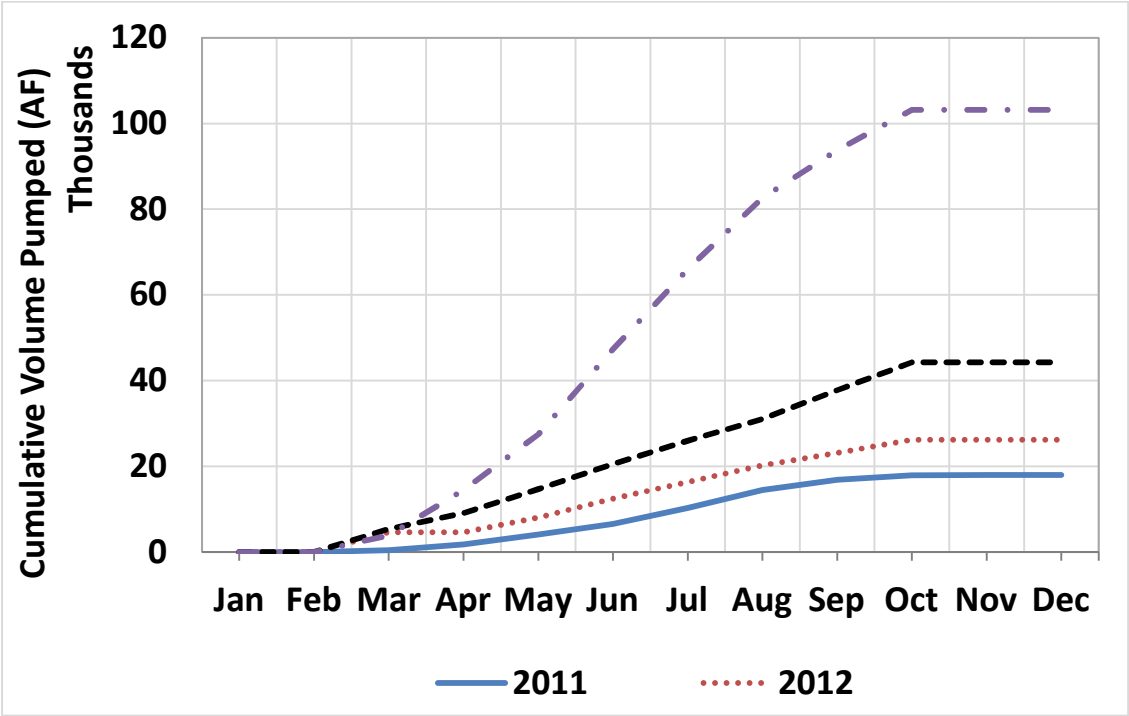

Figure G.4. Monthly Cumulative Private Pumping for 2011 to 2014.

Other water supplies available to TID are recycled water within TID from subsurface drainage, tailwater, spill recovery, and recycled wastewater. TID other water supplies were greatest during in 2011, the last full supply year, and decreased more than 30 percent to less than 14,000 acre-feet in 2014 (Figure G.5). These recycled volumes also reduce as the available surface water supplies reduce during drought periods. The 2015 other water supply volume is not currently available, as these volumes are compiled, summarized and reported after the irrigation season is complete.

TID total water supply was greatest during 2013, 1,500 acre-feet greater than during the last full supply year. TID total supplies were within 15,000 acre-feet for the three years 2011, 2012 and 2013 indicating that TID's conjunctive management strategy is successful in weathering short droughts. However, by the third year of the drought in 2014, TID groundwater production could no longer make up for the loss of surface water supply and total water supplies were reduced by about 100,000 acre-feet from the previous three years (Figure G.6). The 2015 data to date on TID total water supplies is not available due to the unavailability of private pumping and other supply volumes, however the total water supplies are projected to be slightly less than those available in 2014 based on the 2015 cumulative Turlock Lake releases through September 11 (Figure G.2.).

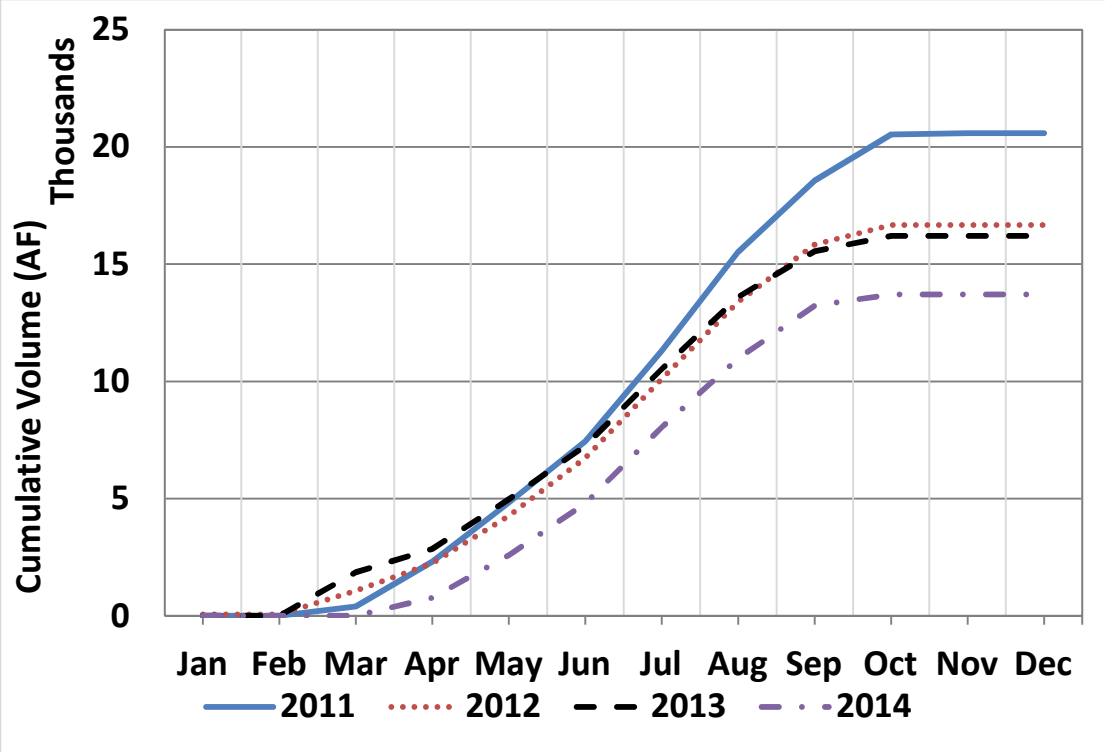

Figure G.5. Monthly Cumulative Other Supply for 2011 to 2014.

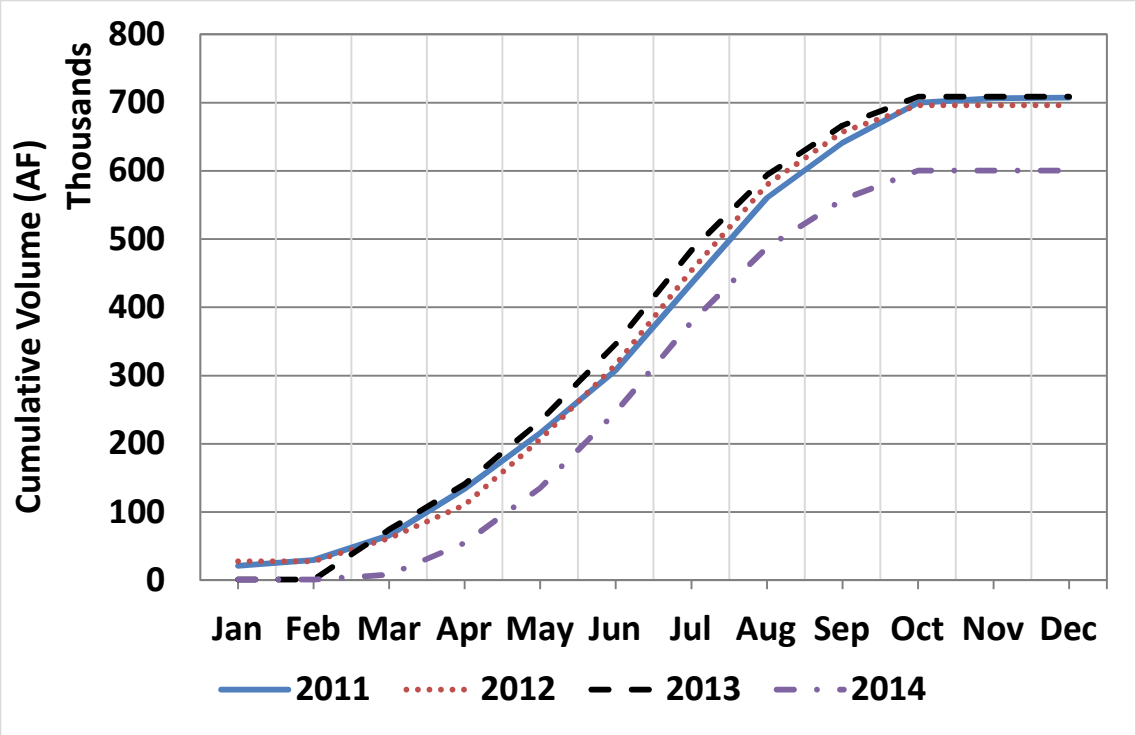

Figure G.6. Monthly Cumulative Total Supply for 2011 to 2014.

WATER DEMAND DURING DROUGHT

To illustrate water demands in TID during drought, water demands for 2011 through 2015 are summarized, to the extent available. The year 2011 represents a normal year with full supply, while the 2012 through 2015 period represent a historic, multi-year drought. Demand is characterized based on monthly deliveries as quantified through the TID water balance, a measure of farm surface water demand; reference evapotranspiration (ET_o), a measure of atmospheric water demand; and crop evapotranspiration of applied water (ET_{aw}), a measure of consumptive water demand.

TID delivery volume was greatest in 2012, about 6,500 acre-feet greater than during 2011, the last full supply year. TID total deliveries were within 6,500 acre-feet for the three years 2011, 2012 and 2013 again indicating that TID's conjunctive management strategy is successful in weathering short droughts. However, by the third year of the drought in 2014, TID deliveries were reduced by about 75,000 acre-feet from the previous three years (Figure G.7). In 2015, deliveries to farms from the TID distribution system through September 12 were slightly less than they were in 2014. The total deliveries have not decreased as much as the TID total supplies due to increases in water use efficiency, namely reduction in spillage and increases in on-farm irrigation efficiency.

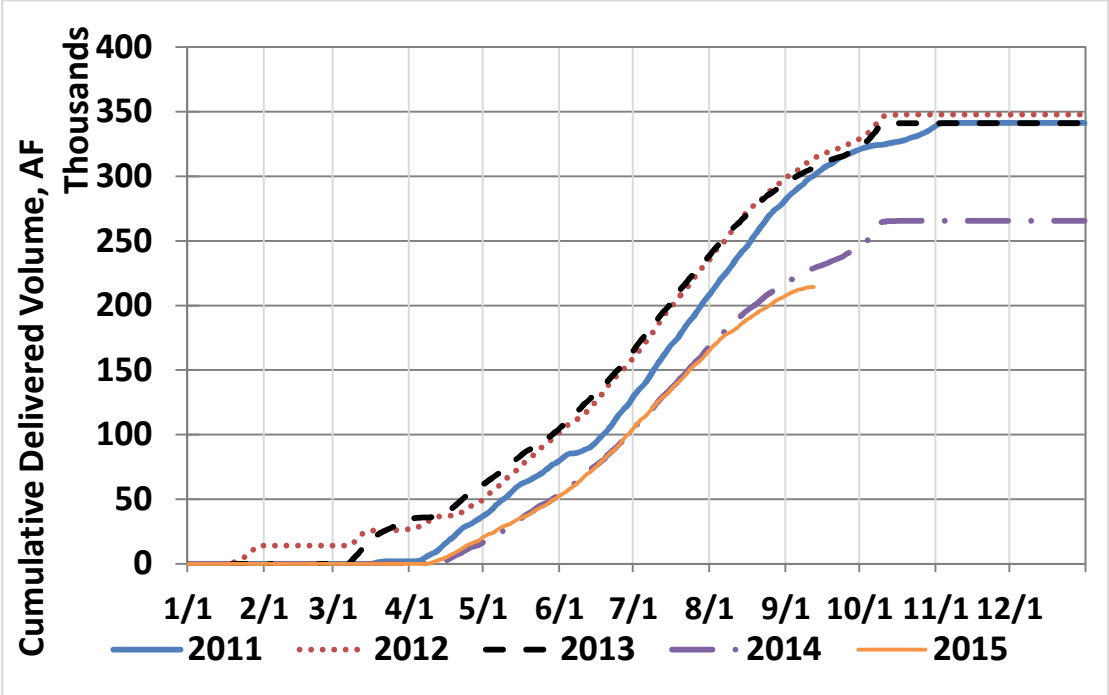

Figure G.7. Monthly Cumulative TID deliveries for 2011 through September 12, 2015 (2015 data is preliminary).

Denair CIMIS ET_o during the last normal year, 2011, and the first year of the drought, 2012 were essentially the same at 52.0 and 52.9 inches, respectively. ET_o during the last three years, including CIMIS records through September 9, 2015, are about 10 percent higher compared to 2011 and 2012, with 2013 and 2014 totaling 56.9 and 57.1 inches, respectively. This year, 2015, cumulative ET_o is slightly lower than that last two years and on track to total about 56 inches. Daily cumulative ET_o for 2011 to 2015 is shown in Figure G.8.

ET_{aw} was lowest during 2011, the last full supply year and increased 86,000 acre-feet to about 364,000 acre-feet in 2013 (Figure G.9). In spite of the large decrease in total supply in 2014 (Figure G.5), ET_{aw} decreased by only about 6,000 acre-feet to 358,000 acre-feet. This is due to the reduction in spillage from the TID distribution system and the increase in on-farm crop consumptive use fraction.

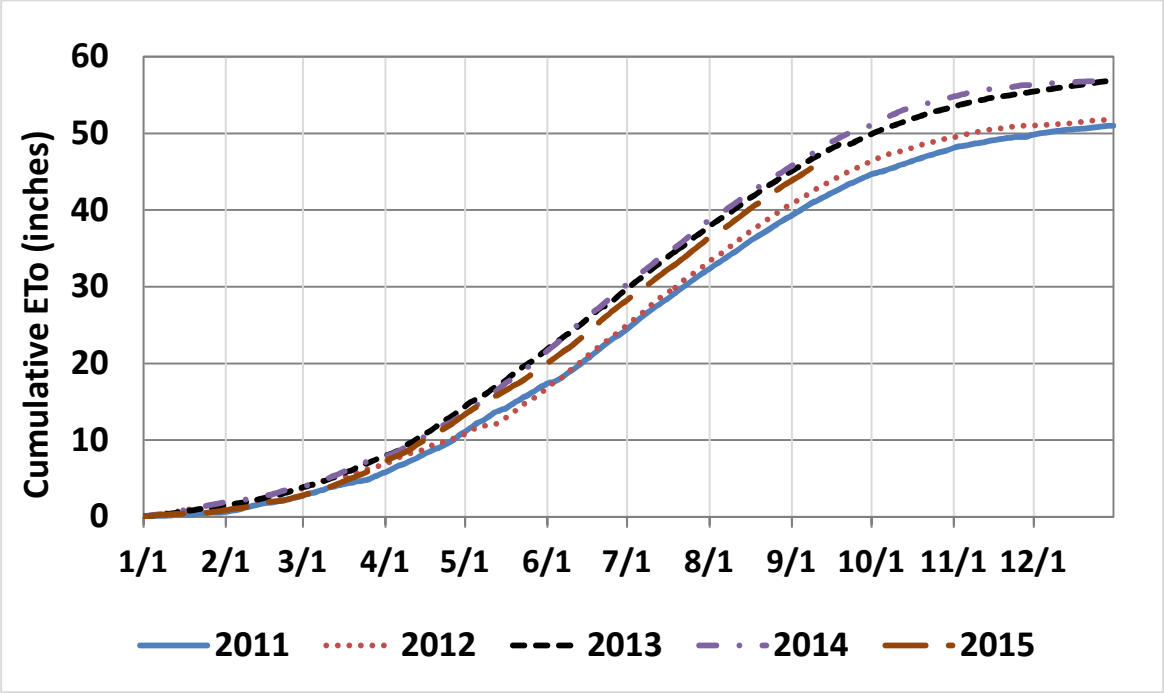

Figure G.8. Daily Cumulative ET_o for 2011 to 2015.

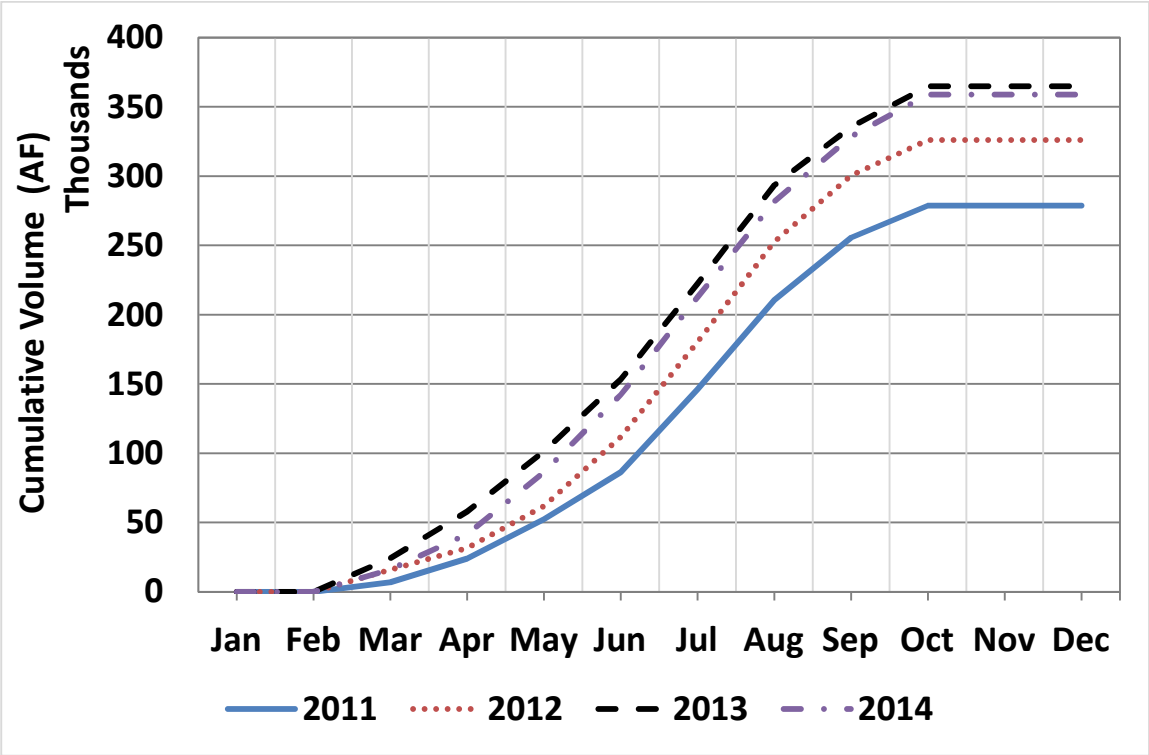

Figure G.9. Monthly Cumulative crop ET_{aw} for 2011 to 2014.

References

DWR. 2015. A Guidebook to Assist Agricultural Water Suppliers to Prepare a 2015 Agricultural Water Management Plan. California Department of Water Resources.

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Attachments

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Attachment G.1. TID Board Meetings

Attachment G.1 can be found on line at: http://www.tid.org/news-resources/minutes-agendas/meetings
Water Report for 1/13/2015, link below
http://www.tid.org/sites/default/files/documents/news-resources/WaterReport_Meeting_1-13-15.pdf
Water Report for 4/7/2015, link below
http://www.tid.org/sites/default/files/documents/news-resources/WaterReport_4-7-15.pdf
Water Report for 6/30/2015, link below
http://www.tid.org/sites/default/files/documents/news-resources/WaterReport_6-30-15.pdf
and
Water Report for 8/25/15, link below
http://www.tid.org/sites/default/files/documents/news-resources/WaterRepor8-25-15.pdf

Attachments G.2, G.3, and G.4 can be found on line at: http://www.tid.org/drought-information

TID General Resources (Attachment G.2)

TID Water Conservation FAQ's
TID Drought Resolution, adopted by TID Board of Directors on Feb. 25, 2014
TID Water Management page
TID Irrigation Tips page
TID Water Usage page for irrigators
TID Water Measurement Project Presentation

Grower Resources (Attachment G.3)

Drought Strategies for Orchards
Strategies for Farming in a Drought
University of California Drought Management page
How NRCS can help?

Grower Meeting Information (Attachment G.4)

January 2014
February 2014
January 2015
February 2015

A copy of Attachments G.1-G.4 are also included with this AWMP on a CD.

TURLOCK GROUNDWATER BASIN

Groundwater Management Plan

Prepared for:

Turlock Irrigation District
333 East Canal Drive/P.O. Box 949
Turlock, CA 95381

March 18, 2008

Prepared by:

Turlock Groundwater Basin Association

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Acronyms and Abbreviations

AB	Assembly Bill
AF	Acre-feet
AF/yr	Acre-feet per year (1,120 AF/yr = 1 MGD)
BCWD	Ballico-Cortez Water District
BMO	Basin Management Objective
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CSD	Community Services District
CVRWQCB	Central Valley Regional Water Quality Control Board
CWC	California Water Code
CWD	County Water District
DBCP	Dibromochloropropane
DCWD	Delhi County Water District
DEH	Division of Environmental Health (Merced Co.)
DER	Department of Environmental Resources (Stanislaus Co.)
DHS	Department of Health Services
dS/m	deciSiemens per meter
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment & Protection
EC	Electrical Conductivity
EDB	Ethylene dibromide
EPA	United States Environmental Protection Agency (also U.S. EPA)
EWD	Eastside Water District
ft	feet
GAMA	Groundwater Ambient Monitoring & Assessment
GIS	Geographic Information Systems
GMP	Groundwater Management Plan
GPD	gallons per day
GPM	gallons per minute
GW	groundwater
HCWD	Hilmar County Water District
ID	Irrigation District
LAFCO	Local Agency Formation Commission
MCL	Maximum Contaminant Level
MGD	million gallons per day (1 MGD = 1,120 AF/yr)
mg/L	milligrams per liter = ppm
Merced ID	Merced Irrigation District
mmhos/cm	millimhos per centimeter
MOU	Memorandum of Understanding
mS/cm	milliSiemens per centimeter
msl	mean sea level
NAWQA	National Water Quality Assessment

NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PBE	Physical Barrier Effectiveness
PCA	Potential Contaminating Activity
PCE	Perchloroethylene
ppb	parts per billion = µg/L
ppm	parts per million = mg/L
psi	pounds per square inch
RWQCB	Regional Water Quality Control Board
RWQCF	Regional Water Quality Control Facility (City of Turlock)
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
SOI	Sphere of Influence
SMSA	South Modesto Service Area
SW	surface water
SWRCB	State Water Resources Control Board
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TGBA	Turlock Groundwater Basin Association
TID	Turlock Irrigation District
TMDL	Total Maximum Daily Load
µg/L	micrograms per liter = ppb
µmhos/cm	micromhos per centimeter
USACE	U.S. Army Corps of Engineers
µS/cm	microSiemens per centimeter
USGS	U.S. Geological Survey
UST	Underground storage tanks
VOC	Volatile organic compound
WPA	Wellhead Protection Area
WSA	Water Supply Assessment

EXECUTIVE SUMMARY

This Groundwater Management Plan (Plan) provides an overview of the local agencies, land uses, and status of groundwater resources in the local groundwater basin, the Turlock Subbasin. The local water agencies, through the Turlock Groundwater Basin Association (TGBA or Association), have taken a cooperative, basin-wide approach to coordinate groundwater management activities and prepare this Plan. The overall goal of the Association is to ensure that groundwater remains a reliable, safe, efficient, and cost-effective water supply for the local area. This Plan presents the basin-wide management objectives proposed to achieve this goal, and concludes with recommended measures that can be drawn from to meet the basin management objectives and the long-term goal of ensuring the viability of the groundwater supply.

THE TURLOCK GROUNDWATER BASIN ASSOCIATION

Many local agencies are eligible to participate in groundwater management within the local groundwater basin. These agencies include the Turlock and Merced irrigation districts; the cities of Ceres, Turlock, Modesto and Hughson; the Hilmar and Delhi county water districts; the Keyes, Denair and Ballico community services districts; the Eastside and Ballico-Cortez water districts; and Stanislaus and Merced counties. These agencies have been cooperating on groundwater management activities in the Turlock Groundwater Basin since the mid-1990s.

A formal group for coordinating groundwater management activities, the Turlock Groundwater Basin Association (TGBA or Association), was initiated in 1995. The TGBA developed the first basin-wide Groundwater Management Plan in 1997. Although the founding Memorandum of Understanding expired upon completion of the Groundwater Management Plan, TGBA members continued to meet and discuss basin-wide planning activities. In 2001 the TGBA was formally reestablished to provide a mechanism to implement groundwater management activities and provide guidance for the management, preservation, protection, and enhancement of the Turlock Subbasin.

The TGBA has prepared this updated Plan to reflect current knowledge and to comply with changes to the Groundwater Management Act (California Water Code Section 10750 et seq.) resulting from the enactment of Senate Bill 1938 in 2002.

LAND USE IN THE TURLOCK GROUNDWATER BASIN AREA

The Turlock Subbasin lies on the eastern side of California's San Joaquin Valley, and encompasses portions of both Stanislaus and Merced counties. The groundwater system is bounded by the Tuolumne River on the north, the Merced River on the south, and the San Joaquin River on the west. The eastern boundary of the system is the western extent of the outcrop of crystalline basement rock in the foothills of the Sierra Nevada. Land uses in the Turlock Subbasin are diverse and include agriculture, urban, and commercial or industrial uses distributed in a mosaic throughout the region.

The Turlock Subbasin underlies an area of approximately 347,000 acres, with irrigated crops (245,000 acres), native vegetation (69,000 acres), and urban development (20,000 acres) as the predominant land uses. The general trend in land use throughout the Subbasin has been an increase in urbanization from less than 4,000 acres in 1952 to approximately 20,000 acres in

2006. The majority of this urbanization has occurred within the cities and unincorporated urban areas within the Turlock Irrigation District boundary. Lands in the Eastside Water District, Ballico-Cortez Water District, and Merced Irrigation District have not seen the substantial increase in urbanization that has occurred in other portions of the Subbasin. However, in the Eastside Water District, there has been a shift from non-irrigated lands to irrigated agriculture as the principal land use. The majority of this agricultural development occurred between 1952 and 1984; land use patterns in the Eastside Water District have generally stabilized since the mid-1980s. The shift to irrigated agriculture has occurred to a lesser extent in the Ballico-Cortez Water District. Land use patterns in the foothill areas in the eastern portion of the Subbasin have also shifted from non-irrigated to irrigated agriculture, but most of this shift has occurred in recent years. Between 1952 and 1992, irrigated agriculture in the foothills non-district area increased gradually from 8,600 acres to 10,800 acres. Following 1992, the irrigated area nearly doubled, reaching 19,500 acres in 2006.

Urban land uses, irrigators in the Eastside and Ballico-Cortez water districts, and irrigators in the foothills and other non-District areas depend on groundwater for water supply. Increases in these types of land uses throughout the Turlock Subbasin increase the demands on the groundwater supply. Consequently, evaluating the status of the groundwater supply and continuing coordination of water agencies are essential for maintaining the viability of the groundwater basin.

WATER RESOURCES IN THE TURLOCK SUBBASIN

Both surface water and groundwater supplies are used to meet the water needs in the management area. The local groundwater source is the Turlock Subbasin, which is a subunit of the San Joaquin Valley Groundwater Basin. The Turlock Subbasin lies in the eastern portions of Stanislaus and Merced counties and has an areal extent of approximately 347,000 acres. As described above, the Subbasin is bounded by the Tuolumne River to the north, the Merced River to the south, the San Joaquin River to the west, and by crystalline basement rock of the Sierra Nevada foothills to the east. Groundwater supplies municipal, industrial, and agricultural demands of the region. Surface water from the Tuolumne River and to a lesser extent, the Merced River, supplies a large proportion of agricultural irrigation demands within the Turlock Subbasin. The following sections summarize the Subbasin hydrogeology, water balance, and water quality issues described in the Groundwater Management Plan.

Hydrogeologic Setting

The primary hydrogeologic units in the Turlock Subbasin consist of either consolidated or unconsolidated sedimentary deposits. The consolidated deposits include the Ione Formation, the Valley Springs Formation, and the Mehrten Formation. The Ione and Valley Springs formations lie beneath the Mehrten Formation and typically contain saline water of marine origin. These consolidated deposits are found at shallower depths in the eastern portion of the Subbasin and generally yield small quantities of water to wells. The Mehrten Formation, however, yields greater quantities of water and is an important water source for the eastern portion of the Turlock Subbasin.

The unconsolidated deposits of the Turlock Lake, Riverbank, and Modesto formations overlie the consolidated deposits. These deposits generally yield moderate to large quantities of water to wells and are the main water-yielding units of the Subbasin. Fine grained deposits within the

Modesto and Turlock Lake formations do not transmit substantial quantities of water and function as aquitards. In the western portion of the Subbasin, where surface deposits are of the Modesto Formation, a discontinuous shallow aquitard creates areas of shallow groundwater. The Corcoran Clay aquitard also occurs in the western portion of the Subbasin within the Turlock Lake hydrogeologic unit. The Corcoran Clay aquitard separates groundwater in the Turlock Subbasin into an upper, unconfined aquifer and a lower, confined aquifer.

The unconfined aquifer is generally 150 feet in thickness and is the water-table aquifer, except in western portions of the Subbasin that are locally confined by the shallow aquitard. The unconfined aquifer is used for both private domestic supply and agricultural supply in the western part of the Subbasin. Wells less than 200 feet in depth draw from this aquifer. The confined aquifer, which is contained under pressure by the Corcoran Clay, occurs in the deeper hydrogeologic units of the Subbasin. In the eastern part of the Turlock Subbasin, the confined aquifer is only semi-confined. The confined aquifer provides extensive municipal and agricultural supplies to the Subbasin. Wells greater than 200 feet deep draw from the confined aquifer, but also may receive flow from the unconfined aquifer.

Below the principal water bearing units of the Turlock Subbasin is a deeply buried confined aquifer that contains saline brine. This saline confined aquifer is under sufficient hydraulic pressure to push water up toward the land surface. This phenomenon results in the migration of saline brines in certain areas (e.g., in groundwater wells or along cracks, fissures, and faults), sometimes as far upward as the unconsolidated sediments. Upwelling also occurs near the San Joaquin River, resulting in elevated concentrations of total dissolved solids (TDS) in groundwater near the river. The saline confined aquifer can be found from depths as shallow as 100 feet in the western portion of the Subbasin to as deep as 1,500 feet in the eastern portion of the Subbasin. Although the saline confined aquifer is not used as a source of supply, migration of the saline brines results in high TDS groundwater that may not be of sufficient quality for agricultural or municipal use where mixing occurs.

Water Balance in the Turlock Basin

A water balance study of the Turlock Subbasin was prepared in 2003 and updated in 2007 to estimate the inflows and outflows from the Subbasin between 1952 and 2006. Outflows from the Subbasin result from municipal, domestic, and agricultural supply and drainage well pumping, discharge to the local rivers, discharges from subsurface agricultural drains, and consumption by riparian vegetation. The estimated average total outflow for the 1997-2006 period is 541,000 AF/yr. The majority of outflow comes from estimated agricultural, municipal and rural residential, and drainage well pumping, which collectively averaged 457,000 AF/yr for the 1997-2006 period.

Inflows to the Subbasin result primarily from deep percolation of agricultural and landscape irrigation water and infiltration of precipitation. The estimated average total inflow for the 1997-2006 period is 519,000 AF/yr. Approximately 72 percent of this quantity occurs on 245,000 irrigated acres of cropland within the Subbasin.

Most of the inflows and outflows can be estimated for the Turlock Basin. The net discharge to rivers is an unknown outflow and must be derived through a mass balance calculation of the known inflows, outflows, and storage change in the Basin. Storage change is calculated from the

groundwater contour maps derived from local monitoring data, and confirmed using the groundwater model.

The contour maps used in the water budget study indicate that estimated groundwater storage decreased by approximately 21,500 AF/yr between 1997 and 2006. Recent reductions in the California Department of Water Resources (DWR) monitoring network have introduced uncertainty in the measurement of groundwater levels. Uncertainty in the estimated groundwater elevation translates into uncertainty in storage estimates. Therefore, the magnitude and direction of changes in groundwater storage cannot be fully characterized through an analysis based solely on the groundwater contours. The Turlock Subbasin groundwater model was used to supplement this analysis and confirm that groundwater storage has decreased slightly in recent years, particularly between 2002 and 2006.

The estimated reduction in storage between 2002 and 2006 suggests that the Subbasin may no longer be in the equilibrium state that existed in the 1990s. Increases in land use types that rely on groundwater for supply have increased the net discharge from the Subbasin. Slight decreases in storage are likely to continue if urban or irrigated land uses are developed in areas dependent upon groundwater.

In any groundwater basin, groundwater storage will fluctuate both seasonally and annually, depending upon the water year classification, distribution of rainfall, and numerous other physical and biological factors. Alternating periods of decline and recovery in groundwater levels are a response to this natural variation. Long-term declines in storage without recovery could be a concern and represent net declines in storage. Continued monitoring by the local public agencies will be important for tracking changes in groundwater conditions and evaluating whether additional management actions should be considered. As part of the Association's goals and objectives, the Association should consider the need to evaluate changes in land use patterns to understand the range of potential impacts to the groundwater supply. The TGBA has initiated a study to evaluate future land use change scenarios and the potential impacts to groundwater resources. This study will help the Association understand how groundwater storage may change in the future and what types of management actions may be appropriate for maintaining adequate storage in the groundwater basin.

Deep percolation of irrigation water is the largest inflow to the groundwater basin and plays an important role in maintaining groundwater storage. Surface water from the Turlock Irrigation District, and to a lesser extent, the Merced Irrigation District is used to supply more than half of the total irrigation water applied within the Basin. Hence, under current conditions the continued use of surface water for agricultural irrigation is vital for sustaining recharge in the Subbasin. Future changes to inflows or outflows resulting from shifts in land use patterns have the potential to reduce recharge and create reductions in groundwater storage.

Water Quality in the Turlock Subbasin

Groundwater quality in the Turlock Subbasin remains high throughout most of the region. Current knowledge indicates that salinity, nitrates, iron and manganese, boron, arsenic, radionuclides, bacteria, pesticides, trichloroethylene, and other trace organics have been found in the Turlock Subbasin. The U.S. Geological Survey, in coordination with numerous state and federal agencies, is conducting an extensive investigation of groundwater quality in the local area through the Groundwater Ambient Monitoring and Assessment Program. This study evaluates a

broader range of constituents and will provide additional information on water quality issues in the Subbasin.

Some of the constituents described above and in detail in this Groundwater Management Plan occur naturally, while others have been introduced into groundwater from anthropogenic sources. Where the constituent concentrations have exceeded drinking water limitations, the municipal water purveyors have implemented actions ranging from wellhead protection to well closure to maintain viable supplies.

Protecting water quality is as important to maintaining the local groundwater supply as sustaining groundwater recharge. The Groundwater Management Plan is intended to create a framework for coordinating actions among different agencies with management authority to protect both the quality and quantity of groundwater resources.

GROUNDWATER MANAGEMENT PLAN

The local agencies within the Turlock Subbasin agree that groundwater and surface waters within the Turlock Subbasin are vitally important resources that provide the foundation for maintaining current and future water needs. Preservation of these resources is essential to maintaining the economic viability and prosperity of the Subbasin area. It is the overall goal of the local water agencies that groundwater will continue to be a reliable, safe, efficient, and cost-effective water supply. This Groundwater Management Plan includes seven Basin Management Objectives (BMOs) to meet this goal. The BMOs serve as targets to guide the groundwater management actions of the local water agencies. The BMOs described in this Groundwater Management Plan include:

1. Maintain an adequate water level in the groundwater basin.
2. Protect groundwater quality and implement measures, where feasible, to reduce the potential movement of existing contaminants.
3. Monitor groundwater extraction to reduce the potential for land subsidence.
4. Promote conjunctive use of groundwater and surface waters.
5. Support and encourage water conservation.
6. Develop and support alternate water supplies, and educate users on the benefits of water recycling.
7. Continue coordination and cooperation between the TGBA members and customers.

Water agencies in the Turlock Subbasin, individually and collectively, are pursuing water management strategies under each of the BMOs to ensure that groundwater continues to be a reliable, safe, efficient, and cost-effective water supply.

GROUNDWATER PROTECTION MEASURES

The water agencies within the Turlock Subbasin are committed to protecting the quantity and quality of groundwater resources. The TGBA has assembled a number of activities of the local water agencies that can be coordinated through the TGBA to support the BMOs of protecting groundwater quality and quantity. These groundwater protection measures are ongoing activities that local agencies may be engaged in, or that agencies may implement in the future. Although

the TGBA does not have authority for implementing these actions, the TGBA can serve as a forum for sharing and researching information, and members can provide feedback and guidance to the local agencies involved with these actions. The groundwater protection measures described in the Plan include:

1. Identification and management of wellhead protection areas.
2. Regulation of the migration of contaminated groundwater.
3. Identification of well construction policies.
4. Administration of well abandonment and destruction programs.
5. Mitigation of overdraft conditions.
6. Replenishment of groundwater extracted by water producers.
7. Construction and operation of recharge, storage, conservation, water recycling, and extraction projects.
8. Control of saline water intrusion.

IMPLEMENTATION OF THE GROUNDWATER MANAGEMENT PLAN

The Groundwater Management Plan is intended to provide a flexible, adaptive plan for achieving the overall goal that groundwater will continue to be a reliable, safe, efficient, and cost-effective water supply. The Plan presents numerous potential actions that can be undertaken by local water agencies and coordinated through the TGBA. The following measures are proposed as suggested management actions that the local agencies may draw from to achieve the Basin Management Objectives:

1. **Protection of natural recharge areas** through mapping and identification, education of the public and planning entities, and encouraging the maintenance of land use practices that promote groundwater recharge.
2. **Feasibility evaluation of artificial recharge projects,** by building upon mapping efforts to protect natural recharge and investigating additional water supplies for percolation, and promoting in-lieu recharge.
3. **Management and optimization of well field operations** to reduce well interference, control the migration of contaminant plumes, and optimize supply blending programs.
4. **Support of public health programs** to protect water quality through proper well construction and destruction.
5. **Water quality management**, beginning with conducting a hydrogeologic assessment to identify contaminant sources and develop strategies to control the migration and movement of poor quality water into or within the Basin.
6. Continue the **groundwater monitoring and subsidence monitoring program** and evaluate the effectiveness of the groundwater level and quality monitoring programs as well as the database used to store and manipulate the data.
7. Provide a forum for **policy assessment** and coordination of regional programs with policy implications or requirements.

8. Continue **promoting coordination and cooperation between water agencies** on regional issues, outreach programs, and actions to implement the BMOs.
9. **Identification and feasibility study of conjunctive use projects** to increase supply flexibility and promote recharge in years when water is available.

The implementation of several of these recommended actions is contingent upon securing funding. Both grant funding and local funding options will be evaluated. Local funding may be especially important for grant eligibility because of matching or local contribution requirements. Availability of funding for groundwater management activities, as well as future regulatory requirements, will influence the speed and level to which each of the measures is evaluated and implemented.

Progress on implementing the BMOs will be evaluated through periodic reports. The reports will also summarize the condition of the groundwater basin and discuss groundwater management activities. The reports may be prepared by the TGBA as a group or by individual agencies. The reporting process will also provide an opportunity to review the Groundwater Management Plan and determine whether the Plan requires modification to meet the goal of ensuring the viability of groundwater resources in the Turlock Basin.

1 INTRODUCTION – GROUNDWATER MANAGEMENT WITHIN THE TURLOCK GROUNDWATER BASIN

The following sections provide a brief introduction to groundwater management and related issues pertinent to the Turlock Groundwater Basin, including: the agencies situated within the Basin and participating in the groundwater management process, historic groundwater management efforts, and other relevant information.

The California Department of Water Resources (DWR) website[1] includes information on Bulletin 118 (2003), the publication in which DWR identifies and describes the various groundwater basins and subbasins within the state. The website and available information from Bulletin 118 (2003) were utilized, along with other documentation, in preparing this report.

It is important to note that the Turlock Groundwater Basin, or Turlock Subbasin, is referenced in a variety of ways within the report. DWR Bulletin 118 (2003) identifies the area covered under this plan as the Turlock Subbasin of the San Joaquin Valley Groundwater Basin. For the purposes of this document, the name "Turlock Subbasin," "Turlock Groundwater Basin," "Basin," and "Subbasin" are used interchangeably to represent the same geographic area. All other groundwater basins referenced in this document are listed by their proper name.

In addition, although this document is titled the "Turlock Groundwater Basin Groundwater Management Plan," it is also referred to as the "Turlock Groundwater Management Plan," the "Groundwater Management Plan" or merely the "Plan."

1.1 GEOGRAPHIC SETTING

The Turlock Subbasin lies on the eastern side of California's San Joaquin Valley, and encompasses portions of both Stanislaus and Merced counties. The groundwater system is bounded by the Tuolumne River on the north, the Merced River on the south, and the San Joaquin River on the west, as shown in Figure 1. The eastern boundary of the system is the western extent of the outcrop of crystalline basement rock in the foothills of the Sierra Nevada.

1.2 LOCAL AGENCIES

Local agencies eligible to participate in a groundwater management plan situated within the Subbasin are: the Turlock and Merced irrigation districts; the cities of Ceres, Turlock, Modesto and Hughson; the Hilmar and Delhi county water districts; the Keyes, Denair and Ballico community services districts; the Eastside and Ballico-Cortez water districts; as well as Stanislaus and Merced counties. Figure 2 shows the location of the various entities within the Subbasin and their respective political boundaries.

It is understood that each local water agency may adopt the groundwater management plan to manage groundwater resources within their jurisdiction. If a county adopts the groundwater management plan, the plan shall apply to those areas lying outside other agencies' boundaries.

[1] At *http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/5-22.03.pdf*

1.3 TURLOCK GROUNDWATER BASIN ASSOCIATION

In 1995 the Turlock Groundwater Basin Association (TGBA) was formed for the purposes of studying and evaluating the condition of the Basin, and developing a groundwater management plan for the preservation, protection, and enhancement of the Basin. The Turlock Groundwater Basin Groundwater Management Plan was adopted by the local public agencies between October and December of 1997. At this time, the 1995 Memorandum of Understanding terminated by its founding provisions.

Following the dissolution of the TGBA in 1997, the local public agencies continued to meet on a regular basis in their efforts to cooperatively manage groundwater resources within the Turlock Basin.

In 2001 the TGBA reformed to provide a mechanism for the local public agencies to collectively implement the Plan. The following purposes and goals were set forth in the resulting Memorandum of Understanding (MOU):

- "To provide a mechanism to coordinate the implementation of the Plan and other groundwater management activities;
- To create an association of the Parties to enhance the ability to obtain funding to carry out the Plan and related groundwater management projects; and
- Provide information and guidance for the management, preservation, protection and enhancement of the Basin."

The MOU is based upon the premise that "non-coordinated action by water providers and users within the Basin could result in counterproductive competition for finite resources resulting in adverse impacts to the groundwater and surface water supplies within the Basin," and that the "creation of an Association for water suppliers within the Basin is important to protect the groundwater and surface water resources and will assist in meeting the needs of all users of such resources within the Basin." In addition, it was clear that local management of water resources was desirable in order to maintain local control of these resources.

The purpose of the TGBA is to provide a forum in which the local public agencies can work cooperatively, to combine the available talent of the respective agency staffs, and to accomplish the purposes of the MOU. As such, the TGBA is not a separate governmental entity. It is designed such that it does not duplicate any services, duties, or authority of any other agency. The TGBA does not have any enforceable regulatory authority over any local agency's facilities or their respective surface water or groundwater supplies or water rights. The local water agencies, individually and collectively, are pursuing water management strategies outlined in this Plan to ensure that groundwater continues to be a reliable, safe, efficient, and cost-effective water supply.

A copy of the MOU is attached to this report in Appendix C.

1.4 ONGOING GROUNDWATER MANAGEMENT-RELATED ACTIVITIES

1.4.1 Historical Perspective

An initial Turlock Groundwater Basin Groundwater Management Plan was developed and adopted by the local public agencies in 1997. Groundwater supply, demand, quality and other issues pertinent to groundwater management change over time. As a result, it is understood that a groundwater management plan must be updated occasionally to reflect current conditions and requirements. The TGBA has developed this Plan, which is intended to update and supersede the 1997 Plan. This update includes the pertinent information contained within the original plan, with additional or updated data inserted as needed to comply with the current groundwater management requirements.

1.4.2 Previous Efforts

The agencies within the Turlock Groundwater Basin have been meeting to coordinate groundwater management efforts since 1995. These meetings resulted in the development of the 1997 version of the Turlock Groundwater Basin Groundwater Management Plan. Following the adoption of the Plan, the agencies continued to meet monthly to discuss groundwater management related issues, including:

- Development of a preliminary groundwater level and water quality monitoring program;
- Identification of groundwater management activities being conducted by the local agencies and coordination needed to accomplish the Plan goals;
- Formation of the Turlock Groundwater Basin Association;
- Contracting with a hydrologist in 2003 to conduct a groundwater balance study for the Basin;
- Contracting with a hydrologist in 2006-2007 to conduct an ongoing study of the potential impacts of land use changes on groundwater resources; and
- Supporting individual groundwater management related efforts by local agencies, as appropriate.

1.4.3 Efforts of Individual Agencies

The local public agencies within the Basin have historically provided a variety of ongoing groundwater management related services including:

- **Well Abandonment or Destruction Programs:** There are existing programs in place at the city or county level. Proper well abandonment or destruction of an old well can be made a condition of installing a new well. Education programs have been implemented to advise well owners of the importance of proper well destruction.
- **Well Construction Standards:** The cities and counties have established well construction standards that are consistent with, or in some cases more stringent than, the State of California Water Well Standards, Bulletin 74-81 and its supplements (DWR 1981a). These standards regulate the installation and abandonment for any new wells installed within the Basin.

- **Public Education Programs:** Many local public agencies have implemented public education programs related to water quality, wellhead protection, water conservation and other water issues.
- **Land Use Planning:** The cities and counties have land use planning programs in place to evaluate and reduce potential impacts to groundwater resources due to proposed development and other land use changes.
- **Regulation of Mitigation of Contaminated Groundwater:** The regulatory agencies responsible for water quality have been the key agencies responsible for this item, with local public agencies coordinating efforts with the regulatory agencies as needed.
- **Development of Relationships with Local, State, and Federal Agencies:** The TGBA provides a mechanism for interaction and coordination among local agencies, as well as communication with state and federal agencies. In addition, the local agencies maintain individual relationships with the various state and federal agencies associated with groundwater management related issues.
- **Funding:** Individual agencies have applied for and secured grants to study a variety of groundwater management related issues, including:
    - In October 2001, the Eastside Water District (EWD) submitted an application for a grant from the Assembly Bill (AB) 303 Local Groundwater Assistance Fund (AB 303) to the DWR Division of Planning and Local Assistance. The proposal was for an "Eastside Water District Groundwater & Multiple Resources Integration Planning Study." The grant was approved and EWD received the final signed contract on September 23, 2002. The amount of the grant was $200,000. The EWD contribution was approximately $100,000. The study examined options for acquisition of additional water supplies as well as alternatives for conveyance of the water to EWD. The study was completed in October 2003.
    - In September 2003, the Denair Community Services District (CSD) was awarded a grant from the AB 303 fund for $200,000. Denair CSD constructed a nested monitoring well with the funds from this grant. Information from this test well and other existing wells will be used to support advancement of a hydrogeologic model of the producing groundwater system and to monitor the quality and quantity of groundwater produced from the alluvial aquifer sequences underlying Denair CSD.
- **Groundwater Monitoring:** The local agencies conduct a variety of groundwater quality and level monitoring. Urban agencies and others providing drinking water to local residents are required to monitor for a variety of water quality constituents. To a lesser extent, agricultural agencies conduct water quality monitoring. Water level measurements are conducted by both agricultural and urban entities. In addition, the following special projects have been implemented:
    - Denair CSD developed its groundwater management program in 2001 with the drilling of a test hole, subsurface interpretations of favorable aquifer sequences, and by creating formal guidelines for residential developers to use to construct Denair CSD-required test and monitoring wells. Due to inadequate funding,

Denair CSD's program is currently limited to residential developers' activities. The first well constructed under the new guidelines was completed in 2002.

- Denair CSD also obtained funding to a nested monitoring well for the purpose of water quality monitoring (see "Funding" section above).

- **Groundwater Recharge:** The EWD, in conjunction with the Turlock Irrigation District (TID), conducted a recharge study, in which a 0.25 acre basin was installed and operated from 1998 through 2000. These districts are currently working on a potential expanded study, in which several larger basins could be installed and operated to further evaluate the potential recharge opportunities within the Subbasin. Testing of a new recharge site began in May 2007.

2 NEED FOR GROUNDWATER MANAGEMENT PLANNING

2.1 DEFINITION OF GROUNDWATER MANAGEMENT

DWR Bulletin 118 (2003) defines "groundwater management" as "the planned and coordinated management of a groundwater basin with a goal of long-term sustainability of the resource." A "groundwater management plan" is defined as a "comprehensive written document developed for the purpose of groundwater management and adopted by an agency having appropriate legal and statutory authority." A "groundwater management program," as defined by the California Water Code (CWC) Section 10752(e), is a "coordinated and ongoing activity undertaken for the benefit of a groundwater basin, pursuant to a groundwater management plan" adopted as specified in the CWC. Sections of the CWC related to groundwater management are provided in Appendix H.

2.2 PURPOSE OF THE GROUNDWATER MANAGEMENT PLAN

The CWC Section 10752(d) defines a groundwater management plan as a "document that describes the activities intended to be included in a groundwater management program." The TGBA developed this Plan for the purposes of documenting:

- Groundwater Basin conditions;
- The areas managed by the local entities and the legal authorities to do so;
- Groundwater management goals and objectives;
- Historic, ongoing and planned future groundwater management activities; and
- Stakeholder involvement processes.

The local public agencies within the Subbasin have developed this Plan to comply with the State of California groundwater management planning requirements under both the CWC and DWR Bulletin 118 (2003). Additionally, the TGBA designed this Plan to create a framework for coordinating groundwater management activities to achieve the individual and collective goals of the various local public agencies within the Basin, as described later in this Plan.

2.3 LEGAL AUTHORITY

The following discussion describes the legal authority for local agencies to develop groundwater management plans and participate in groundwater management related activities.

2.3.1 AB 3030

The Groundwater Management Act (AB 3030) was passed by the State legislature during the 1992 session and became law on January 1, 1993. The Groundwater Management Act, as codified in CWC Section 10750 et seq., identifies groundwater as a valuable resource that should be managed to ensure both its safe production and its quality (Appendix H). AB 3030 also encourages local agencies to work cooperatively to manage groundwater resources within their jurisdiction.

AB 3030 applies to all groundwater basins identified in DWR Bulletin 118 (dated September 1975, and any amendments to this bulletin), except those already subject to groundwater management by a local agency or watermaster pursuant to other law, court order, judgment or

decree, unless the local agency or watermaster agrees. Bulletin 118 specifically identifies the Turlock Groundwater Basin, making it eligible for groundwater management under AB 3030.

The law provides that any district or other political subdivision of the state that is authorized to provide water service and exercises that authority may adopt and implement, by ordinance or resolution, a groundwater management plan within all or a portion of its service area. The law also indicates that a local public agency that provides flood control, groundwater management, or groundwater replenishment, or a local agency formed pursuant to the CWC for the principal purpose of providing water service that has not yet provided that service, may establish an AB 3030 groundwater management plan within its boundaries, provided that those areas are not served by another local agency.

The act also authorizes a local public agency to exercise the specified powers of a water replenishment district, subject to the approval of the voters within the agency's service area.

2.3.2 Other Legislation

Senate Bill (SB) 1938 was enacted in 2002, further refining the CWC Sections related to groundwater management. SB 1938 made a variety of modifications to groundwater management plan requirements, primarily concerning public participation and requirements for State grant applications. Language added to the CWC by SB 1938 requires agencies developing a groundwater management plan to prepare a public notice that describes the manner in which interested parties may participate in the development of that plan. The bill also requires local agencies, which elect to apply for certain types of State grant funding, to prepare and implement a groundwater management plan that contains specific components, including basin management objectives and certain monitoring protocols. Table 1 provides a listing of these components, along with the location of each component in this document.

2.4 GROUNDWATER MANAGEMENT PLAN COMPONENTS

This Groundwater Management Plan (GMP) includes the following required and recommended components:

- CWC Section 10750 et seq. (seven mandatory components). The SB 1938 amendments (effective January 1, 2003) to CWC Section 10750 et seq. require GMPs to include seven components to be eligible for the award of funds administered by DWR for the construction of groundwater projects or groundwater quality projects.
- DWR Bulletin 118 (2003) components (seven recommended components).
- CWC Section 10750 et seq. (12 voluntary components). CWC Section 10750 et seq. includes 12 specific technical issues that could be addressed in GMPs to manage the basin optimally and protect against adverse conditions.

Table 1 in Appendix B lists the section(s) in which each component is addressed.

3 WATER RESOURCES SETTING

3.1 LAND AND WATER USE WITHIN THE BASIN

The Turlock Subbasin is comprised of approximately 347,000 acres, including roughly 245,000 acres of irrigated crops, 20,000 acres of urban development, and 69,000 acres of native vegetation. Figure 2 shows the Turlock Subbasin and the boundaries of five subareas for which land-use acreages have been estimated. Four of the subareas include the areas within the TID, EWD, Ballico-Cortez Water District (BCWD), and Merced Irrigation District (Merced ID). Regions outside the boundaries of a water agency are combined into a fifth subarea.

The TID subarea represents the district's irrigation service area boundaries and includes the communities of Ceres, Delhi, Denair, Hickman, Hilmar, Hughson, Keyes, south Modesto and Turlock. Land uses within the TID service area include irrigated agriculture (using either groundwater or surface water supplies), on-farm non-irrigated lands (e.g., buildings, farm roads, equipment yards, etc.), other non-irrigated lands (e.g., grazing land, non-irrigated cropland, etc.), city urban lands (urbanized areas within a city's political boundaries), non-city urban lands (urbanized areas outside the political boundaries of a city), and highways and roads (highways, roads, canal and railroad right-of-ways).

Figure 3 illustrates the changes in land use within the TID between 1952 and 2006. While the total acreage within the irrigation service area has remained the same, the proportions of irrigated, urban, and other land uses have changed. Most notable is the recent urbanization of the area, characterized by an increase in urban areas, with a corresponding decrease in irrigated agricultural land. In addition, a small number of acres have shifted from the use of canal water to groundwater for irrigation, typically combined with a change from flood irrigation to drip and micro irrigation systems.

Irrigated land within the TID utilizes mainly surface water supplies for irrigation, which is the main source of recharge within the Subbasin. Municipalities currently rely entirely upon groundwater for their water supply. In the future, if urban areas continue to utilize groundwater, the reliance upon groundwater will increase while recharge through agricultural use will decrease as agricultural lands are converted to urban uses. This scenario is likely to result in a reduction in groundwater storage within the Subbasin. Similarly, a significant movement from the use of surface water to groundwater supplies on agricultural lands within the TID also could reduce the sustainable yield of the Subbasin.

Figures 4a through 4c depict the historical changes in land use within the EWD, BCWD, and Merced ID boundaries. These areas have not had the substantial urbanization that has occurred within the TID subarea. However, in the EWD there has been a shift in land use from non-irrigated lands to irrigated agriculture. The majority of the agricultural development occurred between 1952 and 1984. The shift to irrigated agriculture from non-irrigated lands has occurred to a lesser extent in the BCWD.

Irrigated agriculture within the Eastside and Ballico-Cortez water districts is dependent upon groundwater for their water supply. Unless additional land use changes occur within these subareas, the main changes in water needs will likely come from improvements in water use efficiency practices or changing cropping patterns.

Figures 4d through 4g illustrate the land use changes for those areas located outside the boundaries of a water agency. Figure 4d shows changes in land use within the foothill non-district area (those areas to the east of EWD and BCWD). In these areas there was a slight increase in irrigated agriculture between 1952 and the early 1990s, and a marked increase between 1992 and 2006. Between 1992 and 2006, the irrigated acreage in the foothills non-district area nearly doubled. As of 2006, there were approximately 48,000 acres of non-irrigated lands in the foothill area and nearly 20,000 acres of irrigated lands. If this trend continues, the irrigated acreage within this area potentially could triple in size, resulting in a corresponding increase in groundwater usage. However, studies have not been conducted to determine the availability of groundwater in the foothill non-district areas. Anecdotal information from individuals who have attempted to find water in the area suggests that water of a quality suitable for irrigation is limited. Thus, continued conversion of non-irrigated lands to irrigated land uses at the recent rate is uncertain.

Figures 4e through 4g show land use patterns in the non-district areas adjacent to rivers. In all three regions, irrigated agricultural acreage expanded considerably between 1952 and the mid-1980s. Land use in the non-district areas near the San Joaquin River have changed very little between 1990 and 2006. Within the Merced and Tuolumne river non-district areas, however, the irrigated acreage has decreased slightly in recent years. This change can be attributed to a variety of factors, such as rural residential development or expansion of agricultural facilities like machinery yards or shop buildings.

A study, begun in late 2006, will evaluate the impacts of future land use changes anticipated within the Basin on local groundwater resources. The land use study will serve as a planning tool that will help local public agencies determine what types of management actions may be appropriate for maintaining adequate storage in the groundwater basin should groundwater-dependent land uses continue to expand.

3.2 MAJOR WATER PURVEYORS AND OTHER AGENCIES WITHIN THE BASIN

The following section provides a description of the various types of water agencies within the Basin, their histories of formation, water sources, and other pertinent information. Each water agency is an independent entity and is described individually, but the physical boundaries of an agency may include several different types of water users. Within the service boundaries of agricultural water agencies there also are a variety of municipal agencies that provide domestic water to their communities. Those agencies, described in section 3.2.2 below, represent the areas within their jurisdiction. Domestic use in the agricultural water agencies' service areas may be through a private well supplying an individual residence, or through a small public water system. Both rely entirely on groundwater. The small public water systems are regulated through the Merced County Division of Environmental Health or the Stanislaus County Department of Environmental Resources.

It is important to note that there are several other agencies that represent areas within the Subbasin that are mainly rural in nature; however, these agencies do not supply water in their respective service areas. These agencies are described in Section 3.2.3 below.

3.2.1 Purveyors of Agricultural Water Supplies

The Turlock and Merced irrigation districts described below supply irrigation water to growers within the Turlock Subbasin. The irrigation districts represent areas that are mainly rural in nature, and are comprised of small communities, ranches, farms, private residences, etc. In addition to the water supplied by these local agencies, some growers located within an irrigation district's boundaries have their own private irrigation well that they use in lieu of, or in addition to, any water supplied by the local public agency.

In addition to domestic and irrigation uses, water may be pumped for use for other agricultural purposes on dairies and other agricultural facilities located within the areas represented by the irrigation districts.

3.2.1.1 Turlock Irrigation District

The TID was formed in 1887 under the provisions of the Wright Act (CWC Section 20500 et seq.). It supplies irrigation water to approximately 150,000 acres, electricity to a 662 square mile service area, and municipal water to the community of La Grange, California. The TID irrigation service area, represented on Figure 2, covers a significant portion of the Turlock Subbasin.

TID's canal system begins at La Grange Dam on the Tuolumne River, where water is diverted into TID's Upper Main Canal for conveyance to Turlock Lake. Turlock Lake acts as a canal regulating reservoir. From Turlock Lake, water is released into the Main Canal for distribution to downstream growers for irrigating mainly high value, non-subsidized crops.

TID owns and operates approximately 230 miles of canals and laterals, most of which have been concrete-lined. Water that is not utilized for irrigation purposes flows to the river system. Canal spills occur through spill gates or over weirs located at the end of canals, and at several median locations within the canal system. Releases either flow directly to the river or through a drain that then flows to the river.

TID utilizes groundwater pumped from drainage and rented wells to supplement its surface water supplies. In dry years, when less surface water is available, groundwater makes up a larger portion of the overall water supply. Conversely, in wet years, less groundwater is utilized. TID-owned drainage wells are used to help lower groundwater levels, as well as supplement surface water supplies. The groundwater pumped for drainage purposes is utilized as much as possible for irrigation supply. Rented wells are private or improvement district wells that are rented by the TID to supplement irrigation supplies. The actual number and location of wells rented each year varies depending upon a variety of factors, including the anticipated amount of rented pumping needed, condition of the well, quality and quantity of the water pumped, etc. Water pumped from drainage and rented wells either discharges directly into the canal, into a pipeline that flows back to the canal, or into a pipeline from which it is utilized for irrigation purposes.

3.2.1.2 Merced Irrigation District

The Merced ID became a legal entity on December 8, 1919. The Merced ID covers an irrigation service area of 164,394 gross acres and includes approximately 10,000 acres within the Turlock Subbasin. The Merced River provides the principal renewable water supply for Merced ID. Water is diverted from the river into the portion of the Merced ID within the Turlock Subbasin

by the North Side Canal. The North Side Canal draws from a pool in the Merced River created by Merced Falls Dam, east of the town of Snelling.

The Merced ID owns and operates approximately 26 miles of open earthen channels within the Turlock Subbasin. Water that is not used for irrigation passes through one concrete overpour weir and discharges to the Merced River.

The Merced ID operates three small domestic wells within the Turlock Subbasin that provide water for recreation area facilities. The Merced ID does not own or operate irrigation water supply wells within the Turlock Subbasin, but there are an unknown number of privately owned irrigation water supply wells within the area.

3.2.2 Purveyors of Municipal Water Supplies

The municipal water purveyors, described below, currently rely entirely on groundwater for their supply. Some local agencies, however, are continuing to evaluate the potential for utilizing surface water supplies to supplement groundwater resources.

In addition to drinking water supplies, many of these agencies provide wastewater treatment services to the homes and industries located within their boundaries. The majority of wastewater is discharged to surface waters, a portion is used for agricultural or landscape irrigation, and the remainder is evaporated or percolated back into the groundwater system (Table 4).

3.2.2.1 City of Turlock

Turlock was founded on December 22, 1871 and incorporated as a city in 1908. The City of Turlock water system has always used groundwater wells to supply water to its citizens. As growth occurred, the city added new wells as needed, to accommodate the additional demand. The City of Turlock currently serves a population of over 67,000 residents with 24 active groundwater wells and more than 230 miles of water distribution lines. The wells can produce a maximum of 53 million gallons of water per day (MGD), or 59,360 acre-feet per year (AF/yr).

Over the last ten years, potable water use has increased at an average rate of 3.5% per year, with water use in 2006 totaling 8.3 billion gallons. In spite of recent population growth, the total water use for 2004 through 2006 has remained constant at 8.3 billion gallons. The average static groundwater levels over the last twenty years have declined 14 feet in Turlock wells; however, the current levels still remain 8 feet above the record low of 75 feet below ground surface, encountered during the 1988-1989 drought year.

In the last ten years, four city wells have been closed due to contamination. Nitrate contamination was the cause for two of the well closures and is a major threat to wells in the City of Turlock. Average nitrate levels in the City of Turlock's wells have increased over the last twenty years from 12 ppm to 20 ppm (as NO_3).

The City of Turlock also operates a regional wastewater treatment facility, the Regional Water Quality Control Facility (RWQCF). This facility discharges an average 12 MGD (13,440 AF/yr) to the Harding Drain, which flows into the San Joaquin River. Influent flows to the facility are from the City of Turlock, Denair CSD, Keyes CSD and the City of Ceres. Since May 1, 2006, the RWQCF has provided full tertiary treatment to the wastewater entering the facility.

The treated wastewater is currently used for a variety of reuse functions including landscape and agricultural irrigation as well as disposal into the San Joaquin River. Future plans for the treated wastewater include use in industrial cooling towers, irrigation of City of Turlock owned open space, and provision to private users.

3.2.2.2 City of Modesto

The City of Modesto was founded in October 1870 and incorporated as a city in 1884. There are approximately 6,600 City of Modesto water service customers located within the Turlock Groundwater Subbasin, including South Modesto, the community of Hickman, and parts of the cities of Turlock and Ceres. The South Modesto Service Area (SMSA) includes portions of the City of Modesto that are south of the Tuolumne River, portions of unincorporated Stanislaus County contiguous to Modesto, and parts of Ceres that were part of the former Del Este service area.

Currently, the only source of domestic water to the City of Modesto's customers in the Turlock Groundwater Subbasin is groundwater. Groundwater is supplied by 12 wells in the SMSA, two wells in Hickman, and four wells in the Turlock area.

The current annual average (2000-2004) groundwater production of the SMSA is 4,246 AF/yr, while total water demands are 6,793 AF/yr. The SMSA's water demands are supplemented with water from groundwater wells north of the Tuolumne River. Recent population projections indicate that water demands could increase to 8,733 AF/yr by the year 2025. Annual water production is approximately 220 AF for the Hickman wells and 541 AF for the Turlock wells. Both the Hickman and Turlock water service areas are considered to be built-out.

There are groundwater quality concerns in the SMSA, such as radionuclides and nitrates. Currently, there are 4 wells off-line due to water quality issues. Three of the active wells in the SMSA are currently being blended, while another has recently been put back in operation with wellhead treatment. The Hickman and Turlock water supply wells do not have any significant water quality problems at this time. However, the Turlock wells could be affected if the arsenic maximum contaminant level (MCL) is lowered below 10 parts per billion (ppb).

The City of Modesto is currently investigating alternatives to maintain existing supplies, as well as increase the water supplies to the SMSA, including drilling wells in new developments, developing wellhead treatment opportunities, and possibly purchasing treated surface water.

The City of Modesto also provides sewer service to properties in the SMSA that are either within the Modesto Municipal Sewer District No. 1 or have sewer service agreements. The remaining properties are assumed to be on septic tanks.

The City of Modesto Wastewater Treatment Facilities are located on two sites, separated by approximately 7 miles. The Sutter Avenue primary plant (headworks, primary clarification, and solids handling) is adjacent to the Tuolumne River. The Jennings Road secondary plant (oxidation ponds, storage, and ranchlands) is adjacent to the San Joaquin River.

All domestic wastewater produced within the City of Modesto and SMSA is initially treated at the primary treatment plant. After primary treatment, effluent from the primary plant is pumped approximately 7 miles to the secondary plant through twin 60-inch outfall pipelines, where it is treated further. While a portion of the secondary treated effluent is disposed of as ranchland

irrigation, the majority of the effluent is stored in ponds and is seasonally discharged to the San Joaquin River.

3.2.2.3 City of Ceres

The City of Ceres, incorporated in 1918, supplies drinking water to approximately 35,000 customers from groundwater pumped by the city's wells. The City of Ceres' wells are capable of pumping a maximum of 17.5 MGD (19,600 AF/yr). During 2006, water production was 3.3 billion gallons (10,165 AF).

The City of Ceres collects, treats, and disposes of approximately 1.0 billion gallons of wastewater each year. A portion of the disposal (636 million gallons, or 1,952 AF) takes place in 108 acres of percolation ponds. The City currently pumps 345 million gallons (1,059 AF) of treated wastewater to the City of Turlock for disposal, freeing up additional disposal capacity in the City of Ceres percolation ponds. The remaining portion of the City of Ceres' wastewater (72 million gallons, or 221 AF) is used for landscape irrigation purposes.

3.2.2.4 City of Hughson

The City of Hughson was founded in 1907 and incorporated as a city in 1972. Hughson is the smallest city in Stanislaus County, with a population that has grown from 3,259 residents in 1990 to 6,127 residents in 2006. The City of Hughson uses groundwater to provide domestic water to approximately 1,900 connections within its 1.42 square mile service area.

The current annual production within the Hughson service area is 1,888 AF/yr (615 million gallons/year). Recent population projections indicate that water demands could increase to 4,764 AF/yr (1,552 million gallons/yr) by the year 2023.

At the direction of the California Department of Health Services (DHS), the City of Hughson has increased source capacity by adding an additional supply well, Well Number 7, and installing 750,000 gallons of storage tank capacity.

The City of Hughson also provides wastewater services to properties within its service area. All domestic wastewater goes through primary and secondary treatment processes, and is disposed of through percolation ponds.

3.2.2.5 Hilmar County Water District

The Hilmar County Water District (HCWD) was founded in 1965 pursuant to the California Government Code. HCWD provides municipal water, sewer, and wastewater treatment services to the unincorporated community of Hilmar in northern Merced County. HCWD operates in accordance with Permit No. 03-91-032 issued by the DHS Office of Drinking Water. HCWD encompasses approximately 625 acres, of which approximately 20 acres remain to be developed.

The Merced County Planning Department is currently conducting a study to update the Specific Urban Development Plan for the Hilmar area. The results of the study, anticipated to be completed in early 2008, could lead to possible expansion of the HCWD boundaries.

Within its current service area, HCWD provides domestic water and sewer services to 1,559 connections, and a population of approximately 4,850 residents (as of the 2000 census). Current demand for water reaches nearly 2.0 MGD during the summer months with a peak hour flow

demand close to 3,000 gallons per minute (GPM). Annual production of domestic water from HCWD's three wells for the year 2006 totaled 1,311 AF (427 million gallons). In order to accommodate growth, the HCWD master plan calls for construction of storage facilities and additional well development.

HCWD also provides wastewater services to properties within its service area. HCWD treats sanitary sewage utilizing the Advanced Integrated Wastewater Pond System (AIWPS). The wastewater facility is permitted to treat up to 0.55 MGD (616 AF/yr). The current average daily flow is 0.43 MGD (482 AF/yr). In 2005, the annual flow of treated effluent to 17 acres of percolation ponds was 495 AF (161 million gallons).

3.2.2.6 Delhi County Water District

The Delhi County Water District (DCWD), governed by a locally elected Board of Directors, provides municipal water and sewer services to a majority of the community of Delhi. DCWD provides potable water to approximately 2,060 customers. Delhi residents that do not receive water from the DCWD are supplied by individual groundwater wells.

Groundwater is the only existing or planned source of domestic water provided by DCWD. At present the DCWD operates five groundwater wells. All of the wells are located within the DCWD boundaries. The DCWD wells draw water from approximately 150 to 500 feet below ground surface, and have a collective pumping capacity of 5,150 GPM (8,308 AF/yr). The overall water quality of existing wells meets State of California Title 22 requirements.

In DCWD's water system, water is pumped, chlorinated, and conveyed to residents through a pressurized water system with hydrants available for fire protection. Existing water mains and wells are adequate to meet present demands and fire flows in Delhi, although pressure varies throughout the water distribution system. The southeast section of Delhi experiences the lowest water pressure in the system because of its distance from current well sites. Nevertheless, DCWD's water pressure meets the DHS minimum standard of 20 pounds per square inch (psi).

Historically, DCWD has been able to meet all water demands with available groundwater supplies. Total pumping in 2006 was 1,866 AF (608 million gallons). Projected demand in 2025 is estimated to be 3,300 AF/yr (Brown, 2004). DCWD's current wells have a total production capacity of 8,308 AF/yr. However, the current system is not capable of supporting the 2025 projected maximum day flow and fire demands.

3.2.2.7 Denair Community Services District

The Denair CSD is a community water system located in the unincorporated town of Denair approximately four miles northeast of Turlock, in central southern Stanislaus County.

The Denair CSD was formed on October 3, 1961 pursuant to California Government Code Section 61000 et seq., and is under the regulatory jurisdiction of the DHS Stockton District Office. Denair CSD has 1,250 non-metered active service connections and 10 commercial metered connections at various locations. The Denair CSD provides domestic water supply to approximately 3,300 residents, according to the 2000 census. In 2006, total municipal pumping was 1,580 AF (515 million gallons).

All of the water for Denair CSD is supplied from five deep wells. The water produced from these wells has continuously met all State of California Title 22 drinking water requirements. The objective of the Denair CSD is to maintain the highest quality of water to meet all customers' needs in the most efficient and financially sound manner.

Denair CSD does not provide wastewater services to the community of Denair. Wastewater generated from the community is transported to the City of Turlock for treatment and disposal.

3.2.2.8 Keyes Community Services District

The Keyes CSD was formed on June 20, 1955 pursuant to California Government Code, Section 61000 et seq. The Keyes CSD is located in the unincorporated community of Keyes, near the City of Turlock. The boundaries of the Keyes CSD encompass approximately 467 acres, while the Stanislaus County Local Agency Formation Commission (LAFCO) approved Sphere of Influence (SOI) includes a total of 804 acres.

The Keyes CSD provides sewer, water, and street lighting services to the community of Keyes. The Keyes CSD has a contractual agreement with the City of Turlock for sewer disposal services. According to a February 25, 2004 LAFCO report, the Keyes CSD serves 1,274 customers with municipal water and 1,317 customers with sewer service. The 2004 report also indicated that the Keyes CSD is operating its sewer service at capacity and must negotiate with the City of Turlock to purchase additional capacity to serve future development within its SOI.

Since 2004, the Keyes CSD has utilized four groundwater wells to provide domestic water to areas within its boundaries. The Keyes CSD opted out of the TID Regional Surface Water Supply Project after receiving a cost estimate based on a 35% design. As of January 2006, community water suppliers have been required to observe the 10 ppb (10 μg/L) MCL for arsenic. As published in the Keyes CSD 2004 Consumer Confidence Report, average arsenic concentrations in these wells were 11.2 ppb, with detections ranging from 4.4 ppb to 17.5 ppb. Keyes CSD has hired a consultant to investigate options for treating wells with arsenic levels greater than the federal standard. Further, Keyes CSD is in the process of hiring a hydrogeologist to explore alternative water supply options.

3.2.2.9 Ballico Community Services District

The small, rural community of Ballico is located approximately 8 miles southeast of Turlock, and 2 miles north of the Merced River. The community has approximately 65 residences, a small number of businesses, and an elementary school. It has a community public water system operated by the Ballico CSD, but at this time there is no community sewer system available. The community is not large enough at this time for a community sewer system, and it is not able to consolidate with another community due to distance.

The Ballico CSD was formed in the late 1980s for the purpose of constructing a public water system. The system began operation in July 1989. The District currently has one well serving the community. Ballico has grown slightly since the formation of the Ballico CSD; however, future growth in the community depends upon obtaining an additional water supply.

Given the very small size of the community, it is often difficult to find a sufficient number of residents willing to volunteer to serve as members of the Ballico CSD Board of Directors. When

there are no volunteers to maintain the needed number of board members, the Merced County Board of Supervisors appoints persons from the area at-large to serve.

3.2.3 Other Local Public Agencies Participating in Groundwater Management Activities

This section provides a description of the other local public agencies situated within the Turlock Subbasin that play a role in groundwater management. There are two water districts that represent rural areas within the Subbasin, the Eastside and Ballico-Cortez water districts. These agencies do not provide water supplies to their customers, but represent these areas in water-related issues.

In addition, the Turlock Subbasin is bisected by Merced and Stanislaus counties. The counties, should they choose to adopt the Plan, will represent the areas within the Subbasin that are not located within the boundaries of another local public agency. Regardless of whether a county adopts the Plan to officially "represent" those areas, the counties are members of the TGBA, and will continue to participate in groundwater management activities within the Subbasin.

Groundwater makes up the majority of water utilized for domestic and agricultural purposes within the areas represented by the agencies described below. There are some lands, located adjacent to the irrigation districts described in Section 3.2.1 above, which utilize small amounts of surface water supplies provided by an adjacent irrigation district, when possible. The availability of the surface water supplies is subject to a variety of constraints including hydrologic, operational, and regulatory issues. In addition, some local agricultural operations have riparian water rights and pump surface water from the rivers adjacent to the Subbasin. Only those parcels located directly adjacent to the river are able to utilize this supply.

3.2.3.1 Eastside Water District

The EWD is comprised of approximately 54,000 acres in Merced and Stanislaus counties, on which high-value, non-subsidized crops are farmed using highly efficient irrigation methods. Most of the land within EWD is agricultural and irrigated with groundwater. Groundwater within the vicinity has dropped dramatically since the mid 1950s. The only other source of water supply is a very limited amount of surface water from purchases in wet years from the Turlock and Merced irrigation districts' canals adjacent to EWD. In addition, parcels with riparian water rights along the Tuolumne and Merced rivers can utilize surface water for irrigation.

The EWD presently does not supply water. EWD was formed specifically to address declining groundwater levels. It may at some point supply water, however, EWD does not own or operate any water conveyance or storage facilities.

EWD was formed in 1985, after about twenty years of struggle, in recognition that if the overdraft was allowed to continue unabated there could come a time when pumping groundwater for irrigation would no longer be economical, or the quality of water pumped would not be satisfactory for irrigation. EWD was formed by election of landowners within the District, under California Law, as a legal body to address water needs of the area. EWD is governed by an elected five-person Board of Directors whose members serve alternating four year terms.

Since the late 1980s EWD has conducted a number of studies with the objective of identifying ways to stabilize groundwater levels. In 1994, the District completed a Groundwater Management Plan under California Assembly Bill 3030. On a year-to-year basis since 1995,

EWD has developed and funded an incentive program to encourage irrigators to use available wet year water from the Turlock and Merced irrigation districts. In 1996, EWD began investigation of the potential of recharging the aquifer using constructed recharge basins. After boring test holes at various locations in the EWD, a site adjacent to the TID Highline Canal, just south of Monte Vista Avenue was selected for construction of the Monte Vista Pilot Recharge Basin. Operation of the basin in 1998, 1999 and 2000 proved to be successful. EWD and TID are currently working on an expanded study, in which several larger basins could be installed and operated to further evaluate the potential recharge opportunities within the Basin. EWD has identified a new site and began testing of the site in May 2007.

The District has joined other agencies that pump water from the common Turlock Groundwater Basin in developing and adopting this Basin-wide Groundwater Management Plan with the objective of coordination and joint efforts to stabilize groundwater levels.

3.2.3.2 Ballico-Cortez Water District

The Ballico-Cortez Water District (BCWD), located in Merced County, is comprised of about 6,700 acres of high-value, non-subsidized crops. Most of the land within BCWD is agricultural and irrigated with groundwater. The only other source of supply is a very limited amount of surface water from purchases in wet years from the Turlock and Merced irrigation districts' canals lying adjacent to BCWD. The groundwater within the vicinity has dropped dramatically since the mid 1950s.

BCWD currently does not supply water. Like the EWD, BCWD was formed to address declining groundwater levels. BCWD does not own or operate any water conveyance or storage facilities, but may supply water in the future.

The District was formed in the 1960s in recognition that if the overdraft was allowed to continue unabated there could come a time when pumping groundwater for irrigation would no longer be economical, or the quality of water pumped would not be satisfactory for irrigation. BCWD was formed, by election of landowners within the District under California Law, as a legal body to address the water needs of the area. BCWD is governed by a five person Board of Directors elected to serve alternating four-year terms.

3.2.3.3 Stanislaus County

The Stanislaus County Department of Environmental Resources (DER) provides a variety of services to protect the environment including conducting inspections of food establishments, labor camps, substandard housing, water supplies, and sewage and solid waste disposal problems. The DER strives to promote a safe and healthy environment and improve the quality of life in Stanislaus County through a balance of science, education, partnerships and environmental regulation. Partnering with the TGBA in Basin-wide groundwater management is consistent with the Stanislaus County Board of Supervisors' priority of ensuring a safe and healthy community, facilitating economic development, and achieving multi-jurisdictional cooperation.

Stanislaus County has oversight responsibility for land use planning activities, water well construction and destruction, groundwater contamination remediation, small public water systems, individual on-site sewage disposal systems, and hazardous material within its

jurisdiction. Therefore, Stanislaus County's participation in development of this groundwater management plan facilitates coordination of Plan objectives with the following county-level activities:

- Stanislaus County could represent water uses within their jurisdiction not served by participating water purveyors.
- Stanislaus County participation ensures the interaction between groundwater management activities and county land use planning.
- Stanislaus County DER enforces the California Model Well Standards (Bulletin 74-81) and all supplements (DWR, 1991 and DWR, 1981a), as required by the California Water Code, in unincorporated areas.
- The DER issues permits for wells that supply small public water systems.
- The DER issues permits and inspects well construction and destruction in the unincorporated areas (for wells outside of a city's boundaries) and maintains a record of drilling logs of permitted wells.
- Groundwater elevations near contamination sites are reported to the DER.
- The DER has periodically mapped groundwater levels.
- The DER regulates, monitors, and inspects small public water systems for Title 22 compliance to ensure that safe, adequate and dependable water supplies are available for domestic use. DER maintains a database and file records containing water quality monitoring for small public water systems. The DER currently administers 200 small public water systems.
- The DER identifies soil and groundwater contamination associated with leaking underground storage tanks and other point sources and monitors groundwater contamination at 61 sites in the Subbasin.
- The DER is responsible for regulating septic tanks and wastewater disposal in unincorporated areas.

3.2.3.4 Merced County

The Merced County Division of Environmental Health (DEH) was established in 1952. The DEH conducts inspections of food establishments, labor camps, substandard housing, water supplies, sewage, and solid waste disposal problems. The DEH also responds to citizens' complaints relating to nuisances such as flies and odors. Additionally, the DEH has been instrumental in establishing community sewer and public water systems for many communities in Merced County.

The DEH adopted a water well ordinance in 1975. Since that time, it has issued well construction and destruction permits, and began conducting inspections of new water installations and destructions. The DEH also issues permits and conducts inspections of sewage disposal system installations and repairs.

Over the years, the DEH has added and expanded environmental health programs to include land use planning, dairy and animal confinement, underground fuel storage tanks, hazardous

materials, childhood lead exposure, medical waste disposal, tattoo and body piercing facility inspections, backflow prevention, and abandoned vehicle abatement. The programs involve ensuring that federal, state, and local standards are being met, and taking enforcement action when necessary to achieve compliance.

The DEH recognizes the prime importance of protecting and conserving the groundwater supply for quantity as well as quality. The DEH has been an active participant in the local groundwater associations within both the Turlock and Merced subbasins since their inception.

3.3 LAND USE PLANNING AND OTHER RELATED ACTIVITIES

The various agencies within the Subbasin participate in a variety of land use planning activities which serve to ensure water supply availability, groundwater protection, and other groundwater management related activities. Section 1.4.3 above describes some of these activities, and a summary of member agency programs affecting groundwater is provided in Table 2 of Appendix B.

3.3.1 Agencies' Spheres of Influence

A Local Agency Formation Commission (LAFCO) is a county-wide entity in each county that ensures the orderly growth of cities, decides on proposed annexations, and whether district or agency boundaries can be expanded or changed. A LAFCO defines the limits of a city or service district and the sphere of influence for each city and local public agency in the state.

The sphere of influence of a local public agency's land use planning activities are generally consistent with their political boundaries. Figure 2 shows the political boundaries of the local public agencies. In addition, activities outside of an agency's boundaries, which can impact land and water uses within its boundaries, also can be of interest to the agency.

3.3.2 Planning for Growth

Local agencies within the Subbasin have a variety of planning practices to ensure they are able to meet the needs of their constituents. Local cities conduct their own planning activities, while the local county planning department, under the direction of a municipal advisory council, fulfills this role for the unincorporated areas (i.e., any urban area that is not a "city"). Planning efforts, as they relate to groundwater management activities, are described in Section 1.4.3 and Table 2 of Appendix B.

3.3.3 Potential Future Annexations

As urban growth continues, municipal agencies will continue to annex lands historically represented by other local public agencies into their agency. As a result, the sphere of influence of the various agencies is anticipated to change as growth occurs. Further, as urban growth occurs, there is likely to be a corresponding decrease in agricultural lands within the Subbasin boundaries.

3.3.4 Other Land Use Planning or Regulatory Activities

Land use changes on privately owned properties are planned by the individual property owner. Growers, for example, determine the water supply use, irrigation method, cropping patterns, and

other issues for their lands. Unless a permit is required to install buildings, wells, or other structural improvements, the modifications are not part of a larger land use planning process.

Within this area of the State, the Central Valley Regional Water Quality Control Board (CVRWQCB) is responsible for protecting water quality. Although the majority of regulatory programs are surface water-related, the CVRWQCB is responsible for the protection of both surface water and groundwater resources. An example of programs designed to protect water quality include: permitting of wastewater treatment plants, industries, and other point sources discharges; the irrigated lands waiver and urban stormwater runoff programs designed to address non-point source discharges; Basin Plan Amendments implemented to address water quality impairments in surface waters; and a new dairy permitting program.

4 WATER RESOURCES IN THE TURLOCK SUBBASIN

Locations of water agencies within the Turlock Subbasin are shown in Figure 2. Water purveyors within this area utilize both surface water and groundwater supplies. Some rely exclusively on groundwater, while others use a combination of surface water and groundwater to meet their needs. The groundwater and surface water supplies available to the region are summarized below.

4.1 GROUNDWATER SUPPLIES

DWR Bulletin 118 (2003) defines a groundwater basin as an alluvial aquifer or a stacked series of alluvial aquifers with reasonably well defined boundaries in a lateral direction with a definable bottom. In its text, Bulletin 118 further defines a groundwater basin as an area underlain by permeable materials capable of furnishing a significant supply of groundwater to wells or storing a significant amount of water. The bulletin defines a groundwater subbasin as a subdivision of a groundwater basin created by dividing the basin using geologic and hydrologic conditions or institutional boundaries.

The following sections describe the Turlock Subbasin, its geographical location, the geology and hydrogeology of the Subbasin, as well as groundwater facilities, usage, recharge, quality and other groundwater supply related issues.

4.1.1 Turlock Subbasin Location and Description

A map showing the area of the Turlock Subbasin, as defined in DWR Bulletin 118 (2003) is presented in Figure 1. It is important to note that groundwater basins and subbasins are three-dimensional and include both the surface extent and all of the subsurface fresh water yielding material. However, available data used by DWR to determine the groundwater basin and subbasin boundaries, only permits two-dimensional delineation of groundwater basins. The current DWR groundwater basin maps, including the maps used to identify the Turlock Subbasin and the adjacent areas depict a surface expression of groundwater basin boundaries and it should not be interpreted that these boundaries extend downward in a three-dimensional fashion.

As defined in DWR Bulletin 118 (2003), the Turlock Subbasin is a portion of the San Joaquin Valley Groundwater Basin. The San Joaquin Valley is bounded on the west by the Coast Ranges, on the south by the San Emigdio and Tehachapi Mountains, on the east by the Sierra Nevada Foothills and on the north by the Sacramento-San Joaquin Delta and Sacramento Valley. Drainage within the San Joaquin Valley flows in two directions. The northern portion of the valley drains toward the Delta by the San Joaquin River and its tributaries, the Fresno, Merced, Tuolumne, and Stanislaus rivers. The southern portion of the valley is internally drained by the Kings, Kaweah, Tulare, and Kern rivers that flow into the Tulare drainage basin, including the beds of the former Tulare, Buena Vista, and Kern lakes.

The Turlock Subbasin lies within the eastern portion of Stanislaus and Merced counties and covers approximately 347,000 acres or 542 square miles. The Subbasin is situated between the Tuolumne and Merced rivers and is bounded on the west by the San Joaquin River and on the east by crystalline basement rock of the Sierra Nevada foothills. The Subbasin’s northern, western, and southern boundaries are shared with the Modesto, Delta-Mendota, and Merced Groundwater subbasins, respectively.

The following sections provide a description of the geologic and hydrogeologic conditions of Turlock Subbasin.

4.1.1.1 Hydrogeologic Setting and Water Bearing Deposits

As stated above, DWR Bulletin 118 (2003) defines the groundwater basin boundaries and provides a description of the hydrogeologic setting for the San Joaquin Valley Groundwater Basin and the Turlock Subbasin. The description provided below is primarily taken from DWR Bulletin 118 (2003), and supplemented with addition information as it was available.

The San Joaquin Valley represents the southern portion of California's Central Valley. The valley is a structural trough up to 200 miles long and 70 miles wide, filled with up to 32,000 feet of marine and continental sediments of Cretaceous age (140 million years ago) through Quaternary age (through today). The valley geologic formations were deposited due to the periodic inundation by the Pacific Ocean and by erosion of the surrounding mountains, respectively. Continental deposits originating from the surrounding mountains form an alluvial wedge that thickens from the valley margins toward the axis of the structural trough.

The Turlock groundwater basin represents a subbasin of the San Joaquin Valley Groundwater Basin. The primary hydrogeologic units in the Turlock Subbasin include both consolidated and unconsolidated sedimentary deposits that are as much as 16,000 feet in thickness within the western portion of the Subbasin (California Division of Mines and Geology, 1966a). Figures 5 and 6 show the generalized extent, thickness and stratigraphic position for the hydrogeologic units of the Turlock Subbasin.

The consolidated deposits include the following formations, listed in order from the oldest to youngest deposits: the Ione Formation of Eocene epoch, the Valley Springs Formation of Miocene epoch, and the Mehrten Formation, which was deposited during the Miocene to Pliocene epochs. Water within the Valley Springs and Ione Formations is typically saline due to the marine shales contained within these formations. The consolidated deposits lie in the eastern portion of the Subbasin and generally yield small quantities of water to wells, except for the Mehrten Formation, which is an important aquifer.

Unconsolidated deposits, including continental deposits, older alluvium, younger alluvium, and flood-basin deposits, overlie the Mehrten Formation. Those units are known as the Turlock Lake, Riverbank and Modesto formations. Both the Turlock Lake and Modesto formations contain lake and floodplain deposits. Where those fine-grained deposits occur within the Turlock Lake Formation, they are referred to in this report as the shallow aquitard. Lacustrine and marsh deposits, which constitute the Corcoran or E-clay aquitard, underlie the western half of the Subbasin at depths ranging between about 50 and 200 feet (DWR, 1981b). The continental deposits and older alluvium are the main water-yielding units in the unconsolidated deposits. The lacustrine and marsh deposits and the flood-subbasin deposits yield little water to wells. The younger alluvium, in most places, probably yields only moderate quantities of water.

4.1.1.2 Geologic Formations

The following paragraphs describe in more detail each of the water bearing formations within the Turlock Subbasin. Information utilized to prepare this section of the report was derived from the Turlock Groundwater Basin Water Budget (Durbin, 2003), as well as information contained

within DWR Bulletin 118 (2003). As noted above, Figures 5 and 6 show the generalized extent, thickness, and stratigraphic position for the hydrogeologic units comprising the groundwater system, including the Corcoran Clay and the shallow aquitard.

The Modesto Formation, which is of late Pleistocene age (about 1 million years ago), outcrops in the western one-third of the Subbasin (Figures 5 and 6) and is as much as 120 ft in thickness. The formation consists of gravel, sand, and silts with rapid coarseness changes, which yields moderate to large quantities of water to wells. The shallow aquitard member of the Modesto Formation occurs only within the western part of that formation (Figure 5), and does not crop out at the land surface (Figure 6). The shallow aquitard is comprised of silt and clay with some sand. This unit is encountered 30 to 50 ft below the land surface, and is as much as 15 feet in thickness.

The Riverbank Formation, which is of middle Pleistocene age (about 1.5 million to 1 million years ago), underlies the extent of the Modesto Formation and crops out in the central portion of the Turlock Subbasin (Figures 5 and 6). The thickness of the unit increases westward, but the thickness generally is less than 200 ft. The formation consists primarily of sand with scattered gravel and silt lenses, and yields moderate to large quantities of water to wells. The unit tends to coarsen upward (Marchand and Allwardt, 1981).

The Turlock Lake Formation, which is of early Pleistocene and late Pliocene age (2.5 million to 1.5 million years ago), underlies the Riverbank Formation and crops out in the eastern part of the Turlock Subbasin (Figures 5 and 6). The thickness of the unit increases westward, but the thickness generally is less than 600 feet. The formation consists of mostly fine sand and silt (Marchand and Allwardt, 1981), and yields moderate to large quantities of water to wells.

The Corcoran Clay aquitard portion of the Turlock Lake Formation (Figures 5 and 6) ranges in thickness from 10 to 80 feet, and is typically found at depths ranging between 50 to 200 feet. The Corcoran Clay lies in the upper part of the Turlock Lake Formation. The unit does not crop out, and occurs only within the western portion of the Turlock Subbasin. The United States Geological Survey (USGS) recently conducted a comprehensive review of lithologic and hydrologic data for an update of the Modesto Subbasin hydrogeologic model (Burow et al., 2004). As a result of this investigation, the USGS revised the eastern extent of the Corcoran Clay in both the Modesto and Turlock subbasins. The proposed shift in the Turlock Subbasin, shown in Figure 7, is to the west of the existing eastern boundary of the Corcoran Clay modeled in the Turlock Subbasin Water Budget (Durbin, 2003). Due to the uncertainties expressed in the USGS report and after examining the recent data for the Turlock Subbasin, it was decided not to revise the extent of the Corcoran Clay in the Turlock Groundwater Basin Model (Velayas et al., 2005).

The Mehrten Formation, which is of Miocene to late Pliocene age (5 million to 2.5 million years ago), underlies the Turlock Lake Formation and crops out on the eastern edge of the Turlock Subbasin (Figures 5 and 6). The thickness of the unit increases westward, but the thickness generally is less than 800 ft. The formation consists of claystone, tuff siltstone, breccia, sandstone, and conglomerate (Page and Balding, 1973); yields small to moderate quantities of water to wells; and is saline at lower elevations within the western and central parts of the Turlock Subbasin.

The Valley Springs Formation, which is of Miocene age (24 million to 5 million years ago), underlies the Mehrten Formation and crops out on the eastern edge of the Turlock Subbasin (Figures 5 and 6). The thickness of the unit increases westward, but the thickness generally is less than 500 ft (Page and Balding, 1973). The formation consists of siltstone and claystone deposited mostly by rivers with occasional ash deposits, and yields small quantities of water to wells due to the fine ash and clay matrix (Page, 1986).

The Ione Formation, which is of late Eocene age (40 million to 34 million years ago), underlies the Valley Springs Formation and crops out on the eastern edge of the Turlock Subbasin (Figures 5 and 6). The thickness of the unit increases westward, but the thickness generally is less than 200 ft (Page and Balding, 1973). The formation consists of clay, sand, sandstone, and conglomerate and yields only small quantities of water to wells. The Ione Formation is saline throughout much of the Turlock Subbasin (Page, 1986).

4.1.1.3 Aquifers

Groundwater within the Turlock Subbasin occurs under unconfined and confined conditions. As described in DWR Bulletin 118 (2003) a portion of the Basin is underlain by the Corcoran Clay which separates the groundwater into two zones; an upper, unconfined aquifer and a lower, confined aquifer (see Figure 6). There is also a deeply buried confined aquifer containing saline brine that extends upward into the unconsolidated sediments. The presumed origin of the saline brine is the connate water sourced with the Upper Cretaceous marine shales that underlie the Pleistocene and Holocene sediments.

The following sections describe in more detail the various aquifer conditions found within the Turlock Subbasin.

Unconfined Aquifer

An unconfined aquifer is an aquifer in which the groundwater is not under pressure. In the Turlock Subbasin, the unconfined aquifer occurs in unconsolidated sedimentary deposits, mainly within the Modesto and Riverbank formations, situated above and to the east of the Corcoran Clay. In the area underlain by the Corcoran Clay, the top of the clay is the base of the aquifer. To the east of the clay, the top of the consolidated rocks is the base of the aquifer. Above and to the east of the Corcoran Clay, the top of the unconfined aquifer is the water table. The unconfined aquifer has areas, particularly in the western portion of the Subbasin, which are locally confined by clay layers that are not continuous over long distances. This area is referred to as the shallow aquitard and is described further below.

With the exception of those areas containing the shallow aquitard, the unconfined aquifer is the water-table aquifer. It is about 150 feet in thickness, and the depth to its surface ranges from less than 10 feet in the western part of the Subbasin to 50 feet within the central part of the Subbasin. Within the western part of the Subbasin, the unconfined aquifer is used as an agricultural supply. The unconfined aquifer also may be used as a potable supply for private residences. Wells less than 200 feet in depth draw from the unconfined aquifer.

The direction of regional groundwater flow in the unconfined aquifer is mainly westward and southward towards the axis of the valley trough, with the exception of the eastern portion of the Subbasin where there is a localized cone of depression (Figure 7). The direction of groundwater flow is controlled by the elevations of the Tuolumne, Merced and San Joaquin rivers. The

elevation of the water table is maintained along these rivers at the local elevation of the water surface within the river. Groundwater levels are maintained by exchanges of water between the river and the groundwater system.

Freshwater Confined Aquifer

A confined aquifer is an aquifer in which the groundwater is contained under pressure. The aquifer referred to in this report as the confined aquifer is contained within the unconsolidated deposits of the Turlock Lake and Mehrten formations. The top of the consolidated rocks is the base of the unconsolidated deposits. The freshwater confined aquifer is confined by the Corcoran Clay member of the Turlock Lake Formation within the western part of the Subbasin. The top of the confined aquifer in this area is the bottom of the Corcoran Clay. The aquifer is semi-confined within the eastern part of the Subbasin, where the Riverbank Formation directly overlies it. It is unconfined in the eastern part of the Subbasin, where the Turlock Lake and Mehrten formations crop out.

The freshwater confined aquifer is approximately 1,300 feet in thickness, and the depth to its surface ranges from 200 feet in the western portion of the Subbasin to 100 feet within the eastern portion of the Subbasin. The freshwater confined aquifer is used extensively as an agricultural and municipal water supply. Wells greater than about 200 feet draw from the freshwater confined aquifer. However, such wells will also draw from the unconfined aquifer, if the depth to the top of the well perforations is less than 200 feet.

Based on general hydrologic considerations, the direction of groundwater flow in the confined aquifer is probably similar to that in the unconfined aquifer, westward and southward. Under historical conditions, the hydraulic head in the confined aquifer was greater than that of the unconfined aquifer, which caused water to flow upwards through the Corcoran Clay from the confined to the unconfined system. Under present conditions, the pumping that has occurred in the unconfined aquifer would tend to maintain an increase in the upward gradient (head differential) between the aquifers. However, because of the lack of information on the conditions in the confined aquifer, an upward gradient across the Corcoran Clay cannot be confirmed.

Saline Confined Aquifer

Fresh groundwater in the San Joaquin Valley is underlain by a saline brine groundwater body. The saline confined aquifer occurs within the Valley Springs and Ione formations. The aquifer is confined except where the formations crop out. The saline confined aquifer is about 600 feet in thickness, and the depth to its top ranges from as low as 1,500 feet in the eastern portion of the Turlock Subbasin to as high as 100 feet within the western portion of the Subbasin. The deep aquifer is used little as a water supply.

Some gas exploration wells were drilled into the deep marine rocks along the Tuolumne River near Waterford and Ceres. The wells were artesian, flowing wells which produced saline brines without pumping for many years, until they were plugged in the 1970s. The artesian conditions indicate that the deep, saline groundwater is under sufficient hydraulic head (pressure) to push water up to the land surface. This head will cause the saline water to migrate upwards where movement is possible. This upwelling can occur in wells and along cracks, fissures, and faults. Saline brines are migrating upward and mix with the shallow fresh groundwater to form high total dissolved-solids (TDS) groundwater at a certain depth below the surface. The base of the fresh water is extremely variable and often occurs in the unconsolidated sediments.

The deep, saline groundwater flows, as does all the groundwater in the valley, from the valley's sides towards its trough. Upwelling occurs at the trough where the flows from the opposite sides of the valley meet, and the only direction for the water to go is up. On the surface, the San Joaquin River occupies the valley trough. Water for the river flow is derived in the same way. Groundwater flows from the opposite sides of the valley meet and move upwards providing water to the river.

Shallow Aquifer

The discontinuous shallow aquitard and an overlying shallow aquifer that occur within the unconfined aquifer result in a high groundwater table in the western portion of the Subbasin. The low vertical permeability of the shallow aquitard restricts the downward percolation of infiltrated precipitation and irrigation applications. The shallow aquifer is a water table aquifer. The depth to groundwater can be less than 6 feet in these areas. The aquifer is about 40 feet in thickness, and the shallow aquitard forms its base. The shallow aquitard is approximately 15 feet in thickness.

4.1.2 Groundwater Usage

Discharges from the Turlock Basin occur from well pumping, groundwater seepage to the Tuolumne, Merced, and San Joaquin rivers, discharges from subsurface agricultural drains, and water use by riparian vegetation. A water budget study conducted by the Turlock Groundwater Basin Association in 2003 and updated in 2007 resulted in the water usage information described throughout this subsection.

Groundwater is utilized to supply the water needed by both agricultural and urban users within the Basin. Between 1997 and 2006 it is estimated that an average of 457,000 AF/yr was pumped by agricultural and urban agencies, as well as small domestic water systems and private property owners, for domestic or agricultural uses. The following sections further describe these uses.

4.1.2.1 Agricultural Groundwater Pumping

Turlock ID supplements its surface water supply with groundwater to satisfy crop-water requirements, the extent of which varies from year to year depending on the availability of surface water. TID pumps groundwater directly into canals from both TID-owned drainage wells and rented wells for distribution to users within its irrigation service area. In addition, some individual growers within the District pump groundwater to supplement their surface water allotments, while others use groundwater to meet their entire crop-water requirement.

Like TID, Merced ID supplements its surface water supply with groundwater to satisfy crop-water requirements. The extent of groundwater supplementation by Merced ID varies from year to year depending on the availability of surface water. Merced ID pumps groundwater directly into canals, laterals and pipelines exclusively from Merced ID-owned irrigation and drainage wells. All of Merced ID's wells are located outside the area of the Turlock Groundwater Basin. Even so, Merced ID incorporates pumped groundwater into its total supply and makes deliveries to lands in the area of the Turlock Groundwater Basin on the same basis as it delivers to the other lands within its boundaries. Only in severe drought conditions does Merced ID permit the discharge and wheeling of groundwater from privately owned wells into the Merced ID water conveyance system. In some areas of Merced ID, growers meet their crop-water requirements from their own groundwater supplies.

Growers within the Eastside and Ballico-Cortez water districts have limited access to surface water supplies for irrigation purposes, and rely upon the groundwater to supply their crop-water requirements. Within these districts there are individual properties with access to occasional surface water deliveries from either TID or Merced ID. This type of water is not available on a consistent basis, being dependent upon both surface water availability and system capacity constraints. Therefore, due to the unreliability of this type of water, it is appropriate to assume that the growers within the Eastside and Ballico-Cortez water districts must rely on groundwater to supply their crop-water requirements.

There are agricultural areas located outside of the local water agency boundaries that also utilize groundwater to irrigate their crops. This occurs in a fairly large area located on the eastern boundary of the Basin. Between 1992 and 2006 this area, called the "foothill non-district" subarea in Section 3.1, has had significant conversions from non-irrigated to irrigated lands.

In addition to agricultural irrigation water, groundwater is pumped for a variety of agricultural operational needs. A portion of this use ultimately may be used for irrigation supply purposes. For example, groundwater is pumped to meet the water supply needs of dairy operations. A portion of the water may find its way into the lagoon and later be blended with surface water for irrigating dairy feed crops. This water use is considered small compared to the total amount of irrigation water use within the Subbasin.

The total annual application of groundwater for irrigation purposes varies from year to year depending on the availability of surface water. In wet years, less groundwater is needed to supplement irrigation supplies. Drainage pumping to help lower groundwater levels also varies depending on the weather conditions. For the period between 1997 and 2006, the average drainage pumping within the Basin was about 65,000 AF/yr, while the average total agricultural pumping totaled 344,000 AF/yr.

Growers within the TID utilize groundwater to supplement canal deliveries or for use on farm for purposes other than irrigation. Between 1997 and 2006, the average pumping from private and improvement district owned wells for various agricultural purposes is estimated to be 22,000 AF/yr. Figure 8 shows the annual estimated pumping from these wells.

TID uses groundwater pumped for drainage purposes, as well as rented wells to supplement its surface water supplies. Rented pumping by TID varies depending on surface water supplies and operational constraints. Figure 9 show the annual rented pumping between 1977 and 2006. From 1997-2006 the average rented pumping was approximately 18,000 AF/yr.

Some growers within the TID choose not to receive surface water and irrigate with groundwater instead. The average pumping from these types of wells was estimated to average 9,600 AF/yr during the recent 1997-2006 time period. This type of pumping increased from an estimated 2,000 AF/yr in 1997 to about 13,500 AF/yr in 2006. Figure 10 provides a graphical illustration of this type of pumping between 1952-2006. The majority of these lands have switched from flood to drip/micro irrigation methods. Should additional lands choose to make a similar switch and not utilize surface water supplies, the demand upon groundwater will increase.

Growers within the portion of the Merced ID that falls in the Turlock Subbasin also utilize a combination of groundwater and surface water supplies. As with the TID, there are some growers within the Merced ID that choose not to receive surface water and irrigate with

groundwater instead. The estimated amount of private groundwater pumping for agricultural purposes within the Turlock Subbasin portion of the Merced ID ranges from approximately 100 AF/yr to over 400 AF/yr. Figure 11 provides a graphical illustration of the extent of this type of pumping between 1952-2006.

Growers within Eastside and Ballico-Cortez water districts pumped a combined estimated 180,000 AF/yr between 1997-2006. With the exception of those properties adjacent to the rivers that have riparian water rights, these areas rely upon groundwater for their entire water supply. Figures 12 and 13 illustrate the estimated water usage in these areas between 1952 and 2006.

It is estimated that growers within the non-district areas, located along the river margins and east of the Eastside and Ballico-Cortez water districts, pumped an average of 115,000 AF/yr between 1997 and 2006. With the exception of those properties adjacent to the rivers that have riparian water rights, these areas rely exclusively upon groundwater for their water supply. Figure 14 shows the estimated groundwater usage in these areas between 1952-2006. As agricultural development continues in these areas, the dependence upon groundwater likely will increase.

4.1.2.2 Urban Groundwater Pumping

Presently municipal, industrial, and individual domestic water users rely solely on groundwater. While the supply has been adequate, the groundwater quality has deteriorated in some areas to the point where treatment is required to make it suitable for these uses.

The communities of Ceres, Delhi, Denair, Hickman, Hilmar, Hughson, Keyes, south Modesto, and Turlock pump, collectively, from approximately 75 wells. The average pumping from municipal wells was about 44,000 AF/yr during the 1997 through 2006 period. Figures 15a through 15i show the annual pumping for municipal wells for each community from 1952 to 2006. As urban development continues, the demands upon groundwater supplies will increase unless alternative supplies are considered.

There are an estimated 3,700 residences within the Turlock Basin that are not connected to a municipal water system that pump groundwater for domestic supply. The average pumping rural residential areas averaged 4,000 AF/yr between 1997 and 2006.

4.1.2.3 Other Groundwater Outflows

Groundwater discharges occur along the lower reaches of the Tuolumne and Merced rivers, and along the entire reach of the San Joaquin River. Along the upper reaches of the Tuolumne and Merced rivers, groundwater is recharged by streamflow. However, under current conditions, the net effect is that the groundwater discharge to the rivers exceeds the streamflow recharge to the groundwater system. Between 1997 and 2006, the net groundwater discharge to rivers averaged nearly 30,000 AF/yr.

High groundwater levels are known to occur in mainly the western and southern portions of the Subbasin. Water levels that encroach into the crop root zone can reduce crop yields. As a result, some local growers have installed subsurface drains to lower the groundwater table on their lands. Between 1997 and 2006, subsurface drains removed approximately 12,000 AF/yr of high groundwater.

Lastly, phreatophytes, plants that live along the river system with their roots below or near the water table extract their water requirements directly from the saturated zone. There are approximately 18,500 acres of native phreatophytes along the Tuolumne, Merced and San Joaquin rivers. The average groundwater consumption of riparian phreatophytes was estimated to be 41,500 AF/yr between 1997 and 2006.

4.1.3 Groundwater Recharge

Groundwater recharge occurring within the Basin is mainly the result of the irrigation of crops and landscape vegetation, precipitation, percolation from the Tuolumne and Merced rivers, leakage from Turlock Lake, underflow from the Sierra Nevada foothills, and upward seepage from deep geologic fractures. A recent water budget study commissioned by the TGBA (Durbin, 2003) and updated in 2007 resulted in the estimates of recharge occurring within the Basin from 1997 to 2006 discussed throughout this subsection. The total recharge from the various sources within the Basin was calculated to be approximately 520,000 AF/yr between 1997 and 2006.

The majority of recharge results from irrigation practices. Recharge occurs when the applied irrigation water and effective precipitation exceed the consumptive use of agricultural crops or landscape vegetation. The excess water infiltrates below the crop root zone and then percolates downward into the groundwater table. It is estimated that urban and agricultural irrigation produces groundwater recharge of nearly 393,000 AF/yr. Recharge from croplands was estimated to be 375,000 AF/yr, while recharge from landscaping within urban areas is approximately 18,000 AF/yr.

Groundwater recharge from precipitation on dry, undeveloped land occurs when the effective precipitation exceeds the consumptive use of the annual or perennial vegetation. For the 1997 through 2006 period, recharge on non-irrigated lands averaged 22,000 AF/yr.

Turlock Lake, a regulating reservoir on TID's canal system, receives water from the Tuolumne River. The reservoir has a surface area of approximately 3,300 acres. Because Turlock Lake is underlain by the moderately permeable sediments of the Mehrten Formation, water leaks from the lake into the underlying and adjacent groundwater system. The average leakage from Turlock Lake was estimated to be approximately 62,000 AF/yr for the 1997 through 2006 period. Seepage also occurs throughout TID's 230-mile canal distribution system, which is 90% lined. Seepage estimates for the 1997-2006 period averaged nearly 38,000 AF/yr.

The Basin is also recharged from subsurface inflows that enter the groundwater basin across its eastern boundary and the base of the groundwater system. Recharge from both these sources was calculated to be about 3,000 AF/yr.

As indicated in Section 4.1.2.3 above, streamflow from the Tuolumne and Merced rivers provide recharge to the Turlock Basin, mainly along the upper reaches of the rivers. However, within the lower reaches of the Tuolumne and Merced rivers, as well as where the San Joaquin River borders the Basin, groundwater typically discharges to the rivers. Within the water budget study, streamflow-groundwater interactions were expressed in terms of the net groundwater discharge to the rivers (Durbin, 2003). The actual groundwater inflow or outflow by river reach was not calculated. The estimated net discharge to local rivers during the 1997-2006 period was approximately 30,000 AF/yr. Therefore, discharge to the river system from the Basin significantly exceeded recharge.

4.1.4 Groundwater Conditions

Groundwater conditions within the Basin vary. Levels in the eastern areas have declined significantly since the 1960s. Levels in the western areas of the Basin are high to the point of requiring pumping in certain areas to keep the groundwater from encroaching into the root zone of agricultural crops. A water budget or water balance calculation is a tool that can be used to evaluate Basin-wide storage conditions and changes in groundwater levels over time. This section summarizes the methods used to evaluate groundwater conditions in the Basin and describes groundwater storage trends over the last ten years.

4.1.4.1 Water Budget Study Description

The Turlock Groundwater Basin Water Budget study (Durbin, 2003) was commissioned by the TGBA and recently updated to evaluate storage changes within the Basin between 1952 and 2006. The Basin water budget is based on a mass balance calculation, where:

[Total Inflows] – [Total Outflows] = [Change in Groundwater Storage]

Outflows are based on estimates or records of pumping for each of the local public agencies and Non-District areas in the Basin. Other outflows result from discharge to rivers and consumption by riparian vegetation. Water use by riparian vegetation can be estimated from land use maps and climate data. The net discharge to rivers cannot be estimated and is an unknown outflow in the equation.

Groundwater recharge, or total inflows to the Basin, is estimated based on a series of assumptions regarding land use types, rooting depths, effective precipitation, irrigation efficiencies, and surface water use. Recharge can be estimated for each of the local public agencies and Non-District areas in the Basin. Other inflows include seepage from surface water distribution systems and flows from beneath the basin and across the eastern boundary. Each of these inflows can be estimated in the water budget.

The third component, change in groundwater storage, must be estimated to solve the water budget equation, because the net discharge to rivers term is unknown. Storage change is estimated using groundwater contour maps for the Basin. The water budget study uses DWR groundwater level monitoring data to construct these maps. The quality of each map is influenced primarily by the number and timing of measurements. In general, more data points and more coordinated monitoring events lead to better contour maps. As monitoring points are lost and the time between measurements increases, the estimated groundwater elevation becomes more uncertain.

For example, an area of 25 mi^2 may have 12 monitoring wells, or approximately one monitoring point for every two square miles. If seven monitoring wells are lost, each well then represents the groundwater elevation for a five square-mile area. The net result is that estimated groundwater elevations cover a greater percentage of area within the Basin. Further, if there is error in a single measurement, the error influences a greater proportion of area within the Basin.

4.1.4.2 Water Budget Study Results

Figures 16a through 16e show the series of groundwater elevation contours between 1960 and 2005 that were developed for the water budget update. The figures illustrate the cone of

depression that has formed on the eastern side of the Basin, largely due to pumping groundwater to irrigate lands east of TID, where surface water supplies are not available.

Figures 16d and 16f show that the cone of depression had generally stabilized between 1998 and 2002. The recent elevation data shown in Figure 16f suggests that groundwater levels appear to have declined after 2002, particularly in the eastern portion of the Subbasin. Overall these declines are relatively small and may be within the range of error for the estimate of groundwater levels.

The update of the water budget study revealed that there has been a significant change in the DWR monitoring network that is used to create the contour maps. Decreases in funding have reduced the frequency of monitoring and the number of locations monitored during each event. Additionally, numerous monitoring points have been lost due to aging wells that can no longer be accessed. Consequently, the reduction in the number of monitoring points has led to increased uncertainty in estimated groundwater levels in the Turlock Subbasin.

The basin-wide groundwater model was used to evaluate the storage changes derived from the groundwater contour maps. The model was developed and calibrated with additional monitoring points from periods when the DWR monitoring program covered more of the local area, and is considered more representative of the Subbasin. Consequently, using the groundwater model to evaluate current estimates of inflows and outflows provides another estimate of storage changes in the Basin. The groundwater model confirms that the slight declines in storage have occurred between 2002 and 2006.

Analysis of the water level readings from several individual wells also helps provide an understanding of the changes in water levels. Figure 17 provides the general location of the historic and active monitoring wells within the Subbasin. Figures 18a through 18d provide hydrographs of the groundwater levels at four representative monitoring points highlighted in Figure 17. Analysis of the well data shows that groundwater levels have declined since the 1960s, particularly in the eastern portion of the Subbasin. Data for more recent years show that groundwater levels stabilized or recovered during the 1990s. The most recent data suggest that groundwater levels in the central and eastern areas appear to have declined slightly since 2002 (Figures 18b and 18c).

The average inflows and outflows for the 1997-2006 period are summarized in Figure 19. The water budget study estimates that storage decreased by an average of 21,500 AF/yr during that ten year period. Increases in storage occurred in 1998, 2000, and 2001, but were offset by declines in storage in 1997, 1999, and 2002 through 2006. The observed declines in groundwater storage could fall within the natural operations of the Subbasin. In any groundwater basin, groundwater storage will fluctuate both seasonally and annually, depending upon the water year classification, distribution of rainfall, and numerous other physical and biological factors. Alternating periods of decline and recovery in groundwater levels are a response to this natural variation. Long-term declines in storage without recovery could be a concern and represent net declines in storage. Continued monitoring by the local public agencies will be important for tracking changes in groundwater conditions in the Turlock Subbasin and evaluating whether additional management actions should be considered.

It is important to note that a balanced storage condition in the Basin is strongly influenced by irrigation practices. The majority of recharge occurs on agricultural land. It is estimated that

groundwater recharge on agricultural lands is nearly 375,000 AF/yr, or 72% of total recharge within the Basin. Nearly 230,000 AF/yr, or 44% of total recharge occurs on lands that are irrigated by surface water. Changes in irrigation practices from surface water to groundwater sources can lead to declines in storage. Other factors that may result in storage declines are changes in cropping patterns, the expansion of irrigated agriculture in areas dependent upon groundwater, and increases in pumping due to urban growth, particularly when agricultural lands are converted to urban uses.

4.1.5 Groundwater Quality

Groundwater is an important component of the local water supply, and accordingly, the quality of local groundwater is important for its sustained use. The following section describes ongoing monitoring programs, water quality within the Basin, and the various issues and concerns facing the local agencies.

4.1.5.1 Groundwater Quality Monitoring

Water quality monitoring requirements for public water systems are set by Title 22, Chapter 15, of the California Code of Regulations (CCR) and vary depending upon the type of water system. Large public water systems (greater than 200 service connections) are regulated by the State of California. Wells at large public water systems must be sampled for general mineral, physical, inorganic, organic, and radiological analyses. Small public water systems (less than 200 service connections) are regulated by local county environmental health agencies. Sampling of small public water systems is dependent upon type of water system: small community, non-transient non-community, transient non-community, or state small water systems. Public water systems are required to perform routine bacteriological analyses, usually from water distribution systems. Frequency of bacteriological analyses is defined in Title 22, Chapter 15 CCR, and varies depending upon the specific type of water system.

Groundwater contamination sites are also monitored within the Subbasin. The Merced County DEH and Stanislaus County DER take different roles in monitoring groundwater contamination in their respective boundaries. In Merced County, facility operators or property owners are directly responsible for working with the CVRWQCB to monitor groundwater contamination. The Stanislaus County DER takes a more active role in groundwater contamination activities, with 61 active monitoring sites within its boundaries. These sites are monitored for groundwater quality on a quarterly basis. Depending on the type of constituent contamination present, groundwater is monitored for petroleum constituents, chlorinated solvents such as TCE and PCE, metals, and various other analytes based on site-specific target needs.

A standardized monitoring system has not been established for private domestic wells or the agricultural community. Individual domestic well owners, farmers and agricultural agencies do monitor groundwater quality; however, the monitoring frequency and constituents monitored vary throughout the Basin. In most cases, the water quality data for the private domestic and agricultural wells sampled is not publicly available.

4.1.5.2 Water Quality Conditions

There are numerous constituents found in the Basin's groundwater supply. Some constituents occur naturally, while others have been introduced into the groundwater from human activities.

Many constituents found in groundwater do not have the potential to impact groundwater usage within the Basin according to current water quality standards. These constituents are not addressed in this section. The constituents identified in this section either currently impact groundwater usage within the Basin, or have the potential to impact the Basin's future groundwater usage.

Additional data and interpretations of groundwater quality conditions in the Turlock Subbasin should be available in 2008 as a result of water samples taken for the Groundwater Ambient Monitoring and Assessment (GAMA) Program being implemented by the USGS, in coordination with the State Water Resources Control Board (SWRCB) DHS, DWR, and Lawrence Livermore National Laboratory.

Salinity

Salinity can be of concern for both irrigation and municipal uses. Salinity levels are expressed as a total salt concentration or total dissolved solids (TDS), or electrical conductivity (EC). Salinity is a measure of the total sum of dissolved inorganic ions and molecules. The most common salts found in water include sodium chloride (NaCl, also referred to as "table salt"), calcium sulfate ($CaSO_4$, better known as "gypsum"), magnesium sulfate ($MgSO_4$ or "Epsom salt"), and sodium bicarbonate ($NaHCO_3$,also known as "baking soda"). Salts dissolve in water and form positive ions (cations) and negative ions (anions). The most common cations are calcium (Ca^{2+}), magnesium (Mg^{2+}), and sodium (Na^{+}) while the most common anions include chloride (Cl^{-}), sulfate (SO_4^{2-}), and bicarbonate (HCO_3^{-}). Potassium (K^{+}), carbonate (CO_3^{2-}), boron (B^{3+}) and nitrate (NO_3^{-}) also exist in water supplies.

TDS is usually expressed in milligrams of salt per liter (mg/L) of water. This represents the total number of milligrams of salt that would remain after 1 liter of water is evaporated completely. The higher the TDS, the higher the salinity of the water.

EC is another means of describing salinity levels. Salts dissolved in water conduct electricity, and therefore, the salt content in the water is directly related to the EC. Units of EC reported by laboratories are usually in millimhos per centimeter (mmhos/cm) or deciSiemens per meter (dS/m). One millimhos per centimeter is equivalent to one deciSiemens per meter.

Often conversions between EC and TDS are made, but should be done with caution because conversion factors depend both on the salinity level and composition of the water. A typical conversion factor is as follows:

$$\text{TDS (mg/L)} = 640 \times \text{EC (dS/m)}, \text{ when EC} < 5 \text{ dS/m}$$
$$\text{TDS (mg/L)} = 800 \times \text{EC (dS/m)}, \text{ when EC} > 5 \text{ dS/m}$$

In addition, sulfate salts do not conduct electricity in the same way as other types of salts. Therefore, if water contains high levels of sulfate salts, the conversion factors are invalid and must be adjusted upward.

The recommended municipal supply limit for salinity is 500 mg/L (TDS) with 1,000 mg/L being the highest allowable limit for long term use. Municipal wells in the Basin with depths of 184 to 550 feet have produced water between 175 and 810 mg/L TDS.

Agricultural crops vary in sensitivity to salinity levels. Beans, for example, are one of the most salt sensitive crops. Technically, sodium salts are largely responsible for most of the crop injury

or yield loss due to elevated salinity. Salinity reduces crop yield primarily by reducing the ability of the plant roots to absorb water. In essence, even though the field appears to have plenty of water, the plants wilt because insufficient water is absorbed by the roots to replace that which was lost from transpiration.

The TDS levels in groundwater in the eastern two-thirds of the Basin are generally less than 500 mg/L. TDS in groundwater increases westward towards the San Joaquin River and southward towards the Merced River. In these areas, high TDS water is found in wells deeper than 350 feet. Better quality groundwater (less than 1,000 mg/L TDS) in these areas is found at shallower depths.

Within the confined aquifer, groundwater with high TDS concentrations is principally the result of the migration of a deep, saline water body that originates in regionally deposited, marine sedimentary rocks that underlie the San Joaquin Valley. The depth of this saline water body within the Basin boundaries is very shallow compared to other parts of the Valley.

Groundwater with high TDS concentrations is present beneath the entire Basin at depths from about 400 feet in the west to over 800 feet in the east. The shallowest high TDS groundwater occurs in zones five to six miles wide adjacent and parallel to the San Joaquin River and the lower part of the Merced River west of Hilmar, where high TDS groundwater is upwelling.

Under natural pressure, the saline groundwater body is migrating upward. Brines move up through permeable sedimentary rocks and also up through wells, faults and fractures. The chemistry of groundwater in the Basin indicates that mixing is occurring between the shallow, fresh groundwater and the brines. This process produces the high TDS groundwater observed near the San Joaquin and Merced rivers. Pumping of deep wells in the western and southern parts of the Basin may be causing these saline brines to upwell and mix with fresh water aquifers more rapidly than under natural conditions. In addition, the presence of saline soils in the western portion of the Turlock Subbasin (NRCS, 2007) may have an influence on salinity levels in the unconfined aquifer.

The Corcoran Clay has provided a natural impediment to the migration of high TDS groundwater from the confined aquifer into the unconfined aquifer. High permeability pathways through the clay from the confined to the unconfined aquifer may be created by wells perforated in both the unconfined and confined aquifers.

A variety of salts are represented in measured salinity levels within the Basin, including nitrates. As described in the subsection that follows, there are areas within the Basin where the shallow aquifer has higher nitrate concentrations, and therefore higher salinity levels.

Nitrates

Nitrate is an important constituent in drinking water, and in some cases may affect crops. Nitrate can be from both natural and anthropogenic sources, and is widespread in groundwater in many parts of the San Joaquin Valley. High concentrations of nitrate in groundwater are mostly a concern for potable water supplies. The MCL for nitrate in public drinking water supplies is 45 mg/L (as NO_3).

Communities within the Basin, including Ceres, Turlock, Keyes, Delhi, Hilmar, Denair and South Modesto have had wells that test high in nitrate concentrations, either close to or

exceeding the current MCL. No specific areas containing higher concentrations of nitrates have been identified by the urban agencies. The presence of nitrates in the confined aquifer, which is utilized by the urban agencies for water supply, appears to be sporadic. To date, the only means of determining the potential water quality for a new well site is to drill a test hole and draw samples.

The City of Modesto has implemented ion exchange wellhead treatment for a few of the wells that are high in nitrates. In this process, the contaminated groundwater is pumped into the ion exchange unit, where the nitrate levels are reduced below the MCL. The treated water is then introduced back into the water distribution system. The City of Modesto has installed systems at City Well No. 100 in South Modesto and locations outside of the Turlock Subbasin.

Nitrate in irrigation water is not a major concern for many crops because it acts as a fertilizer. However, permanent crop production, including grape vineyards, may be adversely affected by excess nitrate concentrations. In addition, nitrates in groundwater pumped into the canal system for irrigation supply can contribute to aquatic weed growth. Aquatic weeds can clog irrigation systems and impede the flow of irrigation water, impacting irrigation water deliveries.

High nitrate concentrations are typically found in shallower groundwater zones. This pattern has been attributed to various sources, such as agricultural fertilizers, sewer effluent, septic tank disposal, and animal wastes.

Groundwater studies are currently being conducted by the USGS and others to evaluate nitrate sources and potential impacts. The results of these studies were not available for inclusion in this report. The TGBA is coordinating with the agencies conducting these studies and will examine the data as it becomes available.

Iron and Manganese

Groundwater in several areas within the Basin has elevated iron and manganese levels. Some wells in the cities of Ceres and Turlock and in the SMSA have encountered problems due to manganese. Generally “reducing conditions” (lack of oxygen) may lead to elevated iron and manganese levels in groundwater. Also, shallow groundwater near streams often has high manganese and sometimes high iron concentrations.

No specific areas where iron and/or manganese have been identified by the urban agencies. The presence of these constituents in the confined aquifer, utilized by the urban agencies for water supply, is episodic with no distinct affected region. To date, the only means of determining the potential water quality for a new well site is to drill a test hole and draw samples.

Boron

Currently, boron is an unregulated chemical requiring monitoring by the California DHS (Title 22 CCR Section 64450). Unregulated chemicals have notification levels and response levels rather than formally regulated MCLs. The notification level is the level at which the drinking water supplier must notify the governing body of the local agency where water users reside when a constituent is detected at a concentration above the notification level. The response level is the concentration at which DHS recommends removing the water source from service. The notification level for boron is 1 mg/L, while the response level is 100 mg/L (DHS, 2006). Boron is not currently a concern for public drinking water suppliers within the Basin.

Boron is found in most waters used for irrigation in the United States. Although traces of boron

are essential for all plant growth, concentrations above the plant tolerance level can cause damage to the plant and reduce crop production. Plant tolerances for crops currently grown within the Basin vary from 0.5 mg/L for the most sensitive crops to approximately 10.0 mg/L for the most tolerant crops. Current boron concentrations in irrigation water are within plant tolerance levels and do not adversely impact crop production.

Arsenic

Arsenic is naturally present in rocks and minerals in the earth's crust, and is naturally present in groundwater. Concentrations higher than current and contemplated standards have been found in the U.S., especially in the western states. Arsenic is also found in some pesticides, which can be leached to groundwater. Arsenic has been linked to lung and bladder cancer in humans. As a result, the U.S. Environmental Protection Agency (EPA) has promulgated a new, more stringent arsenic rule, lowering the MCL from 50 µg/L to 10 µg/L (10 ppb), effective January 2006. The State of California DHS has considered establishing a lower standard for California; however, it is understood that DHS will conform to the EPA MCL requirements at this time.

Arsenic concentrations in water from public water supply wells in the Basin are typically below the old standard, but some are higher than the new MCL. As a result, urban agencies are considering options available to reduce arsenic levels, including utilizing surface water supplies or installing costly wellhead treatment technologies. Should the State of California adopt new, more stringent standards, most local urban water supplies will be impacted.

Under the new arsenic rule, the City of Turlock has two wells that are, on occasion, slightly over the limit. If this trend continues, it is likely that the wells will have to be placed on standby status and will only be used in an emergency. The arsenic levels in the City of Modesto's water supply wells vary from non-detect to 10 µg/L (10 ppb). If the California DHS lowers the arsenic MCL in the future, several Modesto wells, including a few of its wells in the Turlock Subbasin, could exceed the MCL and would be removed from the domestic water system.

Arsenic levels within the City of Hughson system average around 11 µg/L (11 ppb). A treatment assessment study has been conducted by Carollo Engineers (available on the City of Hughson website at www.hughson.org) to determine suitable treatment options to meet the new arsenic MCL. Hughson is working toward the development and implementation of a treatment system to achieve this goal.

Keyes CSD also has wells that occasionally exceed the new MCL for arsenic, with detections ranging from 4.4 µg/L (4.4ppb) to 17.5 µg/L (17.5 ppb). Keyes CSD has hired a consultant to investigate options for treating wells with arsenic levels greater than the federal standard. Further, Keyes CSD has hired a hydrogeologist to explore alternative water supply options.

Radionuclides

Radionuclides are produced as a result of radioactive decay of certain elements. These parameters are primarily from natural sources and can affect drinking water supplies. The drinking water standard for "gross alpha," the general measure of the potential for radioactive substances to be in water, is 15 picoCuries per liter. Additional testing is required for specific radioactive species, if radiological constituents above the MCL are detected. The MCL for uranium is 20 picoCuries per liter.

Sampling in the Basin for radiological constituents has generally been limited to public water systems. Groundwater with high uranium activities has been detected in the Hilmar, Hughson, Ceres, South Modesto, Denair, and Keyes areas. The occurrences are indicated to be natural and are based on available data.

The City of Modesto's gross alpha levels vary from non-detect to 35 picoCuries per liter, while uranium levels vary from non-detect to 40 picoCuries per liter. A number of City of Modesto wells, including a few in South Modesto, have been removed from water production due to gross alpha and/or uranium contamination.

Within the City of Hughson, uranium was found in one of the production wells in 1986. The well was subsequently closed and remains out of service.

The EPA has discussed establishing a standard for radon in drinking water. Depending on how low this standard is set, natural activities of radon could be a concern in the future.

Bacteria

Bacteriological quality in the Basin is generally acceptable in deep groundwater aquifers. Bacteriological quality of groundwater pumped by individual wells can not be generalized and depends on many factors pertaining to the well and surrounding conditions.

Inadequately constructed and improperly located, destroyed or abandoned water wells may contribute to bacteriological contamination of groundwater. Some of the factors that may influence contamination of water wells include location with respect to sources of contamination, inadequate well construction features, general deterioration and/or inadequate maintenance of wells, and improper use of water wells for disposal of wastes.

Bacteriological contamination of groundwater is a health concern because groundwater is used for drinking water. Water wells used to supply drinking water are routinely tested for pathogenic microorganisms. The City of Ceres, for example, tests its wells weekly.

Pesticides

Two pesticides with contamination issues have been identified in the Turlock Subbasin, resulting from past agricultural activities. Additional data on pesticide contamination will be available from ongoing USGS and SWRCB groundwater studies in the region. These data will be evaluated as they become available.

Dibromochloropropane (DBCP)

Pesticide contamination is primarily the result of the widespread use of the agricultural nematicide Dibromochloropropane (DBCP) on crop lands for several decades before it was banned in 1977. DBCP in groundwater is usually associated with vineyards or orchards where the pesticide was used. DBCP is a carcinogen at very low concentrations in water, and is a concern for potable water supplies. It moves freely with the groundwater and persists for long periods. The MCL for DBCP is 0.2 micrograms per liter (μg/L). DBCP has been found in two wells in the Turlock area at extremely low levels, just above the detection limit of 0.01 μg/L (ppb), pursuant to Title 22 CCR Section 64445.1. DBCP has also been found in public water supply wells in the South Modesto, Keyes, and Ceres areas at levels either close to or exceeding the MCL. In the case where the DBCP levels exceed the MCL, wellhead treatment is being utilized.

Ethylene dibromide (EDB)

Another pesticide that has been detected in the Basin's groundwater is ethylene dibromide (EDB). EDB is also an agricultural nematicide, used primarily on vineyards. EDB was banned in the early 1980s. This pesticide has been detected in one public water supply well in the Turlock area.

Trichloroethylene

Trichloroethylene (TCE) is a nonflammable, colorless liquid with a sweet odor and is used as a solvent for dyes and rug cleaners, as well as a degreaser for metal parts. Improper storage and disposal have made TCE a major contaminant of groundwater supplies in California; however, the extent of TCE contamination within the Turlock Groundwater Basin is currently unknown. TCE is known to contaminate water wells close to refineries, metal processing plants, chemical manufacturers, military bases, and electroplating operations. The contamination is persistent due to TCE's long half-life in groundwater which typically ranges from 9 months to 3 years.

The California Drinking Water Action Level of 5 ppb (5 μg/L) for TCE is based upon what is considered a negligible risk level for cancer. In other words, if one million people drank about 2 liters of water containing TCE at this level every day over a 70 year lifetime, theoretically there would be no more than one additional case of cancer in the million people exposed.

Other Trace Organics

Other trace organic compounds have been detected in the groundwater Basin, including, but not limited to, carbon tetrachloride, perchloroethylene, and hydrocarbon-based products. Improper use, storage, and accidents have resulted in unauthorized releases of these substances.

Volatile organic compounds (VOCs) derived primarily from solvents have contaminated the groundwater in some areas. Some contamination can be attributed to industries that handle, store, and use solvents. Perchloroethylene (PCE) has been detected at one time or another in some of the Basin's public water supply wells. Industrial wastes and dry cleaners are a recognized source of PCE in groundwater in some municipal areas, such as the City of Turlock.

Carbon tetrachloride is often attributed to auto repair shops, which have historically used it as a solvent or degreaser. One well within the City of Turlock was closed in 1999 due to levels of carbon tetrachloride exceeding the MCL of 0.5 μg/L in public water supply wells. It is not clear if this compound was in the groundwater or was a contaminant of the oil used to lubricate the pump.

Several unauthorized releases from underground storage tanks (UST) have occurred in the Basin. Most of these cases are very localized in nature in terms of groundwater impacts, and public water supply wells are not known to have been affected. The Stanislaus County DER and, to a lesser extent, the Merced County DEH, are involved in monitoring and regulating the clean-up of sites involving many VOC and UST spills. The county agencies have a contract with the State Water Resources Control Board to oversee clean-up of releases originating from USTs.

4.1.5.3 Areas of Concern

Agricultural and municipal agencies within the Basin are concerned about maintaining adequate supplies of groundwater within the Basin. Groundwater is the primary source of water for the agricultural agencies on the eastern side of the Basin. As a result, they are concerned about the continued decline of groundwater levels on that side of the Basin. The municipalities, which

also rely on groundwater for their source of water, are not as concerned about the present quantities of water as they are about the future quantities of water that will be needed as the cities continue to expand.

Agencies within the Basin are also concerned about maintaining the Basin's groundwater quality. The Basin generally has good quality groundwater. As a result, the municipalities are not currently required to provide significant water treatment. In most cases, treatment is limited to chlorination. However, there are some areas of water quality concern. For example, saline brines continue to migrate upward from the saline confined aquifer, resulting in increased salinity levels. In addition, constituents such as PCE, DBCP, EDB, uranium, nitrates, manganese and iron have been found in a few water supply wells within the Basin. In a few cases, these constituents have impacted the municipalities' ability to utilize the wells to supply potable water and resulting in the wells being retired, or requiring some form of treatment. In the future, the municipalities within the Basin may be required to investigate various options, such as well head treatment, to meet increasingly stringent minimum water quality requirements. An example of one such substance of concern is arsenic. New EPA and state standards likely will impact most local agencies.

Additionally, it is important to note, that the San Joaquin River is listed by the State of California as impaired for salt and boron. The CVRWQCB adopted a Basin Plan Amendment to implement a control plan in the form of a Total Maximum Daily Load (TMDL) to address both salt and boron concentrations in the river. The water quality objectives at Vernalis are as follows:

Salinity:	0.7 mmhos/cm during the irrigation season 1.0 mmhos/cm during the non-irrigation season
Boron:	0.8 mg/L during the irrigation season 1.0 mg/L during the non-irrigation season

In addition, the Regional Board plans to adopt salinity standards upstream of Vernalis.

The Basin Plan Amendment recognizes the interaction between groundwater and surface water flows, and therefore, that groundwater is a component of the salt loading in the river system. As a result, if implementation measures to control surface water inputs do not result in the required improvements, the CVRWQCB has committed to developing a groundwater control plan to improve the salinity contributions from groundwater sources.

4.2 SURFACE WATER SUPPLIES

4.2.1 Surface Water Sources

The Turlock and Merced irrigation districts are the only entities within the Basin with access to firm supplies of developed surface water. During wet years, TID and Merced ID may provide water to irrigators situated along the districts' canals but outside of the districts' boundaries. In addition, there are some individual property owners with riparian rights that utilize water from the bordering rivers. The extent of this type of usage is undocumented.

The TID's main source of water is through surface water diversions from the Tuolumne River. TID and the Modesto Irrigation District (which operates outside of the Turlock Subbasin) jointly operate the Don Pedro Reservoir on the Tuolumne River to store winter and spring runoff for

agricultural and municipal uses. The surface water available to growers within TID is based on the runoff each year coupled with its share of carry-over storage from Don Pedro.

The Merced ID's main source of surface water is the Merced River. Merced ID operates Lake McClure to store winter and spring runoff for summer irrigation. The surface water available to Merced ID each year is based on the runoff for that year coupled with the Merced ID's direct diversion rights and stored water from Lake McClure.

Surface water supplies more than 50% of the total irrigation water applied to land in the Subbasin boundaries. The average volume of surface water imported into the Subbasin between 1997 and 2006 was 540,000 AF/yr. A significant part of applied irrigation water percolates past the root zone to become groundwater recharge. As illustrated in Figure 19, deep percolation of applied surface water is the largest single component of groundwater recharge. When deep percolation of applied surface water is combined with canal seepage and recharge from Turlock Lake, surface water makes up the majority of recharge to the Subbasin. Therefore, a majority of recharge originates from the Tuolumne River, and to a much lesser extent, the Merced River.

4.2.2 Surface Water Quality

As described earlier, surface water is diverted from the Tuolumne and Merced rivers for irrigation purposes. The quality of this surface water supply is exceptionally high. Similar water is diverted on the north side of the Tuolumne River, treated, and delivered to the City of Modesto for drinking water purposes.

4.3 OTHER SUPPLIES

Although surface water diversions are the main water supply within the Subbasin, other sources of water are utilized. These sources are described in the subsections that follow.

4.3.1 Precipitation

Within the Basin, precipitation alone does not satisfy urban and agricultural water supply requirements. The Basin is characterized by a Mediterranean-type climate with hot, dry summers and cool, wet winters. The majority of precipitation falls between November and March. The amount of precipitation in this part of the Central Valley also varies widely from year to year. According to DWR Bulletin 118 (2003), the average annual precipitation is estimated to be 11 to 13 inches, increasing eastward, with 15 inches in the Sierra Nevada foothills. Records for the Turlock area show annual precipitation totals ranging from roughly 5.5 inches to 27 inches (Table 3 of Appendix B). The long-term average rainfall for the 1952-2006 period for the Turlock area is approximately 12 inches (data not shown).

Because the majority of precipitation falls in the winter, most landscaping, crops and orchards are dependent upon irrigation during the growing season. While precipitation does not fully satisfy water demands, it does contribute to groundwater recharge. Therefore, the groundwater system contains some portion of water that originated from the direct infiltration of precipitation.

Stormwater ponds and dry wells are facilities designed to help manage urban stormwater runoff generated when precipitation falls on impervious areas or in excess of the land's ability to readily absorb the water. These facilities also provide a means for stormwater to percolate down into the

groundwater system. Most communities have stormwater ponds. Dry wells, an older means of disposing of stormwater, are found in many communities within the area.

4.3.2 Recycled Water

The major municipal water suppliers in the Basin, in the course of disposing of treated wastewater effluent, are in the practice of reclaiming water for either reuse or percolation. Many agencies utilize percolation ponds to dispose of wastewater, while others utilize the water for irrigation purposes. Table 4 in Appendix B summarizes the various methods of treated effluent reuse, recharge, and disposal within the Basin.

The City of Modesto recently completed a Recycled Water Feasibility Study for their area of influence. A number of other agencies are continuing to evaluate the use of recycled water for landscape irrigation and other purposes.

4.3.2.1 Reuse

Table 4 of Appendix B provides a summary of treated wastewater effluent use and disposal within the Turlock Subbasin. The City of Modesto sends its wastewater to the Jennings Road secondary plant for additional treatment and disposal. For example, between 2000 and 2004 it imported an average of 10.16 billion gallons per year (31,167 AF/yr). From this volume, an average of 4.59 billion gallons per year (14,087 AF/yr) were utilized for irrigation purposes on 2,526 acres of land adjacent to the San Joaquin River. The remainder was stored in ponds and seasonally discharged to the San Joaquin River or lost due to evaporation. In 2005, 3.67 billion (11,265 AF) gallons of treated effluent were used for agricultural irrigation.

The City of Turlock has a permit from the CVRWQCB for the reuse of a portion of its wastewater effluent to irrigate 300 acres of farmland in the Subbasin. In 2005, 47 million gallons (144 AF) were used for agricultural irrigation on this parcel. No effluent was used for irrigation on this parcel in 2006, but this use may continue in the future under the existing permit.

The City of Turlock RWQCF was recently upgraded to provide tertiary treatment. In the future, up to two MGD (2,240 AF/yr) of this effluent is anticipated to be used by the new TID Walnut Energy Center, which came on-line in early 2006. Plans are also being made to use the tertiary treated effluent for irrigation of parks, medians, landscaping, and additional crop irrigation. Use of recycled water will offset the need for additional groundwater supplies.

The City of Ceres reuses its treated effluent for landscape irrigation purposes at the wastewater treatment plant. Landscape uses total approximately 72 million gallons per year (221 AF), or 300,000 GPD during summer months and 100,000 GPD during winter months.

4.3.2.2 Percolation

The cities of Ceres and Hughson and the Hilmar and Delhi county water districts utilize percolation ponds as a means of disposing of treated effluent. Through these facilities a portion of the water evaporates, while the remaining water percolates into the groundwater system. Approximately 1,302.9 million gallons (3,998 AF) of treated effluent is delivered to percolation ponds each year. As these communities continue to grow, the amount of water percolated through this process will increase proportionately. The 2005 quantities of percolated treated

wastewater effluent for the Turlock Subbasin are described for each agency in Table 4 in Appendix B.

4.4 FACILITIES AND OPERATIONS

Public agencies and individual property owners have facilities they own, operate and maintain to provide water for their needs.

4.4.1 Facilities Owned by Local Public Agencies

Turlock and Merced irrigation districts own and operate a water delivery system of canals and laterals that transport surface water to local growers. The majority of the time, water flows by gravity to the irrigated land. Most land within the districts are irrigated using flood irrigation techniques. However, some growers have moved to drip/micro or other more advanced technologies. Water is managed within the canal system to minimize spills to the river and maximize the efficient use of water within these districts' facilities.

The urban agencies within the Subbasin currently rely exclusively on groundwater for their supplies. Some agencies utilize chlorination and a variety of storage tank options, while others do not. Wells, storage tanks, and distribution lines are designed to meet the needs of each individual community.

Urban agencies utilize the general planning process to evaluate the facilities and resources needed to supply the projected population growth within their community. As communities grow, they continue to consider the best combination of water supply and infrastructure improvements to meet their needs.

4.4.2 Other Public Facilities

There are small community water supply systems that are operated by the community and regulated by the local county environmental health agency. These communities rely entirely upon groundwater for their supplies.

4.4.3 Privately Owned Facilities

All irrigation facilities within the Eastside and Ballico-Cortez water districts are privately owned and operated. Growers have installed irrigation supply wells, as needed, to irrigate their crops.

Privately owned irrigation supply wells and domestic wells are installed in locations throughout the Subbasin to provide irrigation and on-farm water, as well as private domestic supplies to rural homes and businesses. These facilities are installed, operated, and maintained and on an as-needed basis to meet the individual needs of the property owner.

5 GROUNDWATER MANAGEMENT PLAN

5.1 DEFINITION OF THE GROUNDWATER BASIN

The California Water Code Section 10752 defines a groundwater basin as "any basin identified in… Bulletin 118… but does not include a basin in which the average well yield, excluding domestic wells that supply water to a single-unit dwelling, is less than 100 gallons per minute." The Turlock Groundwater Subbasin is a groundwater basin pursuant to this definition. The geographical setting and hydrogeology of the Subbasin are described in detail in Section 4.1.1.

5.2 AGENCIES COVERED UNDER THE GROUNDWATER MANAGEMENT PLAN, THEIR BOUNDARIES, AND GROUNDWATER MANAGEMENT AREAS

As described in Section 1.2, there are a wide variety of agencies located within the Turlock Groundwater Subbasin. The Subbasin has been divided into Groundwater Management Areas or "subareas," defined by the political boundaries of the local public agencies. Each agency represents the lands within their boundaries. In the event that a city, county water district, community services district or other municipal water supply agency lies within an irrigation district or other entity's boundaries, the municipal water supply agency will represent the overlapping areas. Similarly, although both Merced and Stanislaus counties together cover the entire Subbasin, the counties' management areas are defined as those areas not contained within another agency's boundaries.

This document, developed by the TGBA, is designed to cover the entire Subbasin. However, each agency is required to adopt the Plan for their respective agency. As a result, only those areas within the boundaries of the agencies that adopt the Plan, are covered. Appendix G lists the agencies that have adopted the Plan, as well as a copy of the resolutions pertaining to those actions.

It is important to note that agencies that may choose not to adopt the Plan still will be encouraged to continue to participate in the TGBA, work with the other local agencies in groundwater management related activities, and consider adopting the Plan in the future.

5.3 BASIN MANAGEMENT GOALS AND OBJECTIVES

The water agencies in the Turlock Subbasin agree that the groundwater and surface waters within the Turlock Groundwater Basin are a vitally important resource that provides the foundation for maintaining current and future water needs. Preservation of these resources is essential in order to maintain the economic viability and prosperity of the Basin area. It is the goal of the member agencies that groundwater will continue to be a reliable, safe, efficient, and cost-effective water supply. The agencies, individually and collectively, are pursuing and will continue to pursue water management strategies to maintain viable local sources of water supply. The following Basin Management Objectives (BMOs) have been developed by the TGBA for the purpose of meeting this goal:

1. Maintain an adequate water level in the groundwater basin.
2. Protect groundwater quality and implement measures, where feasible, to reduce the potential movement of existing contaminants.

3. Monitor groundwater extraction to reduce the potential for land subsidence.
4. Promote conjunctive use of groundwater and surface waters.
5. Support and encourage water conservation.
6. Develop and support alternate water supplies. Educate users on the benefits of water recycling.
7. Continue coordination and cooperation between the TGBA members and customers.

The local water agencies, individually and collectively, are pursuing water management strategies under each of the BMOs to ensure that groundwater continues to be a reliable, safe, efficient, and cost-effective water supply. The TGBA will support individual actions of local agencies to meet the BMOs. The following sections describe the BMOs in greater detail and provide a framework of potential actions the local water agencies can follow to support each objective.

5.3.1 Maintain Groundwater Levels

Groundwater conditions within the Basin vary. Levels in the eastern areas have declined significantly since the 1960s. Levels in the western area of the Basin are high to the point of requiring pumping in certain areas to help keep the groundwater from encroaching into the root zone of agricultural crops. Recent data show that the groundwater levels stabilized during the 1990s, but appear to have declined slightly in localized areas between 2002 and 2006. Local declines in water levels have been noted on the east side of the Basin and in several cities as their use of water has increased with continued urbanization.

The following is a list of programs and policies that the local water agencies can implement to help maintain adequate groundwater levels in the Subbasin:

- Monitor groundwater for usage, quality and water levels.
- Evaluate the effectiveness of the current monitoring program and make improvements as necessary.
- Encourage conjunctive use policies that decrease the use of groundwater when surface water supplies are abundant.
- Develop a water budget within the Basin to establish if the basin or areas within the Basin are in overdraft.
- Continue efforts to study the potential effects of future land use changes on groundwater storage.
- Support a comprehensive approach to identify and protect natural recharge areas.
- Support and encourage water conservation programs to reduce groundwater usage.
- Evaluate feasibility of groundwater recharge projects.
- Capture storm water run off for recharge or use as an alternate water supply.

Additional information on measures to maintain groundwater levels, including mitigation of overdraft conditions, replenishment of groundwater extracted by producers, and construction and

operation of recharge, storage, conservation, water recycling, and extraction projects, is included in Section 6, Groundwater Protection Measures.

5.3.2 Protect Groundwater Quality

Although water quality within the Basin is generally acceptable, there are many wells that have constituents of concern at levels impacting the use of the water. These water quality concerns primarily affect municipal water suppliers. Contamination is usually found first in public potable water sources because these wells are analyzed on a regular basis. Actions that may be taken by the local water agencies to protect groundwater quality or reduce the risk of movement of existing contaminants include the following:

- Continue to support a program to monitor area wells that are not currently required to test for water quality.
- Develop and maintain a database of water quality data for the use of the TGBA.
- Encourage sound well standards and well abandonment practices to protect groundwater quality.
- Promote land use practices that protect the groundwater recharge areas from contamination.
- Implement measures to stabilize groundwater levels to reduce the movement of contaminants.
- Evaluate the impact of urbanization on groundwater levels and quality.
- Where practicable, use recent hydrogeologic assessments to develop programs and to implement projects that control the migration of poor quality water.
- Where possible, reduce reliance on wells that may induce the upward movement of salts within the Basin.

Additional information on measures to protect groundwater quality, including identification and management of wellhead protection areas, regulation of the migration of contaminated groundwater, identification of well construction policies, administration of well abandonment and destruction programs, and control of saline water intrusion, is provided in Section 6, Groundwater Protection Measures.

5.3.3 Land Subsidence

Historically, land surface subsidence within the Basin has not been significant despite the changes in groundwater levels that occurred in the 1970s and 1980s. Inelastic subsidence has not been observed in the Subbasin, and it does not appear that subsidence will become a major problem in the future. The groundwater level monitoring activities undertaken by the local water agencies and coordinated through the TGBA are designed to evaluate the maintenance of groundwater levels. If substantial declines in groundwater levels occur and subsidence is reported, the TGBA member agencies will evaluate the reports and discuss potential management actions based on the results of the evaluation.

5.3.4 Conjunctive Use

The local water agencies, in conjunction with the TGBA, will continue to promote policies that permit groundwater banking and allow alternate surface water uses that benefit the local groundwater basin, including the following:

- **Using surface water for municipal water supply:** Agencies within the Basin are evaluating the potential for utilizing surface water to supply a portion of the potable water needs within the urban areas. The use of surface water for potable uses will reduce the quantity of groundwater extracted by the domestic water suppliers, thus resulting in in-lieu recharge that helps maintain adequate groundwater levels within these areas.
- **Continuing flood irrigation practices:** Flood irrigation in agricultural operations is useful in banking water for later use in dry years, both through in-lieu recharge and deep percolation of applied surface water. This practice also helps reduce salt buildup in the soil that may be detrimental to crops.
- **Conducting active groundwater recharge:** EWD and TID are conducting an expanded recharge study to evaluate the potential for groundwater recharge basins on the east side of the TID irrigation service area to help stabilize groundwater levels in the area. The study began during the 2007 irrigation season.

5.3.5 Water Conservation

There are several conservation programs that are available for both agriculture and domestic uses. The TGBA and local water agencies will promote conservation for all water users in the Basin, potentially drawing from the following activities:

- **Installation of domestic water meters:** Several studies have shown that meters reduce water use by 20-25%. Current legislation requires the installation of water meters for domestic users on all new residential construction. Recent legislation (AB 2572, September 2004) requires urban water suppliers to implement volumetric pricing for metered service connections beginning January 1, 2010. This legislation also requires urban water suppliers to install water meters on all municipal and industrial service connections by January 1, 2025.
- **Reevaluating water rate schedules:** As described above, recent legislation requires urban water suppliers to implement volumetric pricing for metered service connections beginning January 1, 2010.
- **Conservation education:** Educate users on the most efficient water use practices for agriculture, commercial, industrial, and domestic users that would result in reduced use of groundwater supplies, help maintain groundwater levels, and protect groundwater quality.

5.3.6 Alternate Water Supplies

The local water agencies, in conjunction with the TGBA, will support the development of additional water supplies such as the use of recycled water and storm water, when appropriate. These efforts should be implemented in a manner that is protective of groundwater quality. In

addition, changing water quality regulations must be considered when implementing such programs.

Sources of alternate water supply could include:

- Wastewater effluent, when properly treated, can be used for agriculture, landscaping, and industrial cooling uses.
- Excessive landscape runoff captured by storm water systems could be contained and used for additional irrigation.
- Storm water could be captured and used for groundwater recharge or other uses.
- Reuse of non-potable water: Where feasible, groundwater that does not meet potable water regulations may be used for crops.
- The increased use of non-potable wells for irrigation of crops, landscaping and other non-potable uses could be promoted. These wells typically have been used to reduce high groundwater levels and to supplement irrigation. Other uses of this water could include industrial cooling water, decorative fountains, parks, and roadside landscaping.

5.3.7 Cooperation and Coordination

Members of the TGBA will continue coordination among its member agencies, local water agencies, and interested parties to manage the water supplies within the Turlock Groundwater Basin. The TGBA members will continue to cooperate and develop Basin-wide programs and projects to benefit the Basin's resources.

The TGBA meetings will continue to be a forum where regional, state, and federal agencies can meet to discuss ongoing and future regulatory issues.

5.4 GROUNDWATER MANAGEMENT SUBAREAS' GOALS AND OBJECTIVES

The BMOs for the Turlock Subbasin, described above, are supported by groundwater management goals and objectives for each of the subareas (i.e., each individual agency). In some cases, the Subbasin and subarea goals and objectives may be the same. In other cases, agencies may have additional goals and objectives they wish to pursue, beyond those of the Subbasin. The goals and objectives for each of the subareas are described in detail in Appendix F.

5.5 GROUNDWATER MONITORING PLAN

5.5.1 Groundwater Level Monitoring

Groundwater level monitoring is conducted by a variety of agencies within the Basin. DWR has a network of wells throughout the valley that are monitored on an annual or semi-annual basis. In addition, local agencies have developed a similar program, monitoring groundwater levels at local supply wells. The approximate location of the network of local agency and active DWR monitoring wells is shown in Figure 20. Table 5 of Appendix B presents a summary of the current monitoring efforts of the local water agencies.

Local monitoring activities are typically conducted in November and March of each year. The November measurement is meant to represent the "after irrigation season" measurement, when

crops are going dormant, and irrigation is no longer occurring. Conversely, the March measurement is designed to illustrate the groundwater levels as the next irrigation season starts, and after much of the rainfall received has percolated into the soil. The TGBA has developed procedures for collecting groundwater level measurements to ensure the consistency of data collected by the local water agencies.

DWR has historically conducted similar monitoring of groundwater levels throughout the state, including numerous wells in the Turlock Subbasin. There have been significant changes in DWR's monitoring program over the last ten years. The fall monitoring period has been eliminated or substantially reduced due to funding cuts, and numerous wells have been lost due to settling or other problems with aging. Currently, DWR monitors the majority of its wells in March of each year. Current and historical groundwater data are available on DWR's website at *http://wdl.water.ca.gov/*.

The TGBA currently accumulates water level data from its members and compiles the data in a computer spreadsheet. This data is available for review by all members and an annual review of this data will provide useful information to the TGBA on the status of the groundwater basin.

5.5.2 Groundwater Quality Monitoring

Local cities and small community water systems conduct water quality monitoring of the wells utilized to supply drinking water. The DHS regulates the type of monitoring and frequency required to ensure the quality of local drinking water supplies. The information from these monitoring practices is available for review and analysis and is provided to consumers in the municipal subareas via each municipal supplier's annual Consumer Confidence Report. To a lesser extent, agriculture has conducted limited monitoring of agricultural wells. The wells are typically constructed differently, and often draw from different aquifers than the municipal supply wells. The frequency and type of water quality monitoring efforts are shown in Table 5 (Appendix B). The locations of wells where water quality samples are taken are shown in Figure 20.

Water quality data from all of the major utilities and small water systems is available from the State of California DHS. These data will be obtained from DHS on a periodic basis and the local information will be analyzed to look for any trends.

Water quality data are also available from groundwater contamination monitoring in the Turlock Subbasin. The Merced County DEH and Stanislaus County DER take different roles in monitoring groundwater contamination in their respective boundaries. In Merced County, facility operators or property owners are directly responsible for working with the CVWRQCB to monitor groundwater contamination. The Stanislaus County DER takes a more active role in monitoring groundwater contamination within its boundaries. Currently the DER monitors 61 contamination sites within the Stanislaus County portion of the Subbasin. These sites are monitored for groundwater quality on a quarterly basis. Depending on the type of constituent contamination present, groundwater is monitored for petroleum constituents, chlorinated solvents such as TCE and PCE, metals, and various other analytes based on site-specific target needs. Groundwater is often monitored from shallow and deeper aquifers depending on geologic and hydrogeologic conditions. Water quality data relevant to most of the contaminated sites within both Stanislaus and Merced counties can be found on the SWRCB Geotracker website at

https://geotracker.waterboards.ca.gov. These data can be obtained periodically and examined in conjunction with the data from small water systems to evaluate water quality trends within the basin.

In addition, a comprehensive assessment of statewide groundwater quality conditions, the GAMA study, is being conducted by USGS, in cooperation with SWRCB, DHS, Lawrence Livermore National Laboratory, and DWR. The GAMA study will yield substantial information on chemical constituents not normally available, allowing for the establishment of baseline water quality conditions and the early detection of contamination. Further, this study will provide data that TGBA member agencies can use to examine long-term trends in water quality. The TGBA member agencies are coordinating with the agencies conducting the GAMA study, and plan to evaluate the resulting data as it becomes available.

5.5.3 Subsidence Monitoring

Inquires with DWR have shown no documented occurrences of inelastic subsidence within the Turlock Subbasin (A. Steele, DWR, personal communication October 2004). The groundwater level monitoring activities by the local water agencies are designed to evaluate changes in groundwater storage that could influence land subsidence in the Subbasin. Should groundwater levels change and subsidence is reported, the local agencies will examine reports of land subsidence and discuss potential monitoring activities based on the results of the evaluation.

5.6 FACILITATING CONJUNCTIVE USE OPERATIONS

Conjunctive use of groundwater and surface water in a groundwater basin typically occurs when the surface water supply to the Basin varies from year to year and Basin water demand is relatively constant. In some years, the surface water supply is greater than the Basin water demand; in other years, the surface water supply is less than the Basin water demand. In the years of plentiful supply, surface water is utilized to recharge the groundwater aquifer. Recharge can occur either directly by surface recharge or injection well, or by using surface water in lieu of groundwater when it is available. In effect, the groundwater basin is utilized as a storage reservoir and water is placed in the reservoir during wet years and withdrawn from the reservoir during dry years.

Turlock and Merced irrigation districts have been practicing an informal form of conjunctive use for years as a means of making the best use of available resources. In wet years where more surface water is available, the districts rely more heavily on surface water to supply irrigation customers. In drier years, when less surface water is available, groundwater is used to supplement surface water supplies both by the irrigation districts as well as individual growers with access to wells. Because irrigation is the main source of recharge within the Subbasin, this form of conjunctive use results in surface water recharging the groundwater basin in wet years, making groundwater available in drier years when it is needed.

To a lesser extent, conjunctive use is facilitated by the districts through the sale of irrigation water to lands adjacent to their canals, but located outside the irrigation district service area. When surface water is available, and there is sufficient canal capacity to deliver the water, TID and Merced ID sell surface water supplies to growers that would otherwise be required to pump groundwater to irrigate their crops. The extent that this program is utilized, as well as the amount of water available, varies from year to year. Although the overall amount of water

delivered in this manner is small compared to total irrigation deliveries within the Subbasin, the amount of water utilized results in an equivalent amount of water remaining in the groundwater system for later use. Additional conjunctive use opportunities may be available. The local agencies will continue to explore these opportunities.

6 GROUNDWATER PROTECTION MEASURES

A high priority of the TGBA is the protection of groundwater resources. This will be accomplished through a series of actions, described below, to be implemented by the local water agencies and facilitated by the TGBA.

6.1 IDENTIFICATION AND MANAGEMENT OF WELLHEAD PROTECTION AREAS

The purpose of wellhead protection is to protect the groundwater used for public supply, thereby eliminating costly treatment to meet relevant drinking water quality standards. A Wellhead Protection Area (WPA), as defined by the Federal Wellhead Protection Program established by Section 1428 of the Safe Drinking Water Act Amendment of 1986, is "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield." The WPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WPAs can vary in size and shape depending on subsurface geologic conditions, the direction of groundwater flow, pumping rates, and aquifer characteristics. WPAs are not directly an agricultural issue. However, in the Turlock Groundwater Basin, due to the relationship between agricultural and municipal water uses, some important considerations in delineating WPAs are as follows:

- Location of existing public supply wells
- Identification of probable locations of future public supply wells
- Present direction of groundwater flow
- Probable direction of future groundwater flow
- Construction characteristics of public supply wells (i.e., location of perforated intervals and specifications of annular seals)
- Subsurface geologic conditions (i.e., restricting layers, confining beds, and other features)
- Rate of current groundwater flow
- Pumping from up gradient areas
- Potential sources of contamination
- Forecasted future land use

Potential areas of water quality risk include:

- Areas without improved sewage collection systems
- Areas with leaky sewer pipes and septic systems
- Improperly constructed or abandoned wells
- Confined animal feedlots and dairies
- Agricultural practices where chemicals are used
- Areas with potential for spills of hazardous materials

Identification of WPAs is a component of the Drinking Water Source Assessment and Protection Program (DWSAP Program) administered by DHS. The Program established a goal for all water systems statewide to complete Drinking Water Source Assessments by December 31, 2002. All of the municipal water purveyors described in Section 3.2 have completed their required assessments (DHS, 2004) by performing the three major required components listed below:

- Delineation of capture zones around sources (wells)
- Inventory of Potential Contaminating Activities (PCAs) within protection areas
- Vulnerability analysis to identify the PCAs to which the source is most vulnerable

Delineation of capture zones includes using groundwater gradient and hydraulic conductivity data to calculate the surface area overlying the portion of the aquifer that contributes water to a well within specified time-of-travel periods. Typically, areas are delineated representing 2-, 5-, and 10-year time-of-travel periods. These protection areas need to be managed to protect the drinking water supply from viral, microbial, and direct chemical contamination.

Inventories of PCAs involve identifying the potential origins of contamination to drinking water sources and corresponding protection areas. PCAs may consist of commercial, industrial, agricultural, and residential sites, or infrastructure sources such as utilities or roads. Depending on the type of source, each PCA is assigned a risk ranking, ranging from *very high* for such sources as gas stations, dry cleaners, and landfills, to *low* for such sources as schools, lakes, and non-irrigated cropland.

Vulnerability analysis entails determining the most significant threats to the quality of the water supply by evaluating PCAs in terms of risk rankings, proximity to the well being surveyed, Physical Barrier Effectiveness (PBE), and whether contaminants have previously been detected. PBE takes into account factors that could limit infiltration of contaminants including type of aquifer, aquifer material (for unconfined aquifers), well operation, and well construction. The vulnerability analysis is based on a scoring system that assigns point values for PCA risk rankings, PCA locations within the wellhead protection area, and well area PBE. The PCAs to which drinking water wells are most vulnerable are identified based on the results of the vulnerability scoring.

6.1.1 Actions

The following actions may be implemented by local water agencies individually or in conjunction with the TGBA to address State WPA requirements:

- A component of the DWSAP Program is an assessment of vulnerability of groundwater sources to quality degradation. The TGBA member agencies providing drinking water should obtain proper clearances for the release of information and prepare vulnerability summaries from the DWSAP Program to be used for guiding management decisions in the Basin.
- Contact groundwater basin managers in other areas of the state for technical advice, effective management practices, and “lessons learned” regarding establishing WPAs.
- Attend groundwater conferences and technical workshops and meetings to learn more about groundwater management practices.

6.2 REGULATION OF THE MIGRATION OF CONTAMINATED GROUNDWATER

The migration and remediation of contaminated groundwater is of primary concern to local urban water supply agencies, including the cities of Modesto, Ceres, Turlock, and Hughson. Also of concern is the localized contamination of groundwater by industrial point sources such as dry cleaning facilities, food processors and the numerous fuel stations throughout the Basin.

While the TGBA does not have authority or responsibility for remediation of this contamination, it is committed to coordinating with responsible parties and regulatory agencies to keep the local water agencies informed of the status of known groundwater contamination in the Basin.

6.2.1 Actions

The following actions may be implemented by the local water agencies individually or in conjunction with the TGBA to address groundwater contamination:

- Coordinate with the USGS and/or other appropriate agencies to expand the network of monitoring wells to provide for an early warning system for public supply wells.
- If detections occur in existing or future monitoring wells, facilitate meetings between the responsible parties and potentially impacted water agency(ies) to develop strategies to minimize the further spread of contaminants. Specifically, a water agency could consider altering groundwater extraction patterns or altering production wells in the vicinity of a pollutant plume to change the groundwater gradient.
- Provide a forum to share all information on mapped contaminant plumes and leaking UST sites in order to develop groundwater extraction patterns and in site planning of future production or monitoring wells.
- Meet with representatives of the CVRWQCB staff to establish a positive relationship and identify ways to have open and expedient communications with the CVRWQCB staff regarding any new occurrences of contamination. Open communication channels are especially important when contamination is believed to have reached the water table.
- Track upcoming regulations on septic systems, National Pollutant Discharge Elimination System (NPDES) Permits, agricultural discharges and other regulatory programs that pertain to water quality.

6.3 IDENTIFICATION OF WELL CONSTRUCTION POLICIES

Both the Stanislaus County DER and the Merced County DEH administer the well permitting program in the unincorporated areas of the Turlock Groundwater Basin within their respective boundaries. The standards for construction are consistent with those recommended in State Water Code Section 13801. This section requires counties, cities, and water agencies to adopt the State Model Well Ordinance as a minimum standard for well construction or a more rigorous standard, if desired.

Each city member of the TGBA has enacted a well ordinance adopting the California Well Standards, Bulletin 74-81 (DWR, 1981a), and all its supplements. This ordinance is utilized in wells constructed within the incorporated area of each city. Each city provides a review of well construction plans and specifications within the incorporated area.

The Stanislaus County DER has enacted well ordinances adopting the California Well Standards, Bulletin 74-81 and all its supplements for the unincorporated areas in its boundaries. Merced County DEH has also enacted well ordinances for the unincorporated areas of the county; however, Merced County has chosen to adopt a more rigorous standard. The Merced County Well Ordinance requires that the minimum annular seal for all wells, except monitoring and cathodic protection wells, be 50 ft. Further, the annular seal must extend to 20 ft above the top of the casing perforation, which significantly extends the depth of the annular seal for wells with perforations below 70 ft.

Both Stanislaus and Merced counties also review well permit applications, including construction plans and specifications, and issue permits for wells constructed or destroyed in unincorporated areas. As a part of that process, the counties require and maintain well logs and water well driller reports for constructed wells.

Standards also exist for contractors involved in well construction. Section 13750 of the California Water Code requires that well drillers possess a C-57 Water Well Contractors License. Section 13751 requires well drillers to file a well completion log with DWR for every production or monitoring well constructed.

The number of service connections to a well determines whether operating permits for public drinking water are provided through DHS or by Stanislaus County DER or Merced County DEH. DHS has jurisdiction over public water system wells with over 200 service connections. Wells that serve public water systems with fewer than 200 service connections fall under the jurisdiction of the Stanislaus County DER or Merced County DEH.

6.3.1 Actions

The following actions may be implemented by the local water agencies individually or in conjunction with the TGBA to address well construction policies:

- Ensure that all member agencies are provided a copy of the applicable county well construction ordinance and understand the proper well construction procedures.
- Coordinate with local water agencies to provide guidance, as appropriate, on well construction to prevent creating conduits through regionally confining beds. Where feasible and appropriate, this could include the use of USGS lithologic data prior to construction of the well to assist in well design.

6.4 ADMINISTRATION OF WELL ABANDONMENT AND DESTRUCTION PROGRAMS

There are many unknown, obsolete, or abandoned water supply wells within the Turlock Groundwater Basin. These wells provide potential locations for monitoring of groundwater levels, but more frequently serve as a source of contamination and should be abandoned following proper destruction standards.

One of the primary concerns of local agencies is the groundwater contamination risk posed by unused wells that have not been properly destroyed. Section 21 of DWR Bulletin 74-81 (DWR, 1981a) and revisions contained in Part II of Bulletin 74-90 (DWR, 1991) allow classification of unused wells into two types, abandoned and inactive. An abandoned well is defined as one, which has not been used for a period of one year, and whose owner has declared the well will not

be used again. If the well has not been used during the past year, but the owner demonstrates his/her intention to use the well again for supplying water, the well is considered inactive. Four criteria must be met in order for a well to maintain the inactive, rather than abandoned, classification. These criteria are:

- The well has no defects
- The well is securely covered
- The well is clearly marked
- The surrounding area is kept clear of brush and debris

Failure to meet these criteria could result in the well being classified as abandoned under current regulations. All abandoned wells, exploration or test holes, and monitoring wells must be destroyed as stated in Section 22 of Bulletin 74-81 (DWR, 1981a) and revisions contained in Bulletin 74-90 (DWR, 1991).

An abandonment program should focus on those wells that pose the greatest threat to groundwater; however, numerous factors make the abandonment and destruction of wells difficult. These factors include lack of consistency in records regarding well construction, location, and use; cost of well destruction; and the defined classification for abandonment of wells (i.e., abandoned versus inactive status). Well construction within the Subbasin has taken place for nearly a century, with records and standards altered over time. Recent records pertinent to construction and location of new wells are more complete than earlier records, which are often inconsistent. The lack of financial incentive for well owners to declare a well as abandoned also reduces the effectiveness of the well abandonment program.

Stanislaus County DER and Merced County DEH administer the well destruction program within the unincorporated areas of the Turlock Basin. The cities administer the well destruction program within the incorporated areas. The standards for destruction are identified in the county codes and are based on State of California standards. As with well construction standards, the State has established minimum standards, however, local agencies have the option of requiring more stringent standards to meet the local needs. For example, Merced County has adopted additional sealing requirements for wells that lack information on subsurface geology (i.e., a driller's report or log).

6.4.1 Actions

The following actions may be implemented by the local water agencies individually or in conjunction with the TGBA to address well abandonment and destruction issues:

- Ensure that member agencies are provided a copy of each municipality's code, understand the proper destruction procedures, and support implementation of these procedures.
- Follow up with local water agencies on reported abandoned and destroyed wells to confirm information collected from DWR and to provide information on abandoned and destroyed wells to fill gaps in county records.
- Seek funding to develop and implement a program to assist well owners in the proper destruction of abandoned wells.

6.5 MITIGATION OF OVERDRAFT CONDITIONS

The TGBA supports activities to reduce the dependency on groundwater to help minimize any potential localized overdraft. The TGBA also supports actions by agricultural water suppliers to encourage irrigation customers to receive surface water deliveries, when available, so that growers do not turn to groundwater as a more flexible source of irrigation supply during periods when surface water is abundant.

6.5.1 Actions

The following actions may be implemented by the TGBA and/or its individual members to address mitigation of groundwater overdraft:

- Support programs that relieve aquifer overdraft through substitution of surface water for groundwater.
- Continue implementation of water conservation programs that will reduce reliance on groundwater pumping.
- Continue and enhance groundwater monitoring and groundwater use to maintain groundwater storage.
- Support programs by agricultural water agencies to provide surface water to irrigators who may otherwise irrigate with groundwater because of the greater operational flexibility achievable through individual pumps.
- Seek funding for programs and projects that would identify and mitigate potential condition of overdraft in the Basin.

6.6 REPLENISHMENT OF GROUNDWATER EXTRACTED BY WATER PRODUCERS

A component of wellhead protection and an important groundwater management strategy is the protection of major recharge and withdrawal zones. This strategy has far-reaching effects in the Turlock Basin because of the significant groundwater recharge occurring as a result of agricultural irrigation. Groundwater recharge must be adequate to replenish extracted groundwater, while withdrawal zones need protection from up gradient sources to ensure that the quality of extracted groundwater meets the standards established for the intended use.

A comprehensive approach to the protection and management of the major recharge and withdrawal zones is much more appropriate than the use of individual zoning techniques. Communities, in cooperation with neighboring towns and in unincorporated areas, must develop comprehensive land and water resource management programs that go beyond simple zoning approaches for the protection of agricultural and urban areas.

6.6.1 Actions

The following actions may be implemented by the local water agencies individually or in conjunction with the TGBA to address groundwater recharge issues:

- Communicate with DWR and other governmental agencies studying groundwater and river interactions.
- Support programs that preserve agricultural land uses in groundwater recharge areas.

- Evaluate projected impacts to groundwater recharge when analyzing development projects on agricultural land.

6.7 CONSTRUCTION AND OPERATION OF RECHARGE, STORAGE, CONSERVATION, WATER RECYCLING, AND EXTRACTION PROJECTS

Various water agencies in the Turlock Subbasin share responsibility for development and operation of recharge, storage, conservation, water recycling, and extraction projects. The role of the TGBA is to promote cooperation and sharing of information between the agencies sponsoring water management projects and other local water agencies. To the extent feasible, the TGBA also will support measures to coordinate development and optimize operation of facilities to improve Basin-wide effectiveness and efficiency of water management.

6.7.1 Actions

The following actions may be implemented by the local water agencies individually or in conjunction with the TGBA to address recharge, storage, conservation, water recycling, and extraction construction projects:

- Share information on project planning, design, and operation among local water agencies.
- Promote a coordinated approach toward project development and operation to lower the costs and increase the benefits of water management efforts.
- Seek funding for projects and programs that will contribute to water conservation, recycling, and recharge of the groundwater Basin.

6.8 CONTROL OF SALINE WATER INTRUSION

Saline water intrusion from the San Joaquin River or from the west side of the San Joaquin Valley (including intrusion from the marine layers) is not well documented in the Turlock Groundwater Basin. Groundwater elevations prevalent in the Basin have historically maintained a positive gradient preventing significant migration of saline water associated with groundwater from the western San Joaquin Valley. Maintaining the positive groundwater gradient will continue to prevent induced flow from the river or from groundwater west of the San Joaquin River.

6.8.1 Actions

The following actions may be implemented by the local water agencies individually or in conjunction with the TGBA to address saline water intrusion issues:

- Collect groundwater quality data along the San Joaquin River, and track the progression, if any, of saline water moving east from the San Joaquin River.
- Communicate with DWR's San Joaquin District Office on a biennial basis to check for significant changes to TDS concentrations in wells. DWR has a regular program of sampling water quality in selected domestic, agricultural, and monitoring wells throughout the Basin. These wells may be augmented by additional monitoring wells to develop an early warning system able to detect saline water intrusion from the river.

- The Groundwater Monitoring Program described in the Plan will supplement the program of monitoring for intrusion of saline water. The program includes provisions for monitoring groundwater levels and quality.
- Observe TDS concentrations in public supply wells that are routinely sampled under the DHS Title 22 Program.

7 STAKEHOLDER INVOLVEMENT

7.1 AGENCY INVOLVEMENT

The TGBA was formed to facilitate agency involvement in groundwater management activities within the Turlock Subbasin. The majority of local agencies with jurisdiction in the Subbasin have joined the TGBA. Those that have elected not to join are encouraged to participate in TGBA activities. The MOU utilized to form the TGBA provides a process for additional entities to join (A copy of the MOU is provided in Appendix C). Any local public agency, whose service area includes land located within the Subbasin, which uses groundwater, or is authorized to provide groundwater, groundwater quality management, or groundwater replenishment within its service area, and whose service area includes all or a portion of the Turlock Subbasin, may apply for membership. Application is subject to approval by existing TGBA members, and the joining entity must pay any back contributions, if any, as determined by the TGBA governing body.

7.2 ADVISORY COMMITTEE

TGBA representatives currently serve in an advisory role for groundwater management activities within the Subbasin. Additional committees, including an Advisory Committee, will be formed as necessary. The MOU includes language specifying that the TGBA Board may establish any committees it deems as necessary or desirable.

7.3 COORDINATION WITH OTHER AGENCIES

The TGBA provides a mechanism for local public agencies to coordinate groundwater management activities. Meetings are scheduled on a monthly basis to work through groundwater management issues. In addition to action items included on the agenda, time is allotted at each meeting for participants to provide updates on groundwater and related issues not specifically identified.

In addition, TGBA member agencies have coordinated the planning process with other neighboring water agencies and subbasins. The City of Modesto and Stanislaus County participate in the groundwater management efforts within the Modesto Subbasin. Similarly, Merced ID and Merced County participate in groundwater management efforts occurring within the Merced Subbasin. These agencies have communicated with the associations and other agencies within the Merced and Modesto subbasins, to help to facilitate the coordination of groundwater management efforts taking place within the adjacent subbasins. Additional coordination efforts include development of ongoing and future relationships with State and Federal agencies. These activities are described in Section 7.5 below.

7.4 PUBLIC INVOLVEMENT PROCESS

Prior to developing this plan, local agencies held public hearings, noticed pursuant to Section 6066 of the Government Code. As noticed, the intent of these meetings was to inform the public that an update of the Plan was being developed and to provide an opportunity for the public to provide input on the issues that should be considered in the Plan. All comments received in this process were reported back to the TGBA and considered in the development of the Plan.

All TGBA meetings are open to the public and held pursuant to the Brown Act. Agendas are posted and available for public review. Agendas are submitted directly to interested individuals upon request, as well as each of the local public agencies within the Subbasin. As noticed on the agendas, and documented in meeting minutes, the update of the Plan was discussed regularly during TGBA meetings, providing additional opportunities for interested individuals to participate in the process.

A second public hearing, noticed pursuant to Section 6066 of the Government Code is required for a local public agency to adopt a groundwater management plan. Each agency that adopted this Plan was required to conduct this public hearing independently before adopting the Plan. This hearing created an additional opportunity for the public to provide input on whether or not the agency should adopt the updated Plan.

In addition to these opportunities, the public can participate in the ongoing groundwater management activities of the TGBA. A public comment period is included at each TGBA meeting, where time is allotted for any interested parties to raise issues or concerns. Due to specific Brown Act requirements, items discussed during the public comment period may not be acted upon at that time. However, those issues identified through this forum may be brought back to the TGBA for consideration and action at a future meeting.

7.5 DEVELOPING RELATIONSHIPS WITH STATE AND FEDERAL AGENCIES

Local public agencies that make up the TGBA have relationships with various State and Federal agencies. These individual relationships will continue to be fostered and utilized, as necessary, to implement subarea and Subbasin groundwater management activities.

The TGBA will periodically develop a report documenting its activities, which will be submitted to the DWR. This process will assist in fostering an ongoing relationship with DWR. Additional relationships will be developed with other State and Federal agencies, as necessary.

7.6 DISPUTE RESOLUTION PROCESS

The TGBA has been used effectively as a tool for the resolution of groundwater management issues in the Basin. Discussion of issues in the TGBA meetings is an open and transparent process, which has resulted in cooperative relationships between water agencies representing the various water users within the Basin. The TGBA will continue to provide a forum for discussion and early resolution of the Basin’s groundwater issues.

8 PLAN IMPLEMENTATION

Key features of the plan are the linkages that have been established among program actions. These linkages provide a cohesive program in which the whole is greater than the sum of its parts. These linkages are described throughout the text, including Sections 5 and 6, which provide a discussion of groundwater management measures and activities, and in the implementation measures described below.

The Implementation Plan presents suggested management actions that can assist the TGBA in meeting the Basin Management Objectives (Section 5.3). The overarching purpose of the BMOs and associated actions is to encourage a balance of surface water and groundwater use to protect the resources of the Basin and maximize the reliable supply of high quality water to meet the Subbasin's current and future needs.

It is also important to note that groundwater management requirements and responsibilities, as dictated by the California Code of Regulations, may change over time. Individual agencies, as well as the TGBA, will evaluate regulatory changes and determine how best to address those changes, when and if they occur. The recommendations and implementation priorities may change over time, to accommodate the changing regulatory framework.

8.1 IMPLEMENTATION PLAN

8.1.1 Basin-Wide Management Actions

The following Basin-wide management actions are provided as suggested measures for facilitating the achievement of the BMOs described in Section 5.3:

- Protection of natural recharge areas
- Feasibility evaluation of artificial recharge projects
- Management and optimization of well field operations
- Support of public health programs
- Water quality management
- Groundwater monitoring and subsidence monitoring program
- Policy assessment
- Promoting coordination and cooperation between water agencies
- Identification and feasibility study of conjunctive use projects

The following discussion provides additional information regarding each of the suggested implementation measures to support each management action. Availability of funding for groundwater management activities, as well as future regulatory requirements, will influence the speed and level to which each of the measures is evaluated and implemented.

8.1.1.1 Protection of Natural Recharge Areas

Groundwater recharge will likely diminish as a result of continued urban expansion and further use of more advanced agricultural irrigation practices. New irrigation technologies reduce the

amount of irrigation water applied, and consequently reduce the deep percolation of applied irrigation water. These land use influences on percolation illustrate the need to identify and map the remaining natural recharge areas so that these areas can be protected. The objective is to develop specific planning actions that offer varying degrees of protection, depending on an area's significance as a source of recharge. Types of protection could include:

- Programs to educate the public and planning entities about the importance of protecting recharge areas.
- Pricing and incentive programs to encourage the continued use of surface water for flood irrigation. Because irrigation of agricultural land is currently the largest contributor to groundwater recharge within the Subbasin, pricing and incentive programs could encourage the continuation of this type of recharge within the Basin.

The first steps in implementing this management action would be to identify recharge areas within the cities and counties, develop a GIS-based map of natural recharge areas, inform planning entities of the importance of these areas, and make recommendations for the protection of these areas.

8.1.1.2 Feasibility Evaluation of Artificial Recharge Projects

If future studies or updates of the Subbasin groundwater budget indicate that the Subbasin is in overdraft or is likely to fall into overdraft, two broad options are available for sustaining and enhancing recharge. The first option is to maintain natural recharge by protecting the natural recharge areas. This option is described above in Section 8.1.1.1.

The second option is to augment natural recharge through an artificial recharge program. The evaluation of artificial recharge projects would begin by mapping potential recharges sites, building upon the mapping of natural recharge sites described previously. Existing planning efforts are evaluating using surface water supplies in artificial recharge basins; however, using stormwater flows for artificial recharge also could be evaluated.

An enhanced recharge management action also would evaluate in-lieu recharge projects. These projects would look at opportunities to reduce groundwater demand by supplying surface water to areas now served by groundwater. Such projects could include incentives for TID or Merced ID irrigators to continue irrigating with surface water instead of groundwater, or other approaches available to the irrigation districts to promote groundwater recharge and reduce overdraft.

Additional projects that could be evaluated include development or expansion of conjunctive use projects in urban areas with poor groundwater quality (i.e., supplement the urban water supply with surface water in order to reduce its reliance on groundwater, improve groundwater levels and reduce the movement of contaminants in the basin) as well as a program to evaluate the potential for stormwater recharge.

8.1.1.3 Management and Optimization of Well Field Operation

A component of improved groundwater management could be the optimization of well operations to accomplish specified management objectives. For example, each well in a well field could be instrumented and controlled so that the group of wells is operated to meet single or

multiple objectives. Examples of potential implementation measures for this management action include:

- Minimize the overall pumping costs
- Maintain groundwater levels within specified ranges
- Reduce or eliminate well interference
- Control the migration of contaminant plumes
- Enhance control of pumping into irrigation canals in response to delivery and cutoff orders, hence creating opportunities to conserve water by reducing spillage

In addition, well field optimization can be used to support management of water quality within irrigation canals, by controlling the quantity of poorer-quality water discharged from wells that blends with surface water deliveries. TID uses groundwater pumping to lower groundwater levels and supplement surface water supplies. Groundwater is blended with surface water supplies and utilized for irrigation supply. Urban wells that do not meet drinking water standards could potentially be used to supplement agricultural supplies while helping to manage contaminant migration. The agencies within the Basin could evaluate modifications to the blending program to lower the high groundwater table, manage contaminant migration, and provide good quality water for irrigation supply.

8.1.1.4 Support of Public Health Programs

Well construction and demolition standards are designed specifically to protect groundwater quality. Implementation measures to assist local agencies in complying with public health standards may include:

- Installation of sanitary well seals on all new wells in accordance with the California Well Standards (or a more strenuous standard as determined necessary by the County or other applicable water agency to protect groundwater quality)
- Abandonment of wells in accordance with the California Well Standards (or a more strenuous standard as determined necessary by the County or other applicable water agency to protect groundwater quality)

This management action is particularly valuable in unincorporated areas not served by a water purveyor.

8.1.1.5 Water Quality Management

The protection of groundwater quality is an increasing concern because the Basin's population is continuing to grow. This management action would involve conducting a detailed hydrogeologic assessment of the Basin, focusing on the areas with poor water quality to identify the sources of contaminants. This assessment would result in a GIS-based map of areas with poor water quality. The information could be used in conjunction with the recharge area mapping described above and used to develop strategies to control the migration and movement of poor quality water into and/or within the Basin.

8.1.1.6 Groundwater Monitoring and Subsidence Monitoring Program

Groundwater monitoring, data analysis, and archiving of collected data are essential for any groundwater management plan. Data are needed to understand conditions within the Basin, evaluate trends, facilitate the implementation of management actions, and evaluate their effectiveness.

As described in Section 4.1.4, reductions in DWR groundwater monitoring have resulted in greater uncertainty in the measurement of groundwater levels in the Basin. These data are required to estimate groundwater storage and changes in storage over time. The TGBA should evaluate the current condition and effectiveness of the groundwater level and quality monitoring programs, the database used to store and manipulate the data, and make improvements as necessary.

In addition, the TGBA could consider monitoring inelastic land surface subsidence within the Basin. Given that there have not been subsidence issues in the past, it appears unlikely that inelastic land subsidence would occur if current groundwater conditions are maintained. The ongoing efforts within the Basin to prevent groundwater overdraft further reduce the potential for subsidence. However, the TGBA could consider monitoring and documenting any future changes in land surface elevations. If subsidence is observed, appropriate actions could be recommended.

8.1.1.7 Policy Assessment

Several of the technical management actions introduced above have clear policy requirements and implications. The development of consistent policies could be assisted by a regional groundwater forum, such as the TGBA. This forum would foster coordination and cooperation among participating agencies that manage the Turlock Basin, and would provide a framework for formulation of regional projects and programs for the protection and use of groundwater resources.

For example, TGBA members are mutually concerned about protecting natural recharge areas from pollutants. Local water agencies could work through the TGBA forum to inform other members about land use practices that may contribute to groundwater degradation.

8.1.1.8 Promoting Cooperation and Coordination Between Water Entities

The TGBA will continue to coordinate water management activities within the Basin and work cooperatively to implement the agreed-upon BMOs. The local water agencies also may work together to develop a coordinated outreach program to educate Subbasin residents and groundwater users on groundwater management issues.

8.1.1.9 Identification and Feasibility Study of Conjunctive Use Programs

Conjunctive use programs optimize the use of groundwater resources in combination with surface water supplies to maximize water supply and minimize the potentially adverse effects of using a single source. The overall strategy in conjunctive use is to store water in the groundwater basin for use in drier years by recharging the basin during years when water is more abundant. Groundwater storage activities can include both active (e.g., recharge basins) and passive (e.g., in-lieu recharge) projects.

Many of the implementation measures described in this section of the Plan can be viewed as components of a broader conjunctive management program. The goal of this program would be to balance surface water and groundwater uses to support the BMOs. Implementation of this management action will involve continuing the current conjunctive management activities described in Section 5.6, in addition to the identification and feasibility study of the implementation measures described throughout this section. Ongoing monitoring coordinated through the TGBA provides a means of tracking the success of existing conjunctive management strategies and identifying if additional or alternative strategies should be evaluated.

8.2 GROUNDWATER MANAGEMENT PLAN IMPLEMENTATION REPORT

Periodic reports will be produced, as necessary, to comply with groundwater management requirements. Reports will be designed to summarize groundwater basin conditions, and describe groundwater management activities. These reports may be prepared by the TGBA as a group, or by individual agencies. Reports generated by individual agencies will be coordinated through the TGBA.

The periodic reports may include the following types of information:

- A summary of monitoring results, including historical trends;
- A summary of management actions implemented;
- A summary, supported by monitoring results, of whether management actions are meeting the management goals and objectives;
- A summary of proposed management actions; and
- A summary of any proposed changes to this Plan, including addition or modification of management measures.

8.3 FINANCIAL PLANNING FOR RECOMMENDED ACTIONS/PROJECT IMPLEMENTATION

Progress toward the implementation of recommended actions is contingent upon securing funding for elements of this Plan. Two avenues that are available for funding include grant programs and funds generated internally by the TGBA members.

8.3.1 Grant Funding

Grant funding programs are continually changing. As the TGBA and/or individual agencies implement the recommended actions, funding sources will be evaluated. Grant funding may be secured by the TGBA (likely under the management of a member agency on behalf of the TGBA), or by individual agencies. As has been the practice in the past, the TGBA also will continue to support efforts by local agencies to secure grant funding that is consistent with the TGBA's goals and objectives and furthers groundwater management related issues within the Basin.

8.3.2 Funding through Local Agency Budgeting

Funding from local agencies is a second source of funding available for implementation of the plan. The ability to fund plan implementation locally will be dependent upon available resources and is subject to an individual agency's budgetary process. It is important to note, however, that

local financial support or contributions are often required by state grant programs or other sources of outside funding. Therefore, local contributions may aid in the acquisition of outside funding to implement the plan.

8.4 PERIODIC REVIEW OF THE GROUNDWATER MANAGEMENT PLAN

As indicated in Section 8.2, one of the issues to be evaluated in the periodic reports is whether this Plan requires modification. Hence, when the TGBA develops periodic summary reports, it will also consider whether or not an update of the Plan is warranted. To maintain consistency and encourage coordination among local water agencies, it is the intent of the TGBA that updates of the Plan continue to be a Basin-wide activity.

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Appendix A

Figures

Appendix B

Tables

Table 1. Location of TGBA GMP Components

Description	Section(s)
CWC Section 10750 et seq. Mandatory Components	
1. Documentation of public involvement statement.	7.4
2. Basin Management Objectives (BMOs).	5.3
3. Monitoring and management of groundwater elevations, groundwater quality, inelastic land surface subsidence, and changes in surface water flows and quality that directly affect groundwater levels or quality or are caused by pumping.	5.5-5.6 & 6.1-6.8
4. Plan to involve other agencies located within groundwater basin.	7.1-7.3 & 7.5
5. Adoption of monitoring protocols by basin stakeholders.	5.5-5.6
6. Map of groundwater basin showing area of agency subject to GMP, other local agency boundaries, and groundwater basin boundary as defined in DWR Bulletin 118.	1.1-1.2 & 4.1.1
7. For agencies not overlying groundwater basins, prepare GMP using appropriate geologic and hydrogeologic principles.	N/A
DWR Suggested Components	
1. Manage with guidance of advisory committee.	7.2
2. Describe area to be managed under GMP.	5.2
3. Create link between BMOs and goals and actions of GMP.	8.1
4. Describe GMP monitoring program.	5.6
5. Describe integrated water management planning efforts.	3.3 & 5.7
6. Report on implementation of GMP.	8.2
7. Evaluate GMP periodically.	8.4
CWC Section 10750 et seq. Voluntary Components	
1. Control of saline water intrusion.	6.8
2. Identification and management of wellhead protection areas and recharge areas.	6.1
3. Regulation of the migration of contaminated groundwater.	6.2
4. Administration of well abandonment and well destruction program.	6.4
5. Mitigation of conditions of overdraft.	6.5
6. Replenishment of groundwater extracted by water producers.	6.6
7. Monitoring of groundwater levels and storage.	5.5-5.6
8. Facilitating conjunctive use operations.	5.7
9. Identification of well construction policies.	6.3
10. Construction and operation by local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.	6.7
11. Development of relationships with state and federal regulatory agencies.	7.5
12. Review of land use plans and coordination with land use planning agencies to assess activities that create reasonable risk of groundwater contamination.	3.3

Table 2. Major Programs Affecting Groundwater Within the TGBA Agencies' Boundaries

Facility or Operation	Involved Member(s)
Conjunctive use for irrigated agriculture	TID and Merced ID
Domestic water supply	Urban Agencies[1] and Counties[3]
Groundwater monitoring	All members
Storm water recharge basins	Urban Agencies[1]
Dry wells	Modesto and Turlock
Water conservation	All members
Drainage wells	TID
Review and permitting of well construction	Counties[3] and Cities[2]
Detection of soil and groundwater contamination	Counties[3]
Pilot wellhead protection demonstration project	Counties[3]
Regulation of small public water systems	Counties[3]
Land use planning	Counties[3] and Cities[2]
Wastewater management	Counties[3], Cities[2], and CWDs[4]
Flood control	Counties[3] and TID

Notes:

1 Urban Agencies include: Cities of Modesto, Ceres, Turlock, and Hughson; Denair, Keyes and Ballico community services districts; Delhi and Hilmar county water districts.

2 Cities include: Modesto, Ceres, Turlock, and Hughson

3 Counties include: Stanislaus and Merced

4 CWDs include: Hilmar and Delhi county water districts

Table 3. Monthly Precipitation in the Turlock Subbasin[1], 1970-2006 (Inches)

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1970	3.20	0.76	1.59	0.23	0	0.07	0	0	0	0.36	4.87	2.49	13.57
1971	0.63	0.24	1.32	0.89	0.56	0	0	0	0.01	0.31	1.44	3.26	8.66
1972	0.41	0.39	0.01	0.68	0	0	0	0	0	0.53	3.97	1.31	7.30
1973	3.20	5.28	2.62	0.12	0	0.03	0	0	0	2.22	1.18	3.22	17.87
1974	1.49	0.40	2.23	1.10	0	0.15	0.60	0	0	1.01	0.68	2.34	10.00
1975	0.56	2.67	3.28	1.04	0	0	0	0.55	0.01	1.16	0.28	0.10	9.65
1976	0.15	1.07	1.01	0.65	0	0.03	0	0.35	0.49	0.07	0.84	0.87	5.53
1977	0.85	0.41	0.92	0.03	1.29	0.06	0	0	0.04	0.10	0.52	1.87	6.09
1978	4.39	3.09	4.35	3.96	0	0	0	0	0.69	0	2.27	0.66	19.41
1979	3.37	3.51	1.75	0.36	0.08	0	0.09	0	0	0.96	1.09	2.13	13.34
1980	3.45	3.94	1.10	0.53	0.62	0	0.05	0	0	0.06	0	1.08	10.83
1981	4.31	0.73	3.51	0.58	0.02	0.06	0	0	0	1.14	3.74	0.90	14.99
1982	1.95	1.80	3.89	2.54	0.02	0.11	0	0	1.20	1.11	2.73	1.67	17.02
1983	5.24	3.36	5.03	2.44	0.24	0	0	0	2.68	0.53	4.03	3.48	27.03
1984	0.18	1.12	0.65	0.24	0	0.04	0	0	0	1.13	2.78	1.71	7.85
1985	0.42	0.54	1.54	0.19	0	0.14	0	0	0.23	0.76	2.81	1.29	7.92
1986	1.27	3.10	3.14	0.56	0.01	0	0	0	1.02	0.01	0.03	0.68	9.82
1987	1.68	2.07	3.71	0.10	0	0	0	0	0	1.31	1.13	2.35	12.35
1988	1.95	0.56	0.08	2.06	0.24	0.05	0	0	0	0	1.65	2.27	8.86
1989	0.48	1.13	1.50	0.03	0	0	0	0	1.64	1.04	0.70	0	6.52
1990	2.19	1.64	1.20	0.29	1.99	0	0	0	0	0.11	0.22	0.70	8.34
1991	0.17	2.06	4.59	0.48	0.03	0.31	0	0.01	0	1.16	0.26	1.21	10.28
1992	1.12	5.56	1.97	0.02	0	0.08	0.05	0	0	0.54	0.10	2.87	12.31
1993	5.33	3.32	2.72	0.20	0.97	0.29	0	0	0	0.37	0.83	1.10	15.13
1994	2.15	2.11	0.39	1.28	1.15	0	0	0	0.01	0.16	1.56	0.88	9.69
1995	7.22	0.65	6.46	1.32	1.52	0.16	0	0	0	0	0	4.03	21.36
1996	3.15	3.54	1.06	0.99	1.69	0.02	0	0	0	1.65	1.88	4.87	18.85
1997	5.68	0.18	0.09	0.30	0.04	0.09	0	0	0.01	0.08	2.78	1.91	11.16
1998	4.03	8.47	2.07	1.33	2.65	0.20	0	0	0.01	1.12	1.26	0.85	21.99
1999	2.54	2.39	1.07	0.74	0.20	0	0	0	0	0	0.94	0.21	8.09
2000	3.30	4.88	0.72	1.52	0.72	0.09	0	0.21	0.01	2.23	0.24	0.36	14.28
2001	3.95	2.58	2.00	1.43	0	0.01	0.07	0	0.23	0.09	1.87	3.92	16.15
2002	1.57	0.81	1.32	0.03	0.08	0	0	0	0	0	2.24	3.61	9.66
2003	0.63	0.70	1.06	1.52	0.59	0	0.02	0.05	0	0.04	0.55	3.31	8.47
2004	1.08	3.02	0.73	0.08	0.20	0.01	0.02	0.01	0.42	0.70	1.18	3.26	10.71
2005	2.68	2.91	1.97	0.77	1.10	0.14	0	0.03	0.31	0.18	0.37	2.97	13.43
2006	2.98	1.03	3.54	2.40	0.84	0	0	0	0	0	1.05	2.12	13.96
Min	0.15	0.18	0.01	0.02	0	0	0	0	0	0	0	0	5.53
Max	7.22	8.47	6.46	3.96	2.65	0.31	0.60	0.55	2.68	2.23	4.87	4.87	27.03
Mean	2.40	2.22	2.06	0.89	0.46	0.06	0.02	0.03	0.24	0.60	1.46	1.94	12.39

[1] Values from 1970-2002 are from National Oceanic & Atmospheric Administration (NOAA) Turlock #2 Station; 2003-2006 values are from the California Irrigation Management and Information System (CIMIS) Station #168 (Denair).

Table 4. Year 2005 Treated Wastewater Effluent Use and Disposal

Agency	Annual Totals (million gallons)[1]				
	Percolation Ponds	Agricultural Irrigation	Discharged to River	Other Uses[6]	Total
Ballico[2]	--	--	--	--	--
Ceres[3]	635.7	--	--	72	707.7
Delhi	242.0	--	--	--	242.0
Denair[4]	--	--	--	--	
Hilmar	161.2	--	--	--	161.2
Hughson	264.0	--	--	--	264.0
Keyes[4]	--	--	--	--	--
Modesto[5]	--	3,670.7	4,671.6	--	8,342.3
Turlock[4]	--	47.0	4,336.0	--	4,383.0
TOTAL	1,302.9	3,717.7	9,007.6	72	14,100.2

Notes:

1 1,000,000 gallons = 3.0689 AF

2 Customers within the Ballico Community Services District use septic tank systems for wastewater disposal.

3 TID's Almond Power Plant discharges about 50% of the process water to the City of Ceres percolation ponds. A portion of Ceres wastewater flow is discharged to the City of Turlock.

4 Keyes and Denair CSDs and the City of Ceres contract with the City of Turlock for wastewater treatment and disposal. The wastewater produced by these agencies is included in the City of Turlock's totals reported above.

5 The City of Modesto's effluent flows to agricultural land in the Turlock Basin includes effluent from areas both north and south of the Tuolumne River.

6 The City of Ceres utilizes effluent for landscape irrigation.

Table 5. Current Level of Monitoring Efforts

Local Agency	Total Number of Wells	Pumping Totals Monthly	Number of Wells Where Groundwater Levels are Measured			Number of Wells Where Groundwater Samples are Analyzed for Water Quality	Water Quality Analyses Performed
			Monthly	Semiannual	Annual	Monthly to Every Three Years	
Merced ID	5			5			
Turlock ID	24			24			
City of Ceres	8	8	8	8		8	Per Title 22 and DHS
City of Hughson	5	5		5		5	Per Title 22 and DHS
City of Modesto	20	20	20	20		19	Per Title 22 and DHS
City of Turlock	27	23	27			24	Per Title 22 and DHS
Delhi CWD	5	5	5			5	Per Title 22 and DHS
Hilmar CWD	3	3	3			3	Per Title 22 and DHS
Ballico CSD						1	Per Title 22 and DHS
Denair CSD	5	5	5			5	Per Title 22 and DHS
Keyes CSD	4	4				4	Per Title 22 and DHS
Total	**106**	**73**	**68**	**62**		**69**	

Source: Pers. comm. with local water agencies, March 2007.

Local Agency	Total Number of Wells	Pumping Totals Monthly	Number of Wells Where Groundwater Levels are Measured			Number of Wells Where Groundwater Samples are Analyzed for Water Quality	Water Quality Analyses Performed
			Monthly	Semiannual	Annual	Monthly to Every Three Years	
DWR (including cooperators)	307			307			
DHS (including cooperators)	163					163	Per Title 22 and DHS

Source: DWR, 2003.

Appendix C

MEMORANDUM OF UNDERSTANDING ESTABLISHING THE TURLOCK GROUNDWATER BASIN ASSOCIATION

MEMORANDUM OF UNDERSTANDING
ESTABLISHING THE TURLOCK GROUNDWATER BASIN ASSOCIATION

1. PARTIES:

The parties to the Memorandum of Understanding ("MOU") are: City of Ceres, a California Public Agency; Keyes Community Services District, a California Public Services District; Denair Community Services District, a California Public Services District; City of Turlock, a California public agency; Hilmar County Water District, a California Public Services District; Delhi County Water District, a California Public Services District; City of Hughson, a California public agency; City of Modesto, a California public agency; Merced Irrigation District, a California Irrigation District; Ballico Community Services District, a California Public Services District; County of Merced, a Political Subdivision of the State of California; County of Stanislaus, a Political Subdivision of the State of California; Eastside Water District, a California Water District; Ballico-Cortez Water District, a California Water District; and Turlock Irrigation District, a California Irrigation District.

2. RECITALS:

This MOU is entered into with regard to the following facts and circumstances, among others:

2.1 Groundwater and surface water resources within the Turlock Groundwater Basin are vitally important resources, in that they provide the foundation to maintain current and fulfill future agricultural, domestic, municipal and industrial needs, as well as other needs, and to maintain the economic viability and prosperity of the Basin area.

2.2 The Stanislaus/Merced County area is one of the world's foremost agricultural areas; and the agricultural industry has played a major role in the development of the economy of Stanislaus/Merced County area. In an era of increasing competition for the area's finite water resources, it is important to understand and plan for the utilization of all the area's water resources in order to preserve all elements of the local economy vital to the area's well-being.

2.3 The Parties entered into a Memorandum of Understanding on or around July 14, 1995, for the purposes of studying and evaluating the condition of the Basin, and developing a groundwater management plan for the preservation, protection and enhancement of the Basin. The Turlock Groundwater Basin Groundwater Management Plan was adopted by the Parties on or about October 1997. The 1995 Memorandum of Understanding terminated by its own terms on December 31, 1997.

2.4 The Parties desire to form an association, which will be known as the Turlock Groundwater Basin Association, to provide a mechanism for the Parties

to collectively implement the Plan and the purposes and goals of this Memorandum of Understanding.

2.5 Purposes and Goals: The purposes and goals for the formation of the Association are:

2.5.1 To provide a mechanism to coordinate the implementation of the Plan and other groundwater management activities;

2.5.2 To create an association of the Parties to enhance the ability to obtain funding to carry out the Plan and related groundwater management projects; and

2.5.3 Provide information and guidance for the management, preservation, protection and enhancement of the Basin.

2.6 The Parties believe that non-coordinated action by water providers and users within the Basin could result in counter productive competition for finite resources resulting in adverse impacts to the groundwater and surface water supplies within the Basin.

2.7 The Parties believe that creation of an Association for water suppliers within the Basin is important to protect the groundwater and surface water

resources and will assist in meeting the needs of all users of such resources within the Basin.

2.8 Because of the enactment of Water Code Sections 10750 et seq., it is clear to the Parties that local management of water resources is desirable in order that local control be maintained over such resources.

2.9 The Parties hereto desire to enter into this MOU in order to form an association to promote the stated goals and provide coordinated implementation of the Plan to make the best use of available water resources to meet the needs of their respective constituents and service territories.

2.10 In forming the Association, it is the Parties' desire that the Association not be formed as a separate governmental entity, nor have any enforceable regulatory authority over any Party's facilities or any Party's respective surface water or groundwater supplies or rights, nor duplicate any services, duties or authority of any other agency.

3. AGREEMENT:

The Parties agree as follows:

4. DEFINITIONS:

The following terms, whether in the singular or the plural, and when used herein with initial capitalization, shall have the meanings specified in this Section 4:

4.1 **Basin:** The Turlock Groundwater Basin, which is geographically defined as that area in the State of California bounded on the west by the San Joaquin River; on the north by the Tuolumne River, on the east by the base of the Sierra Nevada foothills; and on the south by the Merced River, and includes the area of land overlying that basin and all tributaries therein.

4.2 **Board:** That body, consisting of one representative from each of the Parties, which governs the Association, as established pursuant to Section 5.2 of this MOU.

4.3 **Chairperson:** The presiding officer of the Association as elected by the Board.

4.4 **Governing Bodies:** The legislative bodies of the governmental Parties to this MOU.

4.5 **MOU:** This Memorandum of Understanding Establishing the Turlock Groundwater Basin Association.

4.6 **Parties:** Each of those entities named in Section 1 of this MOU, or those Parties added pursuant to Section 5.4 of this MOU.

4.7 **Plan:** The Turlock Groundwater Basin Groundwater Management Plan, adopted on or about October 1997.

5. THE ASSOCIATION:

5.1 **Powers and Purposes:** The Parties to this MOU hereby form the Turlock Groundwater Basin Association.

5.1.1 The purpose of the Association is to provide a forum in which the Parties can work cooperatively; to combine the available talent of the Parties' respective staffs; and to accomplish the purposes described in Section 2 of this MOU.

5.1.2 This Association shall have no enforceable regulatory authority over any person or entity, including Parties or Parties' facilities or rights.

5.2 **Board:** The Association shall be governed by a Board whose membership, duties and responsibilities are set forth herein.

5.2.1 Each Party shall designate one person to serve as a member of the Board, and one or more alternates. Each member of the board, and each alternate, shall serve at the pleasure of the Party appointing such member. A Party's alternate may serve in the place of that Party's member in the absence of such member and, in such case, the alternate shall have the powers of the member.

5.2.2 The Board, at its first meeting, shall elect a chairperson and vice-chairperson from its members. Such officers shall serve at the pleasure of the Board and in such capacities until the first meeting of the Board in 2002 at which time the Board shall elect new officers. Thereafter, the Board shall elect a chairperson and vice-chairperson from its members at the first meeting of each even numbered calendar year. The Chairperson shall be responsible for presiding over meetings of the Board, and shall notify committee members of meetings of the Board. The Board shall establish a date, time and place for its regular meetings, and may hold special meetings when required for the proper transaction of business. All meetings of the Board shall be held in accordance with the provisions of the Brown Act, California Government Code §54950 et seq. The Board shall prescribe such procedures for the conduct of its business as it deems appropriate.

5.2.3 A quorum shall consist of a majority of the Voting Members of the Board, except that less than a quorum may adjourn meetings of the Board. Alternatively,

the Chairperson may adjourn a meeting of the Board to a specified time, date and place if there is less than a quorum of members present for a meeting.

5.2.4 The Board shall have the following duties and responsibilities:

a. Develop and implement the activities, including work schedule, designated to achieve the objectives of the Association as set forth in Section 2 of this MOU.

b. Monitor work activities of the Association.

c. Establish such committees as may be necessary or desirable to carry out the purposes of the Association, and to exercise general supervision over such committees.

5.2.6 Except for actions for which a different approval standard is set forth in this MOU, all actions of the Board shall be approved by a majority of the members present.

5.3 **Staff; Employees:** The Association may have employees upon a decision by the Board, and/or may obtain staff and support services through the Parties.

5.4 **New Parties:** New Parties may join the Association, provided that they meet the requirements set forth in this Section 5.4.

5.4.1 Any local public agency, whose service area includes land located within the Basin, which uses groundwater, or is authorized to provide groundwater, groundwater quality management, or groundwater replenishment within its service area, and whose service includes all or a portion of the Basin, may apply for membership in the Association.

5.4.2 Application for membership shall be subject to approval by the Governing Bodies of the Parties; approval shall require the affirmative vote of the Governing bodies of two-thirds (2/3) of the Parties.

5.4.3 Any new Party to this Agreement shall, as a condition of admission to the Association, be required to first pay its proportionate share of back contributions, if any, as determined by the Board.

6. COMMITTEES:

The Board may establish any committees it determines are necessary or desirable.

7. ASSOCIATION COSTS:

7.1 Costs incurred by any Party in connection with any functions of the Association, or any committee established by the Board, and expenses of a Party's personnel including, without limitations, the regular and alternate members appointed by a party to

any committee while performing such functions, shall not be reimbursed by the Association except upon approval of the Board.

8. FUNDING AND VOTING PERCENTAGES:

8.1 It is anticipated that the Parties will fund their own staff work. However, outside funding may be available or the Parties, or any subgroup of the Parties, may make additional funding contributions, if necessary, upon agreement of those Parties participating in the funding.

8.2 **Voting Rights:** Each Party's representative on the Board shall be entitled to one vote.

8.3 **Modification by Party:** Funding percentages and/or voting percentages as indicated in Section 8.1 and 8.2 respectively, may be changed only upon the approval of the Governing Bodies of two-thirds (2/3) of the Parties.

9. RELATIONSHIP OF THE PARTICIPANTS:

9.1 **Each Party's Action is Independent of the Other:** The obligation of each Party to make payments under the terms and provisions of this MOU is an individual and several obligation and not a joint obligation with those of the other Parties. Each Party shall be individually responsible for its own covenants, obligations and liabilities under

this MOU. No Party shall be under the control of or shall be deemed to control any other Party or the Parties collectively. No Party shall be precluded from independently pursuing any of the activities contemplated in this MOU. No Party shall be the agent of or have the right or power to bind any other Party without such Party's express written consent, except as expressly provided in this MOU.

9.2 **No Creation of a Joint Powers Agency:** The Parties agree that by this MOU they do not intend to provide for the creation of an agency or entity which is separate from the Parties pursuant to Chapter 5 (commencing with §6500) of Division 7 of Title 1 of the Government Code, relating to the joint exercise of powers.

10. TERMS OF THIS MOU: The term of this MOU shall commence on November 15, 2001 and shall continue until terminated by Board action.

Upon termination of this MOU, the Board shall determine the assets and liabilities of the Association; make every effort to satisfy all obligations within sixty (60) days of the termination of the MOU; and distribute the remaining fund balance equitably to each Party in proportion to each Party's funding contribution to the Association.

11. GENERAL PROVISIONS GOVERNING MOU:

11.1 **Invalidity of Any Term Not to Invalidate the Entire Memorandum:** In the event that any of the terms, covenants or conditions of this MOU or the application of

any such term, covenant or condition shall be held invalid as to any Party, person or circumstance by any court of competent jurisdiction, all other terms, covenants or conditions of this MOU and their application shall not be affected thereby, but shall remain in full force and effect unless any such court holds that those provisions are not separable from all other provisions of this MOU.

11.2 **Construction of Terms:** This MOU is for the sole benefit of the Parties and shall not be construed as granting rights to any person other than the Parties or imposing obligations on a Party to any person other than another Party.

11.3 **Good Faith:** Each Party should use its best efforts and work wholeheartedly and in good faith for the expeditious completion of the objectives of this MOU and the satisfactory performance of the terms and provisions contained herein.

11.4 **Withdrawal or Termination of Membership:** Except in the event of the termination of this MOU pursuant to Section 10, a party who withdraws or terminates its membership in the Association shall not be entitled to a refund of its funding contributions. Any Party may terminate membership and withdraw from this Association upon thirty (30) days written notice of termination to the Association. If a Party withdraws from the Association when the Party is in arrears as to its funding contributions to the Association, that Party's entitlement to use any work product of the Association as provided for herein shall be determined by the Board.

11.5 **Amendment:** An amendment to this MOU must be approved by the affirmative vote of the Governing Bodies of two-thirds (2/3) of the Parties.

11.6 **Counterpart Execution:** This MOU may be executed in counterparts each of which shall be deemed an original but all of which together shall constitute one and the same instrument.

11.7 **Governance:** This MOU is made under and shall be governed by the laws of the State of California.

11.8 **Reasonable Delivery of Documents:** Each Party agrees upon request by the Chairperson or by the Board, to make, execute and deliver any and all documents reasonably required to implement this MOU.

IN WITNESS WHEREOF, the Parties have caused this MOU to be executed, each signatory hereto represents that he has been appropriately authorized to enter into this MOU on behalf of the Party for whom he/she signs.

Appendix D

DEFINITIONS

AB 3030 - Assembly Bill 3030, the Groundwater Management Act (codified in California Water Code sections 10750 *et seq.*) was passed by the State legislature during the 1992 session, and became law on January 1, 1993.

Abandonment - See "Well Abandonment"

Association - Refers to the "Turlock Groundwater Basin Association"

Aquifer - A geologic formation that stores, transmits and yields significant quantities of water to wells and springs.

Basin - See "Turlock Groundwater Basin"

Conjunctive Use - A term used to describe operation of a groundwater basin in coordination with a surface water reservoir system. The purpose is to artificially recharge the basin during years of above-average precipitation so that the water can be withdrawn during years of below-average precipitation, when surface supplies are below normal.

Groundwater - Subsurface water occurring in the zone of saturation.

High Groundwater - Groundwater levels higher than 6 feet below ground level which can adversely impact crops. High groundwater can be caused by "perched" water, overall high groundwater conditions, or other factors.

Inactive Wells - An unused well that the owner demonstrates his intention to use the well again. The California Water Well Standards (Bulletins 74-81 & 74-90) includes specific guidelines for things the owner must do to show evidence of his intention to continued to use the well

Local county environmental health agencies - Merced County Division of Environmental Health and the Stanislaus County Department of Environmental Resources

Overdraft - The condition of a groundwater basin where the amount of water withdrawn from an aquifer or groundwater basin exceeds the amount of water replenishing the basin (net recharge) over a period of time.

Participating Agency - Any local agency within the Turlock Groundwater Basin which adopts this AB 3030 groundwater management plan. Also referred to as a "member agency."

Public Water System - A system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections OR regularly serves at least 25 individuals daily at least 60 days out of the year, including: 1) A **Community Water System** is a public water system that has 15 or more service connections used by year-long residents OR regularly serves at least 25 year-long residents of the area served by the system; 2) A **Noncommunity Water System** is a public water system that is not a community water system; 3) A **NonTransient-Noncommunity Water System** is a public water system that is not a community water system that regularly serves at least 25 of the same persons during six months of the year; and 4) A **Transient Noncommunity Water System** is a noncommunity water system that does NOT regularly serve at least 25 of the same persons during six months of the year.

Recharge - Flow to groundwater storage from precipitation, infiltration from streams, and other sources of water.

Reducing Conditions - A lack of oxygen in the groundwater.

Safe Yield - The maximum quantity of water that can be continuously withdrawn from a groundwater basin without adverse effect.

Saline - Consisting of or containing salts, the most common of which are potassium, sodium, or magnesium in combination with chloride, nitrate, or carbonate.

SCADA - Supervisory Control and Data Acquisition - a type of remote monitoring and control system.

State Small Water System - A system for the provision of piped water to the public for human consumption that serves at least five, but not more than 14, service connections and does not regularly serve drinking water to more than an average of 25 individuals daily for more than 60 days out of the year.

Subbasin - For the purposes of this document, the name “Turlock Subbasin,” “Turlock Groundwater Basin,” “Basin,” and “Subbasin” are used interchangeably to represent the same geographic area.

TDS - “Total dissolved-solids,” the quantity of minerals (salts) in solution in water, usually expressed in milligrams per liter (mg/L) or parts per million (ppm).

Turlock

Groundwater Basin - A groundwater system located on the eastern side of the San Joaquin Valley bounded by the Tuolumne River on the north, the Merced River on the south, the San Joaquin River on the west, and the Sierra Nevada foothills (specifically the western extent of the low-permeability Valley Springs rock formation) on the east.

Unused Wells - Wells that are not being used are considered "unused." Wells that are not used for a period of one year are considered "abandoned," unless the owner demonstrates his intention to use the well again. (see "Inactive Wells")

Well Abandonment - According to the California State Well Standards *"a well is considered "abandoned"... if it has not been used for one year, unless the owner demonstrates intention to use the well again..."* All "abandoned" wells must be properly destroyed. (see "Well Destruction")

Well Destruction - All "abandoned" wells (see Well Abandonment") and exploration or test holes must be properly destroyed. The objective of well destruction is to restore subsurface conditions as nearly as possible to the conditions that existed before the well was constructed, taking into consideration any changes which may have occurred since the time of construction. Each of the counties and some of the cities within the Basin have established well standards which specify well destruction requirements.

WPA - Wellhead Protection Area defined by the Safe Drinking Water Act Amendments of 1986 as *"the surface and subsurface area surrounding a water well or well field supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water or well field."*

Appendix E

TABLE OF STANDARD CONVERSIONS

Table of Standard Conversions

Category	Unit	Equivalent Units
Area	1 acre	= 43,560 square feet (ft^2)
		= 4,047 square meters (m^2)
		= 0.004047 square kilometers (km^2)
Volume	1 acre-foot (AF)	= 325,851 gallons
		= 43,560 cubic feet (ft^3)
		= 1,233.5 cubic meters (m^3)
Flow	1 million gallons per day (MGD)	= 365 million gallons per year
		= 1,120 acre-feet per year (AF/yr)
		= 1.547 cubic feet per second (cfs)
		= 694.4 gallons per minute (GPM)
	1 gallon per minute	= 1,440 gallons per day
	1 cubic foot per second	= 1.984 AF/day
		= 0.6463 MGD
		= 448.831 GPM
	1 AF per day	= 0.5042 cfs
		= 0.3259 MGD
Concentration	1 part per million (ppm)	= 1 milligram per liter (mg/L)
		= 1,000 ppb
	1 part per billion (ppb)	= 1 microgram per liter (µg/L)
Conductivity	1 deciSiemens per meter (dS/m)	= 1 milliSiemens per centimeter (mS/cm)
	1 mS/cm	= 1,000 microSiemens per centimeter (µS/cm)
		= 1 millimhos per centimeter (mmhos/cm)
	1 µS/cm	= 1 micromhos per centimeter (µmhos/cm)

Appendix F

SUBAREA GOALS AND OBJECTIVES FOR AGENCIES WITHIN THE TURLOCK GROUNDWATER BASIN

MERCED COUNTY - DIVISION OF ENVIRONMENTAL HEALTH

GOALS AND OBJECTIVES

The Merced County Division of Environmental Health endeavors to protect the quantity and quality of groundwater in Merced County.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

Wellhead Protection Program

- Issues well permits for the construction of all new wells in Merced County; samples all new domestic wells for Coliform bacteria, nitrates, DBCP/EDB, and general mineral/inorganics.
- Collects water samples at customer request upon payment of fees.
- Enforces the Merced County Well Ordinance to insure proper well location, setback distances, and proper well construction for all wells in Merced County.
- Maintains a program to identify all possible sources of contamination that may threaten groundwater.
- Operates the small public water system program for all water systems with fewer than 200 service connections.
- Oversees the cleanup of leaking underground fuel storage tank sites.
- Operates the dairy/poultry animal confinement program; also operates the sludge management program, and the food processing waste program.
- Conducts water quality monitoring in areas where there is known contamination and water quality degradation.
- Responds to well emergencies such as floods, droughts, and other conditions which threaten the quality or quantity of drinking water.

Abandoned Well Destruction Program

- Issues well destruction permits for all inactive, inoperative, and abandoned wells in Merced County.
- Conducts a program to find, identify, and destroy old wells needing to be properly destroyed.

Other Activities

- Participates in, and supports, local efforts to protect the groundwater basins in Merced County, and adjacent counties where basins cross county lines.
- Serves as a resource for the general public (individuals and groups) to provide accurate information and some limited technical assistance in dealing with questions regarding water supply, wells, and related groundwater issues.

CITY OF HUGHSON

GOALS AND OBJECTIVES

In the General Plan adopted on December 12, 2005, the City set forth specific Policies, Goals and Actions relevant to groundwater management in the Turlock Subbasin. These elements are discussed in the following section.

Goal PSF-6

Provide sufficient water supplies and facilities to serve the City in the most efficient and financially-sound manner, while maintaining the highest standards required to enhance the quality of life for existing and future residents.

Goal PSF-6 Policies

- **Policy PSF-6.1:** The City will continue to expand its water treatment and distribution facilities to provide good quality drinking water to current and future residents and businesses. Expansion may include the construction of additional storage facilities and/or additional wells.
- **Policy PSF-6.2:** The potable water distribution and storage system shall be sized to serve development allowed by the General Plan and shall not provide for additional growth and development beyond that anticipated under the General Plan.
- **Policy PSF-6.3:** Planning for the water system will be limited to the city limits and the City's Sphere of Influence.
- **Policy PSF-6.4:** The City will start planning and implementing additional improvements necessary to provide adequate water supply and storage for future demand anticipated by the General Plan at least two years in advance of reaching the capacity of existing facilities.
- **Policy PSF-6.5:** The City should consider exploring the possibility of creating a regional water supply partnership to identify alternative regional water supplies.
- **Policy PSF-6.6:** The approval of development shall be conditioned on the availability of sufficient water supply, storage and pressure requirements for the City.
- **Policy PSF-6.7:** The City will require the installation of water lines to occur concurrently with construction of new roadways to maximize efficiency and minimize disturbance due to construction activity.

Goal PSF-6 Actions

- **Action PSF-6.1:** Continue to participate in regional groundwater basin planning efforts to determine the carrying capacity of the groundwater aquifer and ensure that future demand for water does not overdraft the groundwater supply.
- **Action PSF-6.2:** Develop and institute a City-sponsored program of mandatory water conservation measures for new development.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

The City of Hughson is in the process to completing system upgrades, including production, storage, distribution, SCADA, converting the city to AMR Water Metering and other elements, preparing to review and update the Water Master Plan, preparing for a treated surface water supply, adding another new well to the system, revisiting the process for determining adequate utility capacity in advance to development projects. The City of Hughson adopted a water waste control ordinance, and is revisiting the administrative citation process. Hughson also completed a water rate studying in 2005 and established (flat) rates, which will be reviewed again in conjunction with a fully metered system.

CITY OF TURLOCK

GOALS AND OBJECTIVES

The objective of the City of Turlock's groundwater program is to maintain the highest quality of water to meet all customers' needs while protecting health and property and providing a sufficient quantity of groundwater well into the future.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

- Closely monitor each potable water well to insure it meets or exceeds the water quality limits established by the EPA and State of California.
- Frequently test each well for nitrate and TDS data to determine if there is a trend that will result in a reduction of water quality.
- If a contaminant reaches 90% of the MCL for that compound at any well, initiate well head treatment, blending or other methods to insure the water leaving any well site does not exceed this limit.
- Check well water levels monthly to determine the status of underground water storage within the City. If the annual average static water levels are less than 40 feet msl for any three consecutive years, increase the mandated water conservation measures, i.e. go to Stage 2 from Stage 1.
- Maintain a strong City presence within the Turlock Groundwater Basin Association to encourage the replenishment and wise use of the basin's water resources.
- Within the next 10 years, find uses for all of the tertiary treated water produced by the Regional Water Quality Control Facility. This will reduce the need for groundwater extraction in the basin.
- By 2010, install water meters at all of the user connections in the water system and bill for actual water used.
- Find alternate water sources such as surface water to supplement local groundwater.
- Reduce extraction amounts at any well site where there is a trend of increasing TDS and/or nitrate.

CITY OF CERES

GOALS AND OBJECTIVES

- Insure that no constituents exceed the MCL for public drinking water.
- Insure a safe, sustainable supply of drinking water is available for the beneficial use of City of Ceres customers.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

- Monitor groundwater levels monthly.
- Monitor groundwater quality as required by the DHS.
- Manage the groundwater resource to prevent contamination from above ground sources.

EASTSIDE WATER DISTRICT

GOALS AND OBJECTIVES

The primary goal of the Eastside Water District (EWD) is that groundwater will continue to be a reliable, safe, efficient and cost effective water supply.

Groundwater is a vitally important resource to all irrigators within the EWD. In the decades between the 1950s and 1990s water levels dropped dramatically, in significant part, as a result of pumping within the EWD. Groundwater levels appeared to have stabilized by the 1990s. Studies in 2003 confirmed that the aquifer had reached equilibrium, but appear to have declined between 2002 and 2006. The EWD Board of Directors recognize that in future years land uses and groundwater uses may change with the results that groundwater levels may again decline and groundwater quality may be adversely impacted.

The EWD recognizes that the Turlock Groundwater Basin is a shared resource and that it is important for all users in the basin to continue to manage groundwater for the benefit of all.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

- **Water Levels:** Continue to participate in the Turlock Groundwater Basin Association water level monitoring program.
- **Water Quality:** Be alert to existing and changing agricultural and industrial activities within the EWD, which may adversely affect groundwater quality.
- **Conservation:** Continue to encourage irrigators to conserve groundwater by use of highly efficient irrigation methods and use of surface water purchased as available the Turlock and Merced Irrigation Districts.
- **Studies and Investigations:** Continue singularly and in cooperation with other agencies to study methods of avoiding and/or mitigating overdraft conditions.
- **Public Outreach:** Continue a program of public education, water conservation and awareness of basin groundwater issues.

CITY OF MODESTO

GOALS AND OBJECTIVES

Until 1995, the City of Modesto relied solely on groundwater for its service area. Groundwater degradation and more stringent drinking water quality standards resulted in the abandonment of a number of wells within the City of Modesto service area. Currently, Modesto is augmenting its groundwater supplies in its contingency service area north of the Tuolumne River with surface water received from Modesto Irrigation District. In addition, Modesto is also considering augmenting its water supply for its water service customers south of the Tuolumne River by participating in the development of a future regional surface water treatment facility with the Turlock Irrigation District.

In the meantime, however, groundwater quality issues, including elevated levels of uranium and arsenic, continue to threaten the City of Modesto's groundwater supply. To protect its groundwater and maintain groundwater as a viable drinking water source, Modesto has formulated the BMOs for its management area described below.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

Groundwater Quality Protection

The City of Modesto proposes to protect groundwater quality by developing and implementing specific actions to identify potential sources of contamination and to develop a management plan to control and curtail movement of contamination into and within the basin. The specific actions may include the following:

- Develop a database and populate it with water quality data. Using the database information, develop tools to map contaminated areas, as well as historic movement of the contaminants.
- Formulate and implement a geologic assessment to better understand the basin's aquifer characteristics and water movement and to evaluate and understand the sources of contaminants. Detect potential changes in water quality that could affect the long-term quality and quantity of the drinking water supply.
- Develop a well field management plan that will manage groundwater pumping to reduce or eliminate contaminate movement into and within the Basin. Develop well design criteria, including proper spacing and screening of wells to manage groundwater pumping and the movement of contaminants.

Groundwater Levels

Groundwater levels, historically, were declining in this management area. Since 1995, the importation of treated surface water to augment the groundwater supply has allowed the groundwater levels to recover north of the Tuolumne River. A proposed surface water supply may provide an opportunity for the recovery of the groundwater levels in the Turlock Subbasin. However, future population growth in and around the management area will increase groundwater consumption. To maintain groundwater levels in the management area, the City of Modesto formulated the following management objectives:

- Work with other entities in the subbasin to identify and protect potential groundwater recharge areas.
- Evaluate the feasibility of groundwater recharge and conjunctive use projects including the development of artificial recharge areas, conjunctive use projects, and storage tanks with transmission mains for added reliability to the system.
- Work with TID to evaluate the feasibility of developing a cooperative in-lieu recharge and/or water exchange programs including the following:
    - The use of surface water to augment the groundwater supply in the Turlock Subbasin.
    - Develop an exchange program to mix the groundwater of marginal quality (for drinking water) with surface water and deliver it for agricultural use, golf courses, parks, and other open space areas in exchange for a surface water supply for the City of Modesto.

Water Conservation and System Improvement

The City of Modesto, under its Urban Water Management Planning function, will continue to evaluate water conservation and metering opportunities to reduce water demands in the service area. Modesto also plans to undertake a conveyance system interconnection improvement project to connect isolated delivery systems to its delivery network. These actions will add flexibility to the system and enable the City of Modesto to reduce pumping from the areas of poor water quality and reduce movement of contaminants in the basin.

DENAIR COMMUNITY SERVICES DISTRICT

GOALS AND OBJECTIVES

The Denair Community Services District (CSD) is a community water system located in the unincorporated town of Denair approximately four miles northeast of Turlock, in central southern Stanislaus County.

The Denair CSD was formed on October 3, 1961 pursuant to California Government Code Section 61000, et. seq. The Denair CSD is under the regulatory jurisdiction of the Department of Health Services Stockton District Office. The Denair CSD has 1,250 non-metered active service connections and 10 commercial metered connections at various locations.

The Denair CSD has an approximate population of 3300 people, according to the 2000 census.

All of the water for Denair CSD is supplied from five deep wells. The Denair CSD has produced water, which continuously meets all State drinking water requirements. The objective of the Denair CSD is to maintain the highest quality of water to meet all customers' needs in the most efficient and financially sound manner.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

Funding

In September 2003, the Denair CSD was awarded a grant under the Local Groundwater Management Act of 2000 (AB 303) for $200,000.00.

With its AB 303 grant, Denair CSD constructed a nested monitoring (test) well. Information from this two test wells, and other existing wells, will be used to support advancement of a hydrogeologic model of the producing groundwater system and to monitor the quality and quantity of groundwater produced from the alluvial aquifer sequences underlying Denair CSD.

Groundwater Monitoring:

Denair CSD developed its groundwater management program in 2001 with the drilling of a test hole, subsurface interpretations of favorable aquifer sequences, and by creating formal guidelines for residential developers to use to construct Denair CSD-required test and monitoring wells. Due to inadequate funding, Denair CSD's program is currently limited to residential developers' activities.

Proponents of residential development in 2002 recently constructed a nesting monitoring well. This well was the first one constructed to meet the guidelines established by the Denair CSD as part of its groundwater management program.

The Denair CSD provides proponents of residential development with guidelines for nesting monitoring well construction. Denair CSD then approves or disapproves of the test well results before a production well is planned and constructed. These test wells are required by Denair CSD. Funding is also needed for Denair CSD to advance the characterization and test well program in areas where residential development is not currently underway.

DELHI COUNTY WATER DISTRICT

GOALS AND OBJECTIVES

- Maintain water quality that meets all Federal and State requirements.
- Provide and plan for an adequate amount of water to meet existing and projected future demands.
- Research methods which can help conserve water.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

- Monitor each well to insure that its water meets or exceeds all State and Federal requirements.
- Check standing and pumping water levels on a regular basis to establish trends in groundwater levels.
- The Delhi County Water District meters all users. This has had a tremendous effect in conserving water supplies and eliminating waste.

KEYES COMMUNITY SERVICES DISTRICT

GOALS AND OBJECTIVES

- Maintain water quality that meets all Federal and State requirements.
- Provide and plan for an adequate amount of water to meet existing and projected future demands.
- Determine the feasibility of using treated surface water in conjunction with well water.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

- Monitor each well to insure that its water meets or exceeds all State and Federal requirements.
- Check standing and pumping water levels on a regular basis to establish trends in the groundwater levels.
- Install water meters in the next few years to lower water usage. The installation of meters in other communities of this size has resulted in water savings of 20 to 30 percent. A reduction in water usage is needed to lessen the impact on groundwater levels and to reduce the amount of water that is treated for arsenic.
- Continue studies to determine the best method to remove arsenic from the well water. All four of the Keyes CSD's wells have arsenic levels that exceed the new Federal MCL of 10 ppb. Arsenic levels vary roughly between 12 to 20 ppb.

HILMAR COUNTY WATER DISTRICT

GOALS AND OBJECTIVES

The Hilmar County Water District (HCWD) was established in 1965 under Division 12 of the Water Code of the State of California for the purpose of providing potable water to the residents of the Hilmar community. The HCWD also provides wastewater collection and treatment for the community. The objective of the HCWD is "to provide safe, affordable and reliable drinking water, wastewater, and storm drainage service".

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

- Closely monitor each potable water well to insure compliance with all water quality standards as established by the EPA and the State of California.
- HCWD's customer base is fully metered and conservation pricing is in place to encourage wise use of our water resource.
- Continued participation in the Turlock Groundwater Basin Association.

BALLICO COMMUNITY SERVICES DISTRICT

GOALS AND OBJECTIVES

The Ballico CSD is a community water system located in the unincorporated town of Ballico in central northern Merced County. The Ballico CSD water system consists of one well and a distribution system to serve approximately 50 residential connections. The objective of the Ballico CSD is to provide safe, affordable and reliable drinking water service.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

The Ballico CSD will closely monitor the water well to insure compliance with all water quality standards as established by the EPA and the State of California.

BALLICO-CORTEZ WATER DISTRICT

GOALS AND OBJECTIVES

The primary goal of the Ballico Cortez Water District (BCWD) is that groundwater will continue to be a reliable, safe, efficient and effective water supply.

Groundwater is a vitally important resource to all irrigators within the BCWD. In the decades between the 1950s and 1990s water levels dropped as a result of basin-wide pumping. Groundwater levels appeared to have stabilized by the 1990s. Studies in 2003 confirmed that the aquifer had reached equilibrium, but appear to have declined between 2002 and 2006. The Board of Directors recognize that in future years land uses and groundwater uses may change with the results that groundwater levels may again decline and groundwater quality may be adversely impacted.

The BCWD recognizes that the Turlock Groundwater Basin is a shared resource and that it is important for all users in the basin to continue to manage groundwater for the benefit of all.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

- **Water levels:** Continue to participate in the Turlock Groundwater Basin Association water level monitoring program.
- **Water Quality:** Be alert to existing and changing agricultural and industrial activities within the BCWD, which may adversely affect groundwater quality.
- **Conservation:** Continue to encourage irrigators to conserve groundwater by use of highly efficient irrigation methods and use of surface water purchased as available from Turlock Irrigation District.
- **Studies and Investigations:** Continue singularly and in cooperation with other agencies to study methods of avoiding and/or mitigating overdraft conditions.
- **Public Out reach:** Continue a program of public education, water conservation and awareness of basin groundwater issues.

TURLOCK IRRIGATION DISTRICT

GOALS AND OBJECTIVES

The Turlock Irrigation District (TID) utilizes groundwater and surface water conjunctively. As such, it relies upon groundwater as a source of water in drier years, when surface water supplies are less abundant. The TID endeavors to protect the quantity and quality of groundwater in its irrigation service area, such that:

- Groundwater will continue to be a reliable, safe, efficient and cost effective water supply.
- Groundwater provides a high quality water supply to irrigation customers.

The TID recognizes that the Turlock Groundwater Basin is a shared resource and that it is important for all users in the basin to continue to manage groundwater for the benefit of all.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

Water Levels

- Continue to participate in the Turlock Groundwater Basin Association water level monitoring program.
- Continue to monitor shallow groundwater levels located at section corners.
- Continue to provide drainage, as appropriate, so long as it is in accordance with the TID rules and procedures, as well as the changing water quality regulatory requirements.

Water Quality

- Be alert to existing and changing activities within the Turlock Groundwater Basin which may adversely affect groundwater quality.
- Continue to monitor changes to regulatory requirements, and provide comments, as necessary, in these processes.
- Adjust practices, as necessary, to comply with regulatory requirements.

Conservation

- Continue to encourage the use of surface water supplies for irrigation purposes within the District.
- Support urban agencies' use of surface water supplies, where available, from the TID, in addition to or in lieu of groundwater, for urban uses.
- Continue to participate in the Agricultural Water Management Council, and maintain the TID Agricultural Water Management Plan.

Studies and Investigations

- Continue to study, both individually and collectively with other agencies, methods for protecting and preserving the quantity and quality of groundwater supplies within the Basin including:
  - avoiding and/or mitigating overdraft conditions;
  - groundwater quality and means of addressing water quality issues;
  - future water supply needs and availability;
  - water supply for urban uses; and
  - river interactions and the affects upon the groundwater basin.

Public Outreach

- Continue to provide public education on water related issues including, but not limited to, water conservation and awareness of basin groundwater issues.
- Continue participation in the Turlock Groundwater Basin Association.

MERCED IRRIGATION DISTRICT

GOALS AND OBJECTIVES

The Merced Irrigation District (Merced ID) shares the common goal of protecting the quantity and quality of groundwater within the Turlock Groundwater Basin. The Merced ID will continue to cooperate with other agencies in the Turlock Groundwater Basin to promote the efficient use of water. The main objective of participation in the TGBA is to attain stable groundwater levels and a reliable water supply.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

- Participate in the Turlock Groundwater Basin Association water level monitoring program.
- Provide an incentive program for Merced ID water users to use surface water instead of groundwater.
- Participate in Turlock Groundwater Basin Association activities.

STANISLAUS COUNTY

GOALS AND OBJECTIVES

The County of Stanislaus is represented by the Department of Environmental Resources (DER) at TGBA meetings. Partnering with the TGBA in basin-wide groundwater management is consistent with the Stanislaus County Board of Supervisors' priority of ensuring a safe and healthy community, facilitating economic development, and achieving multi jurisdictional cooperation. To meet these priorities, Stanislaus County promotes and participates in TGBA programs that:

- Preserve and protect the groundwater resource;
- Enhance the understanding of groundwater resources through the gathering and sharing of information; and
- Provide factual information that may serve as a basis for land use decisions in the groundwater basin.

ACTIVITIES CONDUCTED TO SUPPORT THESE OBJECTIVES

Public and Private Water Programs

- Issue well permits for the construction of all new wells in the unincorporated areas.
- Enforce the California Model Well Ordinance to insure proper well location, setback distances, and proper well construction for all wells.
- Serve as the Local Primacy Agency for the Stanislaus County small public water system program (water systems with fewer than 200 service connections).
- Oversee the cleanup of leaking underground fuel storage tank sites.
- Respond to water related emergencies such as floods, droughts, and other conditions which threaten the quality or quantity of drinking water.
- Issue well destruction permits for and makes inspections of abandoned wells.
- Conduct a program to inventory water wells and potential sources of contamination.

Other Activities

- Participate in, and supports, local efforts to protect the groundwater basins in Stanislaus County, and adjacent counties.
- Serve as a resource for the general public (individuals and groups) to provide accurate information and technical assistance in dealing with questions regarding water supply, wells, and related groundwater issues.
- Review and comments on land use activities that may impact groundwater resources.
- Review and comments on environmental studies for projects that may impact groundwater and surface water resources.

Appendix G

LIST OF AGENCIES THAT HAVE ADOPTED THE TURLOCK GROUNDWATER BASIN GROUNDWATER MANAGEMENT PLAN AND COPIES OF THE ACTIONS TAKEN TO ADOPT THE PLAN

Appendix H

GROUNDWATER MANAGEMENT RELATED CALIFORNIA WATER CODE SECTIONS

PART 2.75. GROUNDWATER MANAGEMENT (CALIFORNIA WATER CODE SECTION 10750 ET SEQ.)

Chapter	Title	Section(s)
1	General Provisions	10750-70750.1
2	Definitions	10752
3	Groundwater Management Plans	10753-10753.1
4	Finances	10754-10754.3
5	Miscellaneous	10755-10755.4

Chapter 1. General Provisions

10750.
(a) The Legislature finds and declares that groundwater is a valuable natural resource in California, and should be managed to ensure both its safe production and its quality. It is the intent of the Legislature to encourage local agencies to work cooperatively to manage groundwater resources within their jurisdictions.

(b) The Legislature also finds and declares that additional study of groundwater resources is necessary to better understand how to manage groundwater effectively to ensure the safe production, quality, and proper storage of groundwater in this state.

10750.2.
(a) Subject to subdivision (b), this part applies to all groundwater basins in the state.

(b) This part does not apply to any portion of a groundwater basin that is subject to groundwater management by a local agency or a watermaster pursuant to other provisions of law or a court order, judgment, or decree, unless the local agency or watermaster agrees to the application of this part.

10750.4.
Nothing in this part requires a local agency overlying a groundwater basin to adopt or implement a groundwater management plan or groundwater management program pursuant to this part.

10750.6.
Nothing in this part affects the authority of a local agency or a watermaster to manage groundwater pursuant to other provisions of law or a court order, judgment, or decree.

10750.7.
(a) A local agency may not manage groundwater pursuant to this part within the service area of another local agency, a water corporation regulated by the Public Utilities Commission, or a mutual water company without the agreement of that other entity.

(b) This section applies only to groundwater basins that are not critically overdrafted.

10750.8.
(a) A local agency may not manage groundwater pursuant to this part within the service area of another local agency without the agreement of that other entity.

(b) This section applies only to groundwater basins that are critically overdrafted.

10750.9.
(a) A local agency that commences procedures, prior to January 1, 1993, to adopt an ordinance or resolution to establish a program for the management of groundwater pursuant to Part 2.75 (commencing with Section 10750), as added by Chapter 903 of the Statutes of 1991, may proceed to adopt the ordinance or resolution pursuant to Part 2.75, and the completion of those procedures is deemed to meet the requirements of this part.

(b) A local agency that has adopted an ordinance or resolution pursuant to Part 2.75 (commencing with Section 10750), as added by Chapter 903 of the Statutes of 1991, may amend its groundwater management program by ordinance or resolution of the governing body of the local agency to include any of the plan components set forth in Section 10753.7.

10750.10.
This part is in addition to, and not a limitation on, the authority granted to a local agency pursuant to other provisions of law.

Chapter 2. Definitions

10752.
Unless the context otherwise requires, the following definitions govern the construction of this part:

(a) "Groundwater" means all water beneath the surface of the earth within the zone below the water table in which the soil is completely saturated with water, but does not include water which flows in known and definite channels.

(b) "Groundwater basin" means any basin identified in the department's Bulletin No. 118, dated September 1975, and any amendments to that bulletin, but does not include a basin in which the average well yield, excluding domestic wells that supply water to a single-unit dwelling, is less than 100 gallons per minute.

(c) "Groundwater extraction facility" means any device or method for the extraction of groundwater within a groundwater basin.

(d) "Groundwater management plan" or "plan" means a document that describes the activities intended to be included in a groundwater management program.

(e) "Groundwater management program" or "program" means a coordinated and ongoing activity undertaken for the benefit of a groundwater basin, or a portion of a groundwater basin, pursuant to a groundwater management plan adopted pursuant to this part.

(f) "Groundwater recharge" means the augmentation of groundwater, by natural or artificial means, with surface water or recycled water.

(g) "Local agency" means any local public agency that provides water service to all or a portion of its service area, and includes a joint powers authority formed by local public agencies that provide water service.

(h) "Recharge area" means the area that supplies water to an aquifer in a groundwater basin and includes multiple wellhead protection areas.

(i) "Watermaster" means a watermaster appointed by a court or pursuant to other provisions of law.

(j) "Wellhead protection area" means the surface and subsurface area surrounding a water well or well field that supplies a public water system through which contaminants are reasonably likely to migrate toward the water well or well field.

Chapter 3. Groundwater Management Plans

10753.
(a) Any local agency, whose service area includes a groundwater basin, or a portion of a groundwater basin, that is not subject to groundwater management pursuant to other provisions of law or a court order, judgment, or decree, may, by ordinance, or by resolution if the local agency is not authorized to act by ordinance, adopt and implement a groundwater management plan pursuant to this part within all or a portion of its service area.

(b) Notwithstanding subdivision (a), a local public agency, other than an agency defined in subdivision (g) of Section 10752, that provides flood control, groundwater management, or groundwater replenishment, or a local agency formed pursuant to this code for the principal purpose of providing water service that has not yet provided that service, may exercise the authority of this part within a groundwater basin that is located within its boundaries within areas that are either of the following:

(1) Not served by a local agency.

(2) Served by a local agency whose governing body, by a majority vote, declines to exercise the authority of this part and enters into an agreement with the local public agency pursuant to Section 10750.7 or 10750.8.

10753.1.
Nothing in this part, or in any groundwater management plan adopted pursuant to this part, affects surface water rights or the procedures under common law or local groundwater authority, or any provision of law other than this part that determines or grants surface water rights.

10753.2.
(a) Prior to adopting a resolution of intention to draft a groundwater management plan, a local agency shall hold a hearing, after publication of notice pursuant to Section 6066 of the Government Code, on whether or not to adopt a resolution of intention to draft a groundwater management plan pursuant to this part for the purposes of implementing the plan and establishing a groundwater management program.

(b) At the conclusion of the hearing, the local agency may draft a resolution of intention to adopt a groundwater management plan pursuant to this part for the purposes of implementing the plan and establishing a groundwater management program.

10753.3.
(a) After the conclusion of the hearing, and if the local agency adopts a resolution of intention, the local agency shall publish the resolution of intention in the same manner that notice for the hearing held under Section 10753.2 was published.

(b) Upon written request, the local agency shall provide any interested person with a copy of the resolution of intention.

10753.4.
(a) The local agency shall prepare a groundwater management plan within two years of the date of the adoption of the resolution of intention. If the plan is not adopted within two years, the resolution of intention expires, and no plan may be adopted except pursuant to a new resolution of intention adopted in accordance with this chapter.

(b) For the purposes of carrying out this part, the local agency shall make available to the public a written statement describing the manner in which interested parties may participate in developing the groundwater management plan. The local agency may appoint, and consult with, a technical advisory committee consisting of interested parties for the purposes of carrying out this part.

10753.5.
(a) After a groundwater management plan is prepared, the local agency shall hold a second hearing to determine whether to adopt the plan. Notice of the hearing shall be given pursuant to Section 6066 of the Government Code. The notice shall include a summary of the plan and shall state that copies of the plan may be obtained for the cost of reproduction at the office of the local agency.

(b) At the second hearing, the local agency shall consider protests to the adoption of the plan. At any time prior to the conclusion of the second hearing, any landowner within the local agency may file a written protest or withdraw a protest previously filed.

10753.6.
(a) A written protest filed by a landowner shall include the landowner's signature and a description of the land owned sufficient to identify the land. A public agency owning land is deemed to be a landowner for the purpose of making a written protest.

(b) The secretary of the local agency shall compare the names and property descriptions on the protest against the property ownership records of the county assessors.

(c) (1) A majority protest shall be determined to exist if the governing board of the local agency finds that the protests filed and not withdrawn prior to the conclusion of the second hearing represent more than 50 percent of the assessed value of the land within the local agency subject to groundwater management pursuant to this part.
(2) If the local agency determines that a majority protest exists, the groundwater plan may not be adopted and the local agency shall not consider adopting a plan for the area proposed to be included within the program for a period of one year after the date of the second hearing.
(3) If a majority protest has not been filed, the local agency, within 35 days after the conclusion of the second hearing, may adopt the groundwater management plan.

10753.7.
(a) For the purposes of qualifying as a groundwater management plan under this section, a plan shall contain the components that are set forth in this section. In addition to the requirements of a specific funding program, any local agency seeking state funds administered by the department for the construction of groundwater projects or groundwater quality projects, excluding programs that are funded under Part 2.78 (commencing with Section 10795), shall do all of the following:
(1) Prepare and implement a groundwater management plan that includes basin management objectives for the groundwater basin that is subject to the plan. The plan shall include components relating to the monitoring and management of groundwater levels within the groundwater basin, groundwater quality degradation, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping in the basin.
(2) For the purposes of carrying out paragraph (1), the local agency shall prepare a plan to involve other agencies that enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin.
(3) For the purposes of carrying out paragraph (1), the local agency shall prepare a map that details the area of the groundwater basin, as defined in the department's Bulletin No. 118, and the area of the local agency, that will be subject to the plan, as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a groundwater management plan.

(4) The local agency shall adopt monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater pumping in the basin. The monitoring protocols shall be designed to generate information that promotes efficient and effective groundwater management.
(5) Local agencies that are located in areas outside the groundwater basins delineated on the latest edition of the department's groundwater basin and subbasin map shall prepare groundwater management plans incorporating the components in this subdivision, and shall use geologic and hydrologic principles appropriate to those areas.

(b) (1)

(A) A local agency may receive state funds administered by the department for the construction of groundwater projects or for other projects that directly affect groundwater levels or quality if it prepares and implements, participates in, or consents to be subject to, a groundwater management plan, a basinwide management plan, or other integrated regional water management program or plan that meets, or is in the process of meeting, the requirements of subdivision (a). A local agency with an existing groundwater management plan that meets the requirements of subdivision (a), or a local agency that completes an upgrade of its plan to meet the requirements of subdivision (a) within one year of applying for funds, shall be given priority consideration for state funds administered by the department over local agencies that are in the process of developing a groundwater management plan. The department shall withhold funds from the project until the upgrade of the groundwater management plan is complete.

(B) Notwithstanding subparagraph (A), a local agency that manages groundwater under any other provision of existing law that meets the requirements of subdivision (a), or that completes an upgrade of its plan to meet the requirements of subdivision (a) within one year of applying for funding, shall be eligible for funding administered by the department. The department shall withhold funds from a project until the upgrade of the groundwater management plan is complete.

(C) Notwithstanding subparagraph (A), a local agency that conforms to the requirements of an adjudication of water rights in the groundwater basin is in compliance with subdivision (a). For purposes of this section, an "adjudication" includes an adjudication under Section 2101, an administrative adjudication, and an adjudication in state or federal court.

(D) Subparagraphs (A) and (B) do not apply to proposals for funding under Part 2.78 (commencing with Section 10795), or to funds authorized or appropriated prior to September 1, 2002.

(2) Upon the adoption of a groundwater management plan in accordance with this part, the local agency shall submit a copy of the plan to the department, in an electronic

format, if practicable, approved by the department. The department shall make available to the public copies of the plan received pursuant to this part.

10753.8.

A groundwater management plan may include components relating to all of the following:

(a) The control of saline water intrusion.
(b) Identification and management of wellhead protection areas and recharge areas.
(c) Regulation of the migration of contaminated groundwater.
(d) The administration of a well abandonment and well destruction program.
(e) Mitigation of conditions of overdraft.
(f) Replenishment of groundwater extracted by water producers.
(g) Monitoring of groundwater levels and storage.
(h) Facilitating conjunctive use operations.
(i) Identification of well construction policies.
(j) The construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
(k) The development of relationships with state and federal regulatory agencies.
(l) The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

10753.9.

(a) A local agency shall adopt rules and regulations to implement and enforce a groundwater management plan adopted pursuant to this part.
(b) Nothing in this part shall be construed as authorizing the local agency to make a binding determination of the water rights of any person or entity.
(c) Nothing in this part shall be construed as authorizing the local agency to limit or suspend extractions unless the local agency has determined through study and investigation that groundwater replenishment programs or other alternative sources of water supply have proved insufficient or infeasible to lessen the demand for groundwater.

10753.10.

In adopting rules and regulations pursuant to Section 10753.9, the local agency shall consider the potential impact of those rules and regulations on business activities, including agricultural operations, and to the extent practicable and consistent with the protection of the groundwater resources, minimize any adverse impacts on those business activities.

Chapter 4. Finances

10754.

For purposes of groundwater management, a local agency that adopts a groundwater management plan pursuant to this part has the authority of a water replenishment district pursuant to Part 4 (commencing with Section 60220) of Division 18 and may fix and collect fees

and assessments for groundwater management in accordance with Part 6 (commencing with Section 60300) of Division 18.

10754.2.

(a) Subject to Section 10754.3, except as specified in subdivision (b), a local agency that adopts a groundwater management plan pursuant to this part, may impose equitable annual fees and assessments for groundwater management based on the amount of groundwater extracted from the groundwater basin within the area included in the groundwater management plan to pay for costs incurred by the local agency for groundwater management, including, but not limited to, the costs associated with the acquisition of replenishment water, administrative and operating costs, and costs of construction of capital facilities necessary to implement the groundwater management plan.

(b) The local agency may not impose fees or assessments on the extraction and replacement of groundwater pursuant to a groundwater remediation program required by other provisions of law or a groundwater storage contract with the local agency.

10754.3.

Before a local agency may levy a water management assessment pursuant to Section 10754.2 or otherwise fix and collect fees for the replenishment or extraction of groundwater pursuant to this part, the local agency shall hold an election on the proposition of whether or not the local agency shall be authorized to levy a groundwater management assessment or fix and collect fees for the replenishment or extraction of groundwater. The local agency shall be so authorized if a majority of the votes cast at the election is in favor of the proposition. The election shall be conducted in the manner prescribed by the laws applicable to the local agency or, if there are no laws so applicable, then as prescribed by laws relating to local elections. The election shall be conducted only within the portion of the jurisdiction of the local agency subject to groundwater management pursuant to this part.

Chapter 5. Miscellaneous

10755.

(a) If a local agency annexes land subject to a groundwater management plan adopted pursuant to this part, the local agency annexing the land shall comply with the groundwater management plan for the annexed property.

(b) If a local agency subject to a groundwater management plan adopted pursuant to this part annexes land not subject to a groundwater management plan adopted pursuant to this part at the time of annexation, the annexed territory shall be subject to the groundwater management plan of the local agency annexing the land.

10755.2.

(a) It is the intent of the Legislature to encourage local agencies, within the same groundwater basin, that are authorized to adopt groundwater management plans pursuant to this part, to adopt and implement a coordinated groundwater management plan.

(b) For the purpose of adopting and implementing a coordinated groundwater management program pursuant to this part, a local agency may enter into a joint powers agreement pursuant to Chapter 5 (commencing with Section 6500) of Division 7 of Title 1 of the Government Code with public agencies, or a memorandum of understanding with public or private entities providing water service.

(c) A local agency may enter into agreements with public entities or private parties for the purpose of implementing a coordinated groundwater management plan.

10755.3.

Local agencies within the same groundwater basin that conduct groundwater management programs within that basin pursuant to this part, and cities and counties that either manage groundwater pursuant to this part or have ordinances relating to groundwater within that basin, shall, at least annually, meet to coordinate those programs.

10755.4.

Except in those groundwater basins that are subject to critical conditions of groundwater overdraft, as identified in the department's Bulletin 118-80, revised on December 24, 1982, the requirements of a groundwater management plan that is implemented pursuant to this part do not apply to the extraction of groundwater by means of a groundwater extraction facility that is used to provide water for domestic purposes to a single-unit residence and, if applicable, any dwelling unit authorized to be constructed pursuant to Section 65852.1 or 65852.2 of the Government Code.

THE TURLOCK IRRIGATION DISTRICT
IRRIGATION RULES

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I. RULES FOR THE DISTRIBUTION AND USE OF WATER WITHIN THE TURLOCK IRRIGATION DISTRICT

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RULES FOR DISTRIBUTION AND USE OF WATER WITHIN THE TURLOCK IRRIGATION DISTRICT

PREAMBLE

These rules are established pursuant to Water Code Section 22257 to ensure the orderly, efficient, and equitable distribution, use and conservation of the water resources of the District. The District will endeavor to deliver irrigation water in a flexible, timely manner consistent with the physical and operational limits of the delivery system facilities.

The masculine, feminine, or neuter gender and the singular or plural number shall each include the others whenever the context so indicates.

SECTION 1: DEFINITIONS

As used herein, the following words, whether or not initially capitalized, shall have the following meanings:

"Conduits" includes canals, laterals, ditches, drains, flumes, pipes, measurement and control devices, and all related operational facilities.

"District" means the TURLOCK IRRIGATION DISTRICT functioning under Irrigation District Laws of the California Water Code.

"District Conduits" mean conduits owned or leased by the District but do not include improvement district conduits.

"District Facilities" includes dams, structures, wells, conduits, pumps, power plants, reservoirs, and all other facilities of the District, but does not include improvement district facilities.

"Improvement District Facilities" include conduits, pumps, wells, structures, and other facilities owned by an improvement district.

"Irrigable" means all parcels that irrigate and all those parcels greater than one acre with or without on farm irrigation facilities that could be irrigated by either District supplies or from private wells.

"General Manager" means the General Manager or his authorized representative.

"Irrigator" means the landowner or tenant of a parcel of land who has the primary responsibility for irrigating the parcel. The term includes the irrigator's officers, employees and agents.

"Landowner" means holder of title or evidence of title to land.

"Pollutant" means any foreign or deleterious substance or material including, but not limited to, garbage, rubbish, refuse, animal carcasses, matter from any barnyard, stable, dairy or hog pen, herbicides, pesticides, or any other material which is offensive to the senses or injurious to health, or which contaminates or degrades the quality of the receiving water as defined by federal, state or local law.

"Standby" means a charge for services, such as drainage, groundwater management, storm water, etc., assessed against all parcels that irrigate and those parcels greater than one acre outside community or municipal water district boundaries that are irrigable.

"Tenant" means a person or entity who leases, rents, or sharecrops land from a landowner.

"Vehicle" means any motor vehicle, self propelled vehicle, motorcycle, motorized bicycle, or all terrain vehicle.

"Water, additional," means water that is only available to lands served by District drainage pumps or pumps under contract to the District.

"Water Allotment" means the base quantity of water, which is set annually by the TID Board of Directors for each acre of land within the District that can receive District water from District facilities directly or through improvement district or private facilities and which comply with these rules.

"Water, available," means the quantity of water above the water allotment that is made available to each acre of land within the District that can receive District water.

SECTION 2: FACILITIES

2.1 CONTROL OF THE SYSTEM:

District facilities are under the exclusive control and management of the TID Board of Directors, and its authorized agents. No other persons shall have any right to operate or interfere with said system in any manner.

2.2 ACCESS TO LANDS:

Every District director, employee, or authorized agent or representative shall have free access with appropriate vehicle or equipment at all times (including weekends and holidays) to enter any land irrigated with District water or occupied with District or improvement district facilities for any of the following purposes: (1) inspecting District, improvement district, or private irrigation facilities, the flow of water within the facilities (including measurement), and the use of water on the land; (2) determining the acreage of crops irrigated or to be irrigated; and (3) maintaining or operating District or improvement district facilities.

2.3 ENCROACHMENTS:

2.3.1 No trees, vines, shrubs, corrals, fences, or any other type of encroachment shall be planted, or placed in, on, over, or across any District or improvement district conduit or any District right-of-way unless the District has given specific written approval for such encroachment.

2.3.2 Any unauthorized encroachment may be removed by the District at the expense of the encroacher.

2.3.3 Encroachments on an improvement district right-of-way that interferes with the operation or maintenance of that facility may be removed by the District at the expense of the encroacher.

2.4 CONSTRUCTION OF IRRIGATION FACILITIES:

2.4.1 No diverting gates, weirs, structures, or pump intakes shall be constructed or placed in any District conduit until an application in writing has been made to the TID Board of Directors and permission granted therefore.

2.4.2 All such permitted gates, weirs, structures, or pump intakes shall be at the irrigator's expense, built to current District Construction and Engineering Design Standards as adopted by the TID Board of Directors, and shall become the property of the District upon completion.

2.5 CONSTRUCTION OF NON-IRRIGATION FACILITIES:

2.5.1 No improvements or installations such as buildings, bridges, gates, fences, cables, pipes, or other facilities, shall be constructed or placed in, on, over, across or along any District conduit or right-of-way until an application for a Revocable License Agreement has been made to the District and the TID Board of Directors authorization is granted therefore. The applicant does not acquire any rights in the District's right-of-way other than those set forth in the Revocable License Agreement.

2.5.2 All such permitted bridges, gates, fences, cables, pipes or other facilities shall be constructed, erected, installed, and maintained at the irrigator's expense and built to District Construction and Engineering Design Standards.

2.6 MAINTENANCE OF IMPROVEMENT DISTRICT FACILITIES:

2.6.1 Maintenance of improvement district facilities, shall be governed by the current Governing Rules of the Turlock Irrigation District Improvement Districts, Rules for the Formation and Operation of Pump Improvement Districts and the Rules for the Formation and Operation of Subsurface Drainage Improvement Districts adopted by the TID Board of Directors.

2.6.2 Improvement district facilities may be cleaned or repaired by the District at the improvement district's expense when the District determines such action is necessary.

2.6.3 Maintenance and repair of irrigation valves on District or improvement district facilities are the responsibility of the property owner.

SECTION 3: OPERATION OF IRRIGATION SYSTEM FACILITIES

3.1 LIMITS OF LIABILITY:

3.1.1 The District will not be liable for damage of any kind or nature resulting directly or indirectly from any private or improvement district ditch or conduit or the water flowing therein, or for negligent, wasteful, or other use or handling of water by the users thereof.

3.1.2 The District's responsibility shall absolutely cease when the water leaves the sidegate from a District conduit onto the irrigator's land or into a private conduit or improvement district facility.

3.2 CONTROL OF GATES:

3.2.1 The District's employees have sole right and responsibility to open any sidegate from a District conduit, and they have the exclusive responsibility to close such gate. The Water Distribution Operator may make arrangements with an irrigator allowing the irrigator to operate a sidegate during the period the irrigator is scheduled to receive water.

3.2.2 Any irrigator or group of irrigators may lock their sidegate(s) from the District facilities with prior written permission of the District.

3.2.3 The District may lock or require an irrigator to seal or remove, at their sole expense, a sidegate, turnout gate, or other valve where service from that facility is no longer desired, required by the irrigator, or subject to vandalism.

3.2.4 All turnouts from District facilities shall be gated or have another positive shut-off system easily accessible to the Water Distribution Operator within the District right-of-way.

3.3 USE OF CANAL BANK ROADS:

3.3.1 Use of District canal bank roads and rights-of-way is at the sole risk of the user. The District reserves its rights to limit the public and private use of its canal bank roads and rights-of-way.

3.3.2 No person shall drive any vehicle upon any District canal bank road or right-of-way unless such person has received permission from the District to drive upon such road or right-of-way.

3.3.3 The following persons have permission to drive a vehicle upon a District canal bank road or right-of-way:

3.3.3.1 Any District director, officer, employee, or agent in the discharge of their duties.

3.3.3.2 Private parties actively involved with farming a parcel of land adjacent to the specific District canal bank road or right-of-way, or which require the use of a specific District canal bank road or right-of-way for access to irrigation facilities serving that parcel of land.

3.3.3.3 Any sheriff, police, fire, or public safety personnel on official business.

3.3.3.4 Any District contractor who needs to use a specific District canal bank road or right-of-way to perform work under their contract with the District.

3.3.4 The General Manager is authorized to adopt regulations setting forth the procedure for other persons to obtain permission to drive a vehicle on specific District canal bank roads or rights-of-way.

3.4 INTERFERENCE WITH DISTRICT FACILITIES:

3.4.1 Any interference with or damage to any District or improvement district facility, or the banks of any District or improvement district conduit is prohibited.

3.4.2 Except for authorized District employees, agents and representatives, and persons authorized under these rules, no person shall be permitted to do any of the following:

3.4.2.1 To attach or place any boards, ropes, or any other object to, on or upon any District or improvement district facility;

3.4.2.2 To place or remove a weir board in a weir or drop;

3.4.2.3 To be on any counter weight, cable, or any parts of an automatic gate;

3.4.2.4 To remove any chain, board, post, or gate placed on or across any canal bank road of the District.

3.4.3 Any interference with or damage to District facilities by pedestrians, livestock, vehicles, parking of vehicles, or obstructions placed thereon is forbidden. Costs for repair of damages to District facilities shall be borne by the party causing said damage or obstruction.

3.5 PUBLIC USE OF CONDUITS:

District conduits shall be used solely for the authorized purposes of the District, including conveying irrigation water for use on land and for conveying drainage water away from the land. The use of District conduits for any other purpose requires prior authorization by the District and shall be at the sole risk of the user.

3.6 PUMPING FROM CONDUITS:

3.6.1 All landowners or irrigators who pump from District conduits for the purpose of irrigating lands shall be governed in all respects by the rules and regulations applicable to landowners under gravity service, except system design flows.

3.6.2 The District shall not be responsible for any trash or debris that may flow or accumulate in the water, or for any interference with or change in the operation or capacity of any private pump installations, pipelines or irrigation systems.

3.7 DISTRICT DRAINAGE WELLS AND PUMPS:

3.7.1 District drainage pumping plants are not installed to reclaim individual acreage.

3.7.2 The District, within its sole discretion, shall determine the times (if any) to run a District owned drainage pump depending on, certain operating criteria, including but not limited to, facility maintenance, the groundwater level in the vicinity of the pump, available gravity irrigation supply, available canal capacity, peak power load, or quality of the water being pumped.

3.7.3 The water pumped from any District well shall be subject to all the rules and regulations governing the use of gravity water.

3.7.4 All District pumps are to be operated by District personnel only.

3.7.5 Existing deliveries of water being made to irrigators directly from District drainage pumps will be honored only as long as the pump and pipeline are needed for drainage. No new connections will be permitted.

SECTION 4: DUTIES OF IRRIGATOR

4.1 IRRIGATOR RESPONSIBILITIES:

4.1.1 When water is made available to an irrigator by the District's Water Distribution Operator, the irrigator must have a responsible person present, and the land to be irrigated must be properly prepared to efficiently take the water.

4.1.2 From the time delivery of water is commenced to the completion of irrigation, the irrigator shall, day and night, attend and control the water.

4.1.3 When water is delivered to the irrigator, the irrigator shall be responsible for the water at all times after it leaves the District conduit.

4.1.4 The irrigator is responsible and liable for any damage caused by the irrigator's negligence or careless use of water, or the result of failure of the irrigator to properly operate or maintain any ditch, pipeline, or other facility for which the irrigator is wholly or partially responsible.

4.1.5 It is the irrigator's responsibility to close all of the irrigator's private valves at the end of each irrigation.

4.1.6 It is the irrigator's responsibility to clear the common facilities by opening stopgates and closing sidegates, unless directed otherwise by rules of that distribution system.

4.1.7 It is the irrigator's responsibility to call the next irrigator in line and inform them in a timely manner that they are going to receive the water. It is also the irrigator's responsibility to call their Water Distribution Operator immediately after the irrigation to report irrigation times on and off. Irrigation time may be estimated by the Water Distribution Operator, if the irrigator does not call in a timely manner.

4.2 WASTE OF WATER:

4.2.1 All water must be applied efficiently and used in a reasonable and beneficial manner.

4.2.2 Any irrigator who wastes water on roads, vacant land, or land previously irrigated, either willfully, carelessly, or on account of defective or inadequate conduits or facilities, or inadequately prepared land, or who floods a portion of the land to an unreasonable depth or amount in order to irrigate other portions, or floods across one parcel to irrigate another parcel, may be refused District water until such conditions are remedied.

4.3 MAINTENANCE OF FACILITIES:

4.3.1 All private or improvement district conduits must be kept free from weeds and other obstructions, be of sufficient capacity, and be properly constructed and maintained to carry the flow of water applied for, without the danger of breaks, overflow, or undue seepage.

4.3.2 The District may shut off the delivery of water to any private or improvement district facility not meeting the above requirements and require them to be cleaned, repaired, or reconstructed before water is turned into them.

4.4 CAPACITY OF PRIVATE OR IMPROVEMENT DISTRICT FACILITIES:

4.4.1 All new private or improvement district facilities for irrigation purposes shall provide for a gravity flow of not less than fifteen (15) cubic feet per second. A variance from this minimum flow size shall be evaluated by the General Manager on a case-by-case basis considering the impacts on the operation of the delivery system.

4.4.2 The irrigator will be required to install and operate lift pumps to receive water where the District is unable to deliver gravity water.

4.4.3 Where the irrigator chooses to install a pump system, to irrigate the irrigator's lands with sprinkler or other pump systems, the delivery flow rate may be less than fifteen cubic feet per second, provided the lower flow rates are compatible with the remaining gravity deliveries in that portion of the District or improvement district facilities.

4.4.4 The location and tie-in of gravity or pump facilities to District facilities must meet District Construction and Engineering Design Standards and be approved in writing by the District.

SECTION 5: WATER DISTRIBUTION OPERATOR DUTIES

5.1 MEASUREMENT OF WATER:

All measurements of water delivered by the District to irrigators shall be made by the District at the District sidegate. The District shall maintain records of the names of each irrigator, the parcel that each irrigator has irrigated, the number of acre feet of water used by each parcel, and other such irrigation and operations information as required by the General Manager.

5.2 INFORMATION TO WATER USERS:

The Water Distribution Operator will provide a service to water users by informing and advising each irrigator of the anticipated time of water delivery to his parcel of land and the persons water is to be received from and passed on to. The Water Distribution Operator will confirm information on flows, sidegate operation, and any special instructions related to the delivery.

SECTION 6: DELIVERY OF IRRIGATION WATER

6.1 WATER ALLOTMENT AND CHARGES:

6.1.1 The TID Board of Directors shall establish the quantities of water and the charges for each quantity of water, the gardenhead rotation, standby charges, and the beginning and ending dates for the irrigation season.

6.1.2 Pursuant to Water Code Section 22259, the TID Board of Directors may determine that surplus water is available and can be sold for irrigation of lands outside the District boundaries. These above normal water supplies are intermittent and should not be counted on as a firm supply to be delivered every year.

6.1.3 Charges and assessments for improvement district maintenance, operation and construction will be billed on the Improvement District Statement of Assessment for the current calendar year as governed by the State Water Code.

6.1.4 All water charges and other irrigation or drainage related charges shall be due and payable as stated by TID Board of Directors Resolution and notices in billing statements.

6.2 FAILURE TO PAY CHARGES:

6.2.1 The District may refuse to furnish water to any parcel if outstanding charges for water or services already furnished or rendered such parcel (including any accrued interest and penalties) have not been paid in full by the District's prescribed payment date.

6.2.2 All charges shall be made for individual parcels and are the responsibility of the recorded owners of record for each parcel even if the irrigator is only a tenant and not the landowner. All delinquent charges and assessments, together with any accrued interest and penalties, may be collected in accordance with the procedures specified in Water Code Section 25806.

6.2.3 The District may refuse to furnish water to any parcel to which the District holds title by virtue of a collector's deed or on which the District has an outstanding unredeemed certificate of sale for the nonpayment of an assessment.

6.2.4 Unpaid fees and charges for services relating to revocable license agreements, drainage permits, storm water agreements, or any other agreement or permit from the District shall be subject to the provisions of this section, including Water Code Section 25806 which allows the District to place a lien on property for unpaid fees and charges.

6.3 IRRIGATION SERVICE:

6.3.1 Irrigation water will be provided to the irrigator on the basis of an arranged demand delivery, "call system", whereby the rate of gravity water delivery, normally between fifteen (15) or twenty (20) cubic feet per second, is constant, but the frequency and duration of use is requested by the irrigator.

6.3.2 The Water Distribution Operator will endeavor to meet the scheduled time of delivery within the capacity limitations of the District facilities while maintaining efficient and equitable water distribution between irrigators. A time limit may be applied to each delivery of water to prevent unreasonable use or waste of water. Delivery of water to parcels not in the original water order may be curtailed to meet previously scheduled deliveries.

6.3.3 To schedule an irrigation, the irrigator must place an order with the Central Call Center. In the water order, the irrigator should give a reasonably close estimate for the length of irrigation time the water will be used for each individual parcel intended to be irrigated. The irrigator will confirm the delivery flow for each parcel with the Central Call Center. The Water Distribution Operator, within twenty-four (24) hours of receiving the irrigation request will give the irrigator an estimate of the date when water will be available, and will later attempt to give the irrigator at least twelve (12) hours notice of any change in time of delivery. The irrigator must have his land ready to receive water when the water request is made. Water will be made available on requested specific dates, if it does not jeopardize service to another customer or operation of the canal system.

6.4 REFUSAL OF WATER BY IRRIGATOR:

6.4.1 If an irrigator fails or refuses to continuously use the entire head of water normally delivered to him, then the following shall apply:

6.4.1.1 The full amount of the scheduled irrigation will be charged to the irrigator;

6.4.1.2 The irrigator shall not be entitled to use the unused portion of water at any other time;

6.4.1.3 The irrigator will be required to reschedule for delivery of water;

6.4.1.4 The irrigator may not be allowed to reschedule water for a five (5) day period because of repeated refusals of previously scheduled water.

6.4.2 The District will endeavor to utilize canceled water to the benefit of other irrigators and that portion so utilized will not be charged to the irrigator described in Section 6.4.1.

6.5 INTERRUPTIONS OF SERVICE:

When a break occurs in any private or improvement district facility necessitating an interruption of irrigation service, the irrigator whose irrigation was interrupted, shall be allowed, when service is restored, to finish irrigating before water is taken from the irrigator.

6.6 UNAUTHORIZED USE OF WATER:

6.6.1 Any person who uses the District water without the District's permission may become subject to criminal prosecution and civil liability.

6.6.2 First time use of the District's water without the District's permission shall result in an additional charge, for the water taken, at the rate set by the TID Board of Directors for the unauthorized use of water.

6.6.3 Subsequent taking of water without permission shall result in forfeiture of irrigation water for the remainder of the season and an additional charge, for the water taken, at the rate set by the TID Board of Directors for the unauthorized use of water.

6.6.4 If the District cannot make a reasonable estimation of the water taken, the average irrigation in acre-feet of the parcel irrigated without the District's permission shall be used for assessing the additional charge.

6.7 SERVICE TO PRIVATE OR IMPROVEMENT DISTRICT SYSTEMS:

Water entitlements of irrigators who utilize private or improvement district conduits shall be delivered to the head of these facilities by the Water Distribution Operator. It shall be incumbent on the irrigators to control the actions of individuals taking water from private or improvement district conduits.

6.8 TRANSFER OF WATER:

6.8.1 A landowner may transfer water from an owned or rented parcel to another parcel which the landowner owns or rents provided all of the following conditions are met:

6.8.1.1 Both parcels are entitled to receive water;

6.8.1.2 The rented parcel from which water is transferred shows on the District records to have been rented to the same landowner or irrigator during the prior year's irrigation season;

6.8.2 All transfers must be approved by the Water Distribution Department and must be completed by December 20.

6.8.3 The landowner may request that the Water Distribution Department link parcels described in Section 6.8.1 together for the purpose of water transfers. It is the landowners responsibility to designate which parcels are to be linked and to inform the Water Distribution Department of any additions or deletions in the parcels to be linked together.

6.9 IRRIGATION OF GARDEN SERVICE AREAS:

6.9.1 Garden service areas, which are ordinarily parcels each less than five acres in size that are separate or distinct from farm service areas, will be irrigated as a group, where possible, with a standardized rotation irrigation flow consistent with the capacity of the garden service area irrigation facilities.

6.9.2 Deliveries of water to ditches or pipelines for irrigation of garden service areas will be scheduled by the District and may be subject to interruption when it is necessary to minimize waste of water.

6.10 WORK BILLED TO OTHERS

6.10.1 Work Billed to Others are a result of damages done to a District or improvement district facility. These charges are billed to the responsible party or parties causing the damage. A statement will be mailed describing work done and the cost associated with that work.

6.10.2 All Work Billed to Others charges shall be due and payable upon receipt, unless otherwise stated.

6.10.3 The District may refuse irrigation water for any unpaid Work Billed to Others statements.

6.10.4 Customers who may not agree with the District's findings may appeal the statement by referring to Section 10 within these rules.

SECTION 7: DRAINAGE TO DISTRICT FACILITIES

7.1 DISCHARGE TO DISTRICT FACILITIES:

7.1.1 No discharge is allowed to enter into any District or improvement district facility without the prior express written approval of the District.

7.1.2 Use of improvement district facilities for transportation of animal wastewater requires a Revocable License Agreement approved by the District.

7.1.3 Any person who willfully or negligently allows any discharge to enter any District or improvement district facility without the prior express written approval of the District shall be liable for all damages caused by the discharge and the costs of the cleanup of all affected facilities and of all property adversely affected by the discharge.

7.1.4 The District will not deliver water to the land from which the discharge originated until the facilities by which the discharge entered the District or improvement district facilities are removed or permanently sealed and all costs associated with the cleanup and damages have been paid.

7.2 DRAINAGE PERMIT:

7.2.1 A Revocable License Agreement for drainage or discharge, approved by the District, is required to pump, siphon, or drain surplus irrigation water, storm water, wastewater, subsurface drainage, or any other water into any District or improvement district conduit, facility or property.

7.2.2 The rate and quantity of drainage into the District facility is subject to limitations based on the capacity of the facility and the quality of the drainage water. Connections to District facilities shall be made to District Construction and Engineering Design Standards at the permittee's expense.

7.3 DRAINAGE OF WATER:

Where excessive runoff from lands receiving District water are entering District facilities, the District may reduce the quantity of water delivered in an effort to reduce the drainage flows, or require the landowner to install special drainage facilities to regulate the flow back into the District facilities. The District may also require a landowner to cease all such runoff into District facilities whenever necessary for the District's, or the public's interest, including, but not limited to, ensuring water quality standards, preventing injury or damage, or performing repair or maintenance.

7.4 SUBSURFACE DRAINAGE:

Under certain conditions, the District will contribute a portion of the financing for new subsurface drainage projects. The District's proportionate financial contribution will be limited solely to those lands lying within a quarter mile radius of an existing District drainage well. The District's proportionate contribution will be based upon the formula detailed below in Section 7.4.1. The landowners and improvement districts shall be responsible for all other costs associated with the subsurface drainage project. The District's financial participation in subsurface drainage projects is subject to certain conditions and requirements, including but not limited to those set forth in the Rules for the Distribution and Use of Water Within the Turlock Irrigation District, Rules for the Formation and Operation of Subsurface Drainage Improvement Districts and Governing Rules of the Turlock Irrigation District Improvement Districts.

7.4.1 The District will start with its 5-year average electricity costs for pumping, escalated (1 percent annually) over 10 years to account for inflation. This future 10-year payment stream is converted to a present value. It is divided by the number of District active drainage wells and further

divided by 120 (number acres influenced per well), which yields the District contribution per acre.

SECTION 8: WATER QUALITY

8. 1 WATER QUALITY REQUIREMENTS:

8.1.1 In addition to any other legally required standard, any discharge of water into the District facilities must meet District water quality standards for discharge to canal system.

8.1.2 Dischargers are solely liable and responsible for meeting and complying with all local, state, and federal regulation of water quality and subsurface pumping. Dischargers agree to indemnify, defend and hold harmless the District, its TID Board of Directors, officers, employees and agents against all liability, claims, damages and costs (including reasonable attorneys fees) relating to the quality of water discharged by a discharger.

8.1.3 New Drainage Systems: Prior to the first discharge of drainage into District facilities, the District will perform a water quality test on the water to be discharged. In addition, for new subsurface drains, the District requires the installation of test wells prior to construction. All water quality tests performed under this section will be at the expense of the discharger.

8.1.3.1 Drainage systems found to be non-compliant will be required to obtain a variance per section 8.2 prior to commencing discharge into District facilities.

8.1.4 Existing Drainage Systems: the District will perform water quality tests quarterly or at other intervals at the District's discretion. All water quality tests performed under this section will be at the expense of the discharger.

8.1.4.1 Within 1 month of water quality test, the District will notify the discharger of non-compliance. The discharger will be given thirty (30) days to apply for a variance.

8.1.4.2 Failure to apply for a variance within the thirty (30) day period will result in immediate suspension of discharge privileges.

8.2 VARIANCE PROCESS:

8.2.1 Discharger must prepare and provide, along with the variance application, a detailed plan of operation. If land being drained is used for dairy operations or nutrient water is applied to the soil on land subject to subsurface drainage, the grower must also successfully complete the California Dairy Quality Assurance Program, including certification. The District will make staff available to assist growers in these processes.

8.2.2 The objective of the operational plan is to identify all facility modifications or best management practices necessary to improve the water quality such that the discharges will meet water quality standards within the variance period.

8.2.3 Discharger will be allowed up to a sixty (60) month variance to bring a non-compliant facility into compliance with water quality standards for discharges. Any variance period may be reduced as a result of new requirements imposed by any local, state, or federal agency.

8.2.3.1 If after the expiration of the initial variance, the discharge still does not meet applicable water quality standards, the discharger may request 12 month extensions of the variance from the General Manager by providing justification for the extension and an updated operational plan. The General Manager will determine whether or not to grant the extension after reviewing the justification and updated operational plan.

8.2.4 Discharger shall physically implement operational changes according to the schedule detailed in the plan of operation for the variance to remain in effect.

8.2.5 The District may choose to conduct an annual review to verify compliance with the plan of operation and assess the effectiveness of operational changes. Modifications to the original plan of operation may be necessary as a result of the annual inspection. Failure to comply with the provisions contained within the operational plan will result in the suspension of discharge to the District's system until such time that the plan is brought into compliance.

8.2.6 Through normal irrigation operations, the District will accept non-compliant drainage discharges provided that flows within the canal or lateral are sufficient to provide adequate dilution to meet all water quality standards in effect at the time of discharge.

8.2.7 The District may, at its discretion, accept non-compliant drainage discharges during the variance period provided they do not adversely impact water quality standards or cause other potential injury. The District will not re-operate its system to ensure non-compliant discharges meet water quality standards. However, the District can, at its sole discretion, identify methodologies to aid non-compliant discharges in meeting water quality standards, including but not limited to, establishing a rotating block system to cycle available drainage operating times.

8.2.8 In the event that the District concludes that a plan of operation, or suitable best management practices are not available to improve the water quality of the discharges, the discharger will not be allowed to discharge into the District's system.

8.2.9 If at the end of the initial variance, or any extension thereof, the water does not meet standards, the discharge must cease immediately.

SECTION 9: IRRIGATION REGULATIONS

9.1 AUTHORITY OF GENERAL MANAGER TO ADOPT REGULATIONS:

The General Manager is authorized to adopt regulations to implement or supplement these rules.

9.2 VIOLATION OF A REGULATION CONSTITUTES A VIOLATION OF THESE RULES:

A violation of a regulation duly adopted pursuant to Section 9.1 shall constitute a violation of these rules.

SECTION 10: ENFORCEMENT OF IRRIGATION RULES AND REGULATIONS

10.1 TERMINATION OF DISTRICT WATER DELIVERY FOR FAILURE TO COMPLY WITH RULES OR REGULATIONS:

Failure or refusal of any landowner or irrigator to comply with any of these rules or applicable regulations ("rules and regulations") shall be sufficient grounds for terminating delivery of District water to the lands of such landowner or irrigator, and water shall not again be furnished until the landowner or irrigator is in full compliance with all rules and regulations.

10.2 NOTICE AND ORDERS:

10.2.1 The Water Distribution Department Manager is authorized to issue a Notice and Order to any landowner or irrigator the Water Distribution Department Manager determines is in violation of any rule or regulation. An oral or written warning may be issued in lieu of a Notice and Order.

10.2.2 The Notice and Order shall contain a brief description of the alleged violation, a statement of the action to be taken by the landowner or irrigator, and an explanation that a written appeal must be filed within ten (10) calendar days of the date of service of such Notice and Order or the person waives all rights to a hearing on the matter.

10.3 RED TAGS:

10.3.1 The Water Distribution Department Manager is authorized to immediately terminate the delivery of District water to a parcel under any one of the following circumstances:

10.3.1.1 If the land or irrigation facility in question is in such a condition so as to make it immediately dangerous to any person, to the public, or to any property, including but not limited to the flooding of property;

10.3.1.2 If the landowner or irrigator has failed to comply with a prior District Notice and Order or warnings pertaining to the same or similar problem;

10.3.1.3 Such other circumstances as described in regulations adopted by the General Manager pursuant to Section 9.1.

10.3.2 Notice of an immediate termination of the delivery of District water shall be by service of a Notice and Order with a Red Tag.

10.3.3 When a Red Tag is issued, the TID Board of Directors will be notified at the next TID Board of Directors meeting.

10.4 SERVICE OF NOTICE AND ORDERS AND RED TAGS:

Each Notice and Order and Red Tag shall be served upon the landowner or irrigator either personally or by regular mail to each such landowner or irrigator at the address indicated in the District's records. Service by mail shall be effective on the date of mailing. The Red Tag may also be posted on the affected land or irrigation facility.

10.5 COMPLIANCE WITH NOTICE AND ORDERS AND DECISIONS:

10.5.1 A Notice and Order becomes final if a written appeal is not filed within ten (10) calendar days of the date of service of such Notice and Order. The General Manager's decision becomes final if a written appeal to the TID Board of Directors is not filed within the (10) calendar days of the date of service of the decision. The TID Board of Directors decision becomes final on the day the decision is issued.

10.5.2 After a Notice and Order or a decision of the General Manager or of the TID Board of Directors has become final, no person to whom any such order or decision is directed shall fail, neglect, or refuse to obey any such order or decision.

10.5.3 If, after an order or decision has become final, the person whom such order or decision is directed fails, neglects, or refuses to comply with such order or decision, the District may refuse to furnish water to the land in question and the District may institute any other appropriate action under these rules or applicable law.

10.5.4 Whenever any ordered action or repair is not commenced within seven (7) calendar days after any order or decision has become final or is not pursued with sufficient diligence to enable the ordered action or repair to be completed within the time established for compliance, the Water Distribution Department Manager may issue a Red Tag if a Red Tag has not already been issued.

10.6 APPEALS OF NOTICE AND ORDERS AND RED TAGS:

10.6.1 Any landowner or irrigator affected by the Notice and Order and/or Red Tag may file an appeal.

10.6.2 When a Notice and Order is issued without a Red Tag, a written appeal must be filed with the General Manager within ten (10) calendar days of the date of service of such Notice and Order or the person waives all rights to a hearing on the matter by the General Manager and the TID Board of Directors. The General Manager's decision may be appealed to the TID Board of Directors.

10.6.3 When a Notice and Order is issued with a Red Tag and water delivery is terminated, a written appeal must be filed directly with the TID Board of Directors within ten (10) calendar days of the date of service of such

Notice and Order or the person waives all rights to a hearing on the matter.

10.6.4 If the final decision requires compliance with the Notice and Order or any portion thereof and delivery of water is terminated to the land in question for failure to comply with the Notice and Order, no further appeal is allowed and the landowner or irrigator must fully comply with the Notice and Order and with all rules and regulations before water will be delivered.

II. GOVERING RULES OF THE TURLOCK IRRIGATION DISTRICT IMPROVEMENT DISTRICTS

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REVISED JUNE 2, 2009

GOVERING RULES OF THE TURLOCK IRRGATION DISTRICT IMPROVEMENT DISTRICTS

PREAMBLE

These rules are established to govern the formation, operation and maintenance of Improvement Districts within the Turlock Irrigation District. The formation, inclusion of additional lands and dissolution of improvement districts, and the approval and levying of improvement district assessments, are governed by Water Code Sections 23600 et seq., California Constitution Articles XIIIC and XIIID and the Proposition 218 Omnibus Implementation Act, Government Code Sections 53750, et seq.

SECTION 1: DEFINITIONS

The following words have the following meanings:

"**Agricultural Parcels**" are undeveloped parcels that are not urban parcels.

"Authorized Representative" is a person who is designated by a landowner or landowners to act on behalf of the landowner or landowners on TID improvement district matters. All references in these Rules to "landowner" or "landowners" shall be understood to include their authorized representatives. Each authorized representative must be identified and certified as to the scope of the representative's authority on a form approved by TID. Authorized representatives may be asked to confirm their status when submitting official voting ballots on behalf of a landowner or landowners.

"**Committee"** means Improvement District Committee.

"General Manager" means the General Manager or his authorized representative.

"**Irrigation Improvement Districts"** convey irrigation water for agricultural production through facilities owned by the improvement district.

"Landowner" means an owner or owners of a parcel of land whose name(s) and address(es) appear on the current TID improvement district assessment roll maintained by the TID Assessor, or in the case of any public entity, the State of California, or the United States, means the representative of that public entity at the address of that entity known to the TID Assessor.

"**Official Meeting"** is a meeting which is called by the TID giving notice to the improvement district members whose names and addresses are listed on the current assessment roll.

"**O & M"** means Operation and Maintenance.

"**TID"** means Turlock Irrigation District.

"**TID Facility"** means any Turlock Irrigation District irrigation facility.

"Urban Parcel" is a parcel of land within the boundaries of a municipal or industrial water system.

"**Non-Urban Parcel**" is a developed parcel that is used exclusively for non-agricultural purposes.

SECTION 2: IMPROVEMENT DISTRICT FORMATION

2.1 Improvement districts may be formed to construct and maintain facilities on behalf of its members. They may also be formed to acquire and maintain existing private facilities. In either case, the formation process consists of several steps that require approximately four (4) months to complete. These steps include preparing a petition for formation, petition and easement signature, report of survey, preparation of estimated assessment and a public hearing. Once the improvement district is formed, the members will be assessed for construction, operation and maintenance costs on a per acre basis.

2.1.1 **Proposition 218 Governs Voting:** All votes, approvals and consents of landowners that relate to the formation of an improvement district or the levy of a new or increased per-acre assessment must be based upon a "per acre" vote, i.e., one acre = one vote.

2.2 **Formation for construction**. Landowners request the TID to form an improvement district to construct the facilities. Once the improvement district is formed, the TID will prepare the construction plans and specifications and arrange for construction of the facilities. When construction is complete, the TID will issue improvement district warrants. TID will issue assessments on all lands within the improvement district to pay the warrants and future operation and maintenance costs.

2.3 **Formation by acquisition**. The TID can form improvement districts for the purpose of acquiring existing private facilities. Persons interested in forming an improvement district for this purpose should contact TID's Water Distribution Department.

2.4 In order to form an improvement district there must be at least two separate parcels under different ownership.

2.5 Property that benefits from the improvement district's facilities shall be included in the improvement district.

2.6 Improvement districts shall acquire and maintain common facilities serving more than one parcel.

2.7 The improvement district must obtain all necessary easements for TID and improvement

district facilities. The easements shall conform to TID standards and requirements.

2. 8 Improvement districts shall be formed using the following process:

2.8.1 Persons wishing to form an improvement district must first submit a petition to TID's Water Distribution Department requesting that an improvement district be formed.

2.8.1.1 Prior to submitting a petition, persons wishing to form an improvement district should meet with TID's Water Distribution Department to discuss the need and the feasibility of the proposed improvement district as well as the formation process.

2.8.1.2 Petitions must contain the signatures of the landowners who own at least two-thirds of the acres proposed for inclusion within the improvement district and must be in a form approved by TID.

2.8.2 After the petition is submitted to TID, the TID will prepare a detailed engineer's report analyzing the feasibility and costs of forming the improvement district, including the costs of constructing any facilities.

2.8.3 After the engineer's report is prepared, TID will set a date to hold a public hearing before the TID Board of Directors to determine whether the improvement district should be formed and whether an assessment should be levied on the property within the improvement district.

2.8.4 Not less than 45 days prior to the public hearing upon the formation and the proposed assessment, TID will send all landowners of the lands within the proposed improvement district the detailed engineer's report and a ballot on which they can indicate their support or opposition to the proposed assessment.

2.8.4.1 The ballots must be returned to TID before the end of the public hearing on the improvement district.

2.8.4.2 At the conclusion of the public hearing the Secretary or Clerk of the Board, or any other person designated by the TID Board of Directors as an impartial person who does not have a vested interest in the outcome of the proposed formation and assessment, shall tabulate the ballots submitted, and not withdrawn, in support of or opposition to the proposed formation and assessment. Each landowner's vote will be based upon the number of acres owned, i.e., one acre = one vote. For example, a landowner owning 100 acres would be entitled to 100 votes and another landowner owning ½ acre would be entitled to ½ vote. In the event that more than one of the record owners of an identified parcel submits a ballot, then that ballot shall be counted in accordance with Government Code Section 53753(e)(1) or its

successor statute.

2.8.5 At the public hearing on the formation of the improvement district, the TID Board of Directors will consider whether to form the improvement district.

2.8.5.1 At the public hearing, the TID Board of Directors shall consider all protests against the proposed formation and assessment and tabulate the ballots. The TID Board shall not form the improvement district and impose an assessment if a majority protest exists. A majority protest exists if, upon the conclusion of the hearing, the votes submitted in opposition to the formation and assessment exceed the votes submitted in favor of the formation and assessment.

2.8.5.2 The TID Board of Directors may form the improvement district and impose the assessment if a majority protest did not result from the balloting.

2.9 Additional Irrigation Improvement District Formation Requirements

2.9.1 **Engineering services**. Prior to constructing irrigation facilities, the irrigation improvement district shall obtain qualified engineering assistance to provide the following services:

2.9.1.1 **Irrigation study**. Cropping types, acreages and water needs shall be studied to determine the feasibility of providing the intended irrigation service.

2.9.1.2 **Field survey**. The grades and alignment of proposed irrigation facilities shall be established, along with the boundaries of the proposed irrigation improvement district.

2.9.1.3 **Design**. The engineer shall provide a system design consisting of a complete set of plans showing facility design and specifications, and operation and maintenance information. The design must be done in accordance with engineering standards provided by the TID, or other accepted industry standards.

2.9.1.4 **Construction survey and inspection**. The engineer shall provide adequate horizontal and vertical control for system installation. In addition, the engineer must provide certification that the system was installed as designed.

2.10 All petitions to form new improvement districts by acquisition must be submitted to the TID no later than May 1 of the year preceding the assessment year the proposed formation is to become effective. The assessment year runs from September 1st to August 31st.

2.11 All petitions to form new improvement districts by construction must be submitted to TID with sufficient lead time to allow for the following: approximately four (4) months to form the improvement district; time to construct the facilities after the improvement district has been formed; plus an additional eight (8) weeks to finalize the costs and set the assessment by October 1st. In some instances, this would require the petition to be submitted the year prior to the October 1st deadline to allow for the construction of the facilities to occur during the non-irrigation season.

2.12 Upon formation of new improvement districts containing facilities owned by Improvement District No. 52, the Delhi State Land Settlement, ownership of those Improvement District No. 52 facilities shall be transferred to the new improvement district.

SECTION 3: IMPROVEMENT DISTRICT INCLUSION

3.1 Inclusions of property into an improvement district must be done in accordance with provisions of the California Water Code and the California Constitution. The inclusion process consists of several steps that require approximately three (3) months for completion. These steps include preparing a petition for inclusion, petition signature, feasibility report and a public hearing. The owners requesting inclusion must sign the petition and ballot. Once the property is included in the improvement district, the property within the improvement district will be assessed for the construction, operation and maintenance costs on a per acre basis.

3.2 The requesting landowners must obtain all necessary easements for TID and improvement district facilities. The easements shall conform to TID standards and requirements.

3.3 The owner of the including parcel will be required to pay the following amounts prior to the inclusion being finalized:

3.3.1 The current TID Board of Director approved fee for processing the inclusion.

3.3.2 For parcels that were not previously in the improvement district, the cost of the original construction and/or formation as well as the cost of major improvements or construction subsequent to the formation.

3.3.3 For parcels that were previously in the improvement district, all operation, maintenance and construction costs incurred by the improvement district subsequent to the parcel abandoning from the improvement district.

3.3.4 Any other charge the TID Board of Directors deems appropriate.

3.4 All petitions to include into improvement districts must be submitted to the TID no later

than June 15th of the year preceding the year the proposed inclusion is to become effective.

SECTION 4: IMPROVEMENT DISTRICT DISSOLUTION

4.1 Dissolution of an improvement district must be done in accordance with the provisions of the California Water Code. The dissolution process consists of several steps that require approximately two (2) months for completion. These steps may include preparing a petition, petition signature and a public hearing.

4.2 An improvement district may be dissolved prior to incurring any indebtedness or upon full payment of all indebtedness.

4.3 Dissolution of an improvement district may be initiated by the General Manager or members submitting a petition requesting the improvement district be dissolved.

4.3.1 Petitions to dissolve an improvement district must be in a form approved by the TID and must contain the signatures of at least two-thirds of the landowners in the improvement district.

4.4 Upon the request of the General Manager or upon receipt of the petition, the TID Board of Directors will set a time for a public hearing to consider the dissolution of the improvement district.

4.5 In any case in which the TID Board of Directors has by resolution determined that all indebtedness of the improvement district has been paid and the improvement for which the improvement district was formed no longer exists or is no longer operational, the TID Board of Directors may order the improvement district dissolved without a hearing.

SECTION 5: IMPROVEMENT DISTRICT ABANDONMENT

5.1 The following procedures shall apply to all improvement district abandonments:

5.1.1 Subject to the abandonment rules, any landowners of parcels within improvement districts may make a request to the TID Board of Directors to abandon out of an improvement district. The General Manager may, on his own initiative, request the TID Board of Directors to have a parcel abandon out of an improvement district.

5.1.2 Upon receipt of an abandonment request or at the time of the General Manager's request to the TID Board of Directors, the TID’s Water Distribution Department shall prepare and present to the TID Board of Directors a report on the feasibility of the abandonment and impacts of the abandonment on the parcels remaining within the improvement district.

5.1.3 When parcels are allowed to abandon, all valves must be sealed or facilities removed and all prior year, current year, construction assessments and any other obligations payable out of the assessment which are a lien on the property shall be paid.

5.1.3.1 At the TID's discretion parcels defined in Rules 5.2.1 and 5.2.2 may be allowed to abandon from an improvement district without the payment of outstanding O & M assessments or fees. However, no such exemption from fees shall be allowed unless all of the following conditions are met:

5.1.3.1.1 The parcel has paid in full all outstanding construction assessments or fees. Construction includes, but is not limited to, lining or piping conveyance facilities and building or replacing wells.

5.1.3.1.2 The parcel does not have any access to receive water from any improvement district facility. A parcel is considered to have access to receive water when District water can be conveyed to the land by valve, gate, pump, ditch, pipe or other means as determined by TID.

5.1.3.1.3 The abandonment will not result in a materially significant increase in existing or future O & M assessments to other parcels in the improvement district or adversely impact the operation and maintenance of the improvement district facility. What constitutes a materially significant increase shall be determined solely by TID.

5.1.3.1.4 The abandonment and exemption from payment of fees are found to be in the best interest of the District.

5.1.4 Abandoning parcel owners shall be required to grant easements to the TID for any improvement district facilities on or adjacent to their property (e.g., pipelines, ditches, and pumps).

5.1.5 The TID Board of Directors may prescribe any conditions upon the abandonment of the land that is deemed just. Such conditions may include, but are not limited to, the requirement to pay a per acre charge to the improvement district to mitigate any significant adverse financial impacts on the improvement district caused by the abandonment of the land from the improvement district's assessment base.

5.1.5.1 For abandonments from Improvement District 52, the Delhi State Land Settlement, a fee of not less than $25 per acre nor more than

$50 per acre shall be imposed on each parcel abandoning from Improvement District No. 52. The actual fee will be determined based upon the number of petitions to form new improvement districts compared to the number of remaining improvement districts to be formed within Improvement District No. 52. The abandonment fee shall be included in the following year's improvement district O&M assessment or shall be paid as a fee if the requesting owner is not including in another improvement district. Proceeds from the abandonment fee shall be credited to the O&M account of Improvement District No. 52.

5.1.6 All petitions to abandon from improvement districts must be submitted to the TID no later than June 15th of the year preceding the year the proposed abandonment is to become effective.

5.2 **Irrigation Improvement Districts.** The following parcels may abandon from irrigation improvement districts:

5.2.1 Urban parcels of five acres or less

5.2.2 Non-urban parcels

5.2.2.1 Non-urban parcels less than or equal to one acre shall be permitted to abandon.

5.2.2.2 Non-urban parcels greater than one acre that are developing or are completely developed shall be permitted to abandon.

5.2.3 Agricultural parcels shall be permitted to abandon provided that the parcel receives or is entitled to receive District surface water either through privately owned facilities or through facilities of another improvement district.

5.3 **Pump Improvement Districts**. Before abandonment is permitted, the TID Board of Directors shall make a determination that the abandonment will not have an adverse effect on the remaining pump improvement district parcels.

5.4 **Drainage Improvement Districts**. Before abandonment is permitted, the TID Board of Directors shall make the determinations that (1) the abandonment will not have an adverse effect on the remaining drainage improvement district parcels, and (2) the abandoning parcels do not benefit directly or indirectly from the improvement district facilities.

SECTION 6: IMPROVEMENT DISTRICT COMMITTEE

6.1 The California Water Code provides that the TID Board of Directors is the sole governing body with regard to the management of the improvement district. The Improvement District Committee serves as an advisory body to the TID Board of Directors. Landowners within an improvement district have the option of forming a Committee; Committees are not required.

6.2 The Committee officers of the improvement district are a president, a vice president and a secretary.

6.3 The officers will be elected by the landowners within the improvement district at a noticed meeting of the improvement district and will serve until new officers are elected. Election may be held every three years. There is no limit on the number of successive terms an officer may serve. The Committee's secretary will certify a roster of officers within thirty (30) days after the election of Committee officers on the TID established form.

SECTION 7: IMPROVEMENT DISTRICT MEETINGS

7.1 Improvement district meetings are noticed meetings for all landowners within the improvement district. It is recommended that each improvement district hold a meeting at least once every three (3) years.

7.2 A meeting for any purpose relating to the improvement district may be called at any time by the Committee (if any), by ten percent (10%) of the landowners in number or by the TID.

7.3 All requests for improvement district meetings shall be made to the TID's Water Distribution Department. The TID will give notice to the landowners within the improvement district whose names and addresses are listed on the then current improvement district assessment book maintained by the TID Assessor. The notice will include an agenda with proposed TID staff recommendations and actions for consideration at the meeting.

SECTION 8: VOTING AT IMPROVEMENT DISTRICT MEETINGS

8.1 This Section 8 applies to voting at improvement district meetings called pursuant to Section 7. This section shall not apply to any voting required by California Constitution Articles XIIIC or XIIID or any applicable statutes.

8.2 Each landowner's vote will be based upon the number of acres owned, i.e., one acre = one vote, within the improvement district. If there is more than one landowner of a parcel within the improvement district and the landowners disagree on how they should vote on an issue, then their respective votes shall be apportioned in accordance with their percentage ownership of the parcel and the number of acres within the parcel. For

example, Landowner X owns a 60% interest in a 100-acre parcel and Landowner Y owns a 40% interest in the same parcel. Landowner X would get 60 votes and Landowner Y would get 40 votes. When two or more persons are landowners (for example, husband and wife or brothers and sisters) of the same parcel of land within the improvement district and the parcel consists of only one acre or less, then all the landowners of the parcel combined may only cast one vote.

8.3 Every landowner entitled to vote will have the right to do so either in person or by an authorized representative.

8.4 Landowners present at the meeting will be given the opportunity to discuss, comment on and vote on any matter before the improvement district meeting, including, but not limited to, any recommendations and actions proposed by TID staff in the noticed agenda for the meeting.

8.5 Landowners are encouraged to attend all improvement district meetings. Failure to attend and vote will be considered by the TID as the non-attending landowners acquiescing in any action or non-action on any issue at a meeting, including, but not limited to, approval of any recommendation and/or action proposed by TID staff.

SECTION 9: WORK AUTHORIZATION PROCEDURE

9.1 Any person requesting work on improvement district facilities must contact the TID's Improvement District Trouble Shooter (IDTS). The IDTS will schedule a field meeting to review the requested work and initiate the work order process.

9.2 Any work affecting an improvement district facility must first be reviewed and approved by the TID.

9.3 The TID will establish an annual operation and maintenance budget for each improvement district based on past maintenance history.

9.4 The TID will review and may approve any request for work that has an estimated cost at or below the improvement district's O & M budget. Requests for work that for reasons of safety, security or operation are classified as emergencies may be approved regardless of budget considerations.

9.5 The TID will raise the improvement district's O & M budget as required to cover the estimated costs for O & M work which exceed the current budget. The members of the improvement district will be notified by mail that their budget is being raised. If so requested, the TID will call a meeting of the improvement district to discuss the proposed work.

9.6 If the TID approves the request, TID will either do the work or provide for the outside services. All approved requests must be completed in conformance with applicable TID

requirements. Itemized invoices and other documentation of work actually performed, signed by two improvement district members, must be submitted to the TID before payment will be made for any outside services.

9.7 This procedure covers all work affecting improvement district facilities.

SECTION 10: IMPROVEMENT DISTRICT FUNDS

10.1 All funds collected for or on behalf of the improvement district must be deposited with the TID.

10.2 All charges or assessments to be levied on the improvement district must be approved by the TID Board of Directors.

10.3 All disbursements of improvement district funds will be made by the TID.

10.4 Funds in the improvement district's O&M account shall remain in the account unless and until disbursement of funds is requested by vote of the Committee or upon request of the landowners owning more than a majority of the acres within the improvement district. Funds shall be disbursed in accordance with Water Code Section 24529. Landowners who are entitled to any disbursements shall be conclusively determined by the TID Assessor based upon the TID improvement district assessment book current at the time the distribution is made, with unknown and fictitiously named owners being disregarded.

SECTION 11: IMPROVEMENT DISTRICT EXPENDITURES

Administrative, engineering, operation and maintenance costs incurred on behalf of an improvement district shall be charged to the improvement district.

SECTION 12: ASSESSMENT FOR NEW PURPOSES

Whenever it is desired to do additional new work, significantly replace existing improvement district facilities or acquire additional facilities or property, upon the petition of landowners owning at least a majority of the acres within the existing improvement district, an additional assessment may be levied so long as a vote is conducted in the same manner as for an original assessment under Section 2 of these Rules and a majority protest did not result from the balloting. The formation of a new improvement district is not required. The petition must be in a form approved by TID.

III. RULES FOR THE FORMATION AND OPERATION OF PUMP IMPROVEMENT DISTRICTS

CONTENTS

SECTION	TOPIC	PAGE
	Preamble	36
1	Definitions	36
2	Pump Formation Requirements	37
3	Pump Use Approval and Charges	37
4	Collection and Disbursement of Funds	38
5	Operational Requirements	39
6	Water Quality Requirements	39
7	Pump Improvement District Committee Responsibilities	39
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RULES FOR THE FORMATION AND OPERATION OF PUMP IMPROVEMENT DISTRICTS

PREAMBLE

The primary purpose for Pump Improvement Districts is to provide deep-well irrigation water to improvement district members as part of a conjunctive use program to supplement the supply of surface gravity water provided by the Turlock Irrigation District (TID). These rules provide operating rules specifically for Pump Improvement Districts and are supplemental to the Governing Rules of Turlock Irrigation District Improvement Districts.

SECTION 1: DEFINITIONS

The following words have the following meanings:

"**O & M**" means Operation & Maintenance.

"**Off Season**" means the remaining six (6) months of the year that are not On Season.

"**Official Meeting**" is a meeting which is called by the TID giving notice to the improvement district members whose names and addresses are listed on the current assessment roll, pursuant to Section 7 of the Governing Rules of Turlock Irrigation District Improvement Districts.

"**On Season**" means the calendar period of six consecutive months that pump owners will receive a connected load charge. This period will be from April 1st through September 30th unless otherwise specified by the Pump Improvement District Committee.

"**Parcels within the Pump Improvement District**" means all those parcels of land that are within the established boundary of the Pump Improvement District.

"**Parcels outside the Pump Improvement District**" means all parcels of land not within the established boundary of the Pump Improvement District.

"**Pump Improvement District Committee**" - The Committee officers are a president, vice president and a secretary elected and serving pursuant to Section 6 of the Governing Rules of Turlock Irrigation District Improvement Districts.

"**TID Facility**" means any Turlock Irrigation District irrigation facility.

SECTION 2: PUMP FORMATION REQUIREMENTS

2.1 Engineering services. Prior to constructing well and pumping facilities, the pump improvement district shall obtain qualified engineering assistance to provide the following services:

2.1.1 **Groundwater study**. Pumping records and well logs for pumping facilities in the area shall be examined to determine the potential for construction of a well and pump in the area. Locations of existing wells in the area shall be determined and the new location chosen to minimize interference with other pumping facilities.

2.1.2 **Aquifer investigation**. A study to determine soil structure and potential ground water yield shall be conducted to enable the design of the system.

2.1.3 **Field survey**. The grades and alignment of proposed pumping and discharge facilities shall be established along with the boundaries of the proposed pump improvement district.

2.1.4 **Design**. The engineer shall provide a system design consisting of a complete set of plans showing system location, casing size and perforations, pump design and specifications, and operation and maintenance information. The design must be done in accordance with engineering standards provided by the TID, or other accepted industry standards.

2.1.5 **Construction survey and inspection**. The engineer shall provide adequate horizontal and vertical control for system installation. In addition, the engineer must provide certification that the system was installed as designed.

2.2 Property that benefits from the well and pump shall be included in the pump improvement district.

SECTION 3: PUMP USE APPROVAL AND CHARGES

3.1 Approval to Use the Pump

3.1.1 No approval from TID is required for parcels of land within the pump improvement district to use the pump.

3.1.2 Approval by the Pump Improvement District Committee is required for parcels of land outside of the pump improvement district to use the

pump.

3.1.3 The TID must always approve any use of TID facilities for transportation of pump water for each separate occasion.

3.2 Charges - On Season

3.2.1 **Customer and Connected Load** charges will be paid by all the members of the pump improvement district on a per acre basis through the annual O & M assessment.

3.2.2 **Electrical Energy** charges will be paid by the user of the pump.

3.2.3 **Additional Charges** as determined by the Pump Improvement District Committee will be paid by the user.

3.3 Charges - Off Season

3.3.1 **Customer and Connected Load** charges will be paid by the user of the pump.

3.3.2 **Electrical Energy** charges will be paid by the user of the pump.

3.3.3 **Additional Charges** as determined by the Pump Improvement District Committee will be paid by the user.

SECTION 4: COLLECTION AND DISBURSEMENT OF FUNDS

4.1 The TID will bill the pump improvement district's O & M account monthly for all costs incurred during that month. These costs include energy costs, connected load charge, customer charge and any costs for maintenance work performed on the facility by TID or outside contractors. An electrical service bill will be sent to the designated improvement district member monthly.

4.2 The Pump Improvement District Committee shall collect checks made payable to the appropriate TID improvement district for actual use of the pump. The checks shall be submitted monthly to the TID in a timely manner. The TID will then deposit the money collected in the pump improvement district's O & M account. The TID will deposit those funds generated from TID rental of a pump into the pump improvement district's O & M account.

4.3 The TID will bill the pump improvement district members on a per acre basis for all unpaid bills, including electrical charges, annually through O & M assessments.

SECTION 5: OPERATIONAL REQUIREMENTS

Temporary Suspension of Discharge Privileges. In the event it becomes necessary to eliminate water from any portion of the TID's irrigation system affected by this pump improvement district for the purpose of repair, maintenance, replacement, irrigation or storm drainage usage, or for any other purpose, the TID may temporarily turn off any pump or valve by which the pump's water is discharged into the TID's irrigation system. Unless it is an emergency situation, the TID shall endeavor, whenever possible, to give the pump improvement district at least seven (7) days prior notice before suspending any discharge privileges pursuant to this section.

SECTION 6: WATER QUALITY REQUIREMENTS

6.1 Any discharges of water from improvement district facilities into TID facilities must comply with all local, state, federal and TID water quality standards. If the improvement district fails to meet these requirements, the improvement district must immediately cease all discharges of water into TID facilities.

6.2 Prior approval is always required from the TID for the improvement district to be allowed to discharge into TID facilities during the off-season to transport pump water for irrigation purposes.

6.3 Improvement districts are solely liable and responsible for meeting and complying with all local, state, and federal regulation of water quality and subsurface pumping. Improvement districts agree to indemnify, defend and hold harmless the TID, its Board of Directors, officers, employees and agents against all liability, claims, damages and costs (including reasonable attorneys fees) relating to the quality of water discharged by an improvement district.

6.4 The TID will perform water quality tests on water discharged by the improvement district after the construction of its facilities and prior to the first discharge of water into the TID facilities. The TID will retest quality of water periodically at the TID's discretion. All water quality tests performed under this section will be part of the O & M expenses of the improvement district.

SECTION 7: PUMP IMPROVEMENT DISTRICT COMMITTEE RESPONSIBILITIES

7.1 Committee members shall provide and maintain physical access to the pump.

7.2 Committee members shall maintain the pump in good operating condition including the following:

7.2.1 Daily or routine maintenance.

7.2.2 The committee shall maintain a maintenance and repair log which will contain the following minimum information:

7.2.2.1 Dates of regular pump checks;
7.2.2.2 Dates of regular pump maintenance;
7.2.2.3 Dates and description of repair work.

7.3 Committee members shall be responsible for the safety and security of the pump installation and operation including the following:

7.3.1 The pump shall be kept in a safe operating condition. Any condition that constitutes a safety hazard shall be corrected at once.

7.3.2 Adequate security measures shall be taken to prohibit unauthorized access to, or operation of the pump.

7.4 Committee members shall be responsible for the recording of pump usage including the following:

7.4.1 The committee shall provide instructions for use of the pump to the pump improvement district members, or other authorized user.

7.4.2 The committee shall maintain pump usage records which contain the following minimum information:

7.4.2.1 User name;
7.4.2.2 Date and time pump turned on;
7.4.2.3 Date and time pump turned off;
7.4.2.4 Hours used.

SECTION 8: RENTAL TO THE TID

Rental of the improvement district pump to the TID shall be by written agreement under the current TID Board of Directors Resolution.

SECTION 9: OTHER APPLICABLE RULES

9.1 Unless otherwise provided in these rules, the Governing Rules of Turlock Irrigation District Improvement Districts apply to pump improvement

districts.

9.2 All maintenance and repair work done on the pump improvement district facilities shall follow the Governing Rules of Turlock Irrigation District Improvement Districts. Approval for repairs can be obtained by contacting the Improvement District Trouble Shooter at the TID.

IV. RULES FOR THE FORMATION AND OPERATION OF SUBSURFACE DRAINAGE IMPROVEMENT DISTRICTS

CONTENTS

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	Preamble	43
1	Definitions	43
2	Description of Subsurface Drainage Improvement Districts (SDIS)	43
3	SDID Formation Requirements	43
4	Water Quality Requirements	44
5	Operational Requirements	45
6	Payment and Ownership of SDID Facilities	45
7	Other Applicable Rules	45

RULES FOR THE FORMATION AND OPERATION OF SUBSURFACE DRAIN IMPROVEMENT DISTRICTS

PREAMBLE

Subsurface drainage improvement districts (SDIDs) are formed at the request of affected landowners to alleviate high groundwater conditions affecting their property.

SECTION 1: DEFINITIONS

The following words have the following meanings:

> **"SDID"** means **Subsurface Drainage Improvement District**, an improvement district organized to provide below ground surface drainage facilities to alleviate high groundwater conditions affecting member properties.
>
> "**TID"** means Turlock Irrigation District

SECTION 2: DESCRIPTION OF SDID'S

SDID's are composed of the following facilities:

2.1 Collection and transportation facilities consist of a network of perforated and non-perforated drain tubing and pipes that collect groundwater and transport it to the discharge facilities. Collection and transportation facilities consist of laterals and trunk lines.

2.1.1 Laterals are the individual collection pipes within a field.

2.1.2 Trunk lines collect water from laterals and may also be designed to collect groundwater.

2.2 Discharge facilities consist of a sump, pump, and discharge line that transports collected groundwater into a terminal facility such as, a TID canal or drain.

SECTION 3: SDID FORMATION REQUIREMENTS

3.1 Engineering services. Prior to constructing subsurface drainage facilities, the SDID shall obtain qualified engineering assistance to provide the following services:

3.1.1 **Groundwater study**. A study shall be conducted to indicate whether installation of a subsurface drainage system is cost effective for the TID and the proposed improvement district.

3.1.2 **Water quality study.** Testing shall be done to determine if the water to be drained will meet applicable water quality standards.

3.1.3 **Soil and drainage investigation**. A study to determine soil permeability and classification shall be conducted to enable the design of the system.

3.1.4 **Field survey.** The grades and alignment of proposed drainage facilities shall be established, along with the boundaries of the proposed SDID.

3.1.5 **Design.** The engineer shall provide a system design consisting of a complete set of plans showing system layout, drain sizing and grade, sump and pump design and specifications, estimated flows and operation and maintenance information. The design must be done in accordance with engineering standards provided by the TID, or other accepted industry standards.

3.1.6 Prior to construction of subsurface drainage facilities, the discharger must obtain a Revocable License Agreement as set forth in Section 7 of "The Rules For The Distribution and Use of Water Within The Turlock Irrigation District".

3.1.7 **Construction survey and inspection**. The engineer shall provide adequate horizontal and vertical control for system installation. In addition, the engineer must provide certification that the system was installed as designed.

3.2 Property that benefits from the SDID's facilities shall be included in the SDID.

SECTION 4: WATER QUALITY REQUIREMENTS

Any discharges of water from SDID facilities into TID facilities must meet TID water quality standards and must conform to water quality requirements as outlined in Section 8 of the "Rules for the Distribution and Use of Water within the Turlock Irrigation District".

SECTION 5: OPERATIONAL REQUIREMENTS

Temporary Suspension of Discharge Privileges. In the event it becomes necessary to eliminate water from any portion of the TID's irrigation system affected by this SDID for the purpose of repair, maintenance, replacement, irrigation or storm drainage usage, or for any other purpose, the TID may temporarily turn off any pump or valve by which the SDID's subsurface drainage water is discharged into the TID's irrigation system. Unless it is an emergency situation, the TID shall endeavor, whenever possible, to give the SDID at least seven (7) days prior notice before suspending any discharge privileges pursuant to this section.

SECTION 6: PAYMENT AND OWNERSHIP OF SDID FACILITIES

6.1 Laterals may be private or improvement district as determined by the members of the SDID.

6.2 Trunk lines are normally owned and maintained by the improvement district.

6.3 Discharge facilities are owned, operated and maintained by the improvement district.

6.4 District financial participation in a SDID is subject to Section 7.4 of the "Rules for the Distribution and Use of Water within the Turlock Irrigation District".

SECTION 7: OTHER APPLICABLE RULES

7.1 Unless otherwise provided in these rules, the Governing Rules of Turlock Irrigation District Improvement Districts apply to SDID

7.2 All maintenance and repair work done on the SDID facilities shall follow the Governing Rules of Turlock Irrigation District Improvement Districts. Approval for repairs can be obtained by contacting the Improvement District Trouble Shooter at the TID.

V. POLICIES

A. DRAINAGE POLICY WITHIN THE TURLOCK IRRIGATION DISTRICT

DRAINAGE POLICY
WITHIN THE TURLOCK IRRIGATION DISTRICT

EFFECTIVE SEPTEMBER 30, 2003

PREAMBLE

The following statements provide the basis for determining the appropriate response to drainage related issues arising within the Turlock Irrigation District.

These statements set forth the parameters and establish the context under which the District will allow its facilities to be used to convey drainage water and provide surface, subsurface, groundwater drainage and related services. The various elements specify the obligation and responsibilities of the parties requiring or requesting drainage related services, as well as the extent to which the District provides, facilitates, or contributes to such services.

The policy contains elements covering the following categories: Guiding Principles; Groundwater Drainage; Subsurface Drainage; Storm Drainage; and Surface Drainage.

GUIDING PRINCIPLES

The following principles establish the framework upon which each of the policy elements are founded.

1. It is the intent of the Turlock Irrigation District to deliver water of a sufficient quality to grow the predominant crops in the area and to meet all applicable water quality standards established for the waterway into which it may spill.

2. The Turlock Irrigation District's water system is for its exclusive use. With prior written permission, however, TID may accept drainage water from other parties as long as all terms and conditions established by TID are met.

3. Applicable provisions of Resolutions 2002-59 and 2002-78, adopted by the Turlock Irrigation District Board of Directors, are incorporated into the Drainage Policy.

4. In the event of inconsistencies with previous policies, rules, regulations, motions or resolutions, the provisions of this policy shall prevail.

SECTION 1: GROUNDWATER DRAINAGE

INTRODUCTION:

Groundwater drainage, for the purpose of this section, refers primarily to the control of subsurface water by the use of the shallow well system developed over the years by the Turlock Irrigation District. This element of the District's Drainage Policy includes all aspects of the removal of subsurface water except that which is developed or collected by subsurface drains (tile drains) or similar facilities.

STATEMENTS:

1.1 TID will provide groundwater drainage services within the sphere of influence of its existing groundwater drainage facilities, so long as it is practical, reasonable and economically feasible to do so, and only to the extent TID contributed to the need for such drainage based on percolation of irrigation water provided by TID. TID shall not be responsible for groundwater drainage services for any other purpose, including but not limited to, situations where the need for drainage is created by the wasteful or unreasonable acts of TID's customers or third parties, by naturally occurring conditions, or by non-TID water. Due to numerous factors and circumstances which impact groundwater levels within the District, this policy in no way implies or infers that TID can, or will, maintain groundwater to any specific level, either now or in the future.

1.2 The extent to which TID drainage pumping lowers groundwater levels varies depending upon geologic and hydrologic conditions, annual precipitation, land use practices, along with the availability, condition and regulations pertaining to groundwater drainage facilities.

1.3 TID operates its groundwater drainage facilities when possible, based upon numerous criteria, including but not limited to:

- Groundwater level data (i.e. section corner monitoring well data),
- Knowledge of the system,
- Feasibility, including economic feasibility,
- Water quality standards and requirements,
- The nature and source of the high groundwater,
- Land owner requests, and
- Condition and availability of groundwater drainage pumping, discharge and conveyance facilities.

1.4 TID will provide growers with available groundwater level information upon request.

1.5 It is the grower's responsibility to make prudent on-farm decisions including, but not limited to: planting crops appropriate for the local groundwater conditions; irrigating in a manner so as not to create localized high groundwater levels; evaluating the use of on-farm drainage facilities, irrigation methods and practices; and notifying TID of any high groundwater conditions or changes in the area impacting groundwater levels.

1.6 Additional operating standards pertaining to groundwater drainage are found in Section 3.7 – District Drainage Wells and Pumps of the Rules for the Distribution and Use of Water within the Turlock Irrigation District Irrigation.

SECTION 2: SUBSURFACE DRAINAGE

INTRODUCTION:

Subsurface drainage, for the purpose of this section, refers to the control of water immediately below the land surface by the use of collection systems, such as tile drains or similar facilities, installed by private property owners or improvement districts.

STATEMENTS:

2.1 Discharges from subsurface drainage systems may be accepted into District or improvement district facilities so long as such discharges comply with all current and future terms and conditions, including provisions contained within Sections 7 and 8 of the Rules for the Distribution and Use of Water within the Turlock Irrigation District.

2.2 Additional operating standards pertaining to subsurface drainage are found in the Rules for the Formation and Operation of Subsurface Drainage Improvement Districts.

SECTION 3: TAILWATER DRAINAGE

INTRODUCTION:

Tailwater drainage, for the purpose of this section, is considered to be runoff from agricultural lands resulting from the application of irrigation water.

STATEMENTS:

3.1 Discharges from tailwater drainage systems may be accepted into District and improvement district drains so long as such discharges comply with all current and future terms and conditions, including provisions contained in Sections 7 and 8 of the Rules for the Distribution and Use of Water within the Turlock Irrigation District.

3.2 Tailwater discharges into irrigation canals may be allowed on a case-by-case basis where natural drainage patterns have been interrupted by District canals, provided such discharges comply with all current and future terms and conditions, including provisions contained in Sections 7 and 8 of the Rules for the Distribution and Use of Water within the Turlock Irrigation District.

SECTION 4: NUISANCE WATER DRAINAGE

INTRODUCTION:

Nuisance water drainage, for the purposes of this section, is urban runoff resulting from anything other than precipitation. Examples of these sources include, but are not limited to landscape irrigation water runoff, washing of vehicles, sidewalks, and other similar practices.

STATEMENTS:

4.1 Nuisance water discharges will only be accepted from entities having current storm water agreements with the District, so long as such discharges comply with all current and future terms and conditions.

SECTION 5: AGRICULTURAL STORM WATER DRAINAGE

INTRODUCTION:

Agricultural storm water drainage, for the purpose of this section, is considered to be runoff from agricultural lands as a result of precipitation.

STATEMENTS:

5.1 Agricultural storm water runoff may be accepted into District and improvement district drains so long as such discharges comply with all current and future terms and conditions, including provisions contained in

Sections 7 and 8 of the Rules for the Distribution and Use of Water within the Turlock Irrigation District.

5.2 Agricultural storm water runoff may be accepted into irrigation canals on a case by case basis where natural drainage patterns have been interrupted by District canals, provided such discharges comply with all current and future terms and conditions, including provisions contained in Sections 7 and 8 of the Rules for the Distribution and Use of Water within the Turlock Irrigation District.

5.3 Existing roof drainage collected from livestock confinement areas may be accepted into District facilities provided such discharges comply with all current and future terms and conditions.

SECTION 6: URBAN STORM WATER DRAINAGE

INTRODUCTION:

Urban storm water drainage, for the purpose of this section, is considered to be runoff from all non-agricultural lands as a result of precipitation.

6.1 Urban storm water discharges will only be accepted from entities having current storm water agreements with the District, so long as such discharges comply with all current and future terms and conditions.

6.2 Rural urban developments with authorized storm water discharges to District or improvement district facilities prior to July 16, 2002 (the date of the most recent field survey) may continue such discharges so long as such discharges comply with all current terms and conditions.

Attachment G1. TID Board Meetings

Attachment G.1 can be found online at: http://www.tid.org/news-resources/minutes-agendas/meetings

Water Report for 1/13/2015

Water Report for 4/7/2015

Water Report for 6/30/2015

Water Report for 8/25/15

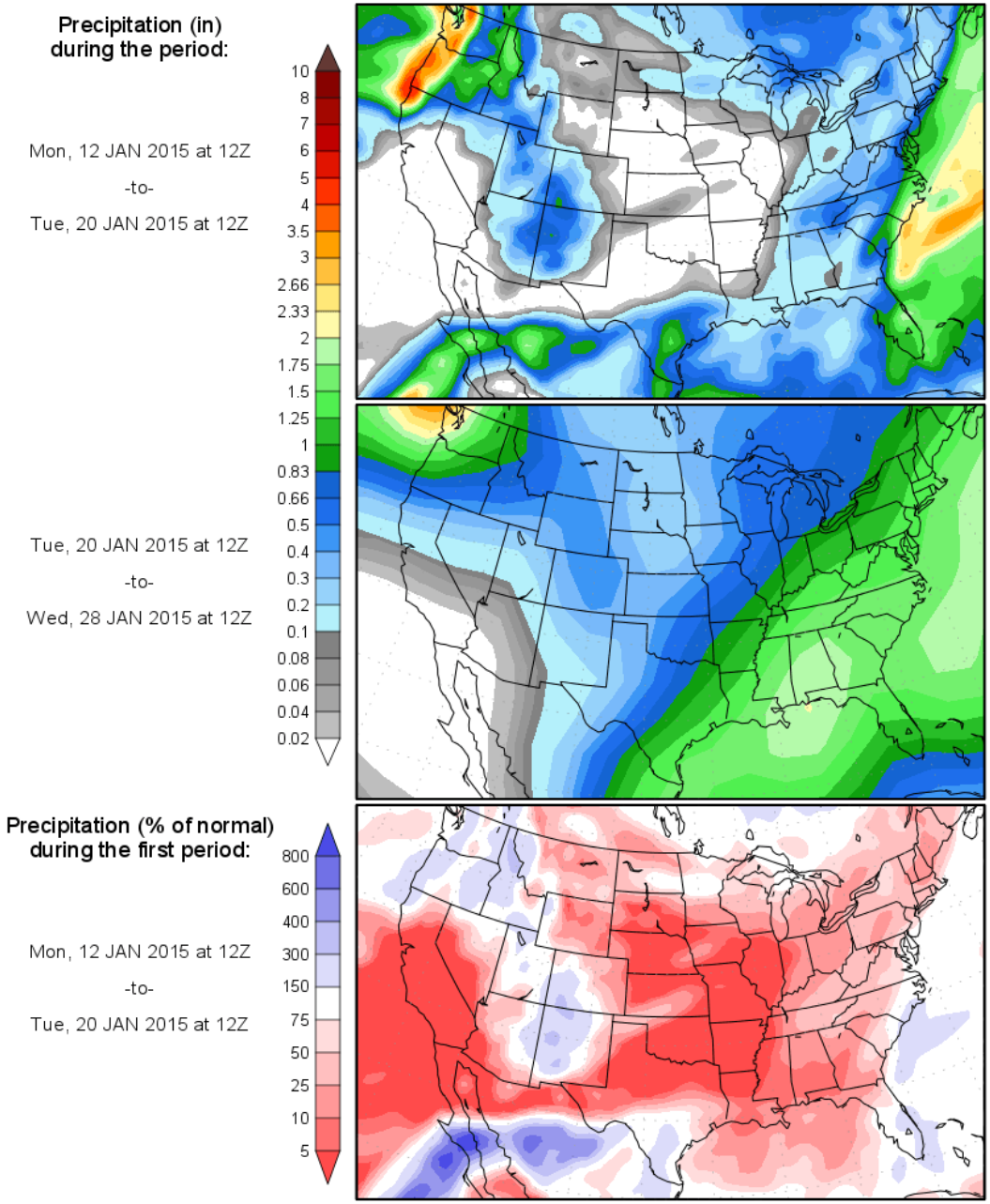
WATER REPORT FOR 1/13/2015

Water Report

January 13, 2015

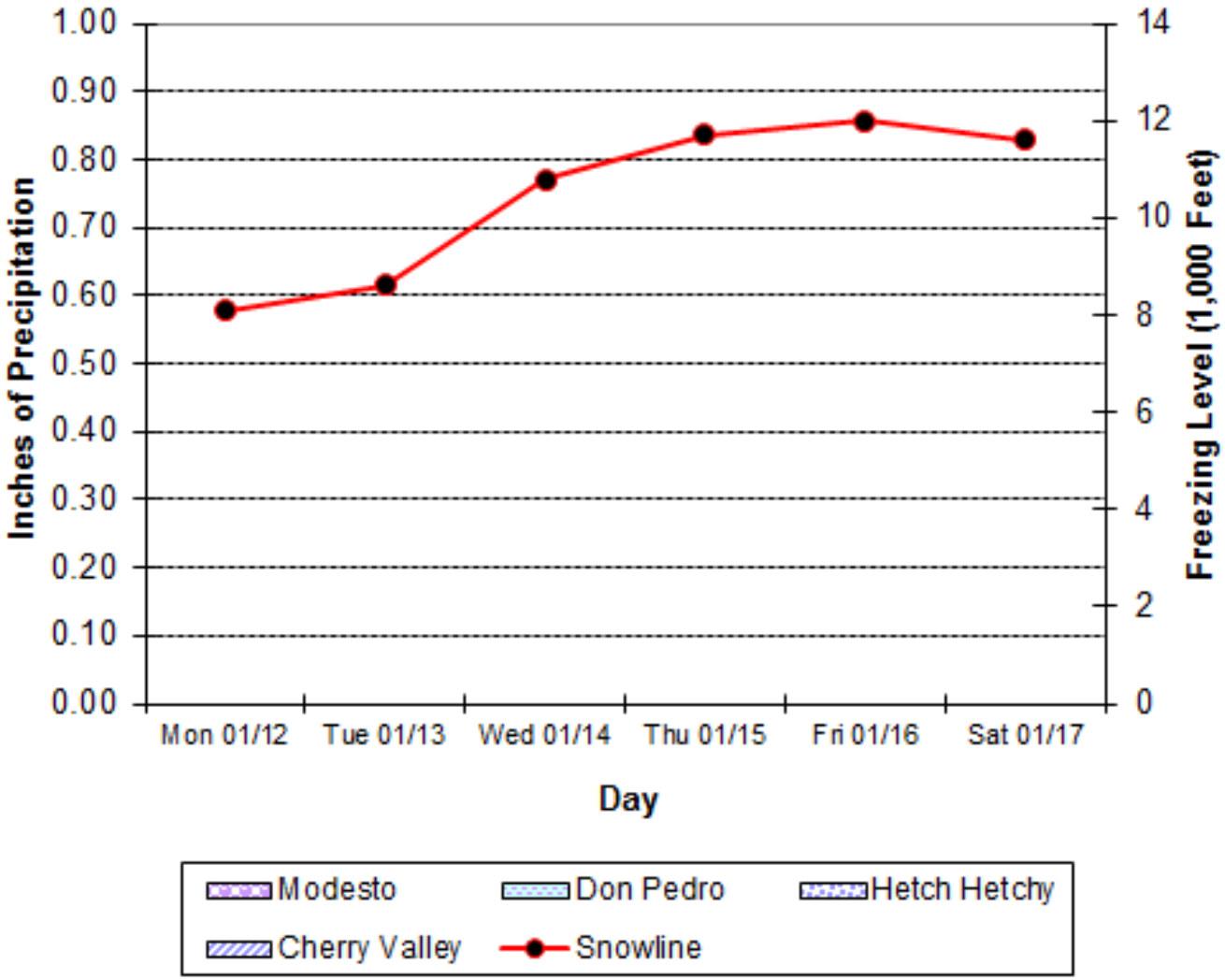
- Weather Forecast
- Status of Watershed
- CCSF Reservoir Storage and Operations
- Don Pedro Reservoir Storage and Operations

Precipitation Forecasts

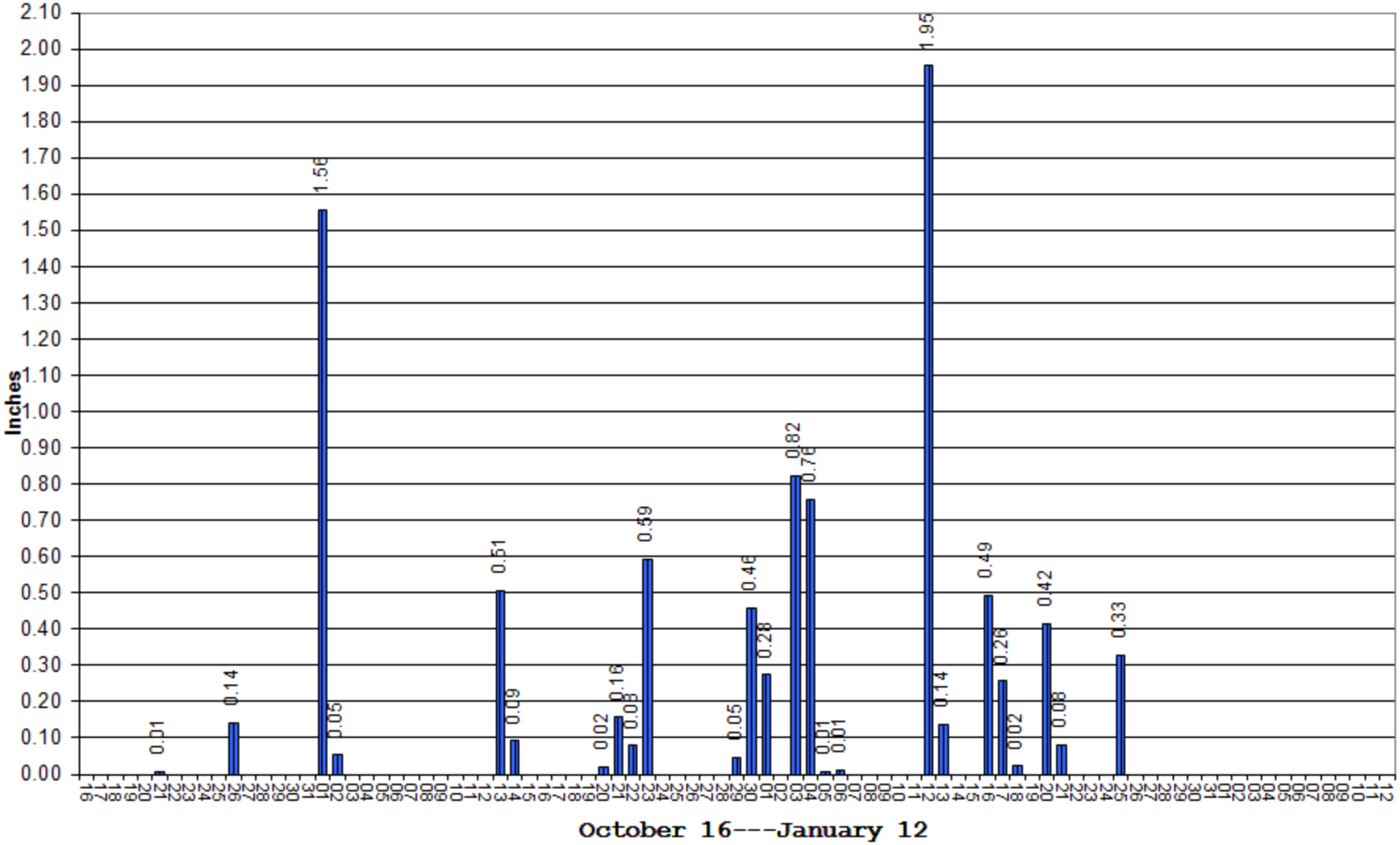


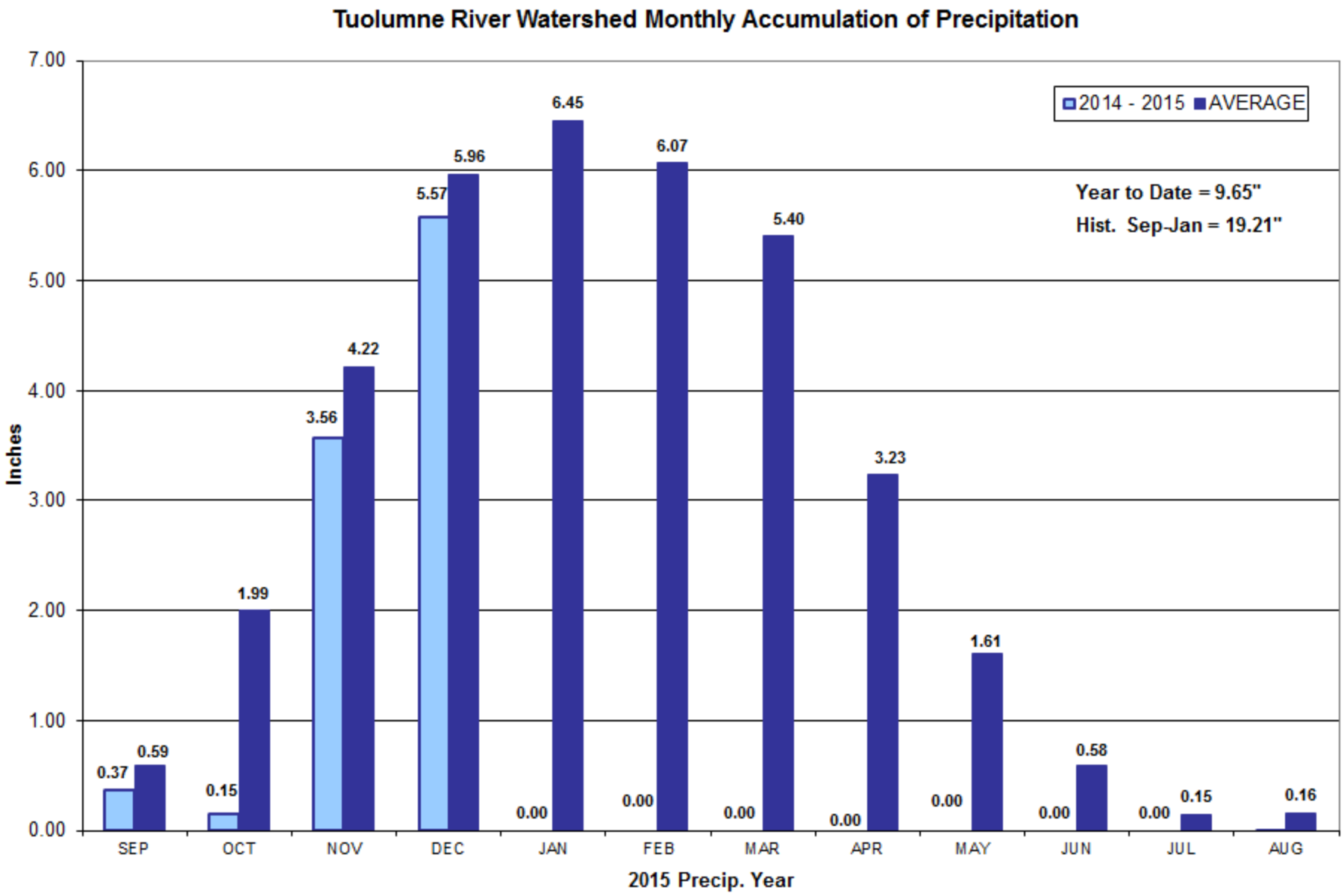
Precipitation forecasts from the National Centers for Environmental Prediction.
Normal rainfall derived from Xie-Arkin (CMAP) Monthly Climatology for 1979-2003.
Forecast Initialization Time: 12Z12JAN2015

GrADS: IGES/COLA

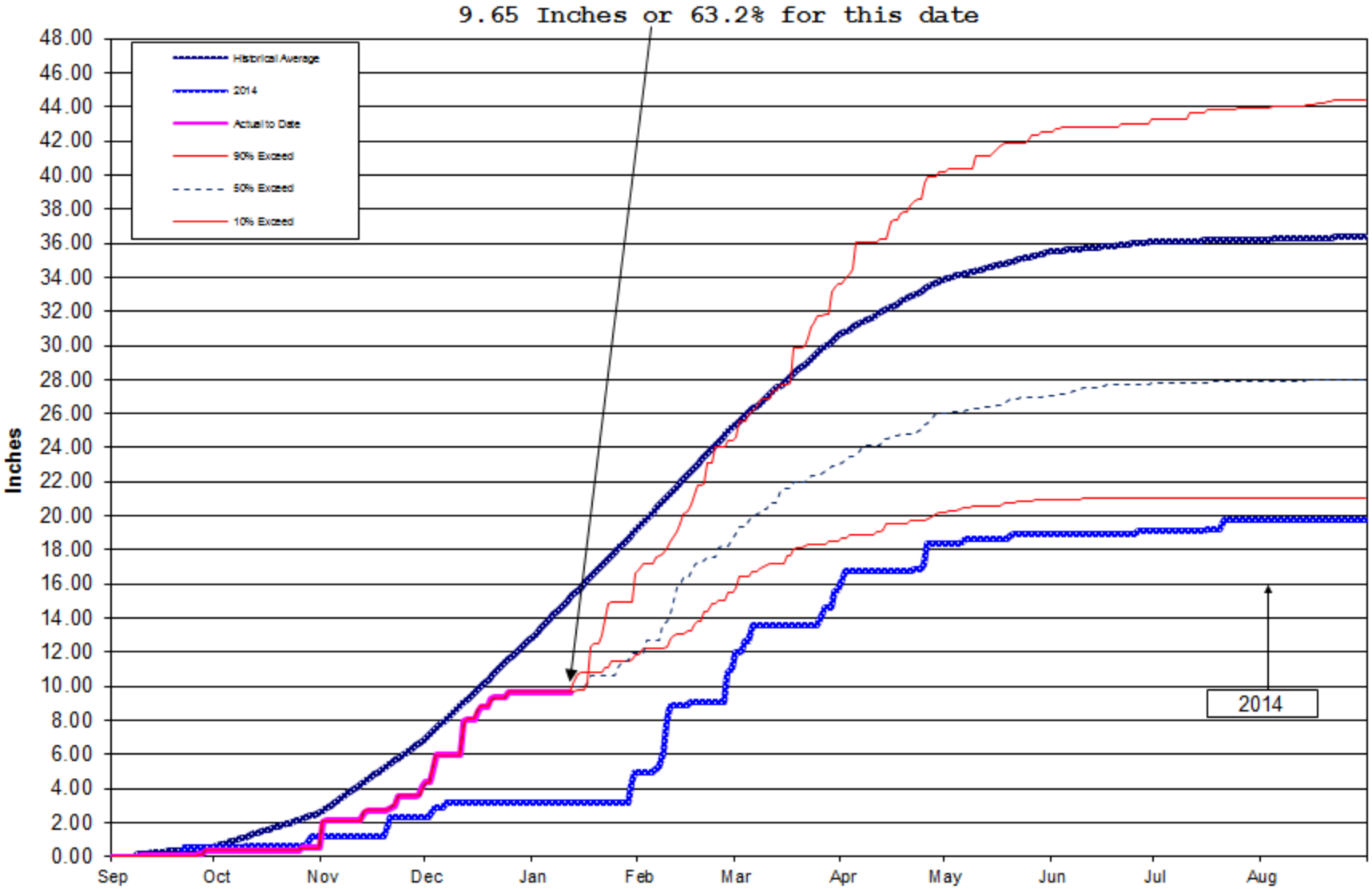

1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Inches of Precipitation
14
12
10
8
6
4
2
0
Freezing Level (1,000 Feet)
Mon 01/12
Tue 01/13
Wed 01/14
Thu 01/15
Fri 01/16
Sat 01/17
Day
Modesto
Don Pedro
Hetch Hetchy
Cherry Valley
Snowline

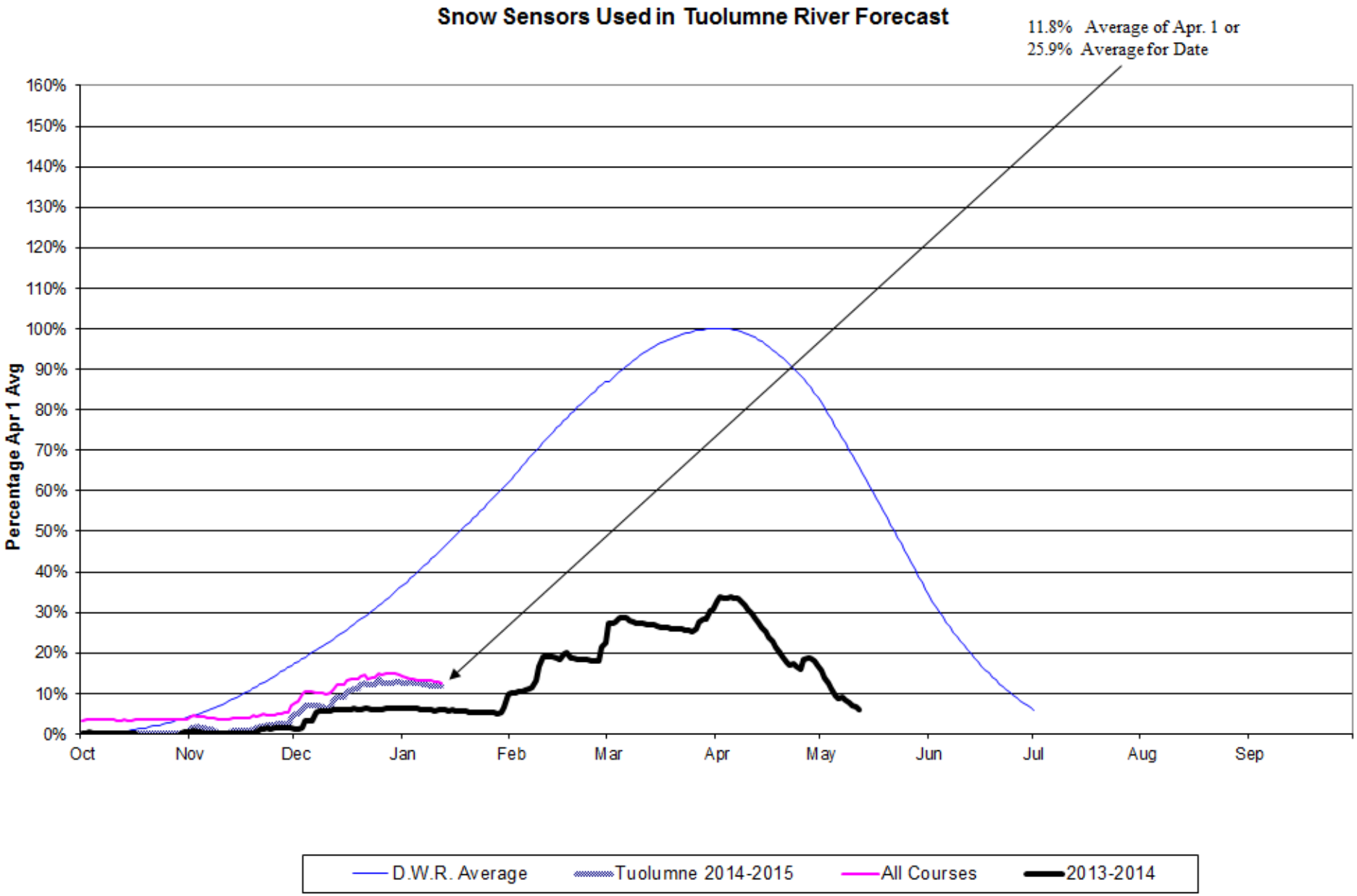
Watershed Daily Precipitation




Tuolumne River Watershed Monthly Accumulation of Precipitation
2014 - 2015
AVERAGE
Year to Date = 9.65"
Hist. Sep-Jan = 19.21"
Inches
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.37
0.59
0.15
1.99
3.56
4.22
5.57
5.96
0.00
6.45
0.00
6.07
0.00
5.40
0.00
3.23
0.00
1.61
0.00
0.58
0.00
0.15
0.16
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
2015 Precip. Year

Tuolumne River Watershed Accumulated Precipitation




Snow Sensors Used in Tuolumne River Forecast
11.8% Average of Apr. 1 or
25.9% Average for Date
Percentage Apr 1 Avg
160%
150%
140%
130%
120%
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
D.W.R. Average
Tuolumne 2014-2015
All Courses
2013-2014

WY2015 Computed Natural Flow

DAY	OCT CFS	NOV CFS	DEC CFS	JAN CFS	FEB CFS	MAR CFS	APR CFS	MAY CFS	JUN CFS	JULY CFS	AUG CFS	SEPT CFS
1	718	1,287	717	116								
2	(273)	41	491	598								
3	639	31	3,374	607								
4	(206)	(39)	5,040	(54)								
5	358	227	1,468	281								
6	(65)	111	1,012	903								
7	57	78	1,160	247								
8	(51)	42	762	863								
9	81	527	449	578								
10	(230)	(241)	293	575								
11	(47)	194	448	331								
12	122	(137)	2,024									
13	503	208	1,551									
14	19	(197)	779									
15	76	170	216									
16	(763)	145	1,394									
17	234	(226)	1,058									
18	181	65	450									
19	(47)	125	1,159									
20	125	162	635									
21	(4)	247	1,446									
22	(129)	163	1,331									
23	5	998	965									
24	(85)	178	1,614									
25	130	(57)	933									
26	105	(78)	1,413									
27	411	(41)	435									
28	94	39	596									
29	129	4	435									
30	(75)	487	966									
31	4		377									
Average C.F.S.	65	150	1,129	459								
Total Monthly A.F.	3,999	8,950	69,405	10,006								
DWR 50 YR Average A.F.	20,000	50,000	88,000	153,000	154,000	209,000	270,000	455,000	359,000	137,000	33,000	16,000

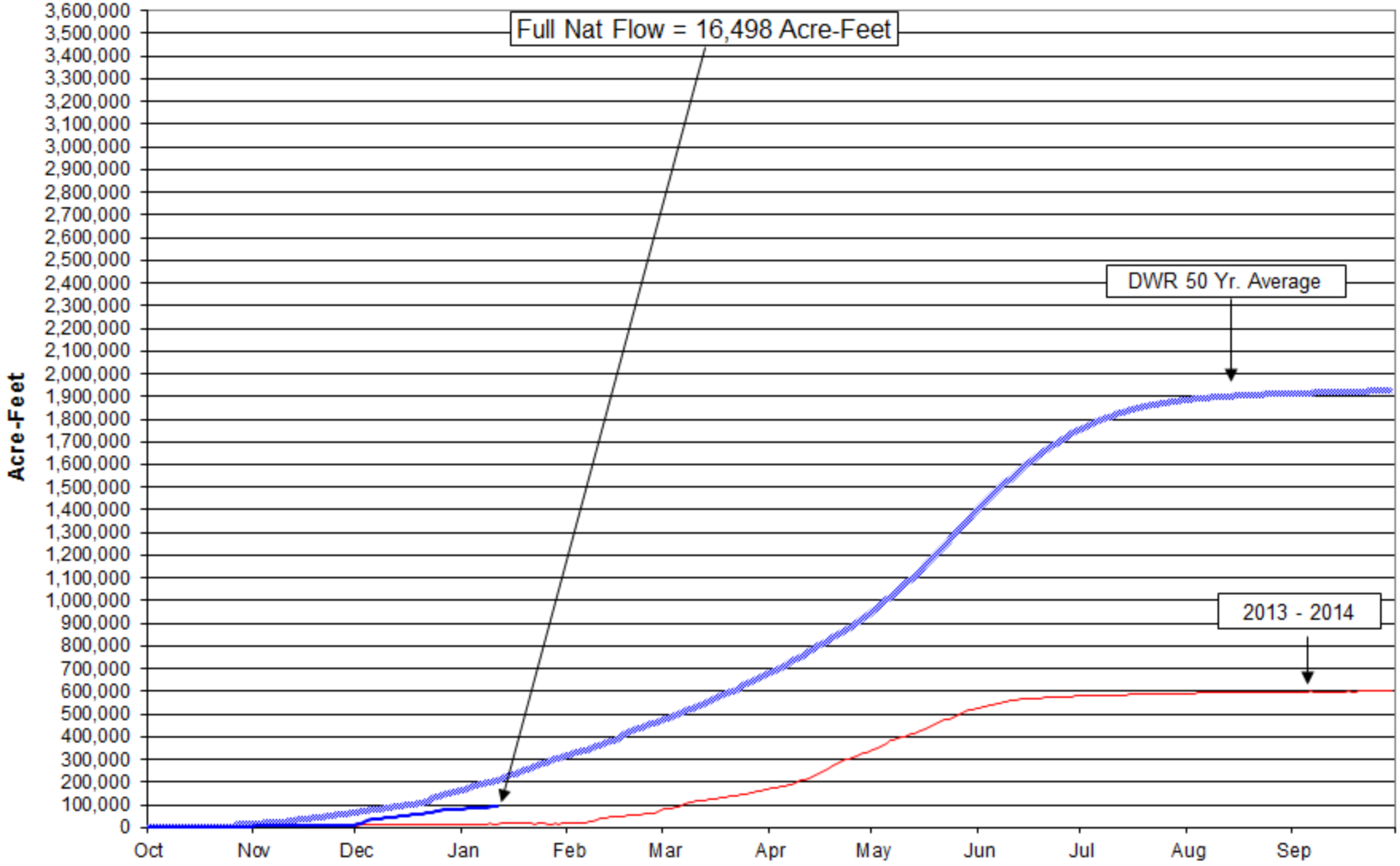
Total October-September Computed Natural Flow= 92,359 A.F.

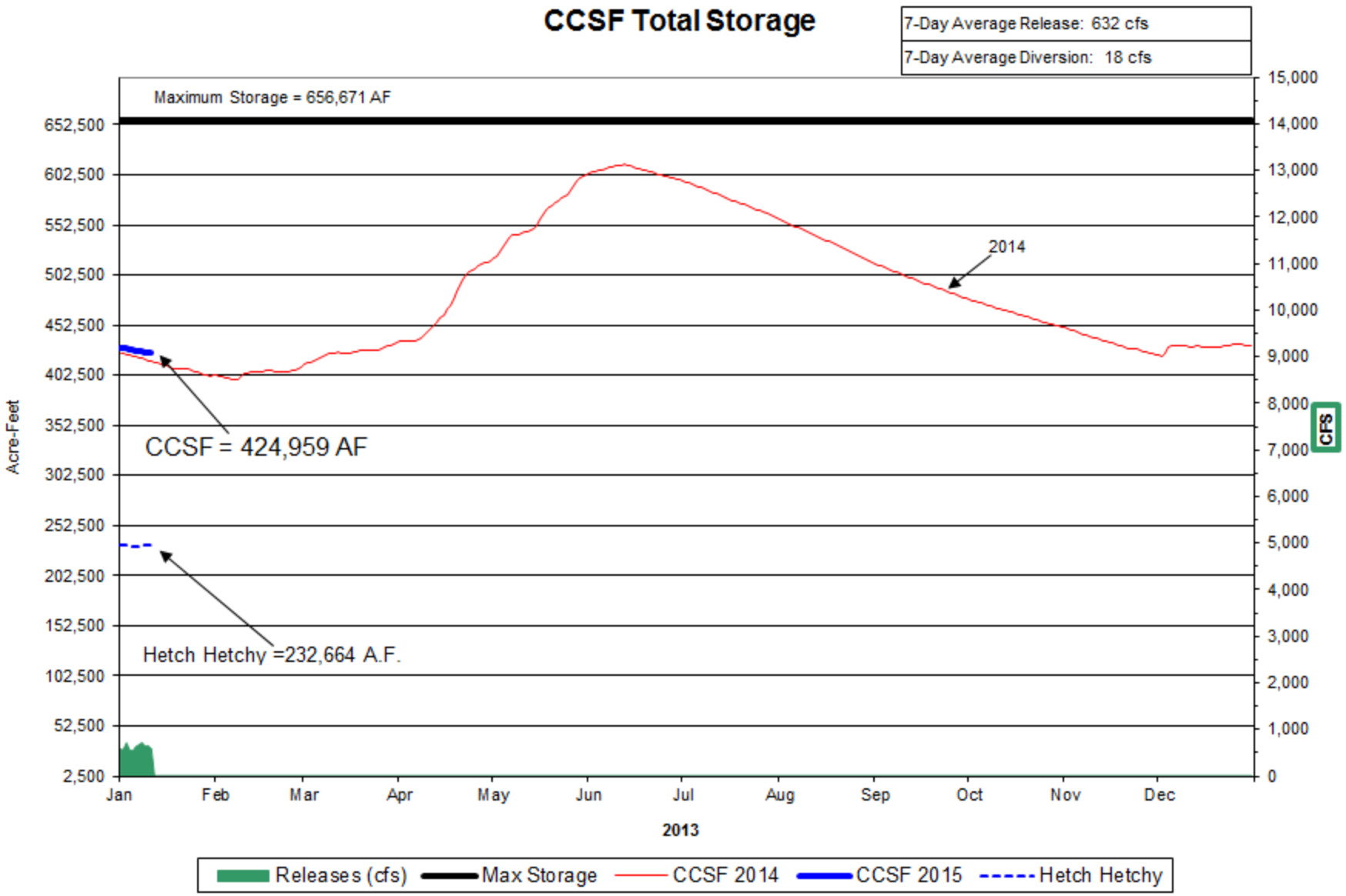
Remaining = 1,851,641

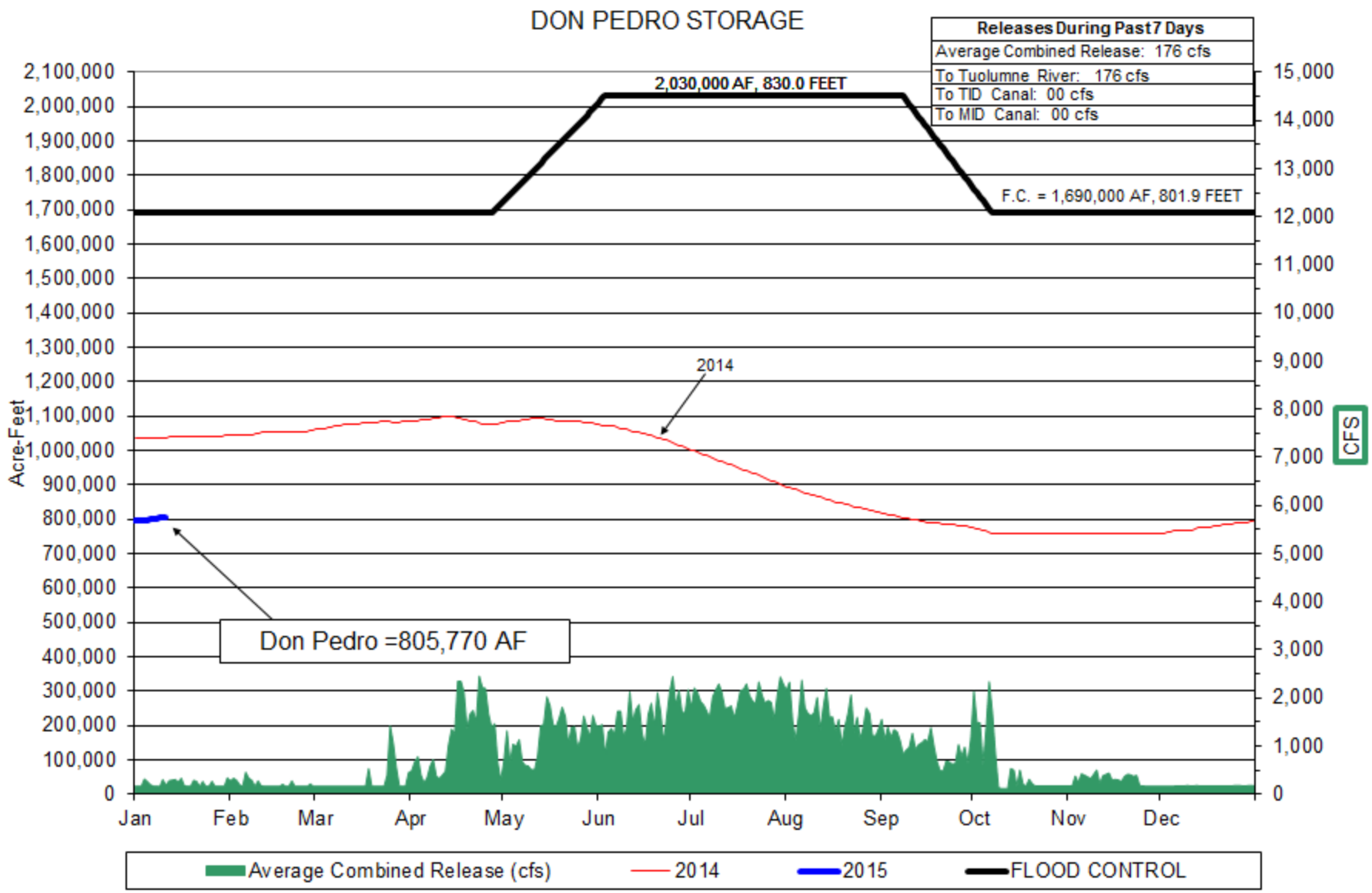
APR-JLY = 0 A.F.

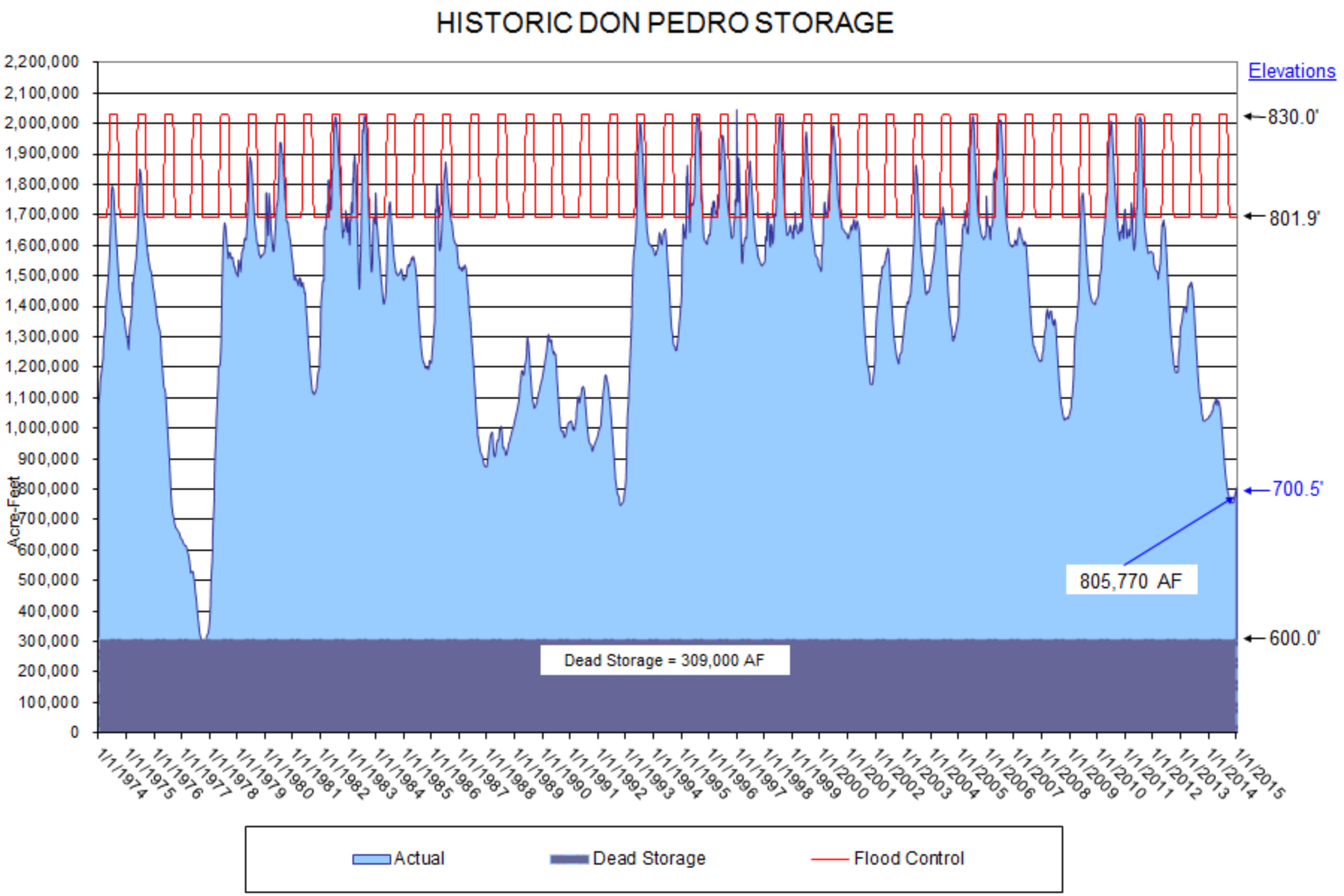
Remaining = 1,221,000

Full Natural Flow




CCSF Total Storage
7-Day Average Release: 632 cfs
7-Day Average Diversion: 18 cfs
Maximum Storage = 656,671 AF
652,500
602,500
552,500
502,500
452,500
402,500
352,500
302,500
252,500
202,500
152,500
102,500
52,500
2,500
Acre-Feet
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
CFS
2014
CCSF = 424,959 AF
Hetch Hetchy =232,664 A.F.
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2013
Releases (cfs)
Max Storage
CCSF 2014
CCSF 2015
Hetch Hetchy


DON PEDRO STORAGE
Releases During Past 7 Days
Average Combined Release: 176 cfs
To Tuolumne River: 176 cfs
To TID Canal: 00 cfs
To MID Canal: 00 cfs
2,030,000 AF, 830.0 FEET
F.C. = 1,690,000 AF, 801.9 FEET
2014
Don Pedro =805,770 AF
Acre-Feet
CFS
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Average Combined Release (cfs)
2014
2015
FLOOD CONTROL


HISTORIC DON PEDRO STORAGE
Elevations
830.0'
801.9'
700.5'
600.0'
805,770 AF
Dead Storage = 309,000 AF
Acre-Feet
2,200,000
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1/1/1974
1/1/1975
1/1/1976
1/1/1977
1/1/1978
1/1/1979
1/1/1980
1/1/1981
1/1/1982
1/1/1983
1/1/1984
1/1/1985
1/1/1986
1/1/1987
1/1/1988
1/1/1989
1/1/1990
1/1/1991
1/1/1992
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1/1/1999
1/1/2000
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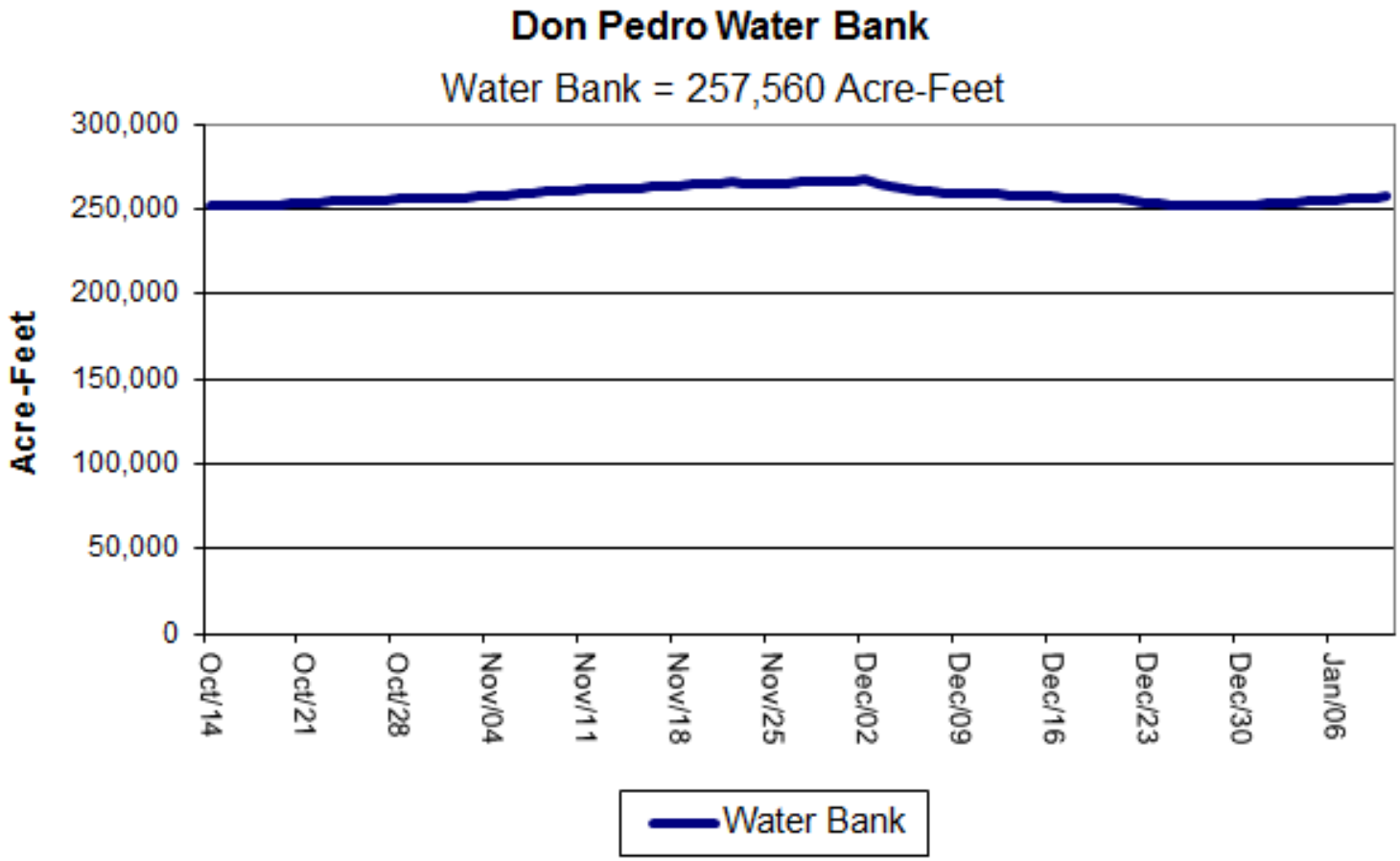
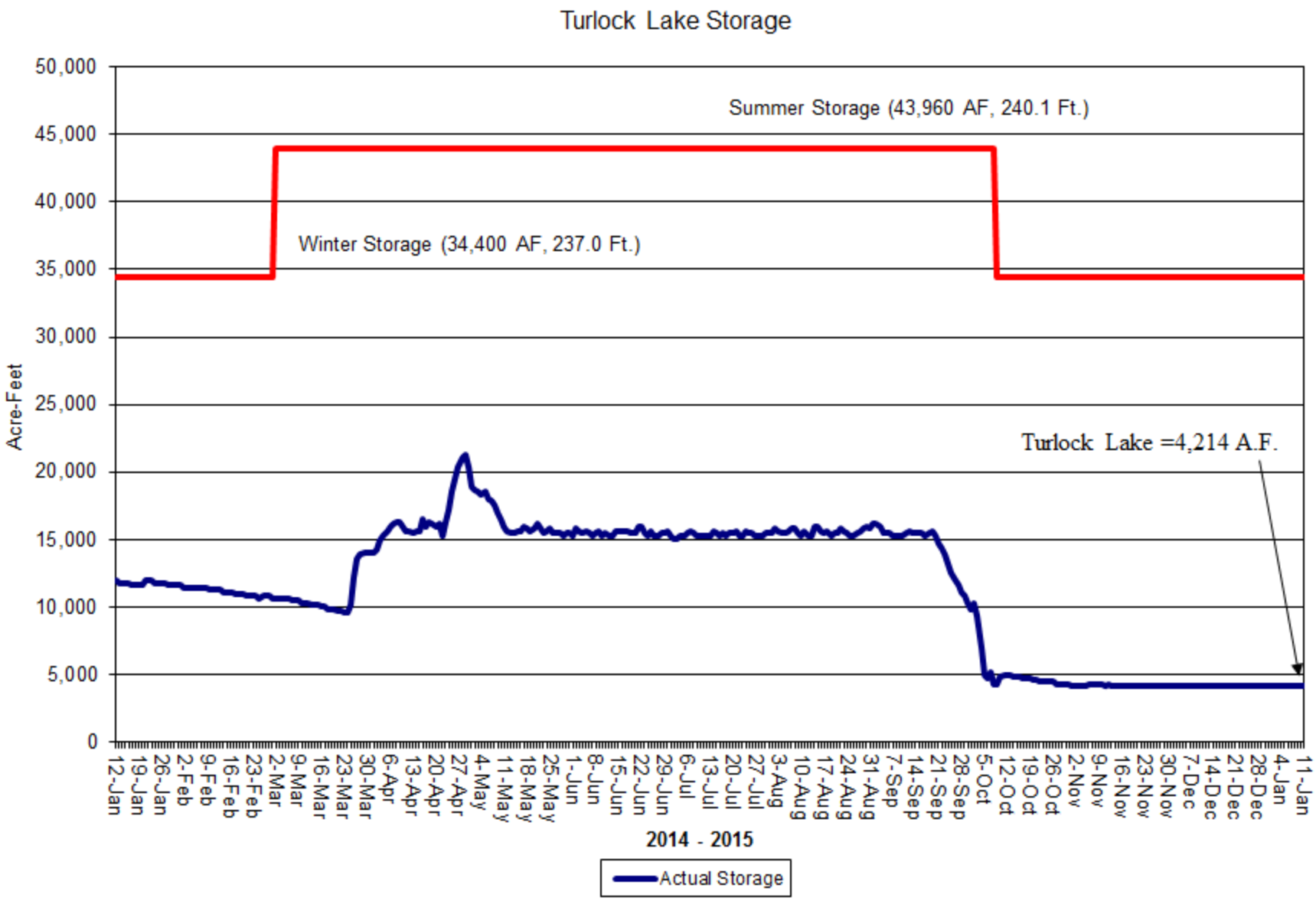
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Actual
Dead Storage
Flood Control


Don Pedro Water Bank
Water Bank = 257,560 Acre-Feet
Acre-Feet
300,000
250,000
200,000
150,000
100,000
50,000
0
Oct/14
Oct/21
Oct/28
Nov/04
Nov/11
Nov/18
Nov/25
Dec/02
Dec/09
Dec/16
Dec/23
Dec/30
Jan/06
Water Bank


Turlock Lake Storage
Summer Storage (43,960 AF, 240.1 Ft.)
Winter Storage (34,400 AF, 237.0 Ft.)
Turlock Lake =4,214 A.F.
Acre-Feet
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
12-Jan
19-Jan
26-Jan
2-Feb
9-Feb
16-Feb
23-Feb
2-Mar
9-Mar
16-Mar
23-Mar
30-Mar
6-Apr
13-Apr
20-Apr
27-Apr
4-May
11-May
18-May
25-May
1-Jun
8-Jun
15-Jun
22-Jun
29-Jun
6-Jul
13-Jul
20-Jul
27-Jul
3-Aug
10-Aug
17-Aug
24-Aug
31-Aug
7-Sep
14-Sep
21-Sep
28-Sep
5-Oct
12-Oct
19-Oct
26-Oct
2-Nov
9-Nov
16-Nov
23-Nov
30-Nov
7-Dec
14-Dec
21-Dec
28-Dec
4-Jan
11-Jan
2014 - 2015
Actual Storage

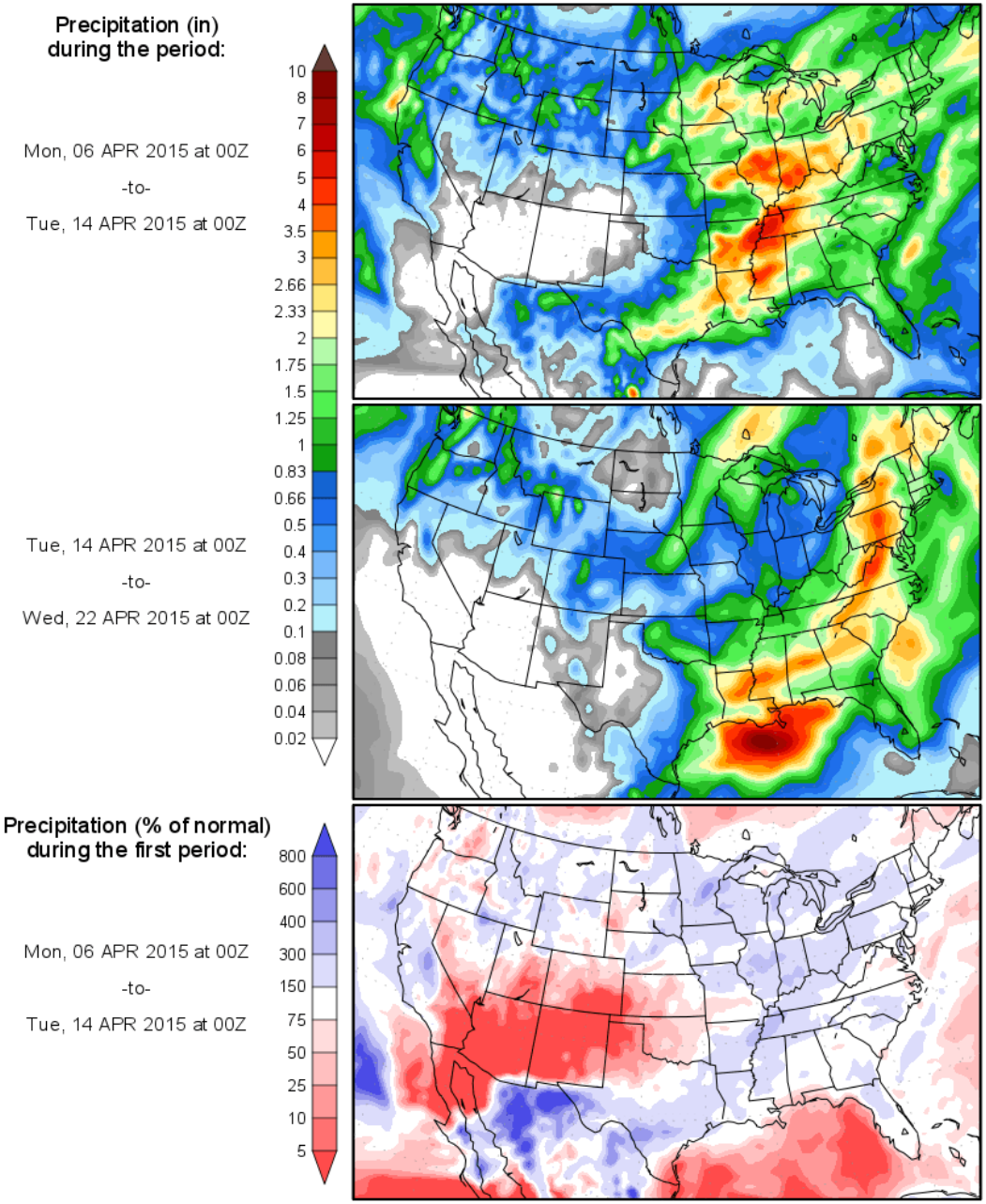
WATER REPORT FOR 4/7/2015

Water Report

April 7, 2015

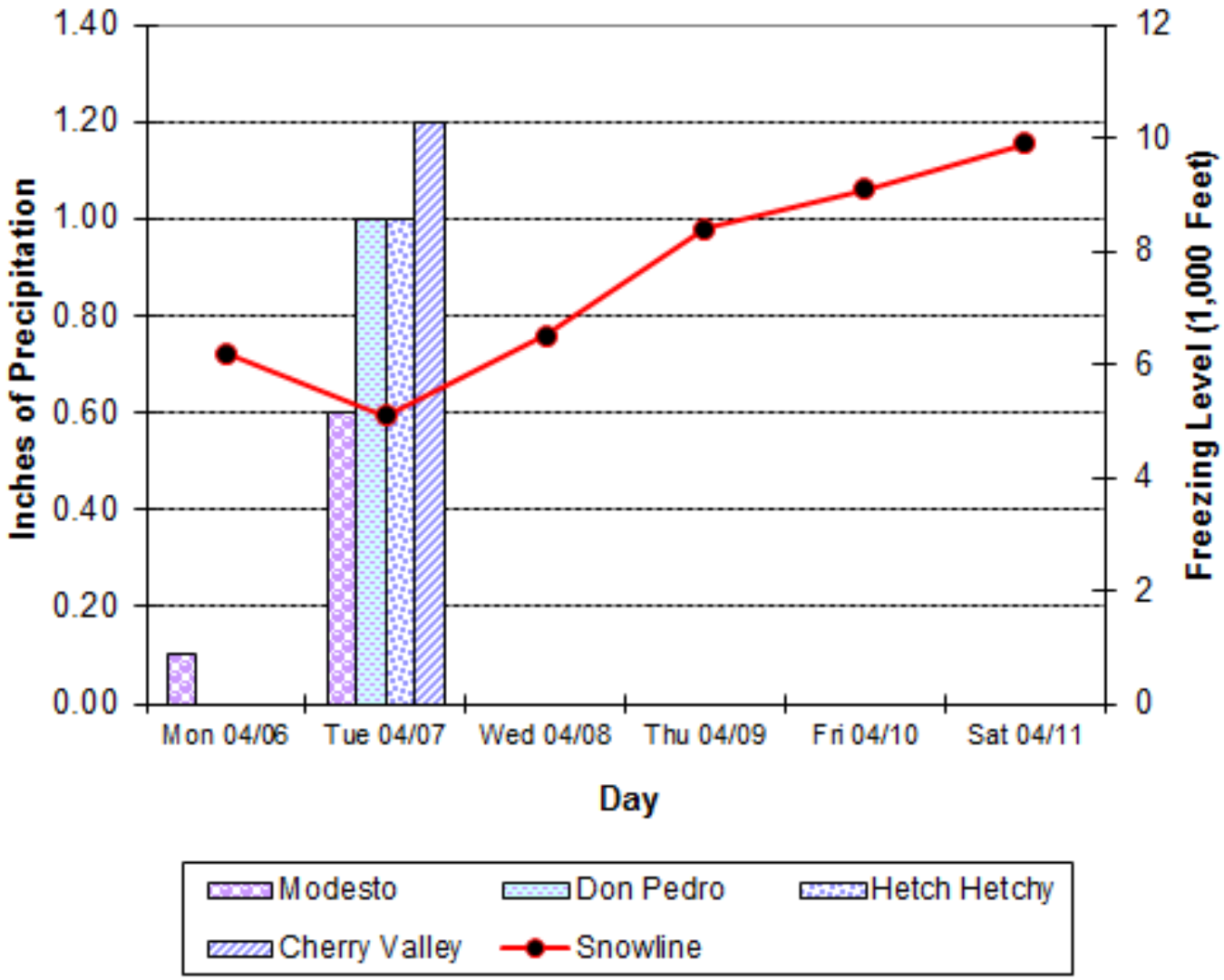
- Weather Forecast
- Status of Watershed
- CCSF Reservoir Storage and Operations
- Don Pedro Reservoir Storage and Operations

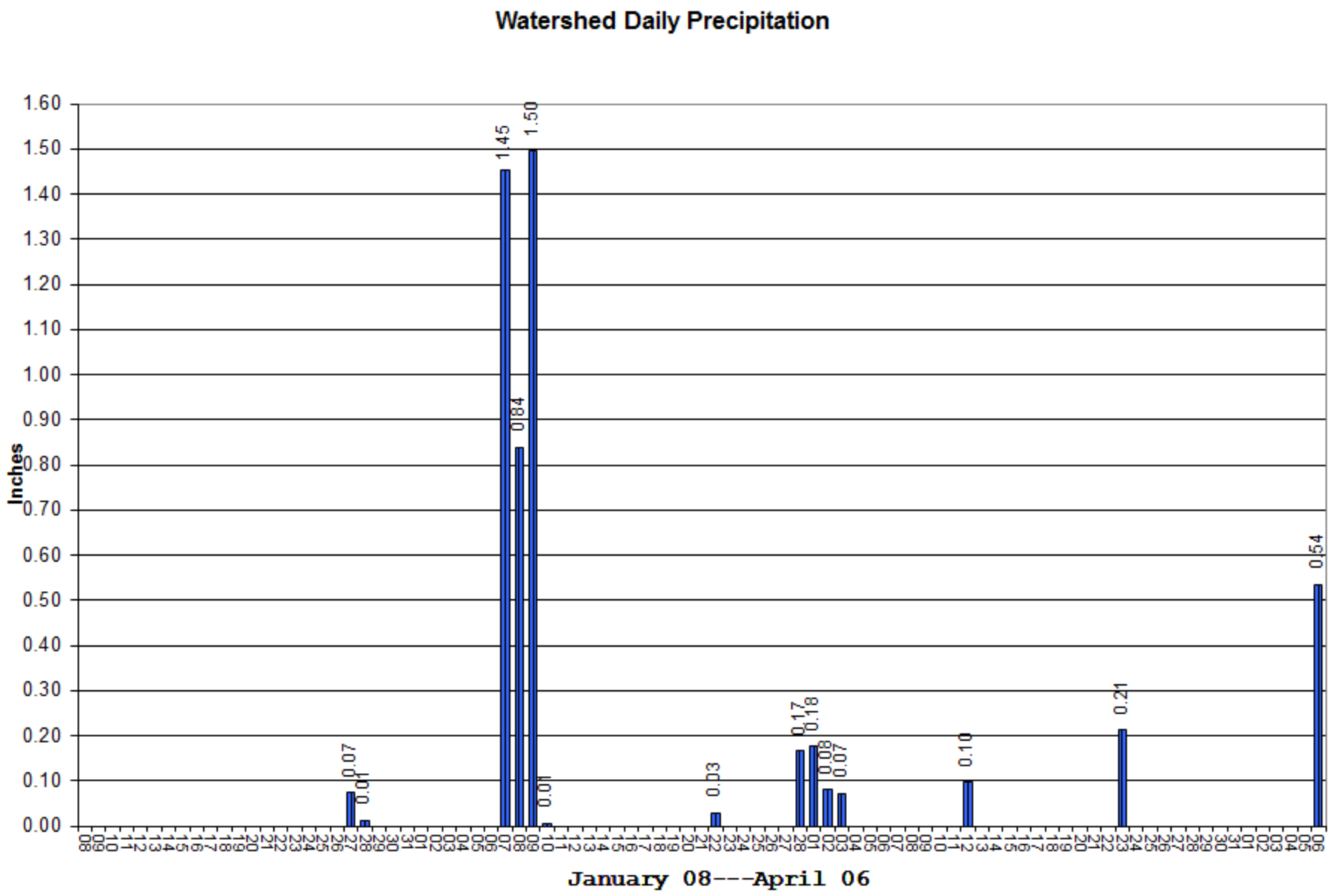
Precipitation Forecasts

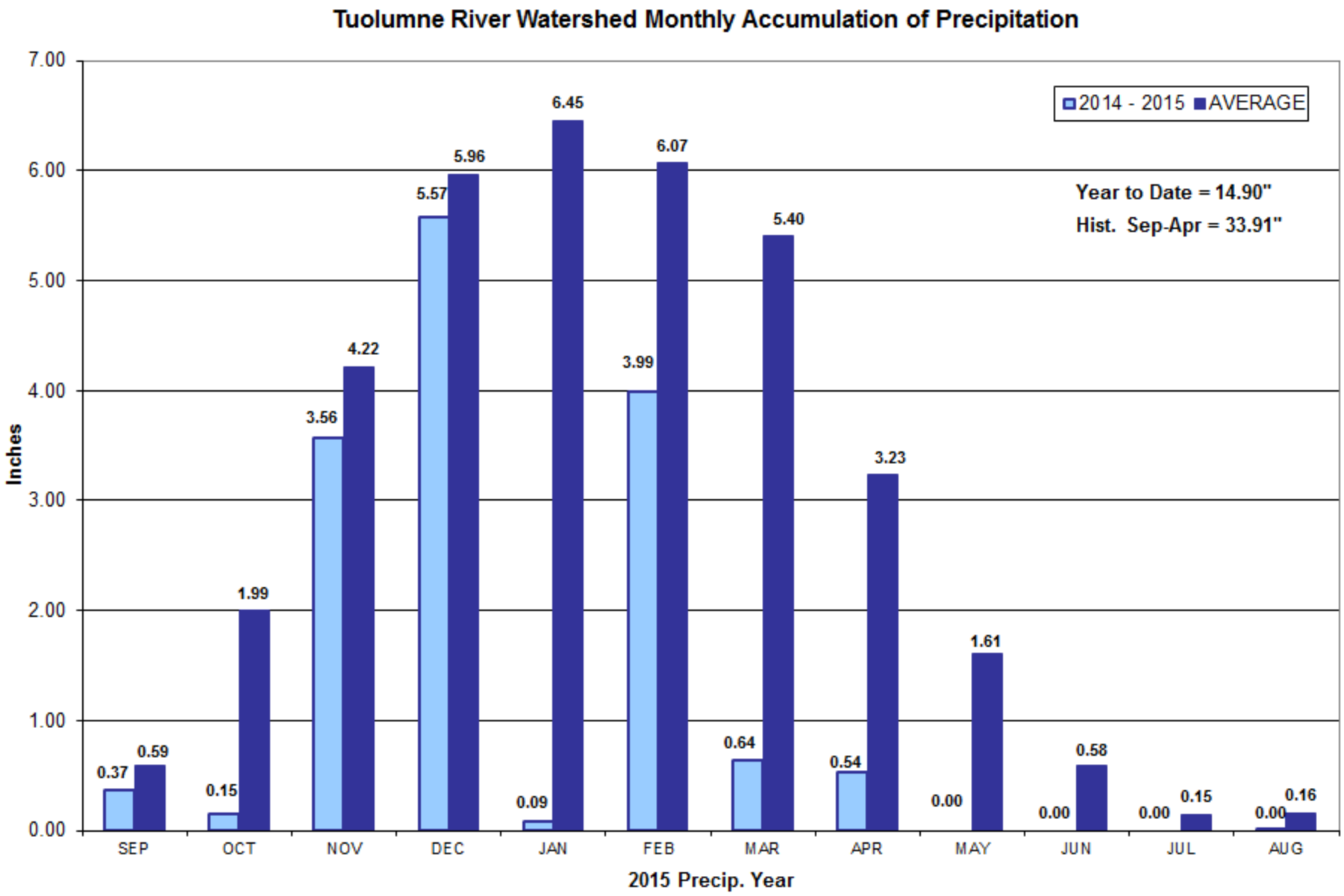


Precipitation forecasts from the National Centers for Environmental Prediction.
Normal rainfall derived from Xie-Arkin (CMAP) Monthly Climatology for 1979-2003.
Forecast Initialization Time: 00Z06APR2015

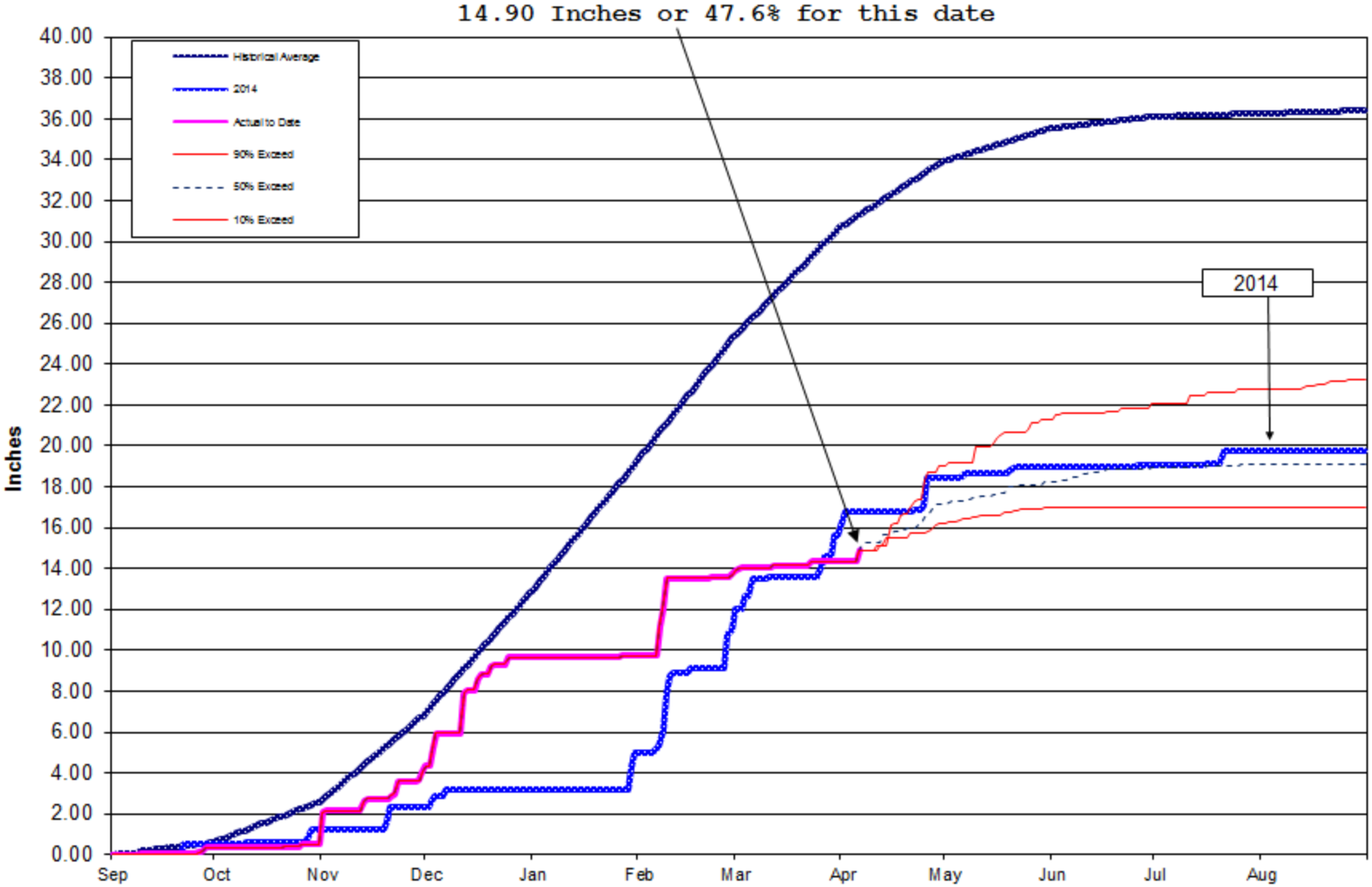
GrADS: IGES/COLA

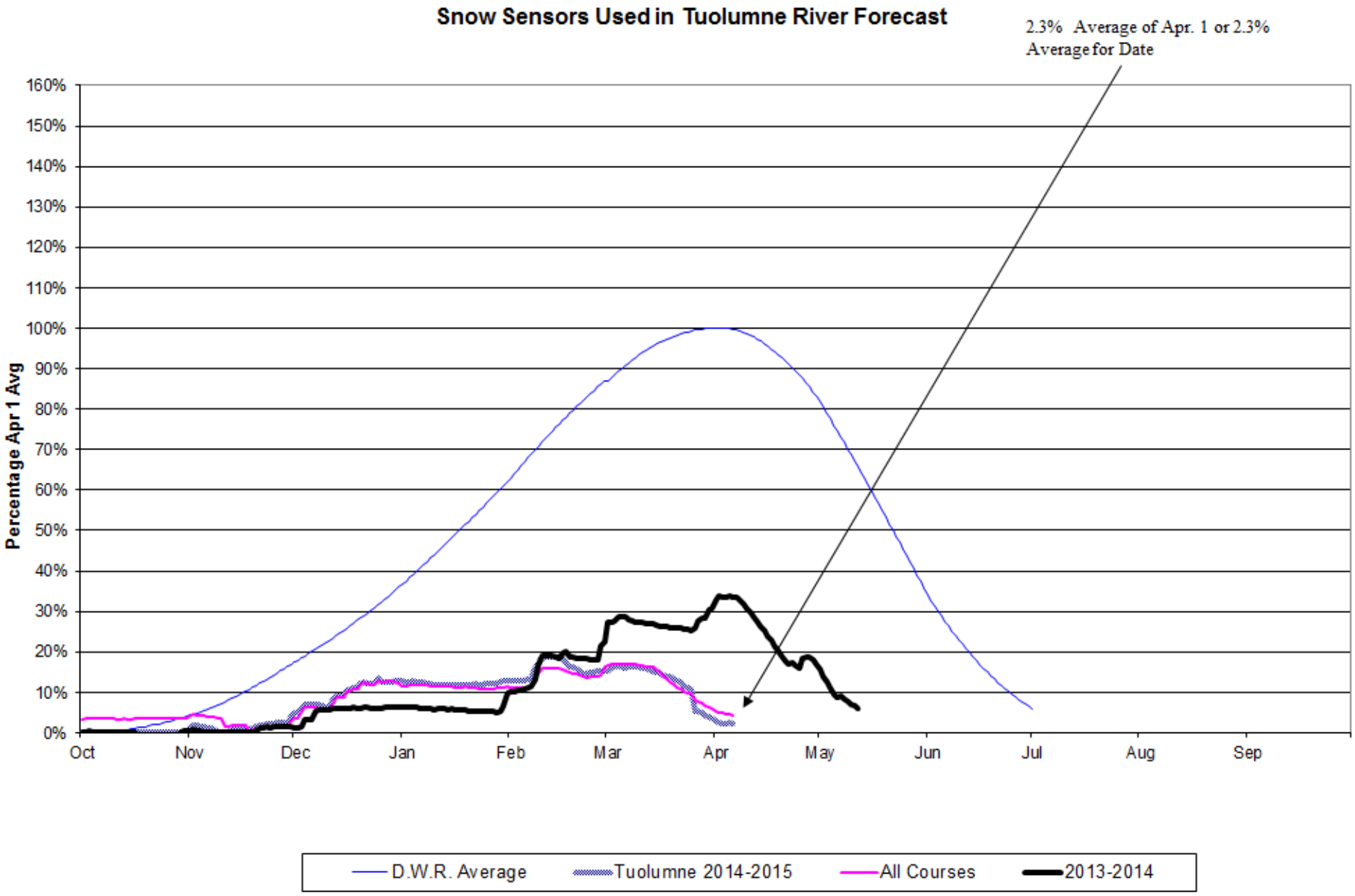

1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Inches of Precipitation
12
10
8
6
4
2
0
Freezing Level (1,000 Feet)
Mon 04/06
Tue 04/07
Wed 04/08
Thu 04/09
Fri 04/10
Sat 04/11
Day
Modesto
Don Pedro
Hetch Hetchy
Cherry Valley
Snowline


Watershed Daily Precipitation
Inches
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.07
0.01
1.45
0.84
1.50
0.01
0.03
0.17
0.18
0.08
0.07
0.10
0.21
0.54
January 08---April 06


Tuolumne River Watershed Monthly Accumulation of Precipitation
2014 - 2015
AVERAGE
Year to Date = 14.90"
Hist. Sep-Apr = 33.91"
Inches
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.37
0.59
0.15
1.99
3.56
4.22
5.57
5.96
0.09
6.45
3.99
6.07
0.64
5.40
0.54
3.23
0.00
1.61
0.00
0.58
0.00
0.15
0.00
0.16
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
2015 Precip. Year

Tuolumne River Watershed Accumulated Precipitation




Snow Sensors Used in Tuolumne River Forecast
2.3% Average of Apr. 1 or 2.3% Average for Date
Percentage Apr 1 Avg
160%
150%
140%
130%
120%
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
D.W.R. Average
Tuolumne 2014-2015
All Courses
2013-2014

WY2015 Computed Natural Flow

DAY	OCT CFS	NOV CFS	DEC CFS	JAN CFS	FEB CFS	MAR CFS	APR CFS	MAY CFS	JUN CFS	JULY CFS	AUG CFS	SEPT CFS
1	718	1,287	717	116	555	953	1,310					
2	(273)	41	491	598	450	1,134	1,225					
3	639	31	3,374	607	221	706	627					
4	(206)	(39)	5,040	(54)	241	(414)	931					
5	358	227	1,468	281	310	740	1,005					
6	(65)	111	1,012	903	884	492						
7	57	78	1,160	247	2,177	589						
8	(51)	42	762	863	9,013	754						
9	81	527	449	578	13,181	839						
10	(230)	(241)	293	575	6,039	619						
11	(47)	194	448	331	3,176	465						
12	122	(137)	2,024	505	1,895	1,014						
13	503	208	1,551	499	2,029	842						
14	19	(197)	779	531	1,806	544						
15	76	170	216	456	1,596	1,277						
16	(763)	145	1,394	205	1,291	1,051						
17	234	(226)	1,058	369	1,430	1,362						
18	181	65	450	204	1,666	1,370						
19	(47)	125	1,159	536	739	920						
20	125	162	635	242	1,302	1,408						
21	(4)	247	1,446	299	1,356	841						
22	(129)	163	1,331	37	1,257	920						
23	5	998	965	460	350	1,448						
24	(85)	178	1,614	6	703	756						
25	130	(57)	933	441	1,105	1,076						
26	105	(78)	1,413	197	755	1,044						
27	411	(41)	435	467	947	420						
28	94	39	596	546	725	1,456						
29	129	4	435	390		1,021						
30	(75)	487	966	199		1,600						
31	4		377	425		1,419						
Average C.F.S.	65	150	1,129	389	2,043	925	1,020					
Total Monthly A.F.	3,999	8,950	69,405	23,916	113,459	56,857	10,114					
DWR 50 YR Average A.F.	20,000	50,000	88,000	153,000	154,000	209,000	270,000	455,000	359,000	137,000	33,000	16,000

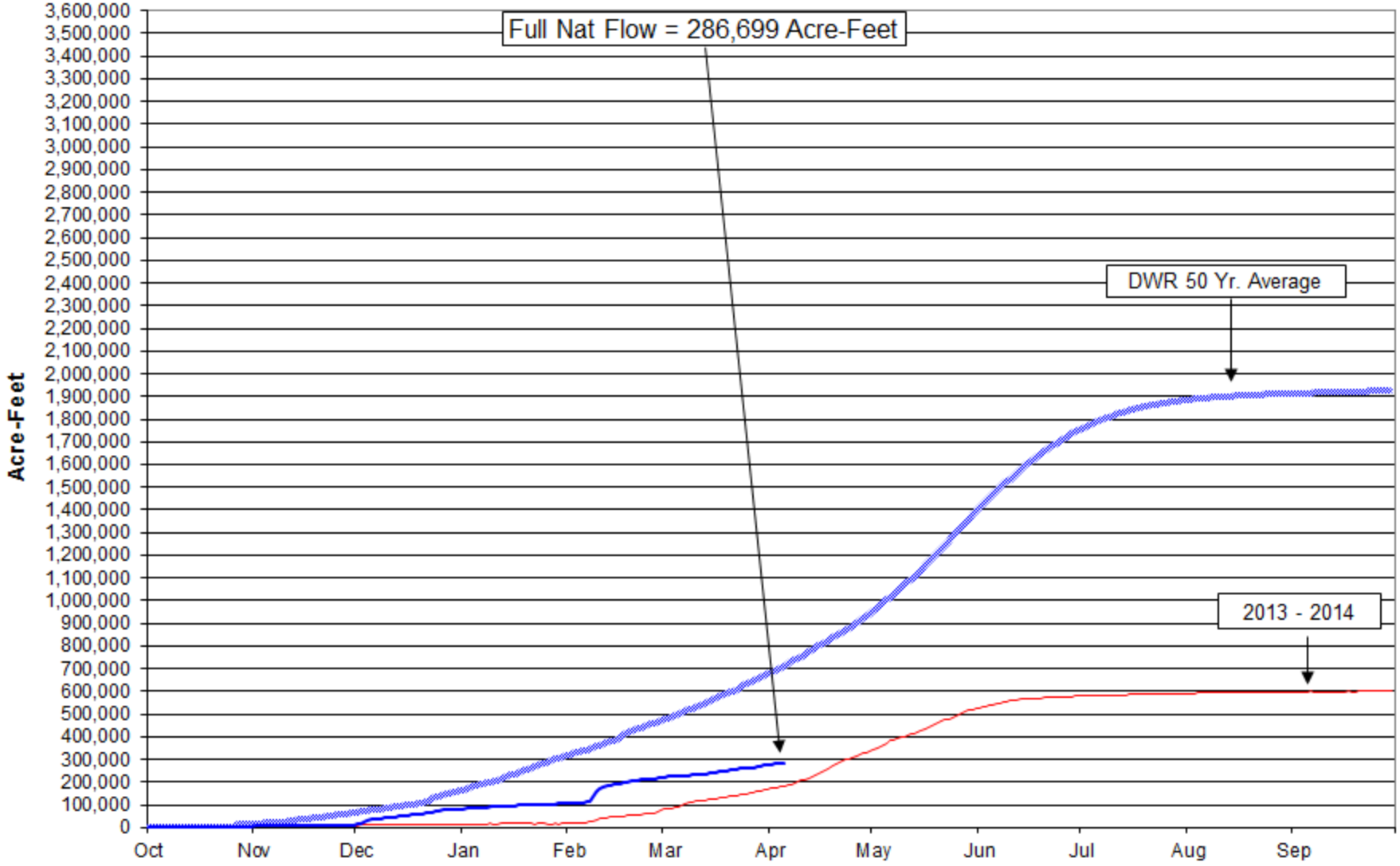
Total October-September Computed Natural Flow= 286,699 A.F.

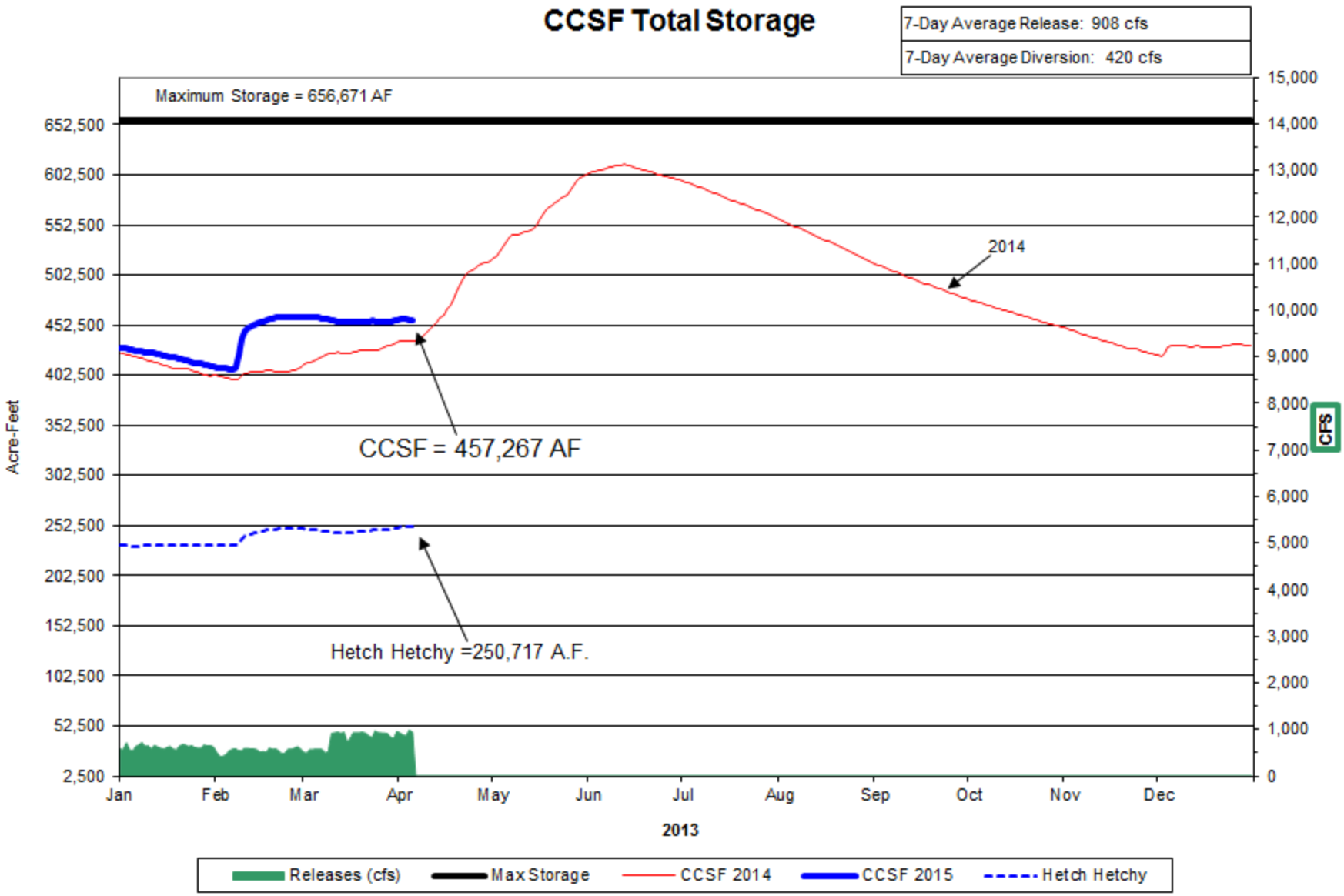
Remaining = 1,657,301

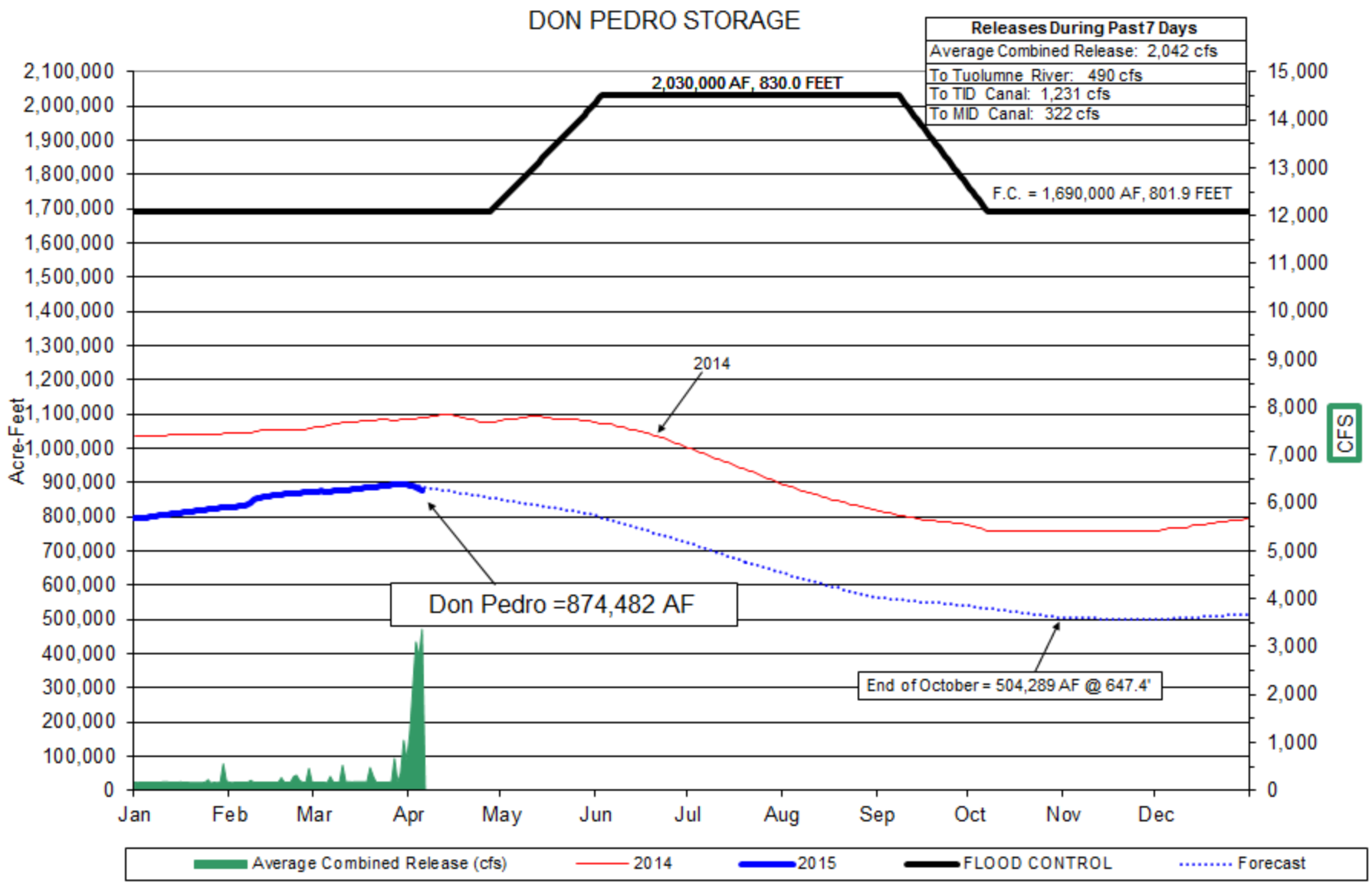
APR-JLY = 10,114 A.F.

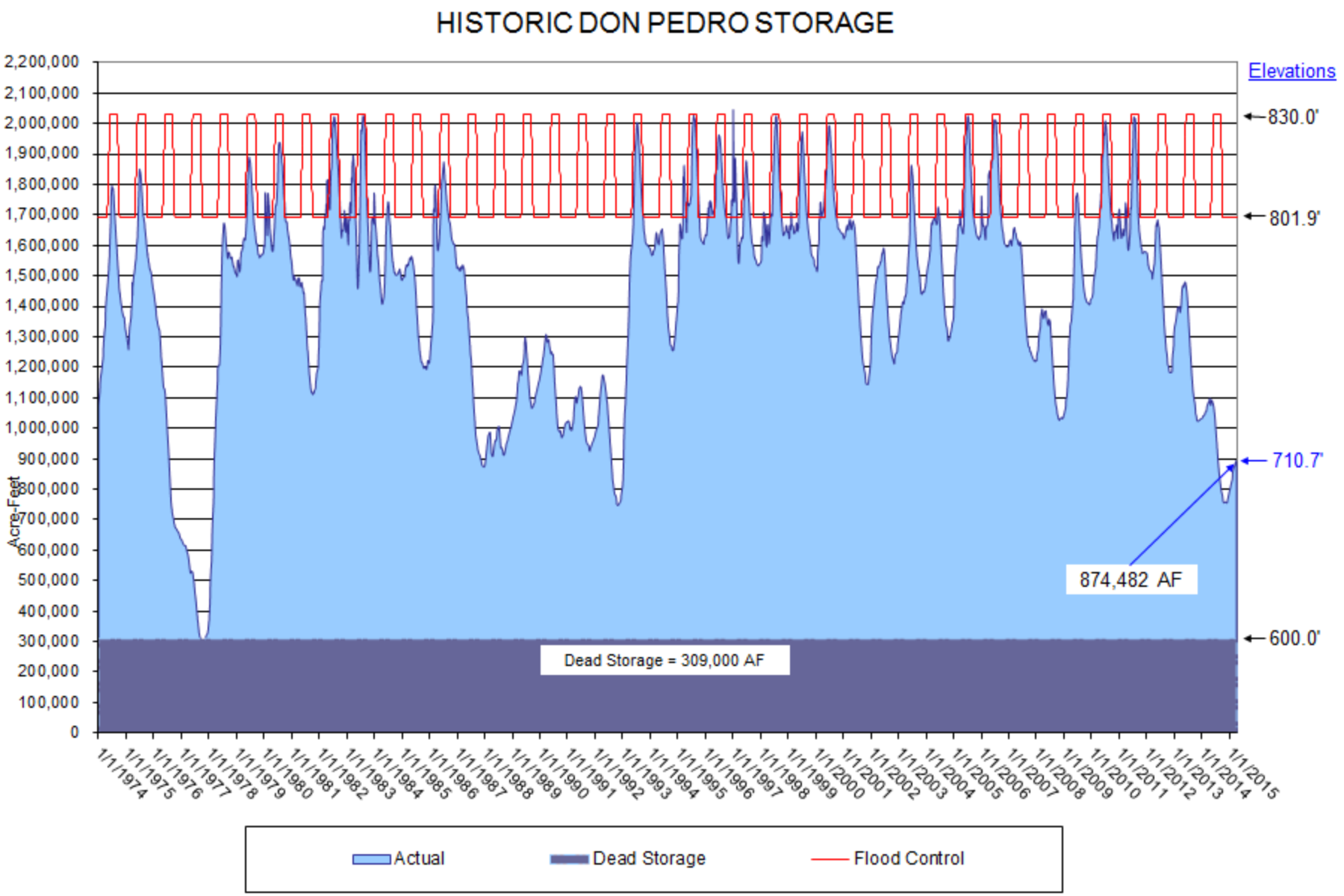
Remaining = 1,210,886

Full Natural Flow




CCSF Total Storage
7-Day Average Release: 908 cfs
7-Day Average Diversion: 420 cfs
Maximum Storage = 656,671 AF
652,500
602,500
552,500
502,500
452,500
402,500
352,500
302,500
252,500
202,500
152,500
102,500
52,500
2,500
Acre-Feet
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
CFS
2014
CCSF = 457,267 AF
Hetch Hetchy =250,717 A.F.
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2013
Releases (cfs)
Max Storage
CCSF 2014
CCSF 2015
Hetch Hetchy


DON PEDRO STORAGE
Releases During Past 7 Days
Average Combined Release: 2,042 cfs
To Tuolumne River: 490 cfs
To TID Canal: 1,231 cfs
To MID Canal: 322 cfs
2,030,000 AF, 830.0 FEET
F.C. = 1,690,000 AF, 801.9 FEET
2014
Don Pedro =874,482 AF
End of October = 504,289 AF @ 647.4'
Acre-Feet
CFS
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Average Combined Release (cfs)
2014
2015
FLOOD CONTROL
Forecast


HISTORIC DON PEDRO STORAGE
Elevations
830.0'
801.9'
710.7'
600.0'
874,482 AF
Dead Storage = 309,000 AF
Acre-Feet
2,200,000
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1/1/1974
1/1/1975
1/1/1976
1/1/1977
1/1/1978
1/1/1979
1/1/1980
1/1/1981
1/1/1982
1/1/1983
1/1/1984
1/1/1985
1/1/1986
1/1/1987
1/1/1988
1/1/1989
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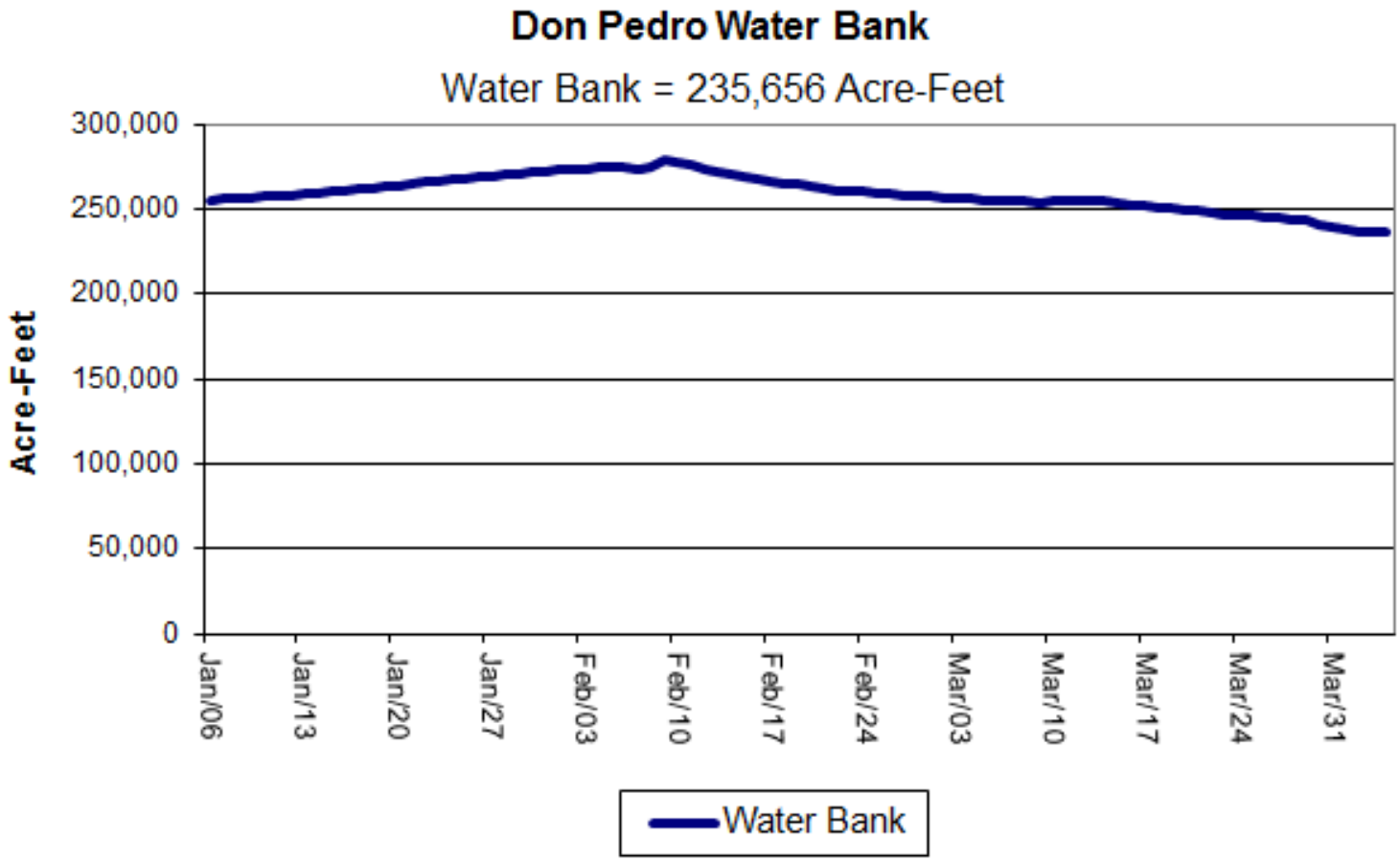
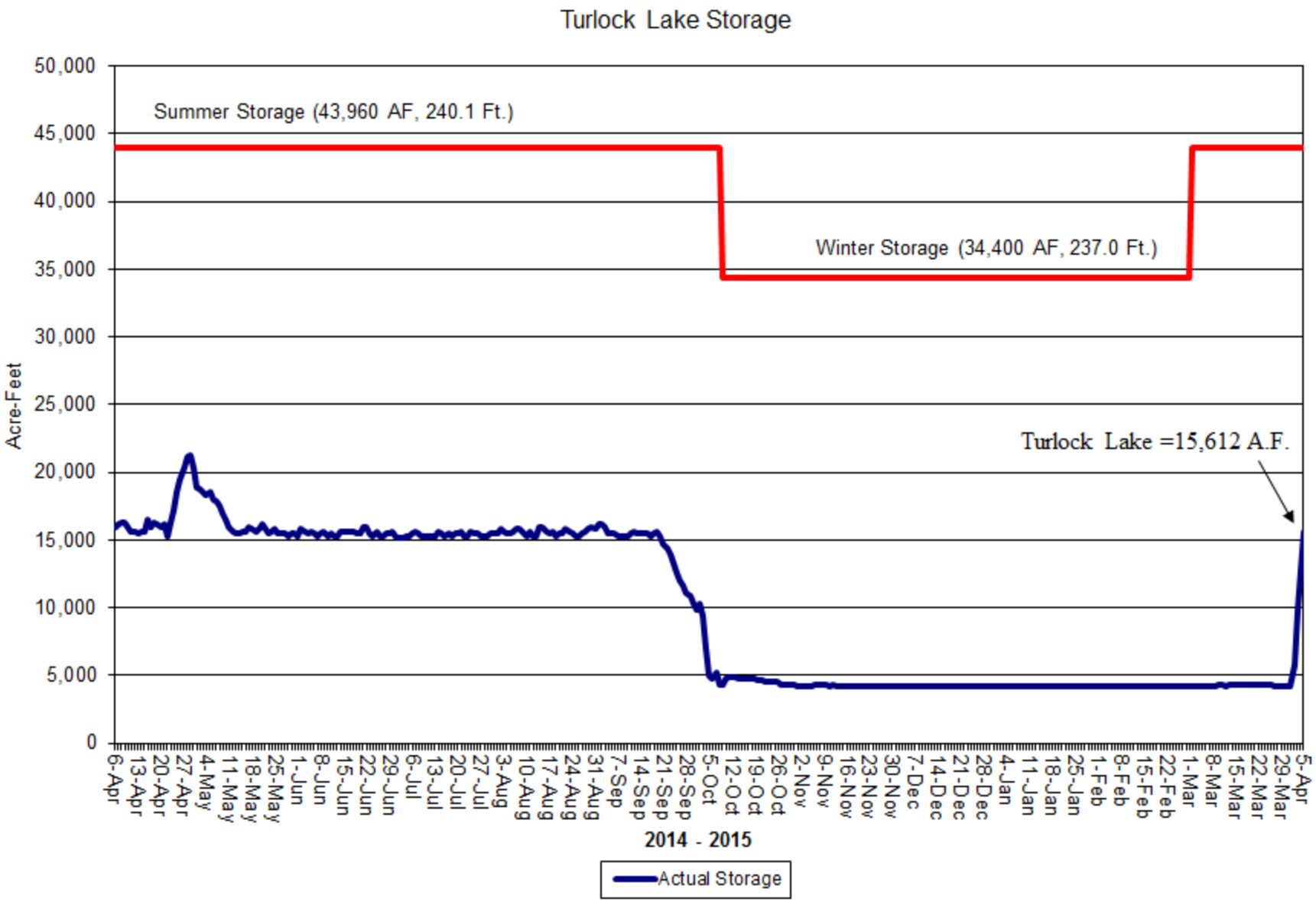
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Actual
Dead Storage
Flood Control


Don Pedro Water Bank
Water Bank = 235,656 Acre-Feet
Acre-Feet
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan/06
Jan/13
Jan/20
Jan/27
Feb/03
Feb/10
Feb/17
Feb/24
Mar/03
Mar/10
Mar/17
Mar/24
Mar/31
Water Bank


Turlock Lake Storage
Summer Storage (43,960 AF, 240.1 Ft.)
Winter Storage (34,400 AF, 237.0 Ft.)
Turlock Lake =15,612 A.F.
Acre-Feet
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
6-Apr
13-Apr
20-Apr
27-Apr
4-May
11-May
18-May
25-May
1-Jun
8-Jun
15-Jun
22-Jun
29-Jun
6-Jul
13-Jul
20-Jul
27-Jul
3-Aug
10-Aug
17-Aug
24-Aug
31-Aug
7-Sep
14-Sep
21-Sep
28-Sep
5-Oct
12-Oct
19-Oct
26-Oct
2-Nov
9-Nov
16-Nov
23-Nov
30-Nov
7-Dec
14-Dec
21-Dec
28-Dec
4-Jan
11-Jan
18-Jan
25-Jan
1-Feb
8-Feb
15-Feb
22-Feb
1-Mar
8-Mar
15-Mar
22-Mar
29-Mar
5-Apr
2014 - 2015
Actual Storage

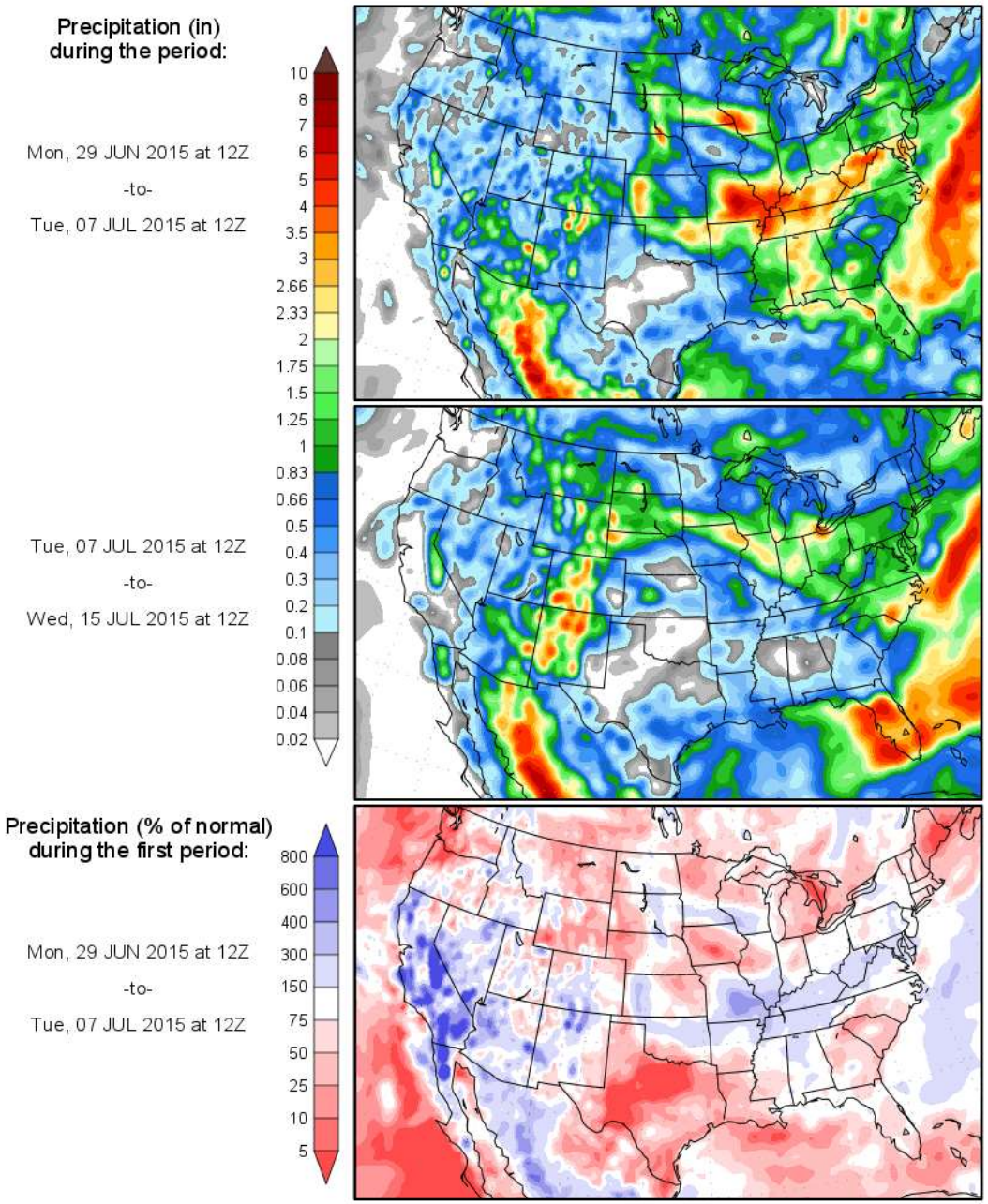
WATER REPORT FOR 6/30/2015

Water Report

June 30, 2015

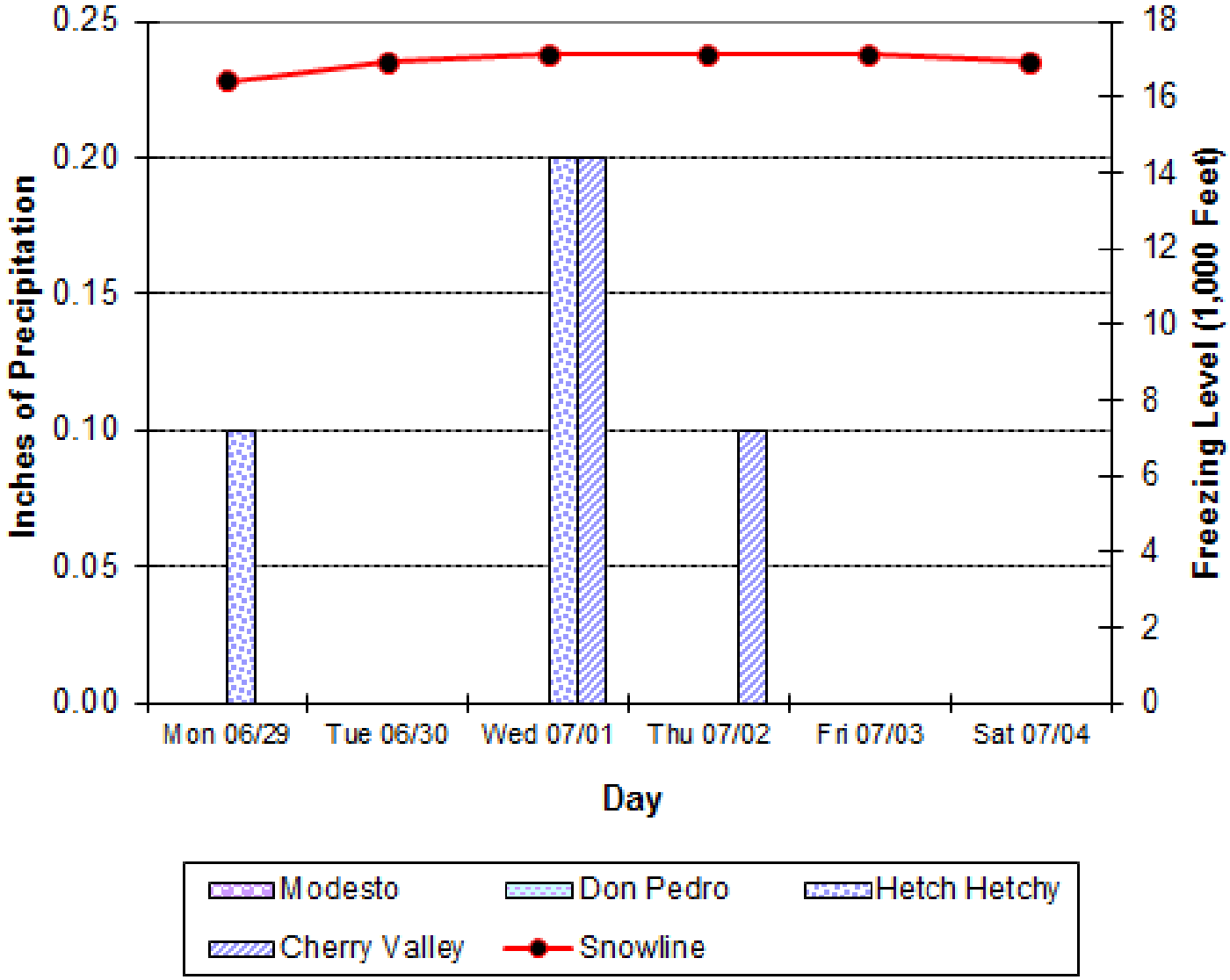
- Weather Forecast
- Status of Watershed
- CCSF Reservoir Storage and Operations
- Don Pedro Reservoir Storage and Operations

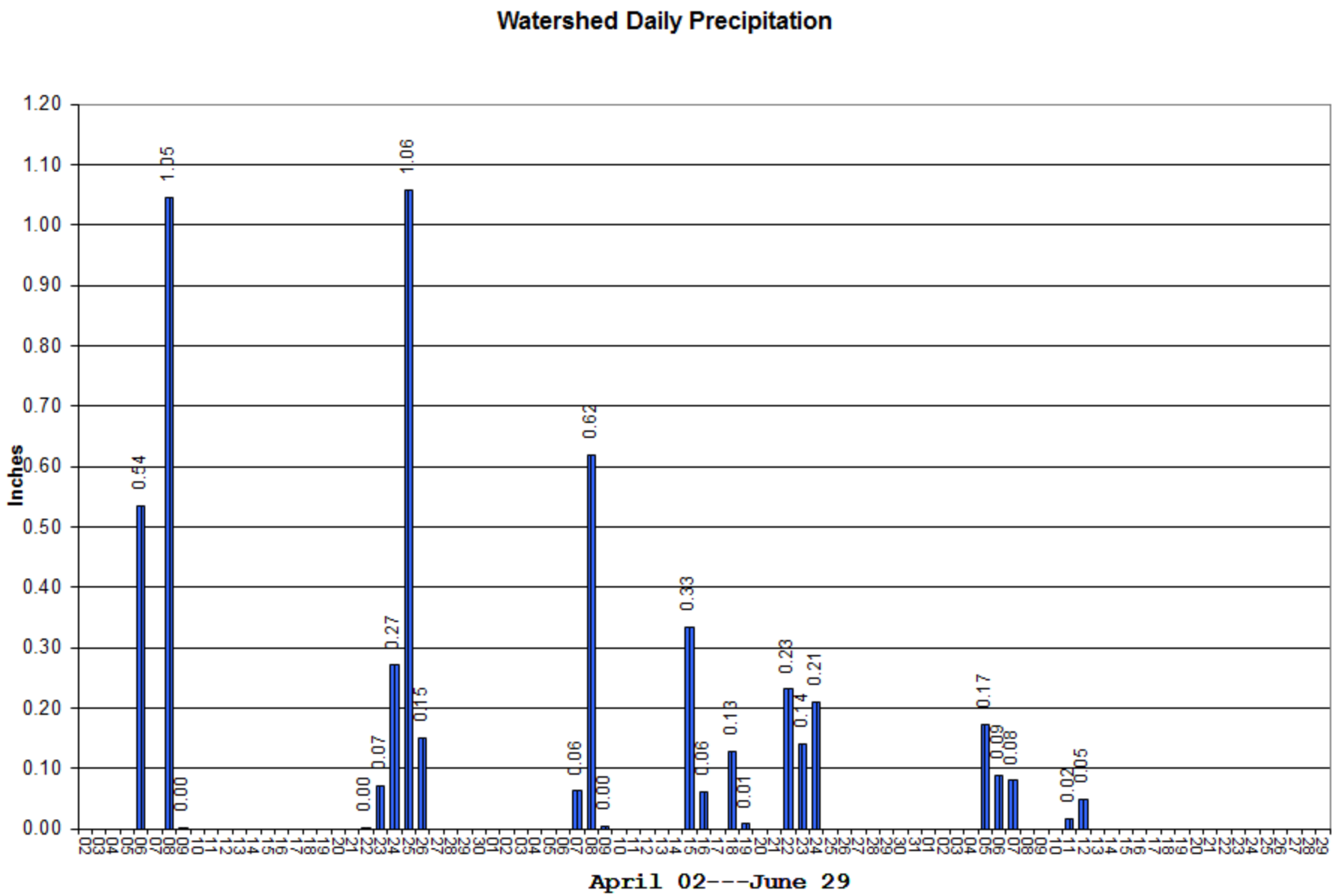
Precipitation Forecasts

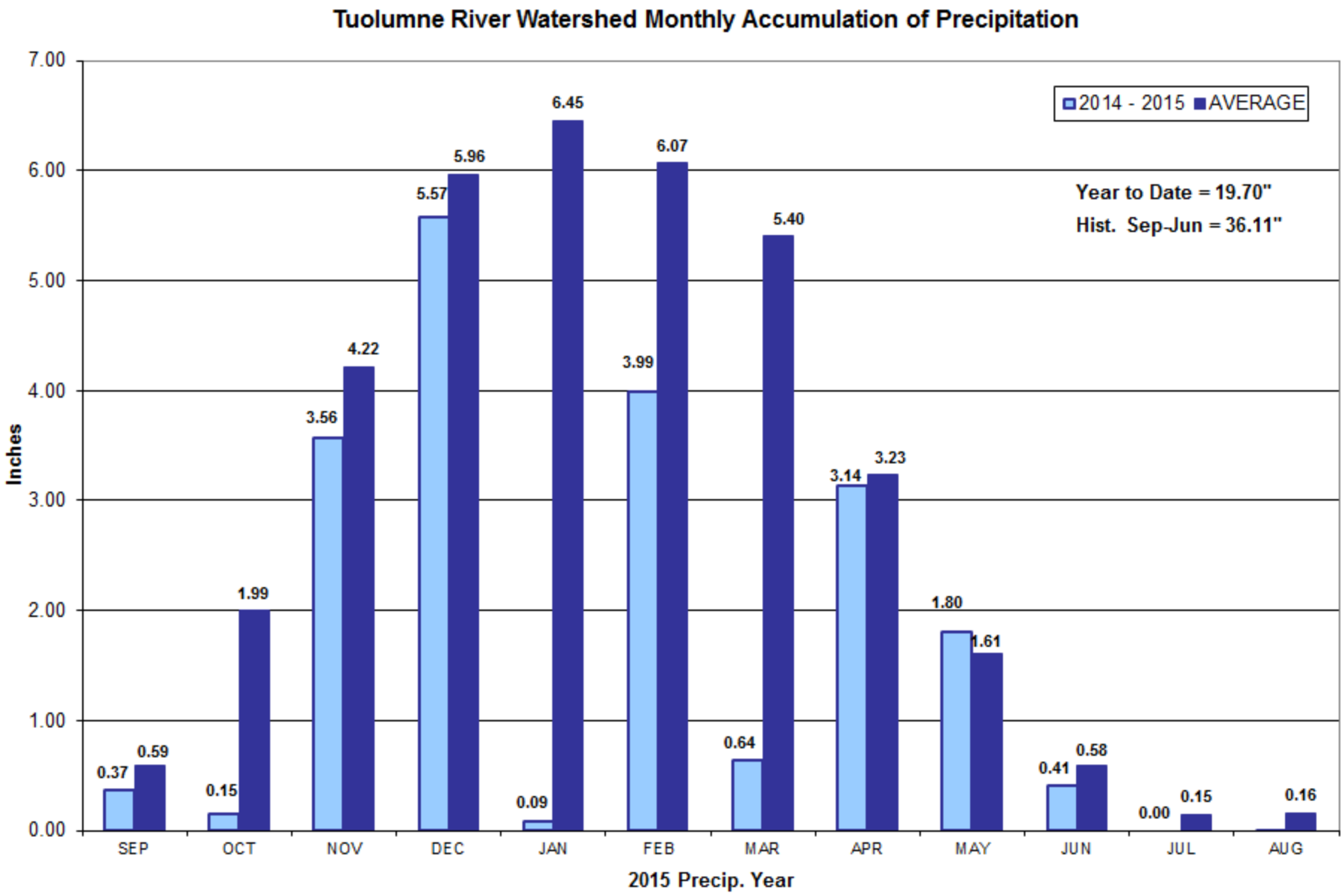


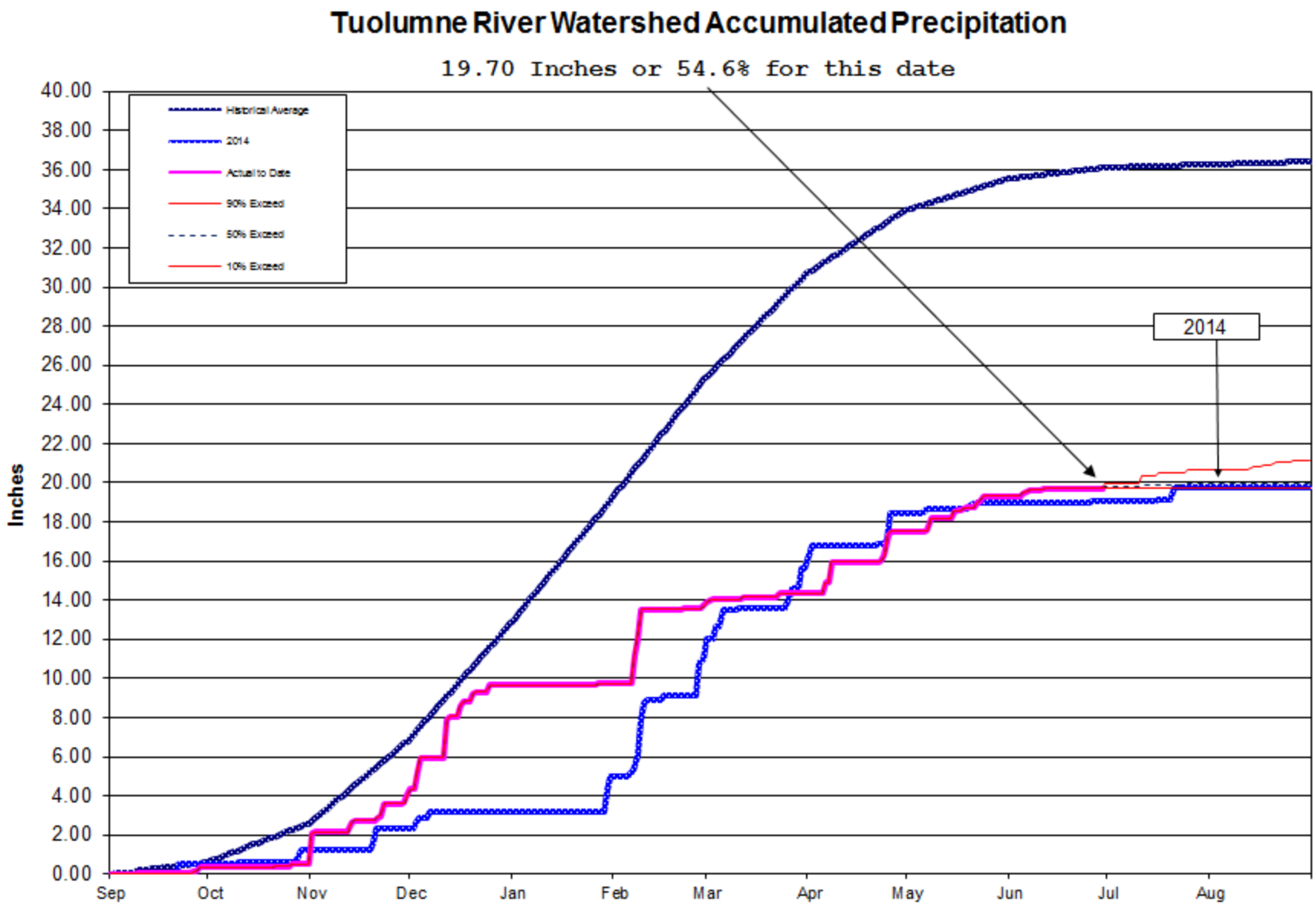
Precipitation forecasts from the National Centers for Environmental Prediction.
Normal rainfall derived from Xie-Arkin (CMAP) Monthly Climatology for 1979-2003.
Forecast Initialization Time: 12Z29JUN2015

GrADS: IGES/COLA


0.25
0.20
0.15
0.10
0.05
0.00
Inches of Precipitation
18
16
14
12
10
8
6
4
2
0
Freezing Level (1,000 Feet)
Mon 06/29
Tue 06/30
Wed 07/01
Thu 07/02
Fri 07/03
Sat 07/04
Day
Modesto
Don Pedro
Hetch Hetchy
Cherry Valley
Snowline


Watershed Daily Precipitation
Inches
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.54
1.05
0.00
0.00
0.07
0.27
1.06
0.15
0.06
0.62
0.00
0.33
0.06
0.13
0.01
0.23
0.14
0.21
0.17
0.09
0.08
0.02
0.05
April 02---June 29


Tuolumne River Watershed Monthly Accumulation of Precipitation
2014 - 2015
AVERAGE
Year to Date = 19.70"
Hist. Sep-Jun = 36.11"
Inches
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.37
0.59
0.15
1.99
3.56
4.22
5.57
5.96
0.09
6.45
3.99
6.07
0.64
5.40
3.14
3.23
1.80
1.61
0.41
0.58
0.00
0.15
0.16
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
2015 Precip. Year


Tuolumne River Watershed Accumulated Precipitation
19.70 Inches or 54.6% for this date
Historical Average
2014
Actual to Date
90% Exceed
50% Exceed
10% Exceed
2014
Inches
40.00
38.00
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug

WY2015 Computed Natural Flow

DAY	OCT CFS	NOV CFS	DEC CFS	JAN CFS	FEB CFS	MAR CFS	APR CFS	MAY CFS	JUN CFS	JULY CFS	AUG CFS	SEPT CFS
1	709	1,281	713	116	555	953	1,310	2,343	2,516			
2	(283)	33	485	598	450	1,134	1,225	2,679	1,922			
3	630	25	3,368	607	221	706	627	2,143	1,789			
4	(217)	(45)	5,034	(54)	241	(414)	931	2,290	1,532			
5	348	220	1,462	281	310	740	1,005	1,897	1,832			
6	(74)	104	1,008	903	884	492	752	2,030	1,364			
7	53	72	1,157	247	2,177	589	1,121	1,391	1,536			
8	(61)	35	757	863	9,013	754	1,066	2,289	1,701			
9	73	528	446	578	13,181	839	1,423	2,527	1,212			
10	(240)	(248)	285	575	6,039	619	1,149	3,215	1,241			
11	(56)	189	439	331	3,176	465	1,398	3,034	2,194			
12	113	(144)	2,020	505	1,895	1,014	1,596	2,389	1,778			
13	495	201	1,547	499	2,029	842	1,553	2,348	1,650			
14	9	(204)	771	531	1,806	544	1,638	1,420	1,313			
15	66	166	210	456	1,596	1,277	1,336	1,956	730			
16	(772)	143	1,386	205	1,291	1,051	1,071	1,877	1,085			
17	225	(230)	1,050	369	1,430	1,362	786	1,806	515			
18	173	61	442	204	1,666	1,370	1,073	2,178	1,198			
19	(56)	122	1,150	536	739	920	757	1,824	537			
20	115	160	628	242	1,302	1,408	1,257	1,889	679			
21	(15)	243	1,439	299	1,356	841	814	1,470	221			
22	(138)	160	1,323	37	1,257	920	1,194	2,650	173			
23	(4)	995	957	460	350	1,448	862	3,416	630			
24	(94)	176	1,608	6	703	756	1,383	3,744	(82)			
25	123	(60)	927	441	1,105	1,076	2,093	2,747	818			
26	98	(83)	1,408	197	755	1,044	2,504	2,830	403			
27	404	(47)	429	467	947	420	2,797	2,270				
28	86	34	591	546	725	1,456	3,223	3,125				
29	121	(1)	428	390		1,021	2,538	2,257				
30	(81)	481	959	199		1,600	2,487	2,294				
31	(3)		369	425		1,419		2,227				
Average C.F.S.	56	146	1,122	389	2,043	925	1,432	2,340	1,172			
Total Monthly A.F.	3,458	8,661	69,020	23,916	113,459	56,857	85,231	143,906	60,465			
DWR 50 YR Average A.F.	20,000	50,000	88,000	153,000	154,000	209,000	270,000	455,000	359,000	137,000	33,000	16,000

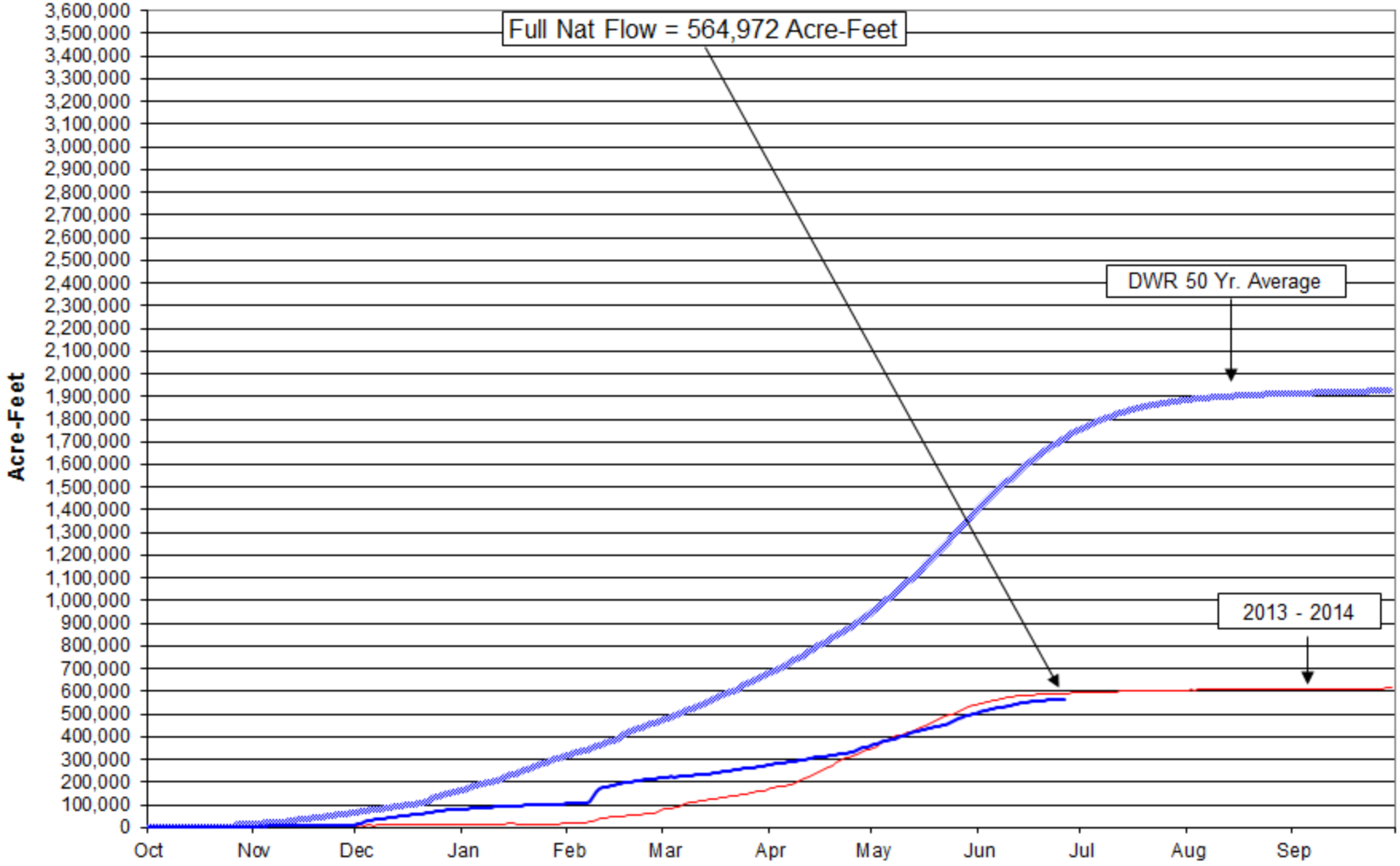
Total October-September Computed Natural Flow= 564,972 A.F.

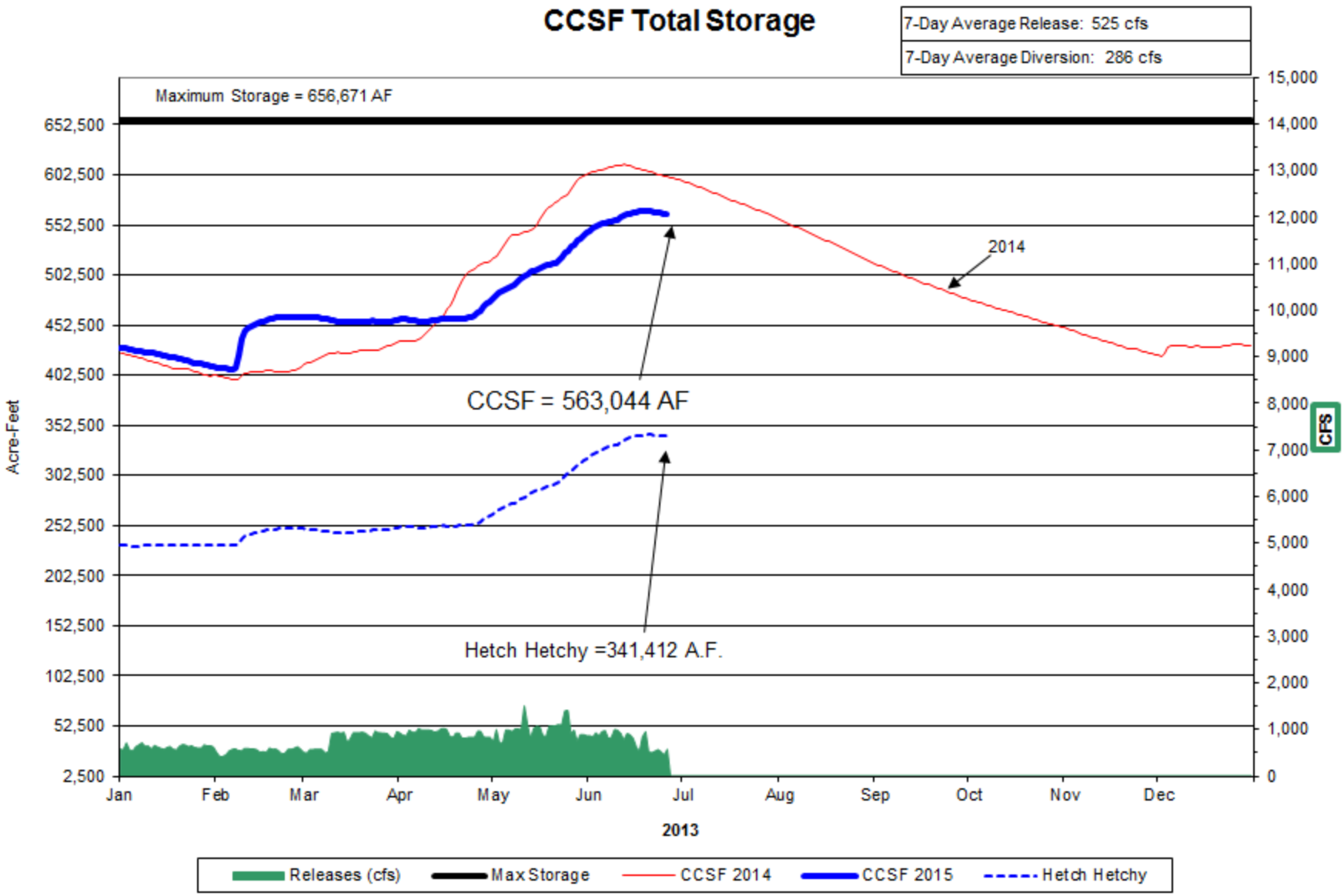
Remaining = 1,379,028

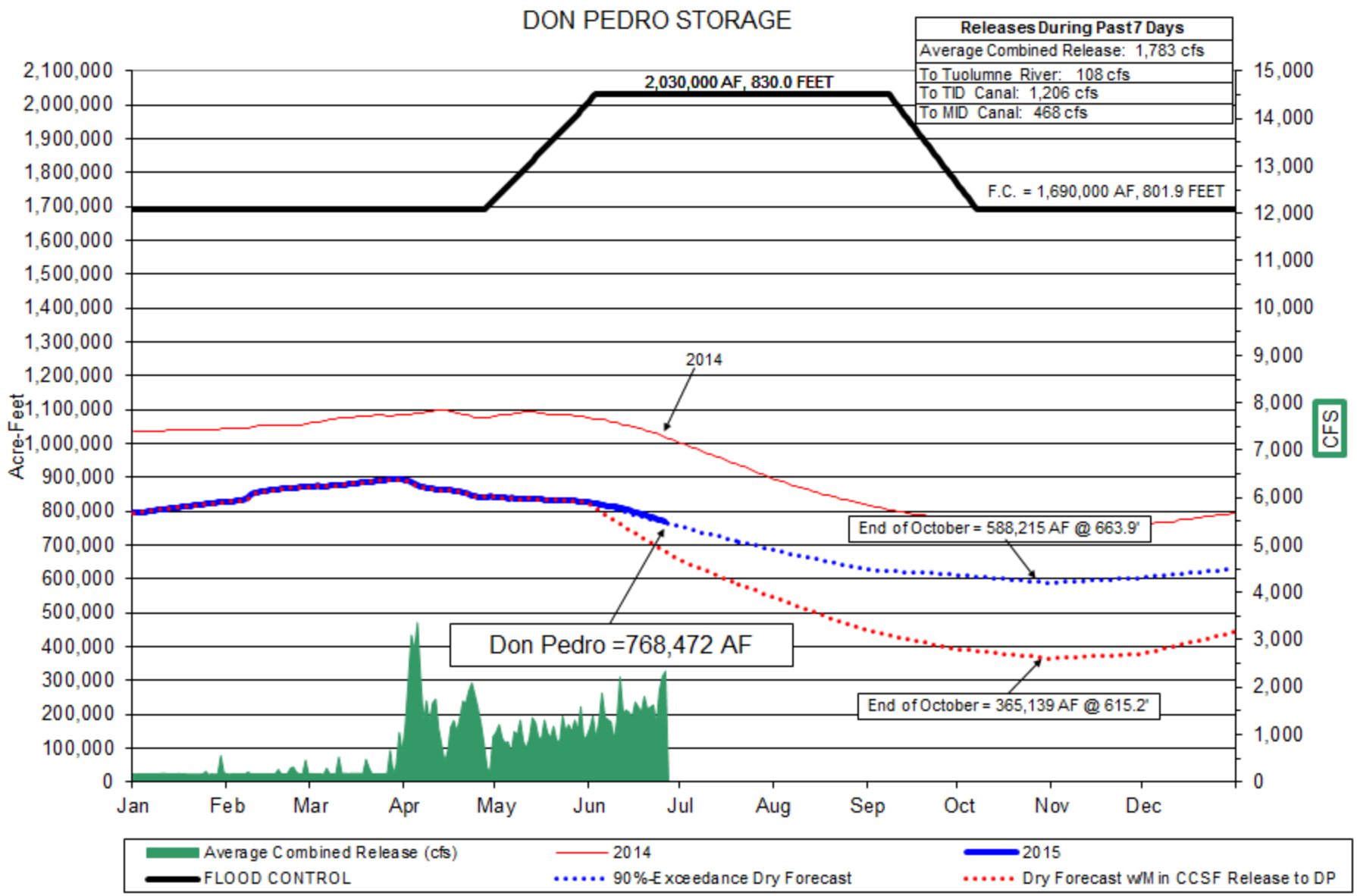
APR-JLY = 289,602 A.F.

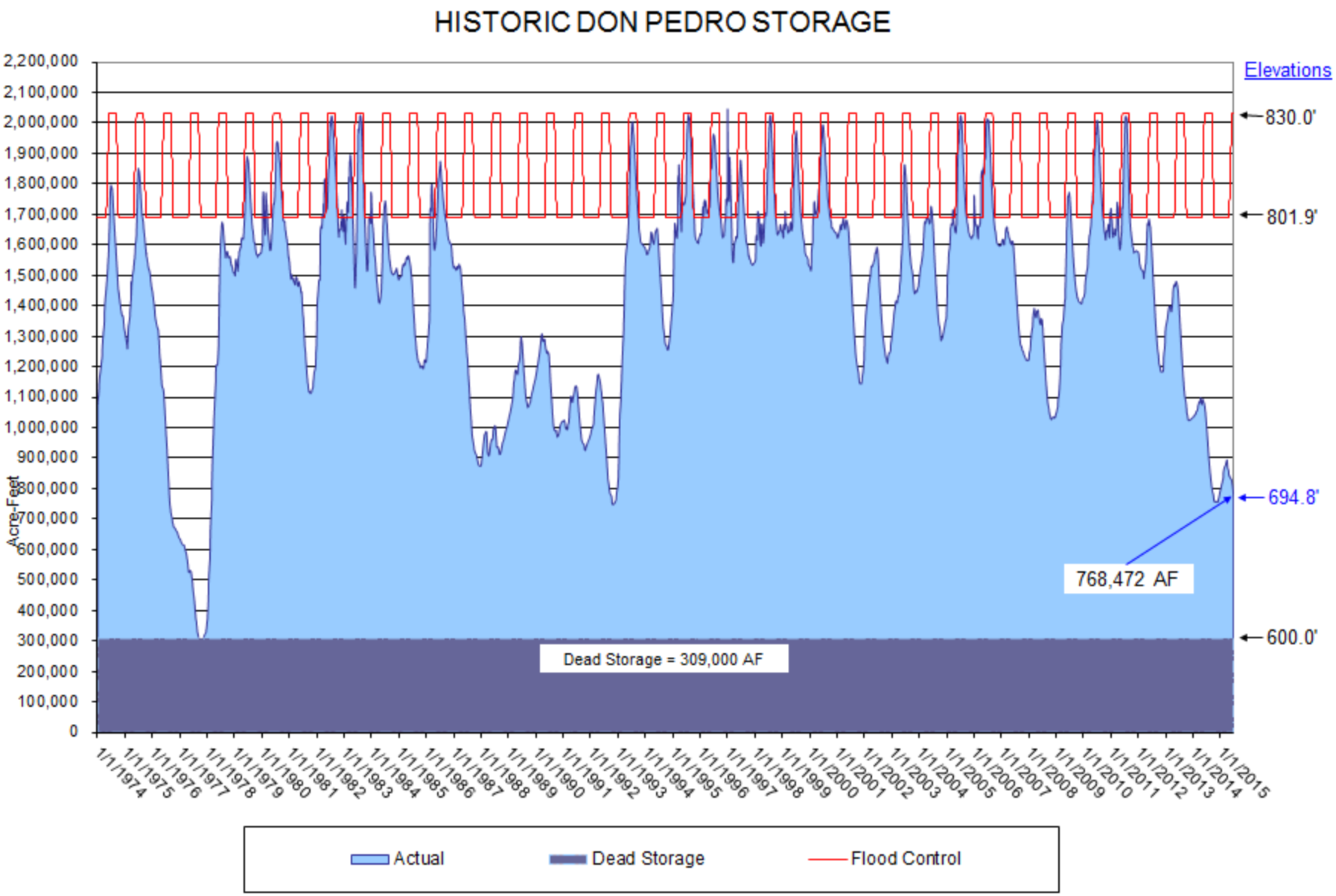
Remaining = 931,398

Full Natural Flow




CCSF Total Storage
7-Day Average Release: 525 cfs
7-Day Average Diversion: 286 cfs
Maximum Storage = 656,671 AF
652,500
602,500
552,500
502,500
452,500
402,500
352,500
302,500
252,500
202,500
152,500
102,500
52,500
2,500
Acre-Feet
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
CFS
2014
CCSF = 563,044 AF
Hetch Hetchy =341,412 A.F.
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2013
Releases (cfs)
Max Storage
CCSF 2014
CCSF 2015
Hetch Hetchy


DON PEDRO STORAGE
Releases During Past 7 Days
Average Combined Release: 1,783 cfs
To Tuolumne River: 108 cfs
To TID Canal: 1,206 cfs
To MID Canal: 468 cfs
2,030,000 AF, 830.0 FEET
F.C. = 1,690,000 AF, 801.9 FEET
2014
End of October = 588,215 AF @ 663.9'
Don Pedro =768,472 AF
End of October = 365,139 AF @ 615.2'
Acre-Feet
CFS
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Average Combined Release (cfs)
2014
2015
FLOOD CONTROL
90%-Exceedance Dry Forecast
Dry Forecast w/Min CCSF Release to DP


HISTORIC DON PEDRO STORAGE
Elevations
830.0'
801.9'
694.8'
600.0'
768,472 AF
Dead Storage = 309,000 AF
Acre-Feet
2,200,000
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1/1/1974
1/1/1975
1/1/1976
1/1/1977
1/1/1978
1/1/1979
1/1/1980
1/1/1981
1/1/1982
1/1/1983
1/1/1984
1/1/1985
1/1/1986
1/1/1987
1/1/1988
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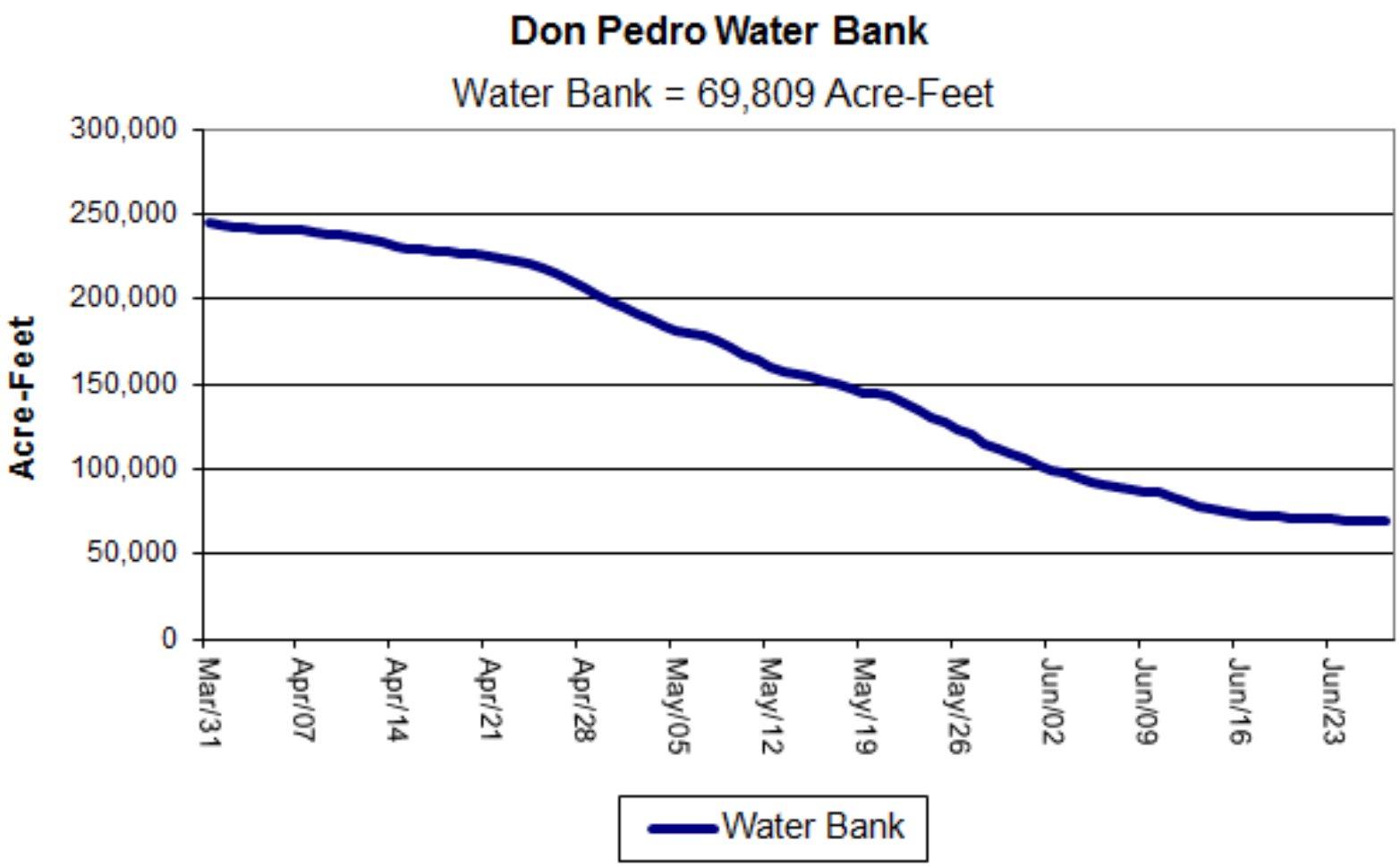
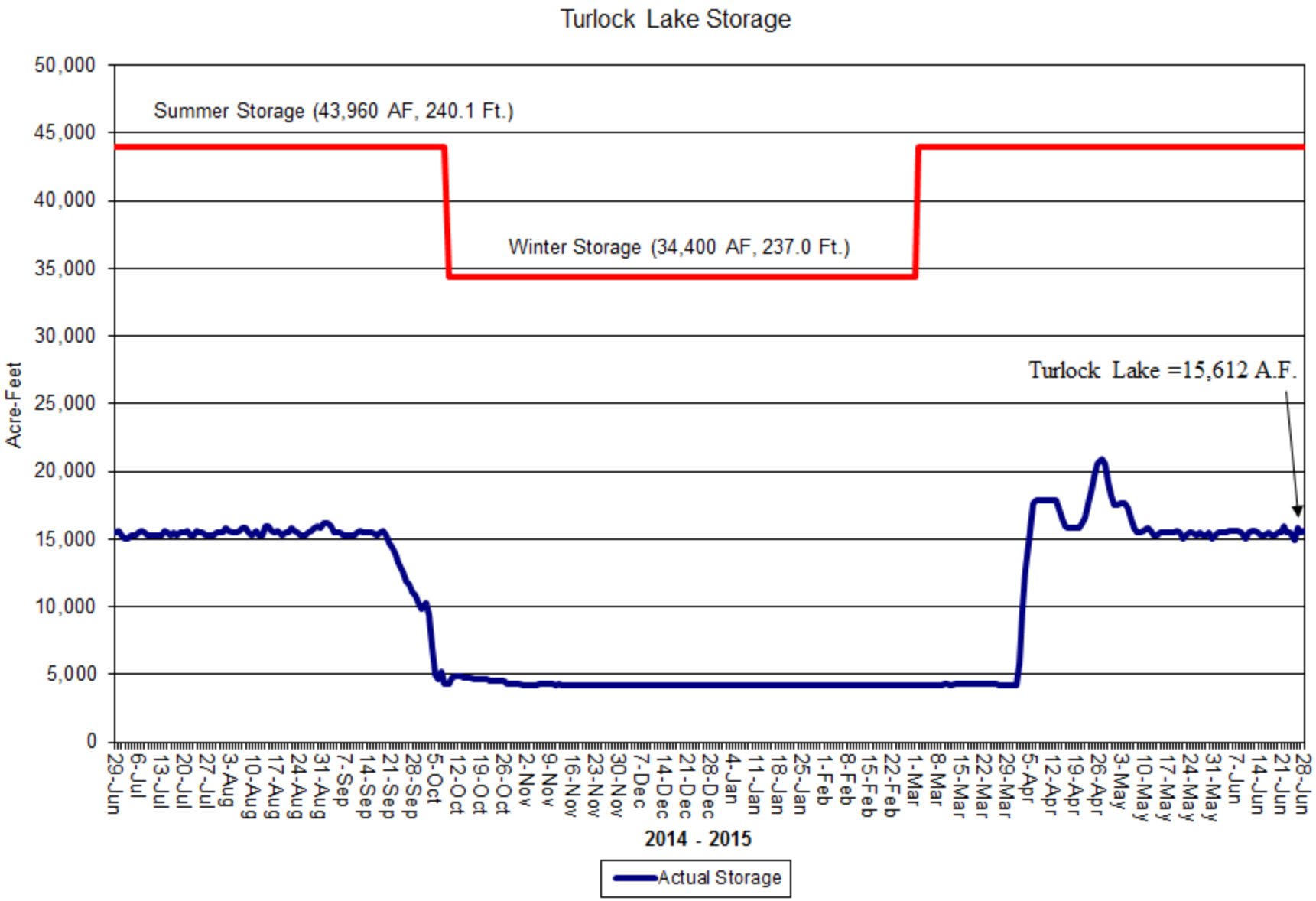
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Actual
Dead Storage
Flood Control


Don Pedro Water Bank
Water Bank = 69,809 Acre-Feet
Acre-Feet
300,000
250,000
200,000
150,000
100,000
50,000
0
Mar/31
Apr/07
Apr/14
Apr/21
Apr/28
May/05
May/12
May/19
May/26
Jun/02
Jun/09
Jun/16
Jun/23
Water Bank


Turlock Lake Storage
Summer Storage (43,960 AF, 240.1 Ft.)
Winter Storage (34,400 AF, 237.0 Ft.)
Turlock Lake =15,612 A.F.
Acre-Feet
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
29-Jun
6-Jul
13-Jul
20-Jul
27-Jul
3-Aug
10-Aug
17-Aug
24-Aug
31-Aug
7-Sep
14-Sep
21-Sep
28-Sep
5-Oct
12-Oct
19-Oct
26-Oct
2-Nov
9-Nov
16-Nov
23-Nov
30-Nov
7-Dec
14-Dec
21-Dec
28-Dec
4-Jan
11-Jan
18-Jan
25-Jan
1-Feb
8-Feb
15-Feb
22-Feb
1-Mar
8-Mar
15-Mar
22-Mar
29-Mar
5-Apr
12-Apr
19-Apr
26-Apr
3-May
10-May
17-May
24-May
31-May
7-Jun
14-Jun
21-Jun
28-Jun
2014 - 2015
Actual Storage

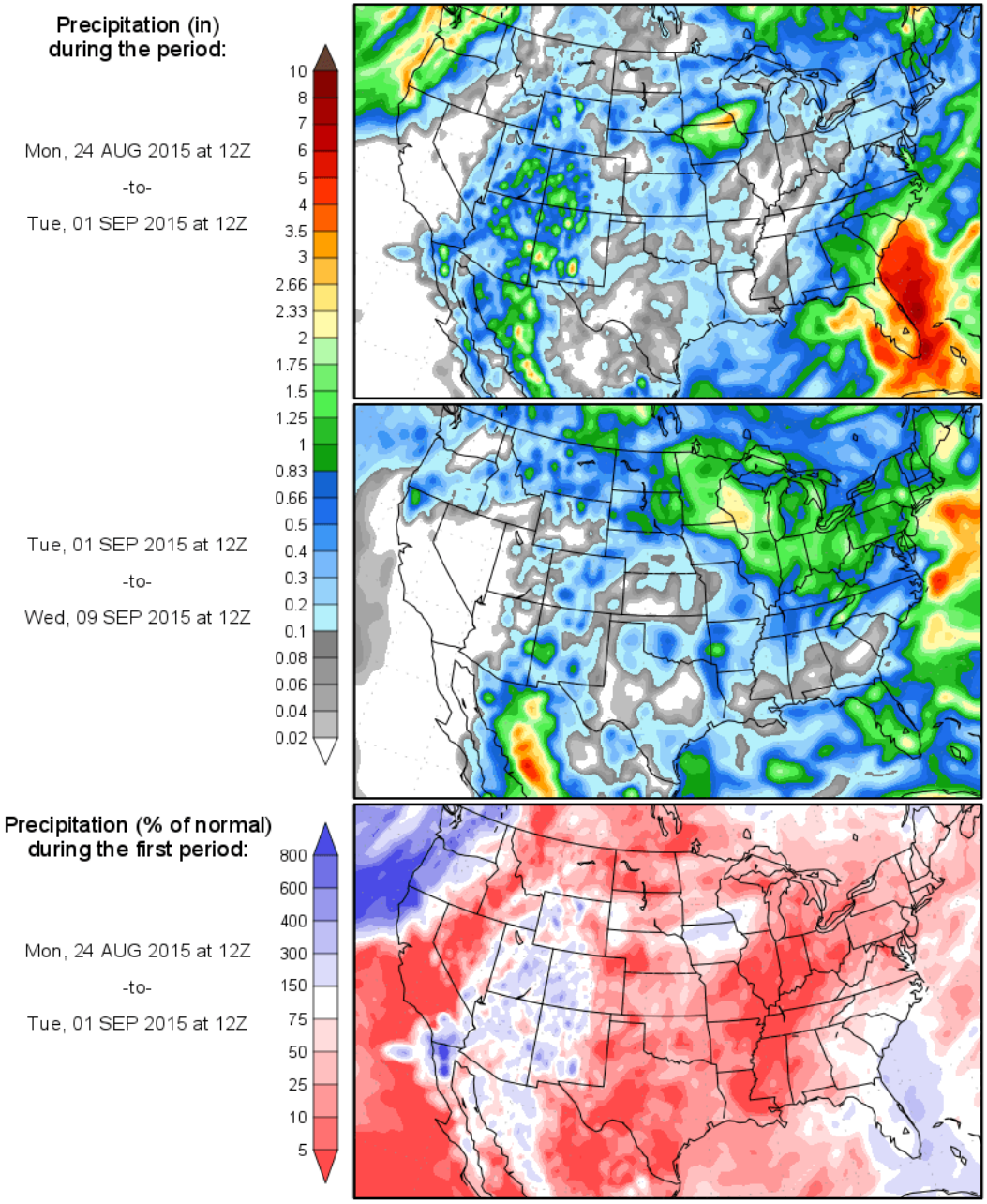
WATER REPORT FOR 8/25/15

Water Report

August 25, 2015

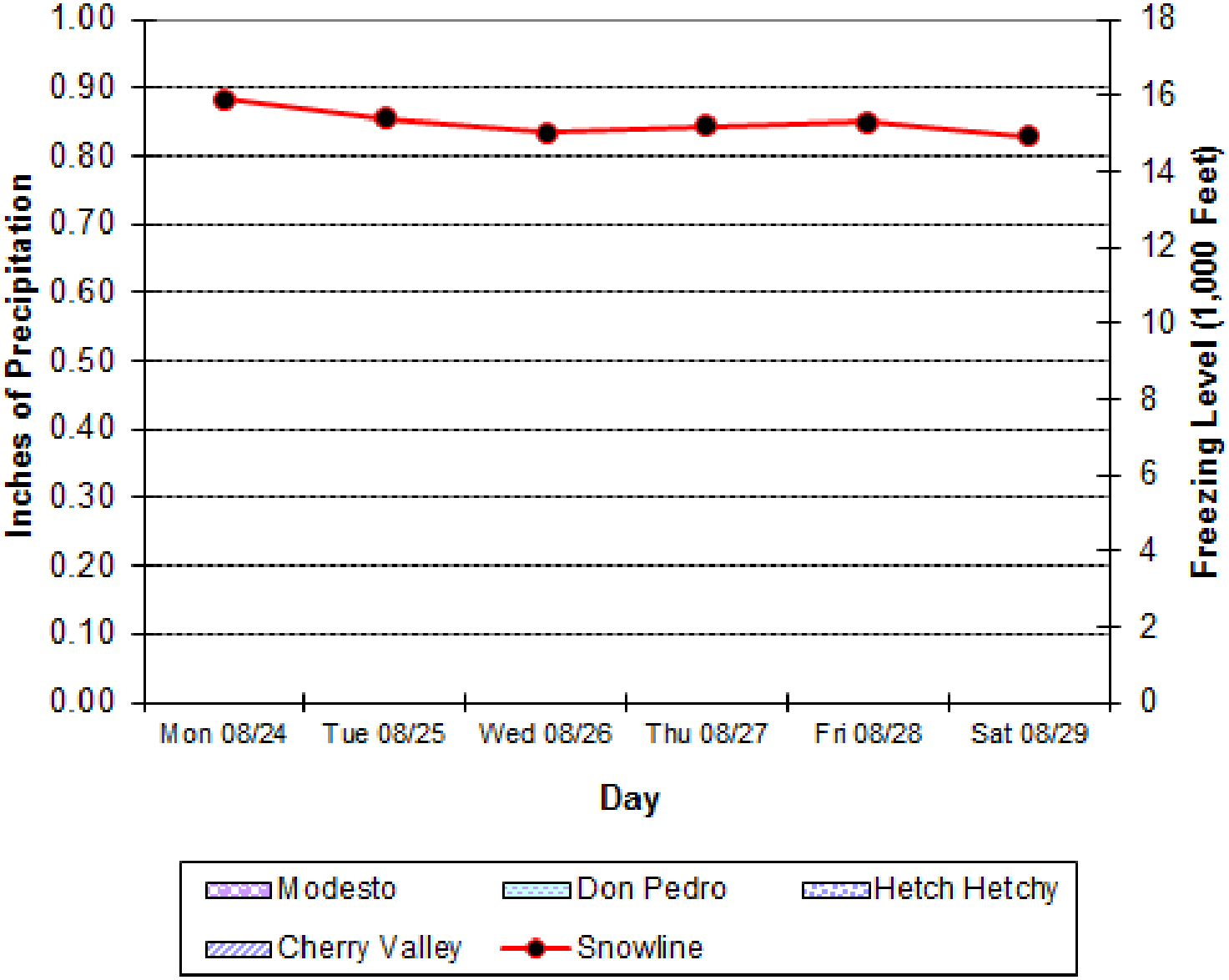
- Weather Forecast
- Status of Watershed
- CCSF Reservoir Storage and Operations
- Don Pedro Reservoir Storage and Operations

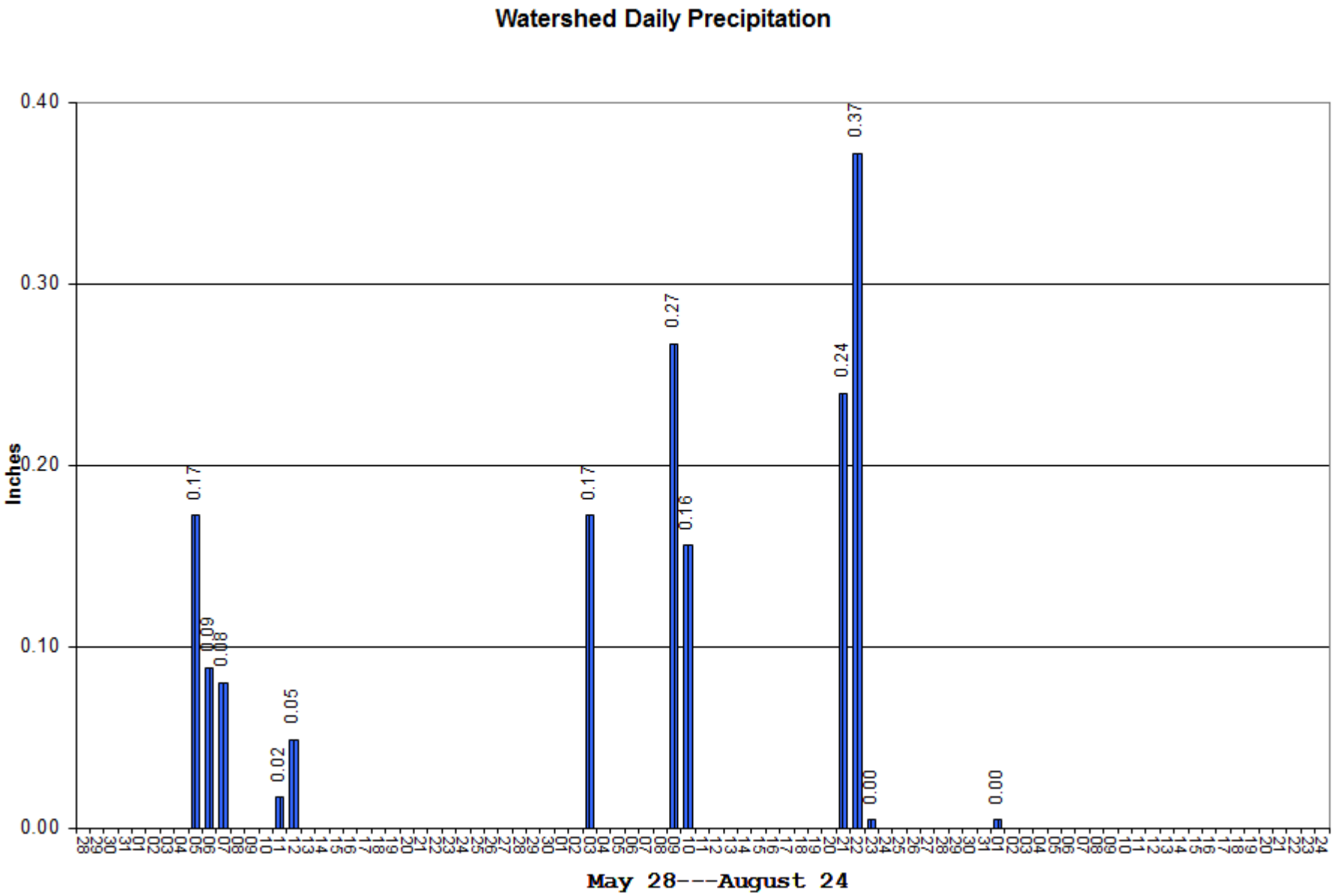
Precipitation Forecasts

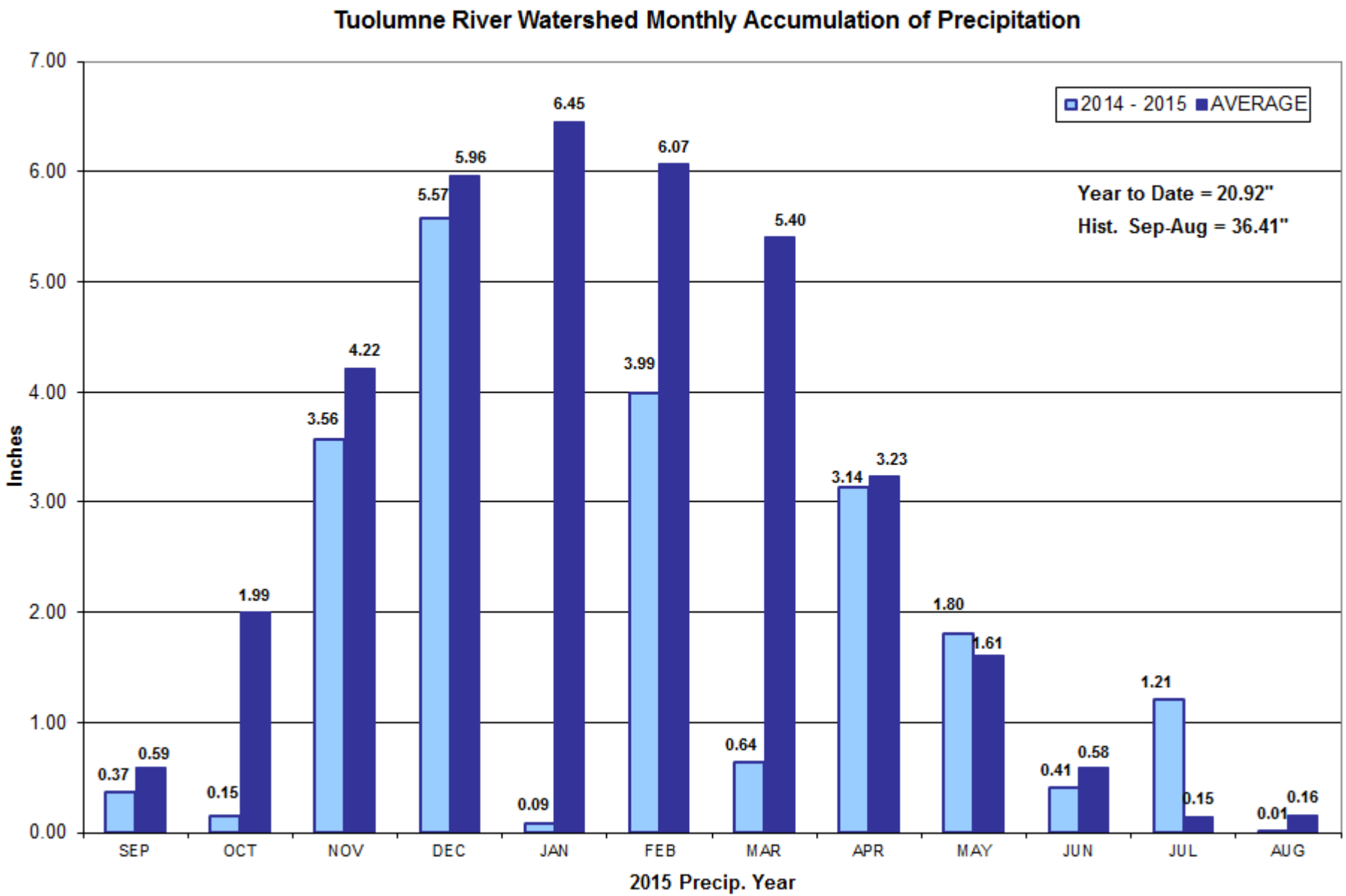


Precipitation forecasts from the National Centers for Environmental Prediction.
Normal rainfall derived from Xie-Arkin (CMAP) Monthly Climatology for 1979-2003.
Forecast Initialization Time: 12Z24AUG2015

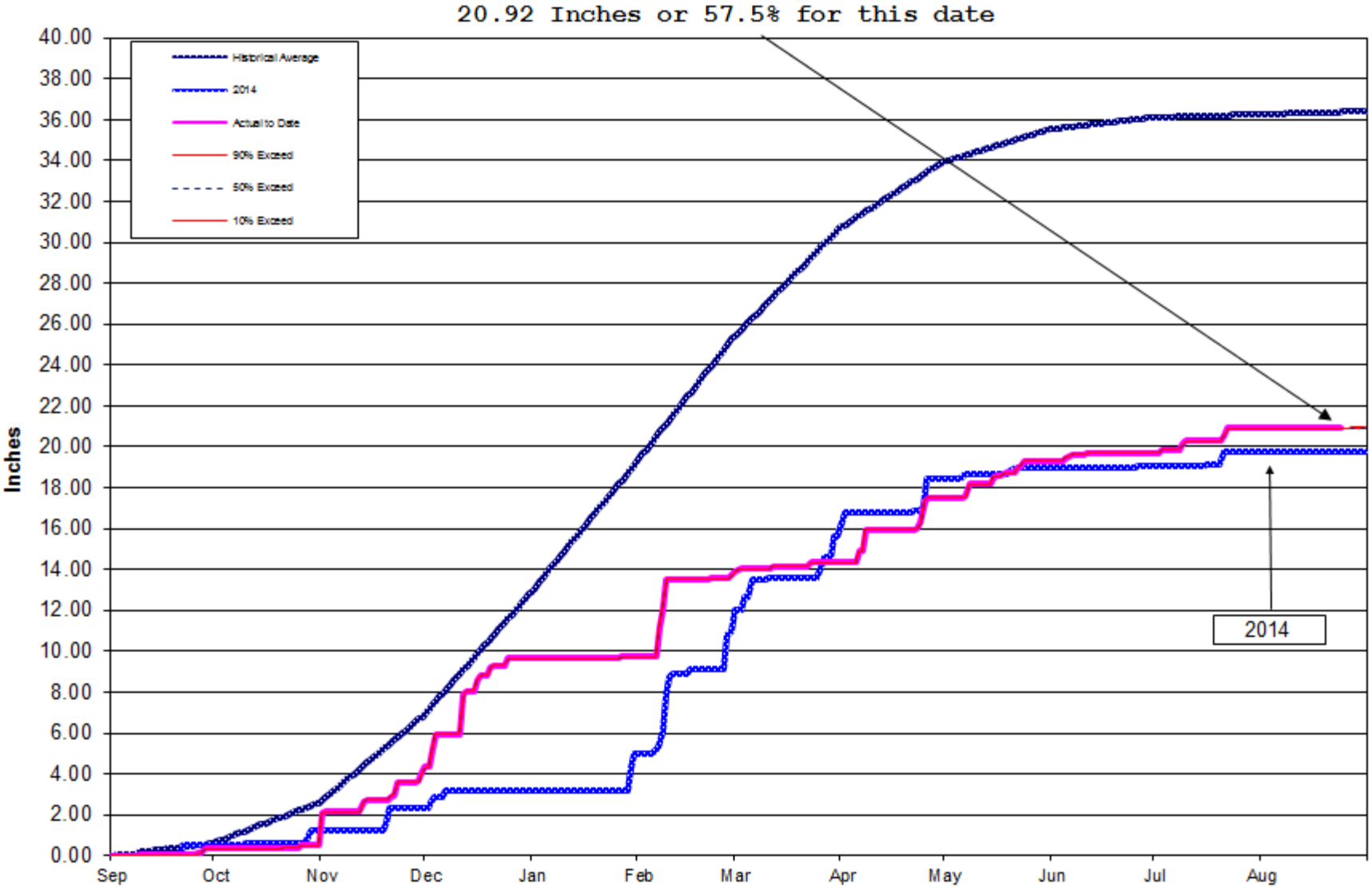
GrADS: IGES/COLA


1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Inches of Precipitation
18
16
14
12
10
8
6
4
2
0
Freezing Level (1,000 Feet)
Mon 08/24
Tue 08/25
Wed 08/26
Thu 08/27
Fri 08/28
Sat 08/29
Day
Modesto
Don Pedro
Hetch Hetchy
Cherry Valley
Snowline


Watershed Daily Precipitation
Inches
0.40
0.30
0.20
0.10
0.00
0.17
0.09
0.08
0.02
0.05
0.17
0.27
0.16
0.24
0.37
0.00
0.00
May 28---August 24


Tuolumne River Watershed Monthly Accumulation of Precipitation
2014 - 2015
AVERAGE
Year to Date = 20.92"
Hist. Sep-Aug = 36.41"
Inches
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.37
0.59
0.15
1.99
3.56
4.22
5.57
5.96
0.09
6.45
3.99
6.07
0.64
5.40
3.14
3.23
1.80
1.61
0.41
0.58
1.21
0.15
0.01
0.16
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
2015 Precip. Year

Tuolumne River Watershed Accumulated Precipitation



WY2015 Computed Natural Flow

DAY	OCT CFS	NOV CFS	DEC CFS	JAN CFS	FEB CFS	MAR CFS	APR CFS	MAY CFS	JUN CFS	JULY CFS	AUG CFS	SEPT CFS
1	709	1,281	713	116	555	953	1,310	2,343	2,516	521	208	
2	(283)	33	485	598	450	1,134	1,225	2,679	1,922	(181)	(278)	
3	630	25	3,368	607	221	706	627	2,143	1,789	1,301	(311)	
4	(217)	(45)	5,034	(54)	241	(414)	931	2,290	1,532	(171)	456	
5	348	220	1,462	281	310	740	1,005	1,897	1,832	482	(152)	
6	(74)	104	1,008	903	884	492	752	2,030	1,364	(64)	689	
7	53	72	1,157	247	2,177	589	1,121	1,391	1,536	920	(183)	
8	(61)	35	757	863	9,013	754	1,066	2,289	1,701	(256)	484	
9	73	528	446	578	13,181	839	1,423	2,527	1,212	206	645	
10	(240)	(248)	285	575	6,039	619	1,149	3,215	1,241	132	(238)	
11	(56)	189	439	331	3,176	465	1,398	3,034	2,194	740	(243)	
12	113	(144)	2,020	505	1,895	1,014	1,596	2,389	1,778	233	450	
13	495	201	1,547	499	2,029	842	1,553	2,348	1,650	254	(32)	
14	9	(204)	771	531	1,806	544	1,638	1,420	1,313	760	325	
15	66	166	210	456	1,596	1,277	1,336	1,956	730	(253)	622	
16	(772)	143	1,386	205	1,291	1,051	1,071	1,877	1,085	550	1,019	
17	225	(230)	1,050	369	1,430	1,362	786	1,806	515	262	(1,145)	
18	173	61	442	204	1,666	1,370	1,073	2,178	1,198	67	427	
19	(56)	122	1,150	536	739	920	757	1,824	537	(233)	252	
20	115	160	628	242	1,302	1,408	1,257	1,889	679	668	(444)	
21	(15)	243	1,439	299	1,356	841	814	1,470	221	160	282	
22	(138)	160	1,323	37	1,257	920	1,194	2,650	173	183	392	
23	(4)	995	957	460	350	1,448	862	3,416	630	486	(236)	
24	(94)	176	1,608	6	703	756	1,383	3,744	(82)	(36)		
25	123	(60)	927	441	1,105	1,076	2,093	2,747	818	472		
26	98	(83)	1,408	197	755	1,044	2,504	2,830	403	416		
27	404	(47)	429	467	947	420	2,797	2,270	(6)	152		
28	86	34	591	546	725	1,456	3,223	3,125	358	(179)		
29	121	(1)	428	390		1,021	2,538	2,257	205	355		
30	(81)	481	959	199		1,600	2,487	2,294	89	269		
31	(3)		369	425		1,419		2,227		410		
Average C.F.S.	56	146	1,122	389	2,043	925	1,432	2,340	1,038	278	130	
Total Monthly A.F.	3,458	8,661	69,020	23,916	113,459	56,857	85,231	143,906	61,745	17,110	5,931	
DWR 50 YR Average A.F.	20,000	50,000	88,000	153,000	154,000	209,000	270,000	455,000	359,000	137,000	33,000	16,000

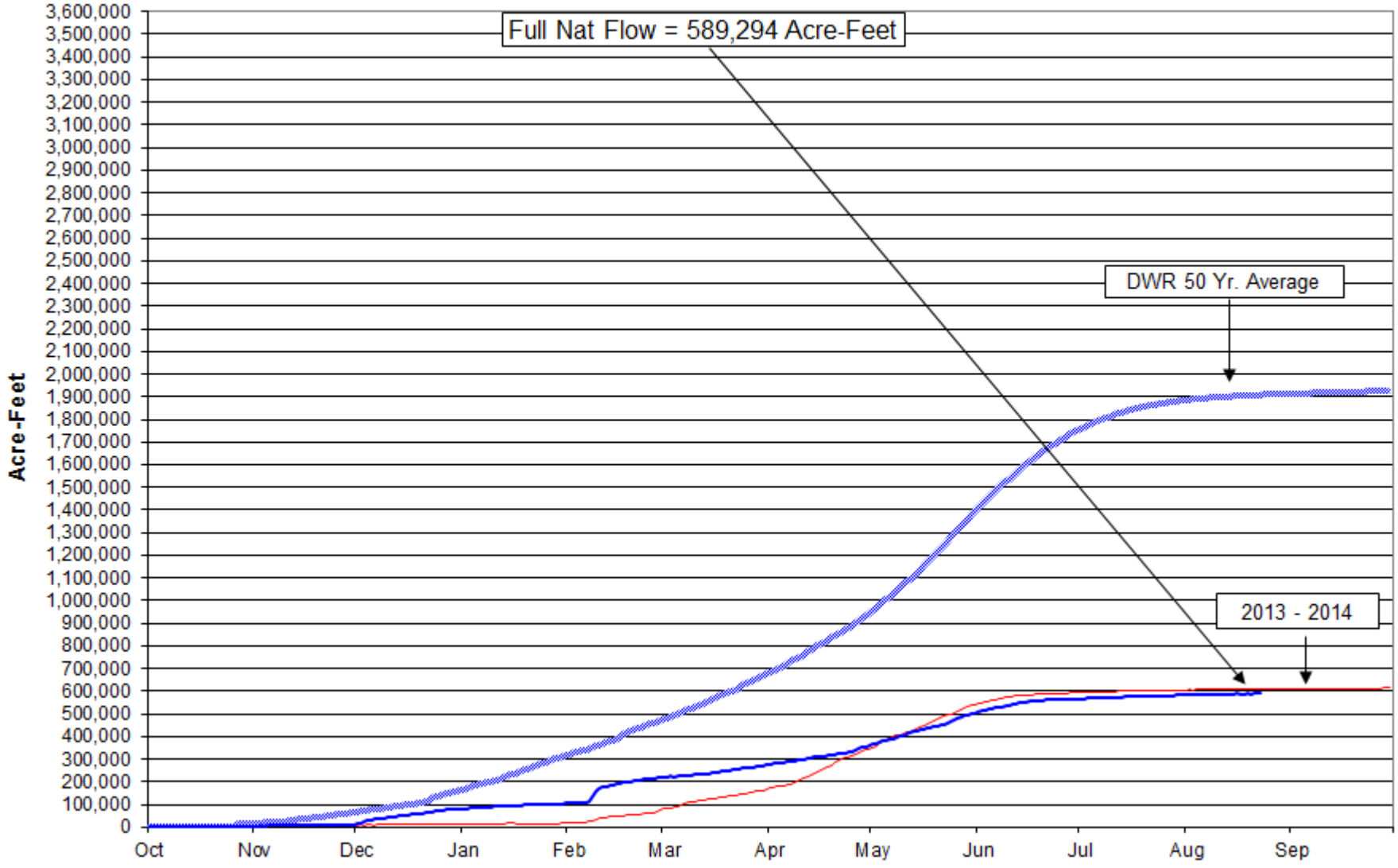
Total October-September Computed Natural Flow= 589,294 A.F.

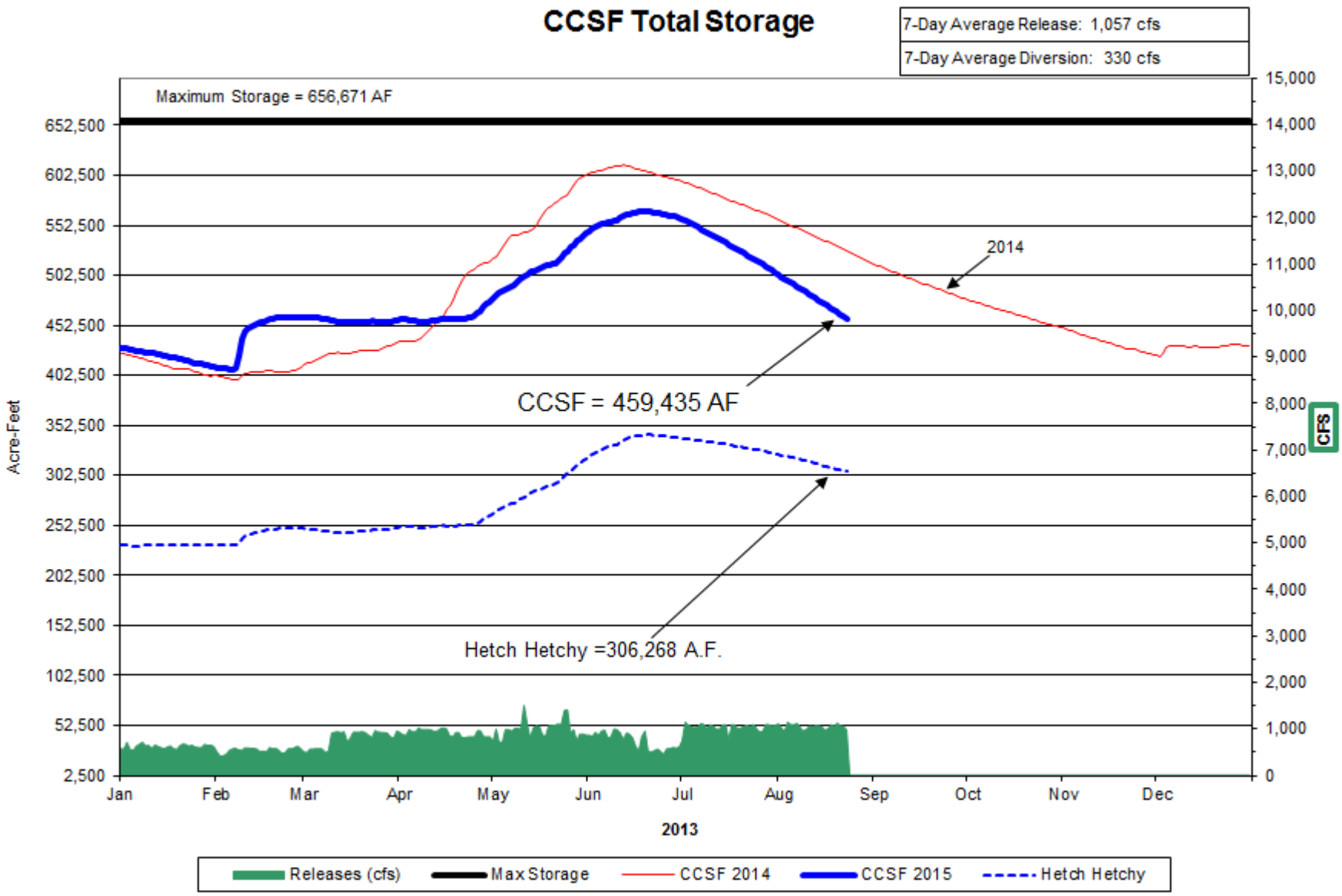
Remaining = 1,354,706

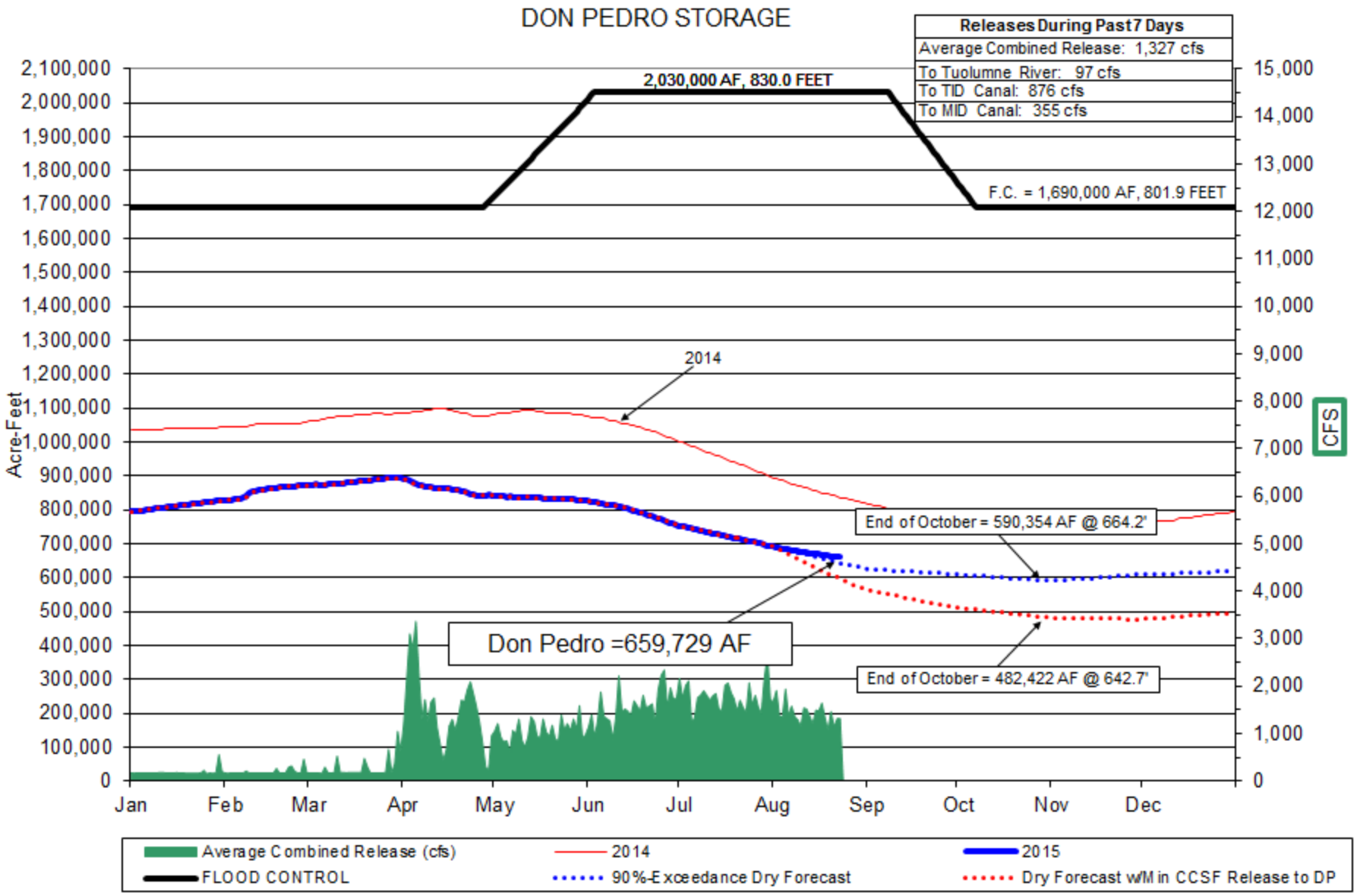
APR-JLY = 307,992 A.F.

Remaining = 913,008

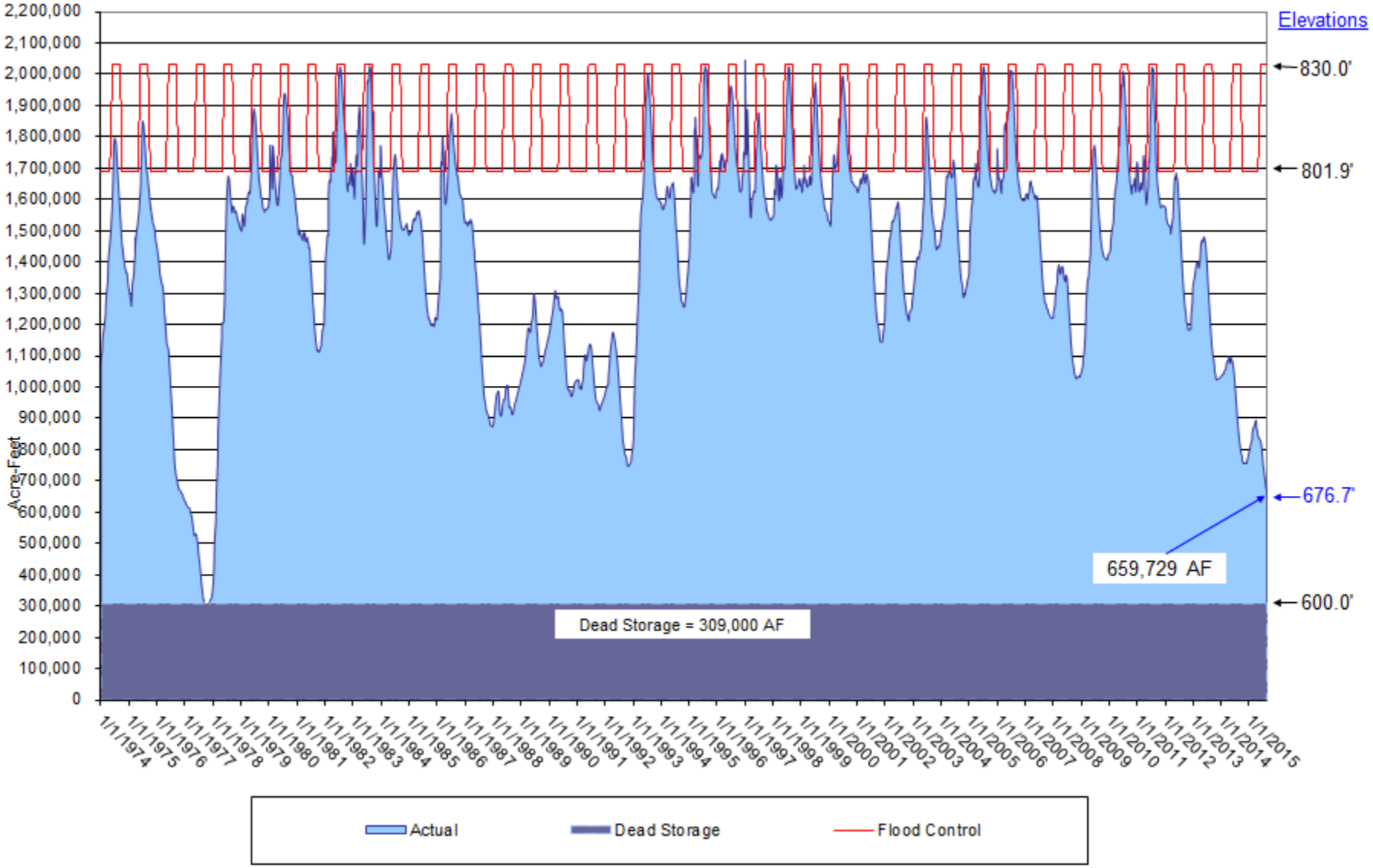
Full Natural Flow

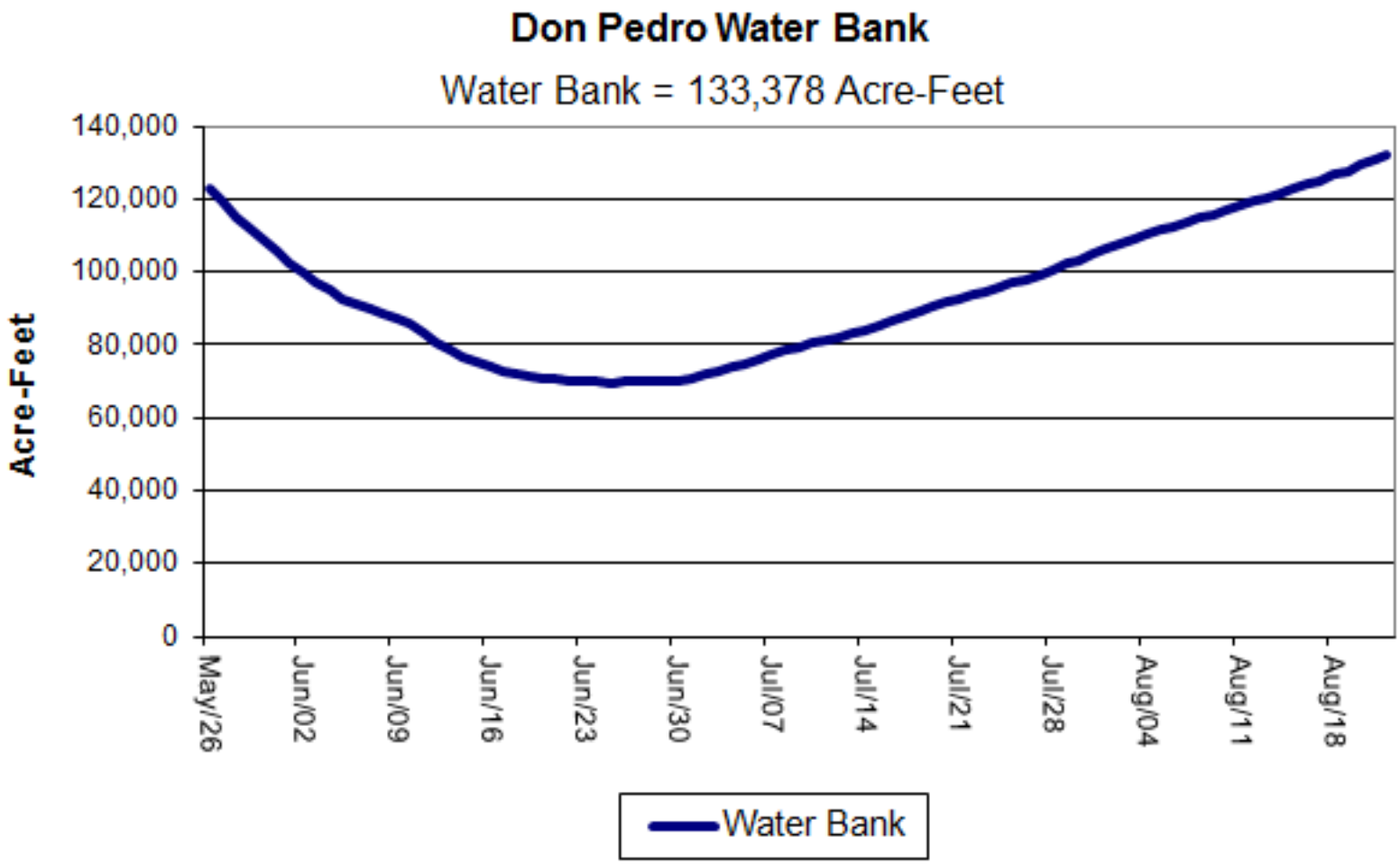


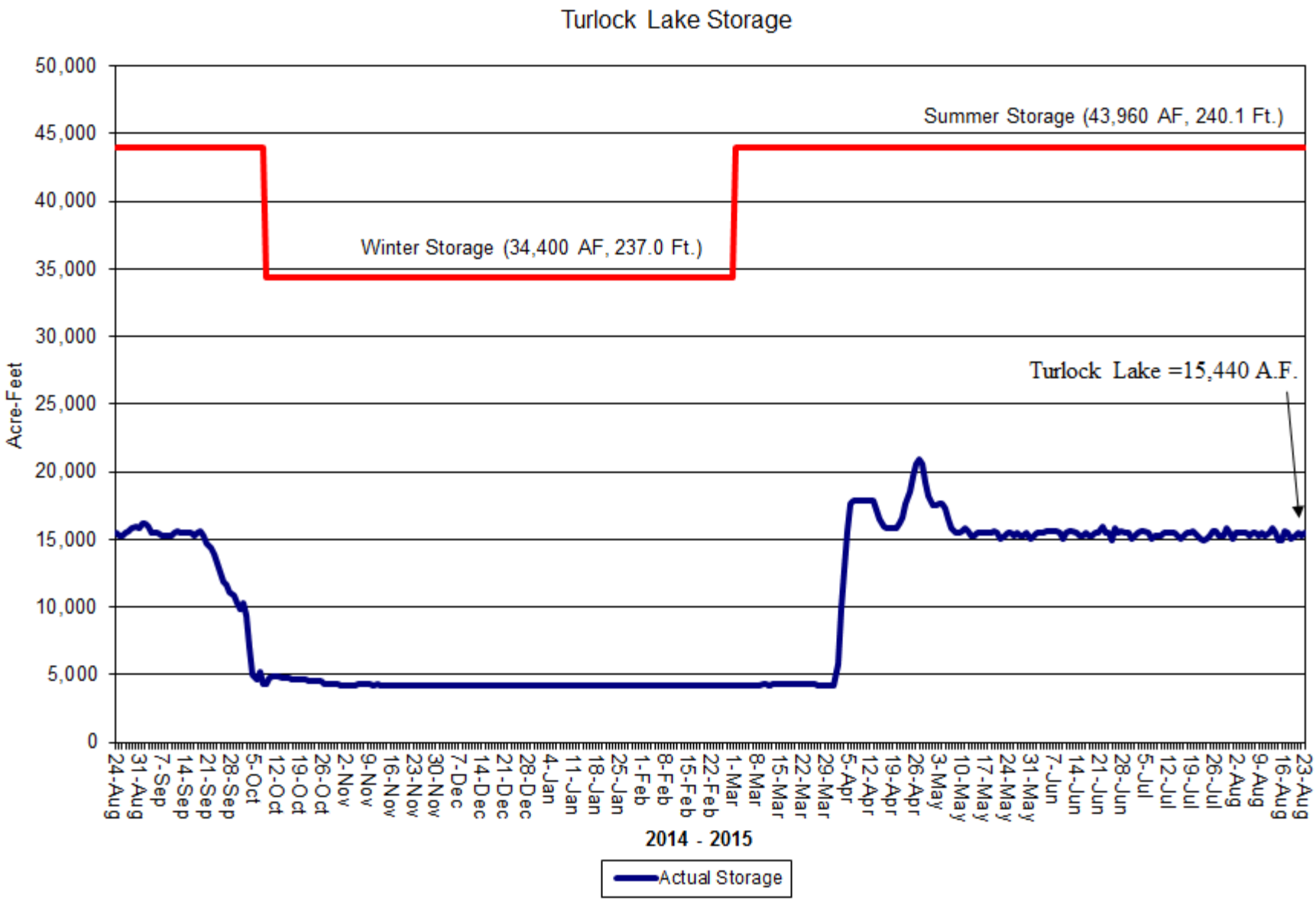

CCSF Total Storage
7-Day Average Release: 1,057 cfs
7-Day Average Diversion: 330 cfs
Maximum Storage = 656,671 AF
652,500
602,500
552,500
502,500
452,500
402,500
352,500
302,500
252,500
202,500
152,500
102,500
52,500
2,500
Acre-Feet
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
CFS
2014
CCSF = 459,435 AF
Hetch Hetchy =306,268 A.F.
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2013
Releases (cfs)
Max Storage
CCSF 2014
CCSF 2015
Hetch Hetchy


DON PEDRO STORAGE
Releases During Past 7 Days
Average Combined Release: 1,327 cfs
To Tuolumne River: 97 cfs
To TID Canal: 876 cfs
To MID Canal: 355 cfs
2,030,000 AF, 830.0 FEET
F.C. = 1,690,000 AF, 801.9 FEET
2014
End of October = 590,354 AF @ 664.2'
Don Pedro =659,729 AF
End of October = 482,422 AF @ 642.7'
Acre-Feet
CFS
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Average Combined Release (cfs)
2014
2015
FLOOD CONTROL
90%-Exceedance Dry Forecast
Dry Forecast w/Min CCSF Release to DP

HISTORIC DON PEDRO STORAGE




Don Pedro Water Bank
Water Bank = 133,378 Acre-Feet
Acre-Feet
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
May/26
Jun/02
Jun/09
Jun/16
Jun/23
Jun/30
Jul/07
Jul/14
Jul/21
Jul/28
Aug/04
Aug/11
Aug/18
Water Bank


Turlock Lake Storage
Summer Storage (43,960 AF, 240.1 Ft.)
Winter Storage (34,400 AF, 237.0 Ft.)
Turlock Lake =15,440 A.F.
Acre-Feet
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
24-Aug
31-Aug
7-Sep
14-Sep
21-Sep
28-Sep
5-Oct
12-Oct
19-Oct
26-Oct
2-Nov
9-Nov
16-Nov
23-Nov
30-Nov
7-Dec
14-Dec
21-Dec
28-Dec
4-Jan
11-Jan
18-Jan
25-Jan
1-Feb
8-Feb
15-Feb
22-Feb
1-Mar
8-Mar
15-Mar
22-Mar
29-Mar
5-Apr
12-Apr
19-Apr
26-Apr
3-May
10-May
17-May
24-May
31-May
7-Jun
14-Jun
21-Jun
28-Jun
5-Jul
12-Jul
19-Jul
26-Jul
2-Aug
9-Aug
16-Aug
23-Aug
2014 - 2015
Actual Storage

Attachments G.2, G.3, and G.4 can be found online at: http://www.tid.org/drought-information

Attachment G.2. TID General Resources

TID Water Conservation FAQ's
TID Drought Resolution, adopted by TID Board of Directors on Feb. 25, 2014
TID Water Management page
TID Irrigation Tips page
TID Water Usage page for irrigators
TID Water Measurement Project Presentation

APPENDIX G

TID WATER CONSERVATION FAQ'S

WATER & POWER
Serving Central California since 1887
(209) 883.8300 • www.tid.com
333 East Canal Drive • P O Box 949 • Turlock, CA 95381-0949

Water Conservation FAQ

- **What is TID doing to help the City of Turlock achieve its water conservation goals?**

TID doesn't provide water to the City of Turlock for municipal uses but, we're doing our part to conserve and help the city and region achieve the water conservation goals set by the state.

For example**;** TID has stopped watering the grass areas around our Canal Drive and Broadway offices and, once the purchase of the Palm Street Operations Complex is complete, TID will re-landscape the entire complex with drought tolerant landscaping. TID is also installing a demonstration landscape in front of the Canal Drive Office and will include information on the plants and techniques used so residents can install similar landscaping at their home or business.

- **Why is agriculture not being cut back like urban water users are?**

Agriculture has been at the forefront of water restrictions for the past 4 years. The last wet rainy season was in 2011 and since then, growers have seen their available water shrink with the supply. Growers in the TID have been reduced by 62% in 2015. This is on top of a 58% reduction in availability in 2014. Reductions also occurred in 2013 and 2012.

- **What has TID done to be more efficient?**

TID has taken a number of steps to improve efficiency and maximize the amount of water available for our growers. The following is a partial list -

- TID is operating Turlock Lake around 50% of capacity in order to reduce seepage and evaporation.
- TID is piloting several water efficiency projects including:
  - A regulating reservoir in Hilmar to capture water that would otherwise be spilled into the river unused.
  - A system of automated gates on the Lateral 8 canal which are used to automatically control the amount of water in the canal, minimizing spillage and increasing efficiency.
- TID is in the second year of a multi-year project to install automated gates and meters at the point of delivery to the growers throughout the District. This will significantly increase its ability to measure the water delivered.
- This year, TID more than doubled irrigation water rates which will encourage conservation.

- **What are the penalties for the unauthorized use of water?**

TID's Board of Directors adopted the following penalties for unauthorized use of water as part of the 2015 Irrigation Season Rules.

  - 1st offense - $1,000 fine and water taken will be billed at the highest tier amount.
  - 2nd offense- Potential loss of water for the remainder of the season.

- **How do I report unauthorized water use?**

TID has a tip line to report water theft and tipsters can remain anonymous (209) 883-8359 (Monday - Friday, 8 a.m. to 4:30 p.m.)

- **I've heard Agriculture uses 80% of the water in California. Is that true?**

There is some confusion about the amount of water used by agriculture in California and it comes in part from the way the Department of Water Resources (DWR) previously reported usage numbers.

Beginning in 2007, the DWR began including urban, agricultural *and* environmental mandates in their water accounting system. Under this new system, agriculture accounts for 40.9% of water used and urban residents 8.9%. According to the California Department of Water Resources the environment receives 50.2% of California water – nearly 40-million acre-feet – to manage wetlands, meet Delta, stream and river flows.

TID DROUGHT RESOLUTION, ADOPTED BY TID BOARD OF DIRECTORS ON FEB. 25, 2014

RESOLUTION NO. 2014 - 8

RESOLUTION PROCLAIMING TURLOCK IRRIGATION DISTRICT IN A DROUGHT STATE OF OPERATION

WHEREAS, Governor Brown proclaimed California to be in a drought state of emergency on January 17, 2014; and

WHEREAS, Turlock Irrigation District is on pace to have experienced the three driest consecutive water years in the history of record keeping come this September; and

WHEREAS, the full natural flow of the Tuolumne River thus far in the 2014 Water Year is less than 10 percent of the historical average; and

WHEREAS, the amount of available water in Don Pedro Reservoir represents a volume that is among the lowest in TID's history of distributing irrigation water; and

WHEREAS, the drought has negatively impacted TID hydroelectric generation capabilities and recreational opportunities at Don Pedro Reservoir; and

WHEREAS, the TID Board of Directors plans to set an amount of available water to customers for the 2014 Irrigation Season that amounts to a significant reduction compared to past irrigation seasons.

NOW, THEREFORE BE IT HEREBY RESOLVED by the Board of Directors of the Turlock Irrigation District that TID is experiencing an unprecedented drought with potentially alarming effects on its customers.

BE IT FURTHER RESOLVED that:

1. TID will continue to be a good steward of water, which includes delivering water as efficiently as possible, limiting operational spills that exit the TID distribution system, and continuing environmental stewardship efforts, among other actions.

2. TID will balance its responsibilities to maximize the near-term and long-term best interests of its irrigation and electric customers.

3. TID will assist the Don Pedro Recreation Agency to take measures to reduce the impact of drought conditions to water based recreation on and around Don Pedro Reservoir.

4. Staff is directed to develop and implement strategies to conserve water in 2014 and beyond.

5. TID will continue to strategically utilize its conjunctive use program of planned groundwater recharge in wet years and managed pumping in dry years.

6. Staff is directed to strictly enforce the existing Irrigation Rules. Customers are responsible for knowing and complying with the Irrigation Rules, and staff will assist customers with any questions of interpretation.

7. TID will strive to inform and assist irrigation customers to the best of staff's ability and with measured flexibility, while fully acknowledging the constraints of the drought.

Moved by Director Fernandes, seconded by Director Santos, that the foregoing resolution be adopted.

Upon roll call the following vote was had:

Ayes:	Directors Fernandes, Santos, Frantz, Alamo, Macedo
Noes:	Directors None
Absent:	Directors None

The President declared the resolution adopted.

I, Tami Wallenburg, Executive Secretary to the Board of Directors of the TURLOCK IRRIGATION DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at a regular meeting of said Board of Directors held the 25th day of February, 2014.

Executive Secretary to the Board of
Directors of the Turlock Irrigation District

TID WATER MANAGEMENT PAGE

Customer Service: 209-883-8222 | My Electric Account

Search...

Water Management

Proper management of the District's water is critical to ensuring a stable and reliable supply for irrigation customers, especially in dry years. The District works cooperatively with other local agencies to promote long-term sustainability of this precious resource. Proper planning as well as efficient use of water benefits both the local urban and agricultural communities.

Groundwater Management (http://www.tid.org/water/water-management/groundwater-management)

Groundwater within the District is supplied by the Turlock Groundwater Basin, which is a subunit of the larger San Joaquin Valley Groundwater Basin. The District utilizes a combination of surface water and groundwater to supply irrigation water to its growers.

Agricultural Water Management Plan (http://www.tid.org/water/water-management/agricultural-water-management-plan)

TID's Agricultural Water Management Plan (AWMP) evaluates water use within the District and applicable management practices to make the best use of available resources.

Volumetric Water Measurement (http://www.tid.org/water/water-management/volumetric-water-measurement)

Water metering equipment is currently being installed throughout Turlock Irrigation District. This project is related to the Water Conservation Act of 2009, also known as SBx7-7.

California Irrigation Management Information System (http://www.tid.org/water/water-management/california-irrigation-management-information-system-cimis)

The California Irrigation Management Information System (CIMIS) is designed to help growers develop efficient water budgets and irrigation strategies. CIMIS is a standardized way of accounting for water consumed through evapotranspiration (ET) by the soil and plants.

TID IRRIGATION TIPS PAGE

Customer Service: 209-883-8222 My Electric Account

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Irrigation Tips

The tips below are designed to help growers reduce both tailwater drainage and the amount of deep percolation that contributes to high water tables and localized drainage problems. Most TID growers produce no tailwater. While these Irrigation tips are mainly intended for growers on the west side of the District who have access to area drains or use tile drainage systems, all growers can benefit during a drought.

Following these tips may lead to changes in the layout of the checks in your fields and cultural practices for growing field crops. Improved irrigation also saves on fertilizer costs because less of the expensive nutrients are leached out of the soil with deep percolation of the unused irrigation water that passes the crop roots. A grower making these changes must reach a balance between field layouts based on production and labor needs and the goal to reduce tailwater drainage and deep percolation losses.

Water Saving Strategies to Reduce Drainage from Flood Irrigation

The key to reducing tailwater drainage and deep percolation is to irrigate very fast and control how long the water is on the field. Good irrigation practices can result in overall irrigation efficiencies of 75 percent. These irrigation strategies were developed with the U.C. Cooperative Extension during the 1987 to 1992 drought and they still apply to today's practices.

- Reduce check size to irrigate as fast as possible, thus minimizing the volume of tailwater.
  - Smaller or narrower checks irrigate better.
    For example: on sandy soils use 1 acre checks 65 to 55 feet wide by 700 to 800 feet long; on loamy soils use 1.5 to 2 acre checks 80 to 90 feet wide by 800 to 1000 feet long.
  - On existing large checks, install a berm in the center to make 2 narrow checks.
- Increasing the flow of water in the check results in a faster irrigation time.
  - If the checks are already narrow, then run both valves into one check to maximize flow across check.
  - If the existing check has been split by the addition of an extra berm (I b above), then irrigate only one check at a time. On most pipelines the flow of water from just one valve increases to nearly what two valves delivered.
  - Plant crops with the check rather than across the check to speed the flow down the check.
- Preparation of the field is critical to achieve a uniform flow of water across the check. A high uniformity of irrigation means all parts of the field have the same amount of water for the same time. This also reduces deep percolation losses.
  - Laser level to insure cross slope is flat and check slope is uniform.
  - A narrow check with normal slope of 1/10 percent irrigates more uniformly across the check than a wider check with a steeper slope of 2/10 percent.
- Practice "cutback irrigation" by turning off the water before it reaches the end of the check. This will reduce ponding, deep percolation losses, and tailwater volume. Cutback irrigation works because the water on the upper portion of the check will continue to flow down the check after the shutoff and irrigate the remainder of the check.
  - Change shutoff times during season to match how soil seals between irrigations. Midseason cultivation will also change the shutoff time.
  - Shut off times will vary through the season. The first irrigation may require shutoff when the water reaches 90 percent of the distance down the check. By the third irrigation this shutoff time may be reduced to only 70 percent of the distance down the check.
- Schedule irrigations to match crop needs and soil water-holding characteristics. To reduce drainage volume, how long you irrigate is just as important as how often.
  - On sandy loam soils 1.25 inches of applied water fills 1 foot of soil; on sandy soil 1 inch of water fills 1 foot of soil. The plants can only utilize 50 percent to 60 percent of the water applied to the soil.
  - Understanding the crop rooting depth can save water. Rooting depth of the crop varies with the stage of growth. The highest deep percolation losses occur early in the growth season for annual field crops when the roots are not well developed. For example, the depths of corn roots are typically 3 feet during the peak stage of crop growth. Each irrigation requires only 3 inches on a sandy soil. Since the irrigation efficiency is 75 percent) the total applied water is 4 inches, or 25 percent more than use by the crop.
  - For winter oats the rooting depth in May is typically 18 inches while alfalfa roots can

reach 5 feet.

- How long to irrigate is critical to reducing tailwater and deep percolation, even if no changes are made to the size of the check. TID delivers large flows of water so every minute counts when practicing cutback or early shutoff irrigations.
  - A 15 cfs flow applies .25 inches per acre per minute, so 16 minutes per acre applies 4 inches of water, just right for corn on a sandy soil. A 20 cfs flow applies .33 inches per acre per minute, so the irrigation should be only 12 minutes per acre on sandy soil.
  - For a sandy loam soil and oats in May, only 2.5 inches of water should be applied and with a 20 cfs flow, the irrigation time would be only 8 minutes per acre.
- How often to irrigate is based on how fast the plant uses the water in the soil. Use crop water use or evapotranspiration (ET) information will help determine how much water is taken from the soil between irrigations.
  - A typical corn crop uses .27 inches of water per day at peak growth in early August. On sandy soil with 3 foot roots, there is about 60 percent of the 3 inches of water in the soil or 1.8 inches of water available for the plant between irrigations. To keep the soil moisture at optimum for best yields, irrigate every 7 days.
  - For the same crop and soil in June, the corn uses only .l3 inches per day and irrigations could be 13 days apart.
  - Crop ET varies seasonally. Use the current year ET values to schedule irrigations. The local CIMIS site is Denair #168.
- Each Grower's field is different. To obtain optimum yield irrigation practices need to be tailored to specific situations. Your local Farm Advisor can be of assistance in developing these practices.

TID WATER USAGE PAGE FOR IRRIGATORS

Welcome to Turlock Irrigation Online Water Request

Email address

Register

Password

Password

Forgot your Password?

Log In

*All first time users must register

2014 TURLOCK IRRIGATION DISTRICT (http://www.tid.org)

TID WATER MEASUREMENT PROJECT PRESENTATION

SBx7-7 Water Measurement Project

Key Points of the Water Conservation Act of 2009

- Designed to improve water management & conservation statewide
- Law includes both **Ag & Urban** Agencies
- Ag water suppliers providing water to more than 25,000 acres had to comply by 7/31/12
- Ag portion **requires:**
  - Measurement, accounting & reporting
  - "Volumetric" pricing structure that encourages conservation
  - Water Management Plan that evaluates and reports measurement, pricing & other water conservation practices to the Department of Water Resources
  - Existing devices = +/- 12% accurate by volume
  - New devices = +/- 5% by volume (Must be lab certified)
  - All parcels to be measured by volume and to within a specified accuracy as of 7/31/12
  - Common thread with the law is measurements by volume at a specific "delivery point". The "delivery point" is the canal side gate because that's where the District transfers responsibility of the water over to it's customers

Water Conservation Act of 2009

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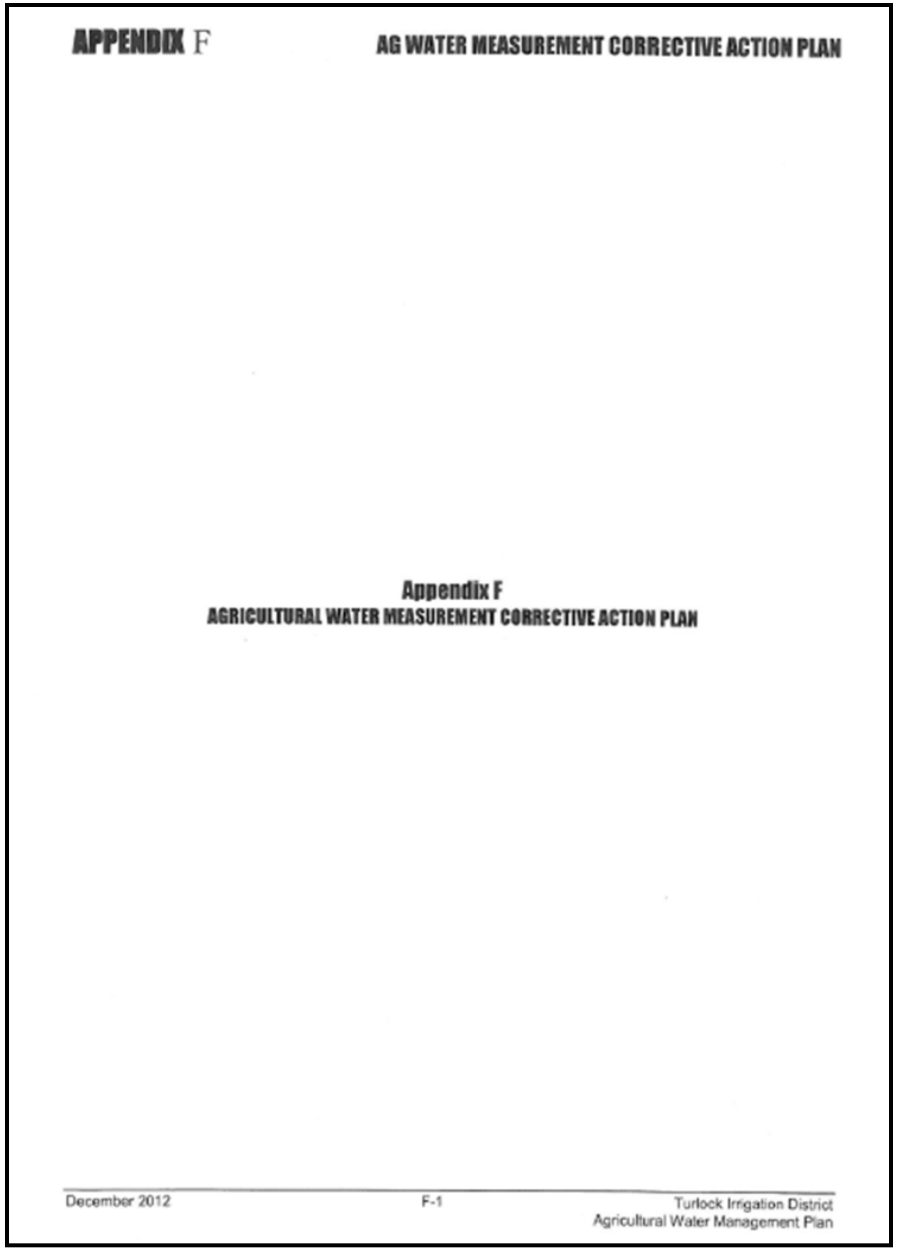
What did this 2009 legislation mean to TID?


APPENDIX F AG WATER MEASUREMENT CORRECTIVE ACTION PLAN

Appendix F
AGRICULTURAL WATER MEASUREMENT CORRECTIVE ACTION PLAN

December 2012 F-1 Turlock Irrigation District
Agricultural Water Management Plan

- The DWR was given the task of creating a measurement regulation
  - The regulation requires measurement accuracy to make volumetric pricing possible
  - Part of the regulation requires us to report aggregate farm-gate deliveries on a quarterly basis
- Since we could not comply by 7/31/2012, the law required us to devise an **"**Ag Water Measurement Corrective Action Plan"
- Per the law, this plan has to be in place by 12/31/2015
- The plan is available to the public by visiting our website. Go to: **tid.com/AWMP** & see **"Appendix F"** for specifics
- Our system was designed to reliably deliver water…now it must do this to a specific efficiency as well
- Bottom line: We have to start measuring & billing deliveries to each parcel by volume

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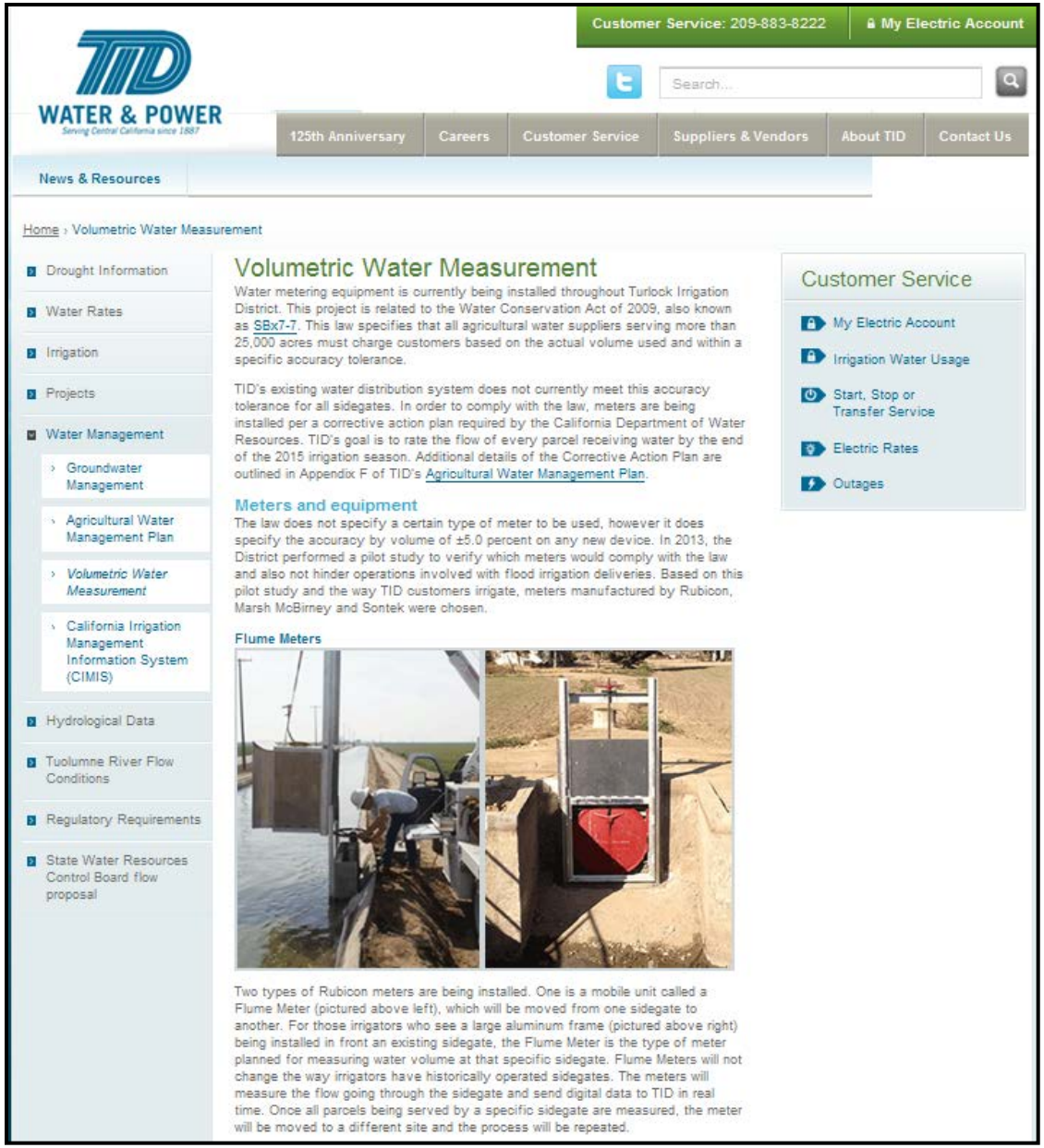
Customer Outreach



Customer Service: 209-883-8222 | My Electric Account

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News & Resources

Home › Volumetric Water Measurement

- Drought Information
- Water Rates
- Irrigation
- Projects
- Water Management
  - Groundwater Management
  - Agricultural Water Management Plan
  - *Volumetric Water Measurement*
  - California Irrigation Management Information System (CIMIS)
- Hydrological Data
- Tuolumne River Flow Conditions
- Regulatory Requirements
- State Water Resources Control Board flow proposal

Volumetric Water Measurement

Water metering equipment is currently being installed throughout Turlock Irrigation District. This project is related to the Water Conservation Act of 2009, also known as SBx7-7. This law specifies that all agricultural water suppliers serving more than 25,000 acres must charge customers based on the actual volume used and within a specific accuracy tolerance.

TID's existing water distribution system does not currently meet this accuracy tolerance for all sidegates. In order to comply with the law, meters are being installed per a corrective action plan required by the California Department of Water Resources. TID's goal is to rate the flow of every parcel receiving water by the end of the 2015 irrigation season. Additional details of the Corrective Action Plan are outlined in Appendix F of TID's Agricultural Water Management Plan.

Meters and equipment

The law does not specify a certain type of meter to be used, however it does specify the accuracy by volume of ±5.0 percent on any new device. In 2013, the District performed a pilot study to verify which meters would comply with the law and also not hinder operations involved with flood irrigation deliveries. Based on this pilot study and the way TID customers irrigate, meters manufactured by Rubicon, Marsh McBirney and Sontek were chosen.

Flume Meters

Two types of Rubicon meters are being installed. One is a mobile unit called a Flume Meter (pictured above left), which will be moved from one sidegate to another. For those irrigators who see a large aluminum frame (pictured above right) being installed in front an existing sidegate, the Flume Meter is the type of meter planned for measuring water volume at that specific sidegate. Flume Meters will not change the way irrigators have historically operated sidegates. The meters will measure the flow going through the sidegate and send digital data to TID in real time. Once all parcels being served by a specific sidegate are measured, the meter will be moved to a different site and the process will be repeated.

Customer Service

- My Electric Account
- Irrigation Water Usage
- Start, Stop or Transfer Service
- Electric Rates
- Outages

- New dedicated webpage has been created on our website addressing what customers are seeing in the field
- "How To" videos in English, Spanish & Portuguese will be posted on our website
- Important information will be mailed to customers receiving slip meters
- WDOs and office staff will train customers how to operate the new gates
- Grower Newsletters

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Methods of Measurement TID Has Tried…

The District has tested many different methods to measure flood deliveries over the last **4** years:

- Marsh McBirney
- Mace Meter
- ISCO Meter
- Sontek
- Rubicon

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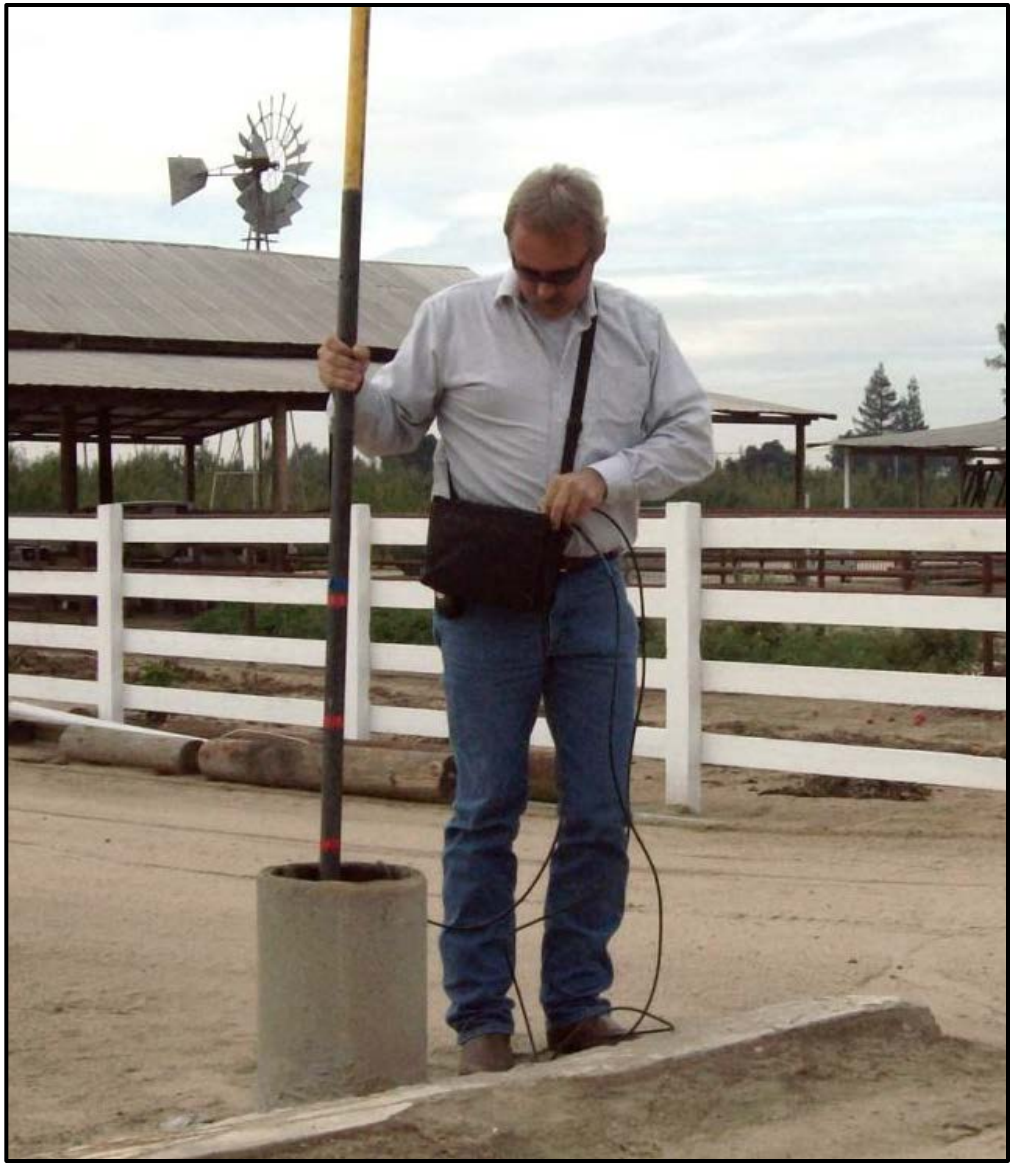
Marsh McBirney & Sontek Flow Meters



Some Parcels Will Be Checked Using Portable Flow Meters

- Can accommodate various measurement conditions
- Marsh McBirney **cannot** measure partial full pipes
- Sonteks **can** measure partial pipes and open ditches
- Approximately 550 parcels will be measured this way

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Rubicon Slip Meters & Flume Meters

Slip Meter

Flume Meter

What’s the difference??

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Rubicon Flume Meter

- A Flume Meter is the frame & meter box that slides in front of existing side gates
- These are considered to be mobile and will not change the way you irrigate
- Irrigator continues to operate existing side gate
- Meter resides at side gate for 4-5 weeks to capture all parcels. Meter is then moved to another side gate
- District wide, there will be 50 Flume Meters measuring over 1984 parcels throughout the District

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Rubicon Slip Meter

- Replaces your existing side gate and will change the way you irrigate
- Irrigator enters flow rate and the Slip Meter delivers that flow rate as long as there's enough water in the canal
- Irrigator can also enter a stem height and the gate will remain at that height regardless of flow
- Installation is permanent
- Live data will be transmitted to the District's SCADA system
- 2900 parcels will be served by Slip Meters = 51% of total TID irrigated acres

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Installation Progress

Flume Meter Sites

- So far there are 231 offset frames installed on 21 canals
- 45 frames left to install before the 2014 season begins

Slip Meter Sites

- So far there are 29 Slip Meters installed on 12 canals
- 38 left to install before the 2014 season begins

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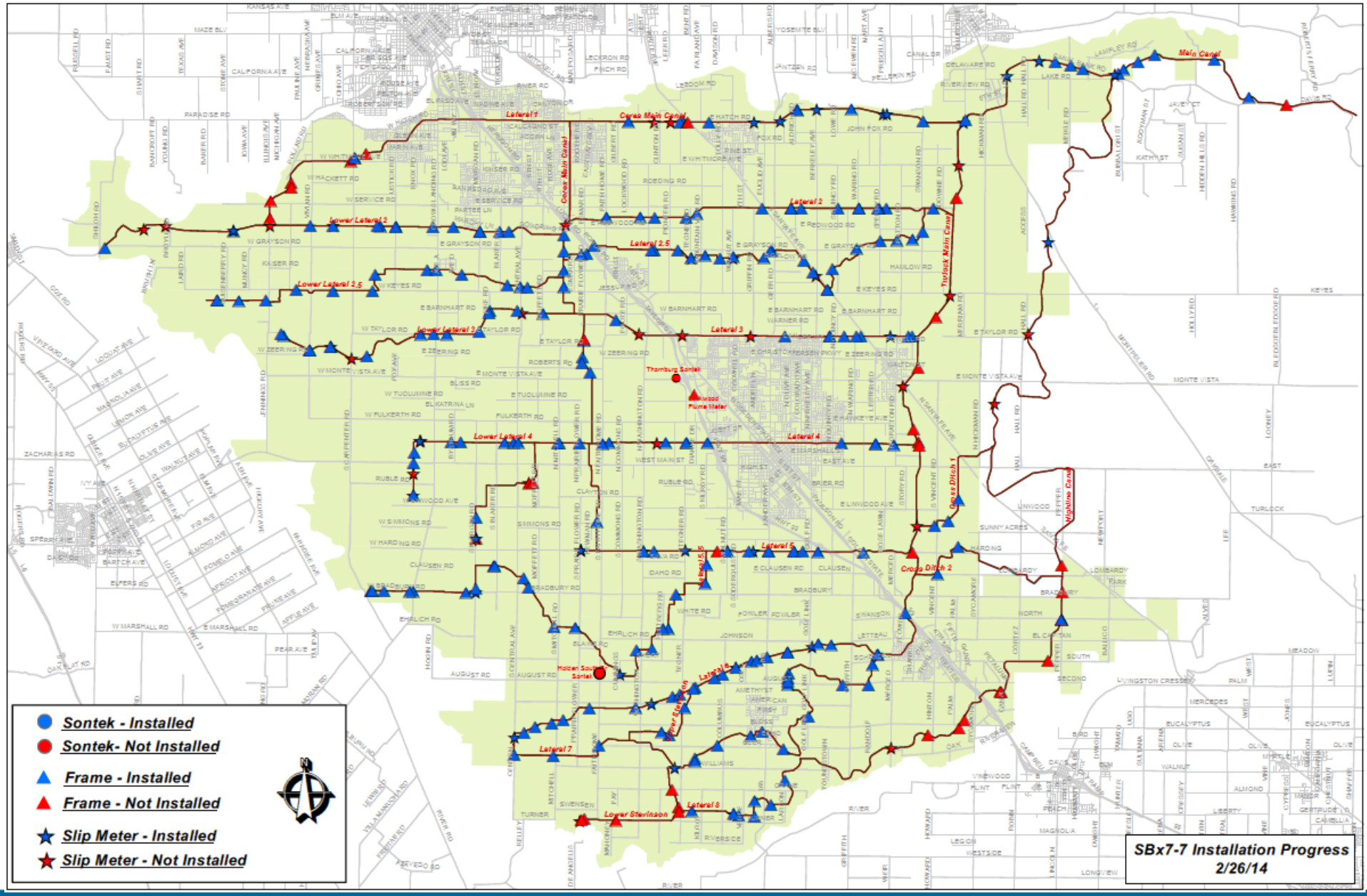
2013-2014 Installation Progress Map



What About Booster Pump Systems?

By law, these systems also must be measured

Full Spool Mag Meter

New Saddle Mag Meter

- 400 sites have been planned for the project
- An inventory identifying important dimensions of each system is being performed by District staff
- Existing metered systems will be rated by a mobile sonic meter to verify accuracy of +-12% by volume
- TID plans to have these systems connected via radio to our SCADA software
- TID will install the appropriate mag meters on existing sites that do not meet the accuracy requirements of the law

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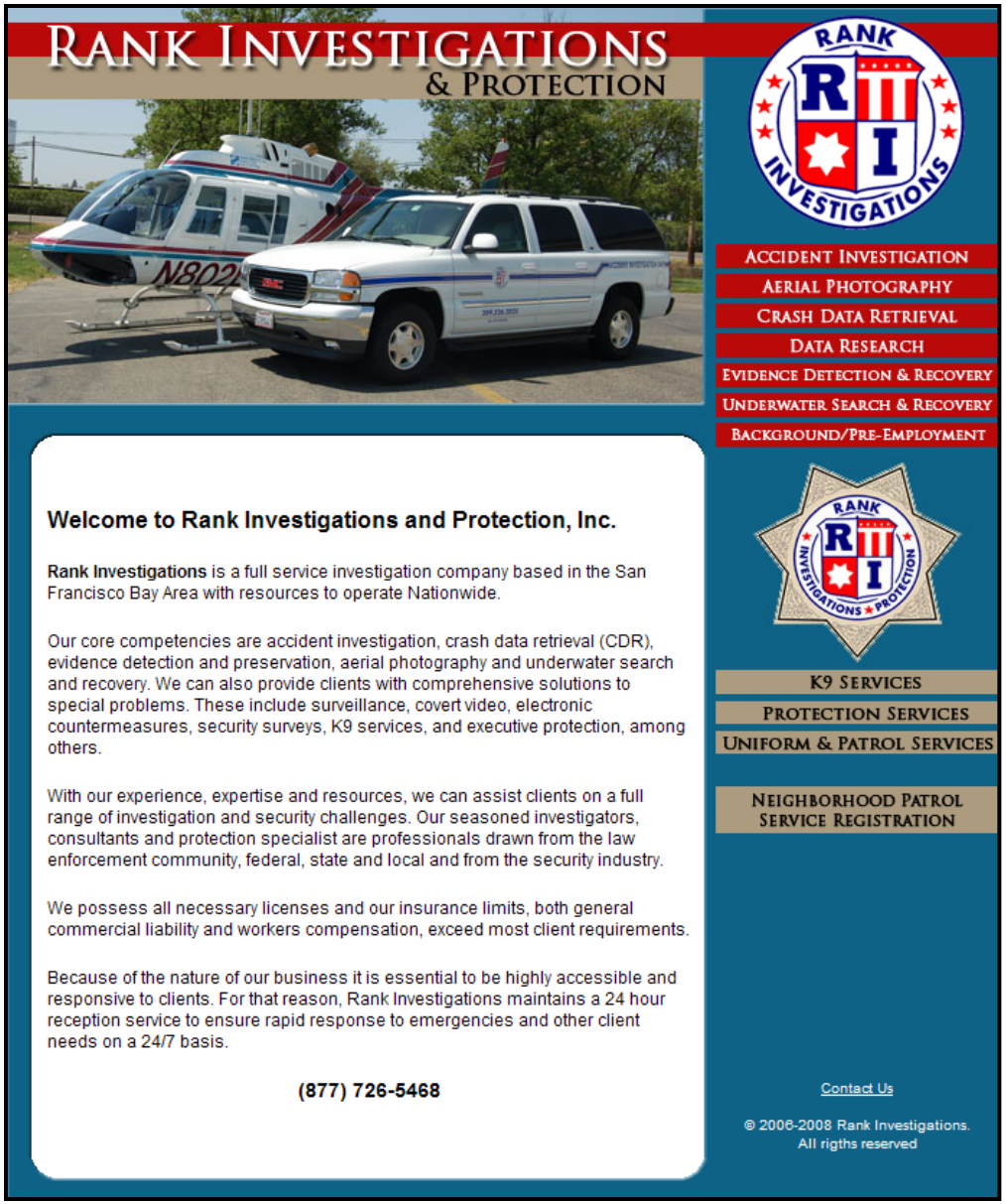
Vandalism & Security



- ✓ All Rubicon sites are remotely monitored and alarmed 24 hours per day
- ✓ Remote surveillance on each site will electronically notify staff immediately if there are issues
- ✓ Rank Security will get specific locations of sites to perform more frequent patrols
- ✓ Many security measures have been implemented on every site

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How will this project affect the farmers??

- ✓ The goal is to affect farmers as little as possible but we understand there will be a learning curve
- ✓ Our WDOs and office staff will train customers on how these meters operate and we will be as responsive as possible when concerns are raised
- ✓ In the interest of fairness, the District does not intend to bill from these meters until all parcels have been rated which will take at least 2 years
- ✓ Measurements during the 2014 and 2015 seasons will help the District identify where the water is going and will be used as a baseline for future operations

TID WATER & POWER
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Re-cap of Measurement Project

- ✓ TID was required by law to measure volumetrically and within a specific accuracy by 7/31/12
- ✓ TID couldn't comply by 7/31/12 on **ALL** gates…law requires us to have corrective action plan in place by 12/31/15
- ✓ The accuracy & volumetric requirements for every site meant we could not use our existing sidegates alone as measuring devices
- ✓ 50 Flume Meters & 125 Slip Meters will be in use during the 2015 season
- ✓ A projected 400 booster pump sites will be metered before the 2016 season

It's the

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Questions???

Attachment G.3. Grower Resources

Drought Strategies for Orchards
Strategies for Farming in a Drought
University of California Drought Management page
How NRCS can help?

APPENDIX G

DROUGHT STRATEGIES FOR ORCHARDS

University of California
Agriculture and Natural Resources
Making a Difference for California

Drought Strategies for Orchards

How best to manage it and what to expect

Roger Duncan
Pomology & Viticulture Advisor
University of California Cooperative Extension
Stanislaus County

*Many slides borrowed from Ken Shackle, UC Davis
David Doll, UCCE Merced

Calculating Water Use by Evapotranspiration (ET)

- $Et_{crop} = Et_o \times K_c$
- Et_o = reference ET (based on grass)
  - Can obtain from CIMIS

- K_c = crop coefficient.
  - Is a ratio of tree water use compared to grass
  - Varies through the season
  - Different crops have different K_c

AT&T 4G 4:10 PM

cimis

Daily Report

Modesto - San Joaquin Valley - Station 71

Date	CIMIS ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Pt (°F)	Avg wSpd (MPH)	Wnd Run (miles)	Avg Soil Temp (°F)
05/01/2014	0.23	0.00	590	12.9	90.8	52.6	72.0	86	24	48	51.3	3.8	91.5	65.1
05/02/2014	0.25	0.00	600	10.1	87.0	48.7	69.0	82	23	42	44.9	5.0	121.4	65.1
05/03/2014	0.25	0.00	593	10.9	76.8	55.2	65.0	80	34	52	46.9	9.1	219.9	65.1
05/04/2014	0.22	0.00	601	11.2	73.9	48.1	61.5	83	43	60	47.4	7.2	174.3	64.1
05/05/2014	0.20	0.00	500	9.8	69.6	52.3	59.8	77	40	56	44.0	9.3 Y	223.7 Y	67.3
05/06/2014	0.22	0.00	550	9.1	72.7	47.7	59.9	77	33	52	42.1	7.5	181.9	65.8
05/07/2014	0.21	0.00	618	10.1	74.7	41.0	58.4	91	38	61	44.8	4.7	112.4	65.2
05/08/2014	0.16	0.00	479	12.4	71.6	45.4	60.9	90	45	68	50.2	5.2	125.3	65.2
05/09/2014	0.25	0.00	360	8.1	71.8	49.4	61.3	85	33	44	39.0	8.3	201.5	66.4

Calculating Water Use with ET

Date	ETo	Kc	ETc	Cumulative ET
July 1	0.23	1.11	0.26	0.26
July 2	0.25	1.11	0.28	0.54
July 3	0.33	1.11	0.37	0.91
July 4	0.32	1.11	0.36	1.27
July 5	0.26	1.11	0.29	1.56
July 6	0.35	1.11	0.39	1.95
July 7	0.34	1.11	0.38	2.33

Past and present Almond Kc values and ETc estimates

DATE	Old Almond Kc values	Almond Kc-2013	Average ETc (in / day)	Total ETc (in / period)	Etc Gal/tree/day*
Mar 1-15	NA	0.54	0.049	0.74	10.2
Mar 15-31	0.54	0.77	0.070	1.05	14.6
Apr 1-15	0.60	0.94	0.119	1.79	24.8
Apr 16-30	0.66	0.99	0.130	1.95	27.2
May 1-15	0.73	1.02	0.180	2.70	37.6
May 16-31	0.79	1.04	0.195	2.93	40.8
June 1-15	0.84	1.08	0.269	4.04	56.2
June 16-30	0.86	1.11	0.275	4.13	57.5
July 1-15	0.93	1.11	0.320	4.80	66.9
July 16-31	0.94	1.11	0.320	4.80	66.9
Aug 1-15	0.94	1.11	0.278	4.17	58.1
Aug 16-31	0.94	1.06	0.278	4.17	58.1
Sept 1-15	0.94	0.93	0.201	3.00	43.5
Sept 16-30	0.91	0.77	0.201	3.00	42.0
Oct 1-15	0.85	0.65	0.118	1.77	24.7
Oct 16-31	0.79	0.52	0.109	1.64	22.8
Nov 1-15	0.70	0.28	0.041	0.62	8.6
Total ETc	**38-42”**	**48-56”**		**~48”**	

* 16 x 21 tree spacing

Canopy cover dictates water needs

Orchards with 80% shaded area will use about 56” of water

(B.D. Lampinen)

.

About 35% shaded area uses about 25” of water

(B.D. Lampinen)

Average vs. 2014 ETc

DATE	Almond Kc Values	Average ETc (in / period)	2014 ETo (in / period)	2014 Etc (Denair)	Precipitation	Water Used So Far
Mar 1-15	0.54	0.74	1.67	0.90	0.61	0.29
Mar 15-31	0.77	1.05	2.12	1.63	1.16	0.76
Apr 1-15	0.94	1.79	2.31	2.31	0.39	2.68
Apr 16-30	0.99	1.95	3.14	3.11	0.29	5.50
May 1-15	1.02	2.70	3.74	3.81	0.02	9.29
May 16-31	1.04	2.93	3.11*	3.37*	0.01	12.65
June 1-15	1.08	4.04				
June 16-30	1.11	4.13				
July 1-15	1.11	4.80				
July 16-31	1.11	4.80				
Aug 1-15	1.11	4.17				
Aug 16-31	1.06	4.17				
Sept 1-15	0.93	3.00				
Sept 16-30	0.77	3.00				
Oct 1-15	0.65	1.77				
Oct 16-31	0.52	1.64				
Nov 1-15	0.28	0.62				
Total ETc	**48-56”**	**~48”**				

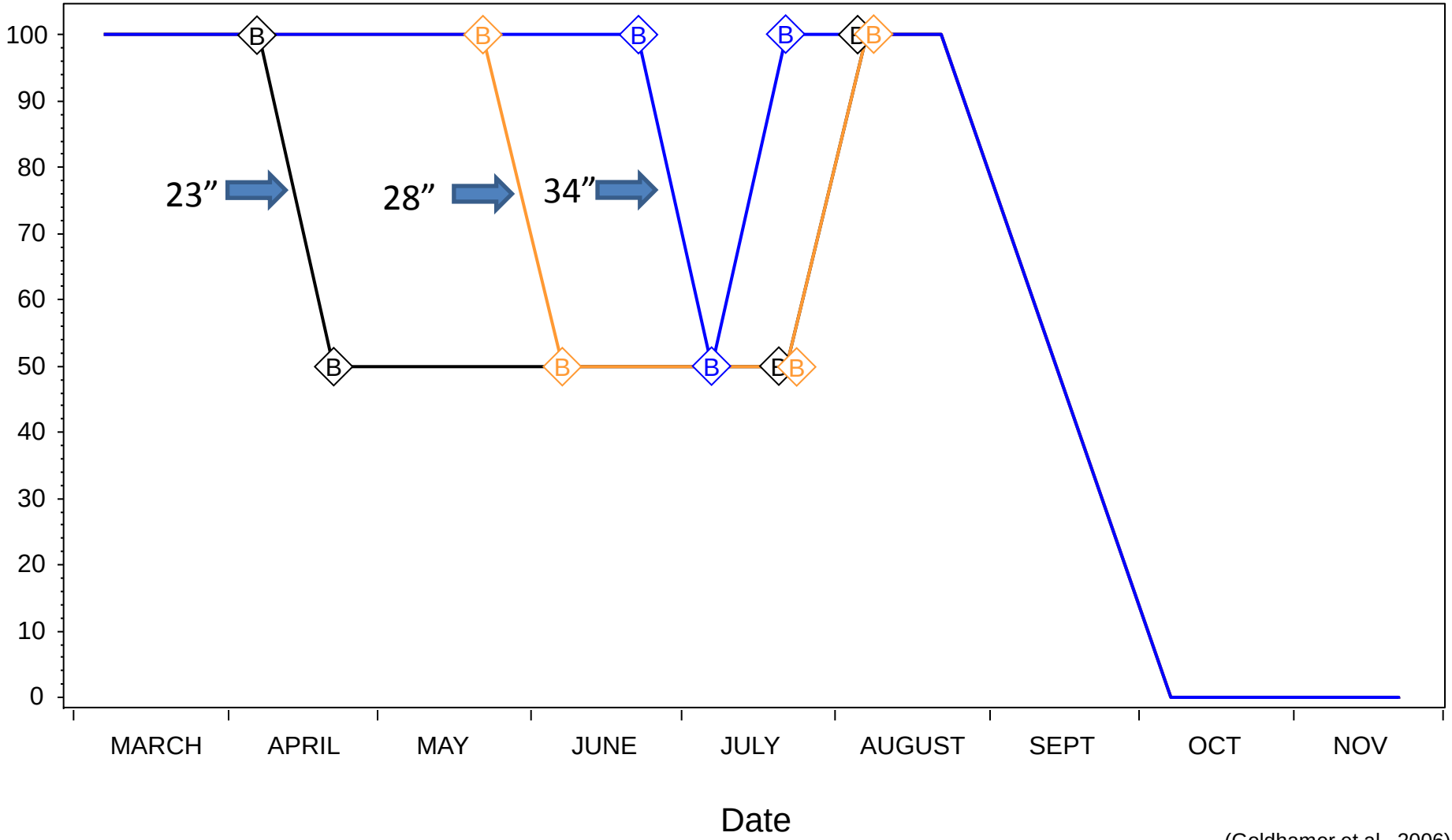
MID & TID customers are limited to 24 inches of water in 2014, roughly half of the full irrigation requirement.

- With only half of the desired water available, trees <u>will</u> stress.
- We can only determine when and how much
- Timing of stress will affect the current and the following year's yields

What is the best way to allocate a limited amount of water?

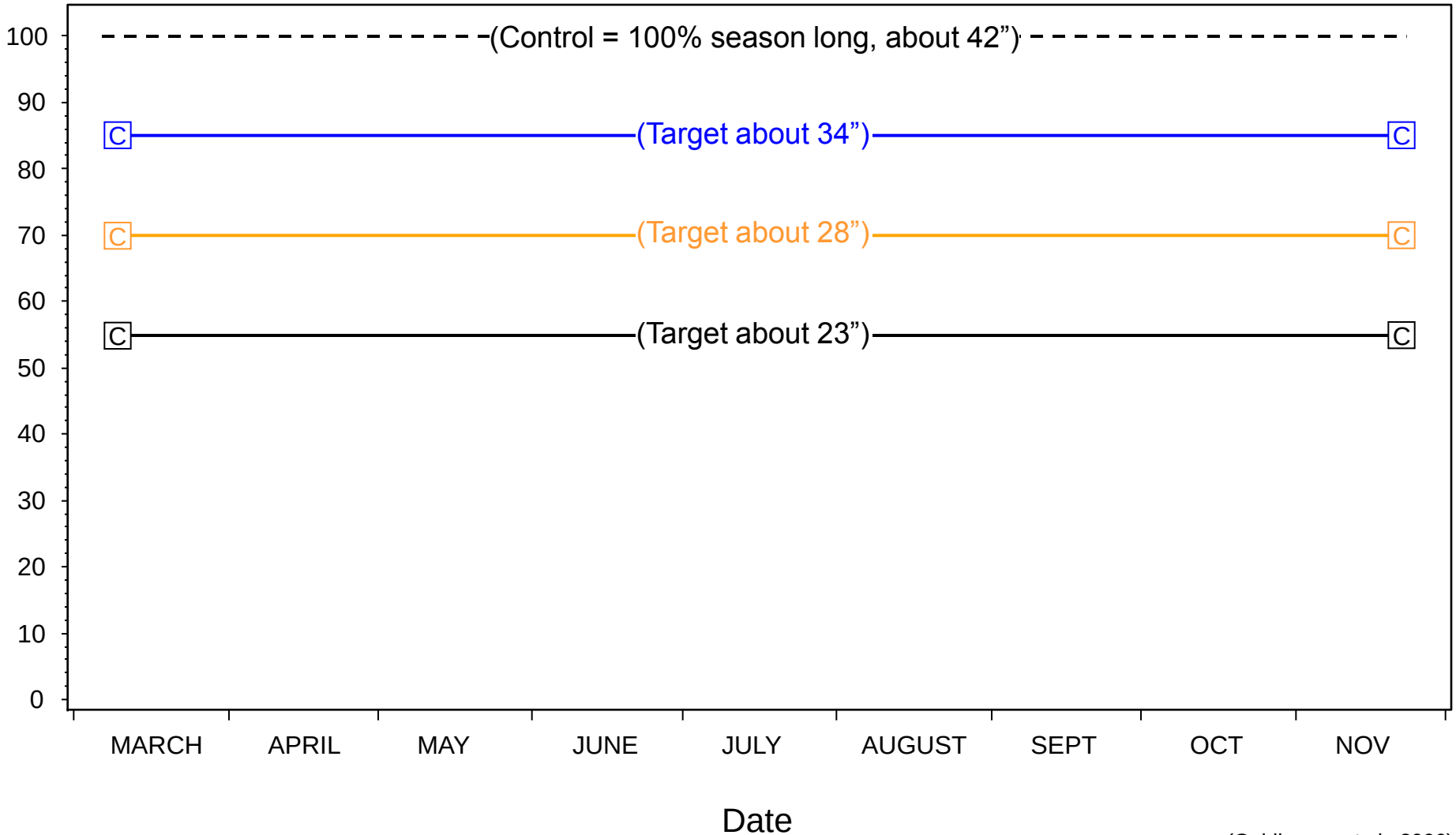
- 1993 -1996 study (Goldhamer et al, 2006), Southern SJV, mature orchard
- 3’ root zone, 7.5” average rainfall during study (no pre-irrigation)
- 3 levels of irrigation deficit (34”, 28”, 23”) (80%, 67%, 55%)
- Control (100% Etc = 42”)
- 3 patterns of deficit irrigation
  - “A” – Deficit focused mostly in early season – full irrigation at end
  - “B” – Deficit focused at end of season – no irrigation after mid August
  - “C” – Deficit spread throughout the season

“B” pattern: Some deficit early, most deficit post-harvest



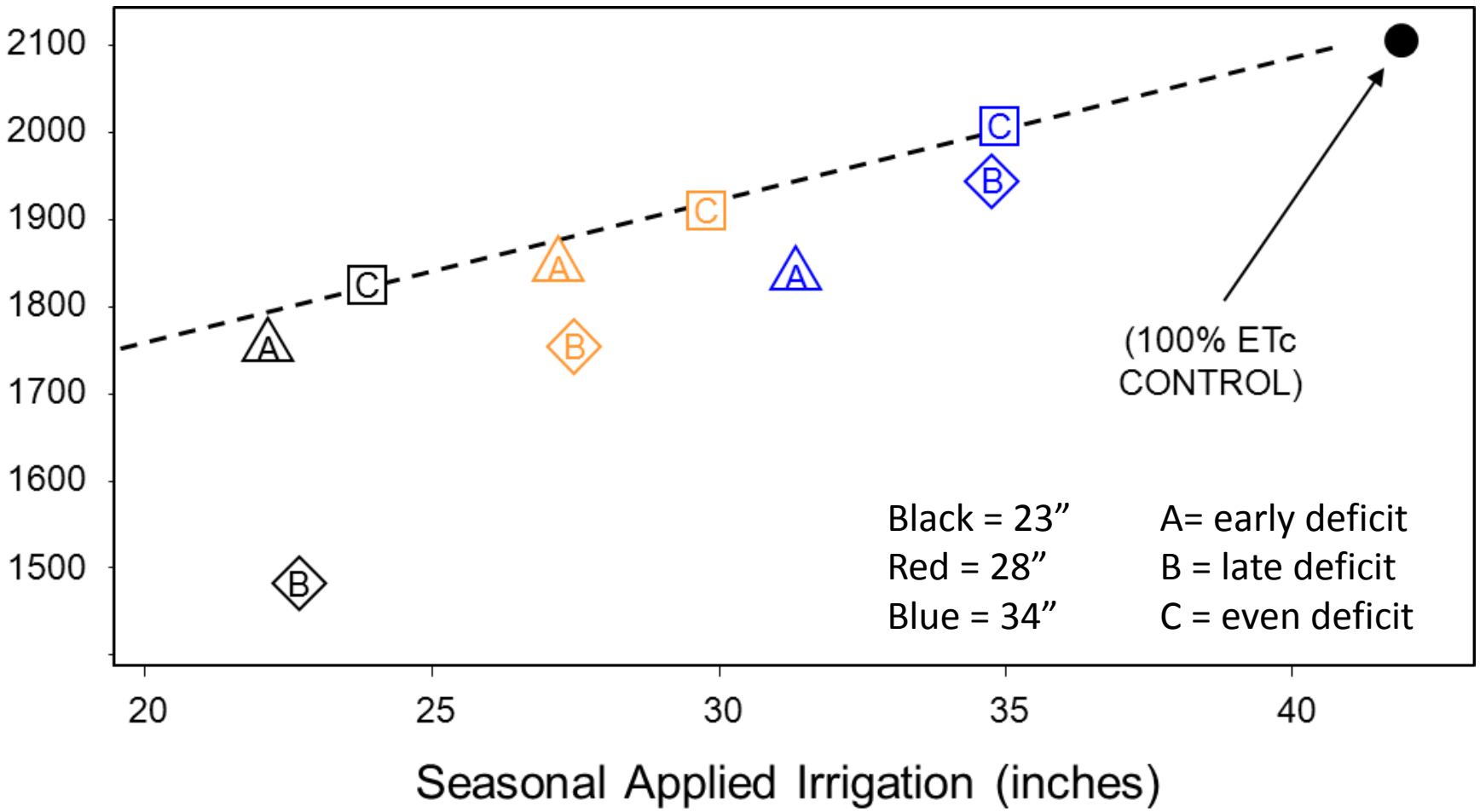
(Goldhamer et al., 2006)

“C” pattern: Equal irrigation deficit all season



(Goldhamer et al., 2006)

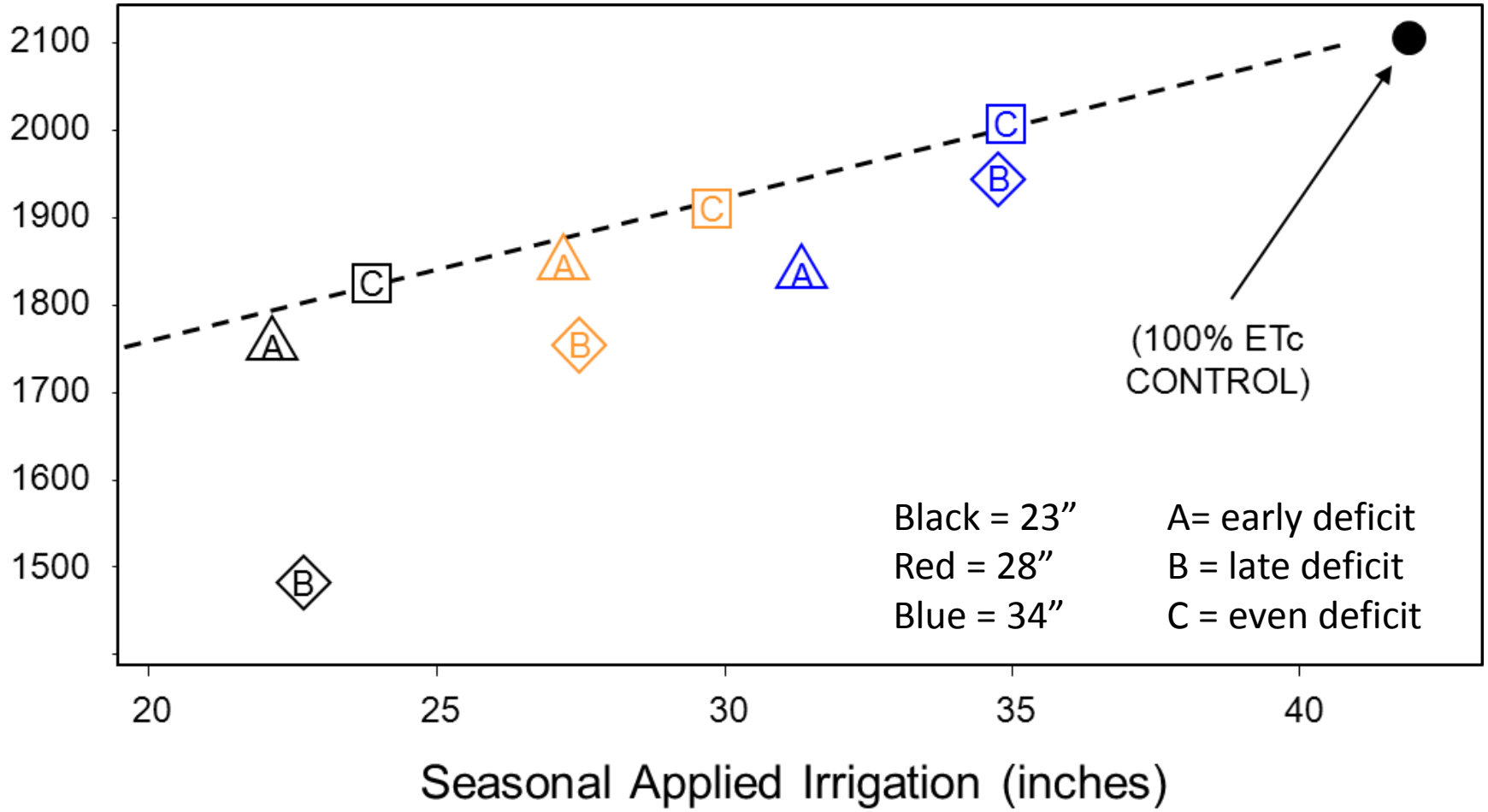
Average Kernel Yield (lbs/ac) 1993-1996



(Goldhamer et al., 2006)

Average Kernel Yield (lbs/ac) 1993-1996

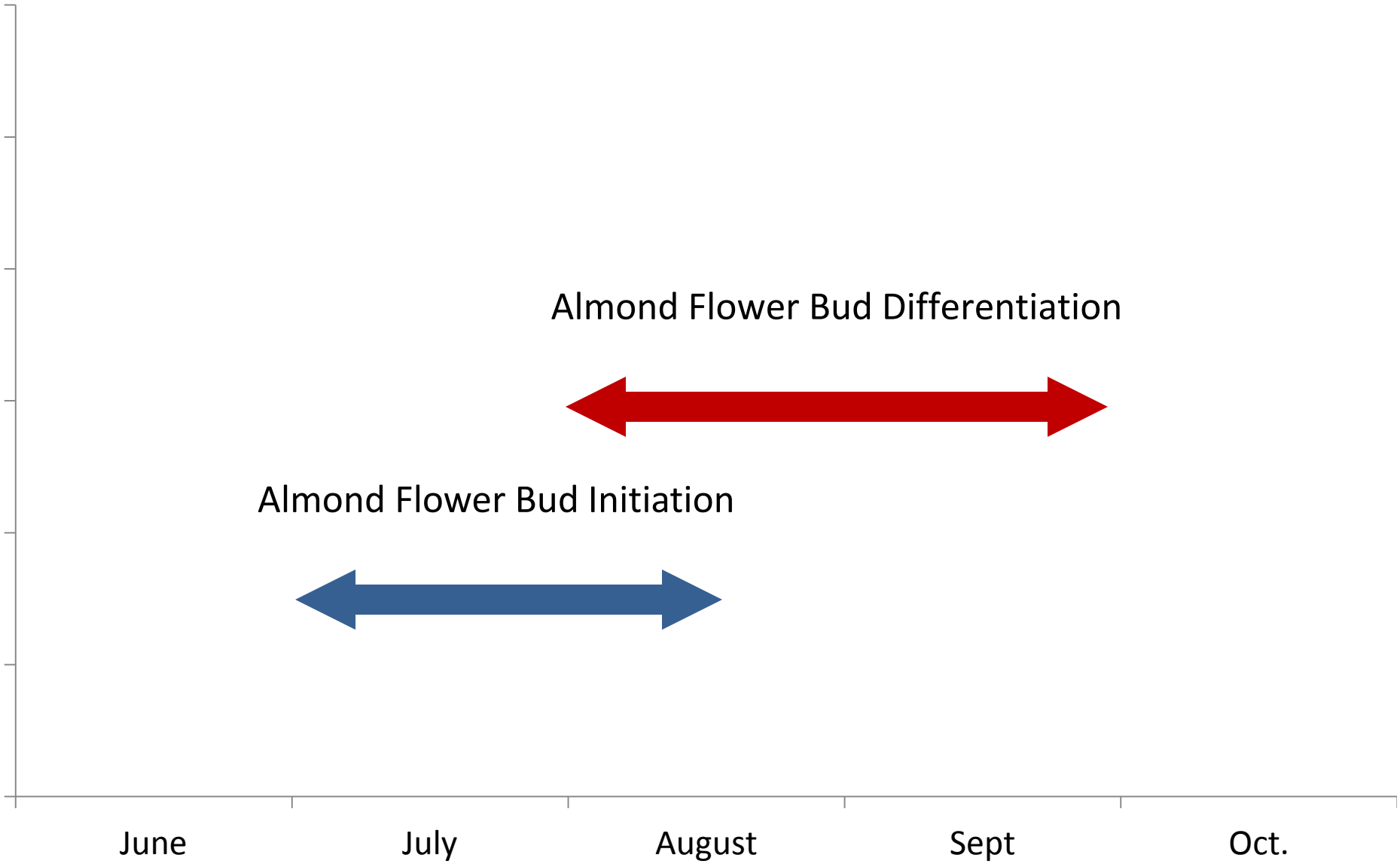
An **even deficit** over the season always gave the best result



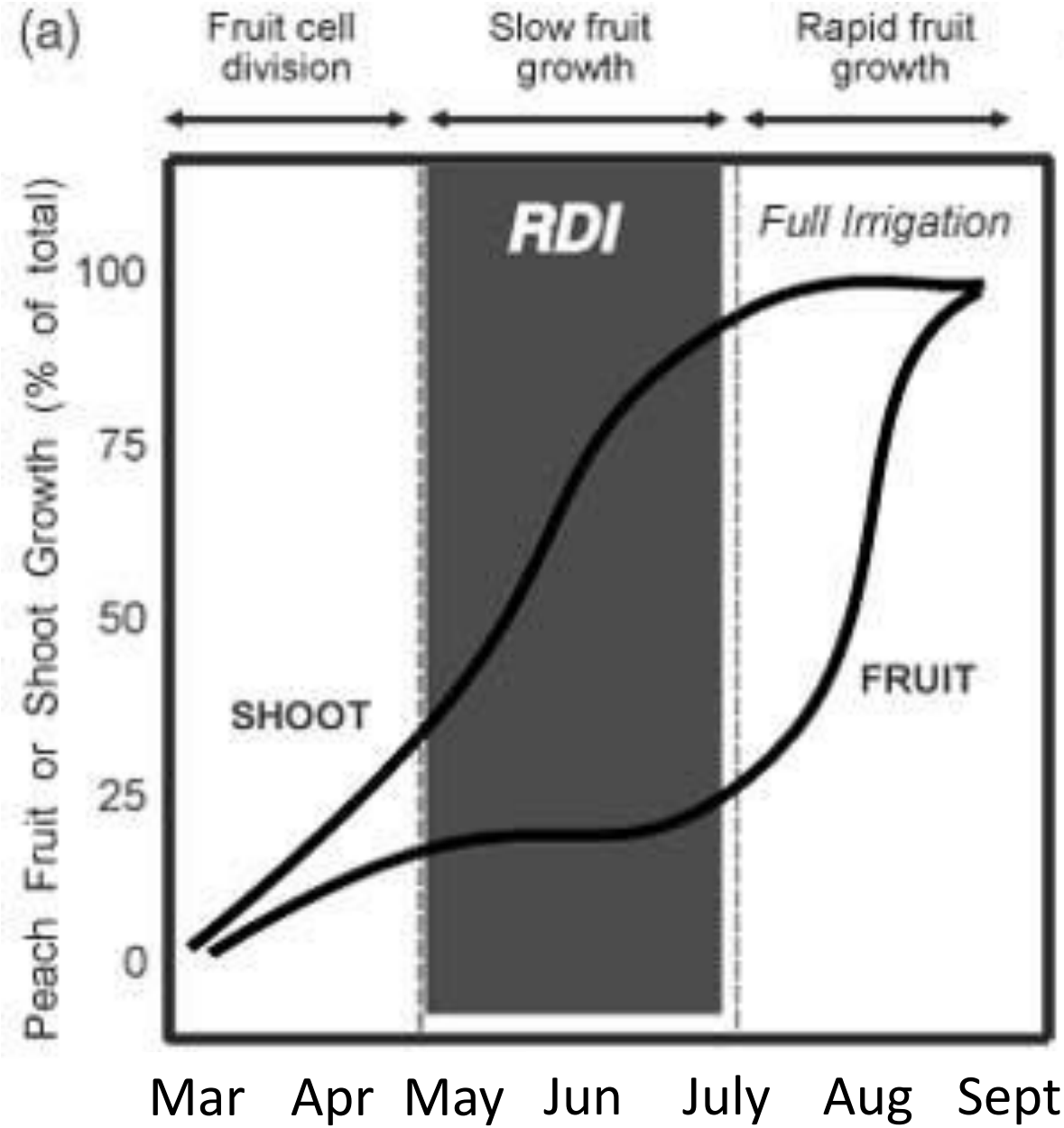
(Goldhamer et al., 2006)

Spread Pain Through the Season

- Full ET is about 48”
- MID & TID customers get half of that in 2014
- If you normally run your microsprinkler irrigation system 20 hours twice each week in June & July, run it for 10 hours twice each week
- If you flood irrigate, spread irrigations evenly


Almond Flower Bud Differentiation
Almond Flower Bud Initiation
June
July
August
Sept
Oct.

Double Sigmoid Growth Curve of Stone Fruit



- Stage 1 – sensitive to drought but too early for severe stress
- Stage 2 – Seed development. Most tolerant of stress. Earliest onset of pit tip hardening
- Stage 3 – 80% of fresh weight; due to cell expansion. Very sensitive to drought

Estimating Water Application of 24” Total

DATE	ETc (in / period)	Water application with only 24”	50% Etc Gal/tree/day*
Mar 1-15	0.74	0.37	5.1
Mar 15-31	1.05	0.53	7.3
Apr 1-15	1.79	0.90	12.4
Apr 16-30	1.95	0.98	13.6
May 1-15	2.70	1.35	18.8
May 16-31	2.93	1.47	20.4
June 1-15	4.04	2.02	28.1
June 16-30	4.13	2.07	28.8
July 1-15	4.80	2.40	33.5
July 16-31	4.80	2.40	33.5
Aug 1-15	4.17	2.09	29.1
Aug 16-31	4.17	2.09	29.1
Sept 1-15	3.00	1.50	21.8
Sept 16-30	3.00	1.50	21.0
Oct 1-15	1.77	0.89	12.4
Oct 16-31	1.64	0.82	11.4
Nov 1-15	0.62	0.31	4.3
Total ETc	**~48”**	**24”**	

*Gal/tree/day based on 16’ x 21’ spacing

Gal/tree/day = Etc (in/day) x ft^2 x 0.622

1 year almond drought study, 2009

Water from			
Irrigation	Rain	Soil	Total
0”	2.1”	5.5”	7.6”
3.6”	2.1”	6.7”	12.4”
7.2”	2.1”	5.9”	15.2”
30.8”	2.1”	(?)	(32.9”)

A small amount of irrigation (3.6”) spread evenly over the season resulted in **more use** of deep water than did **no irrigation**.

July 21, 2009

Control tree

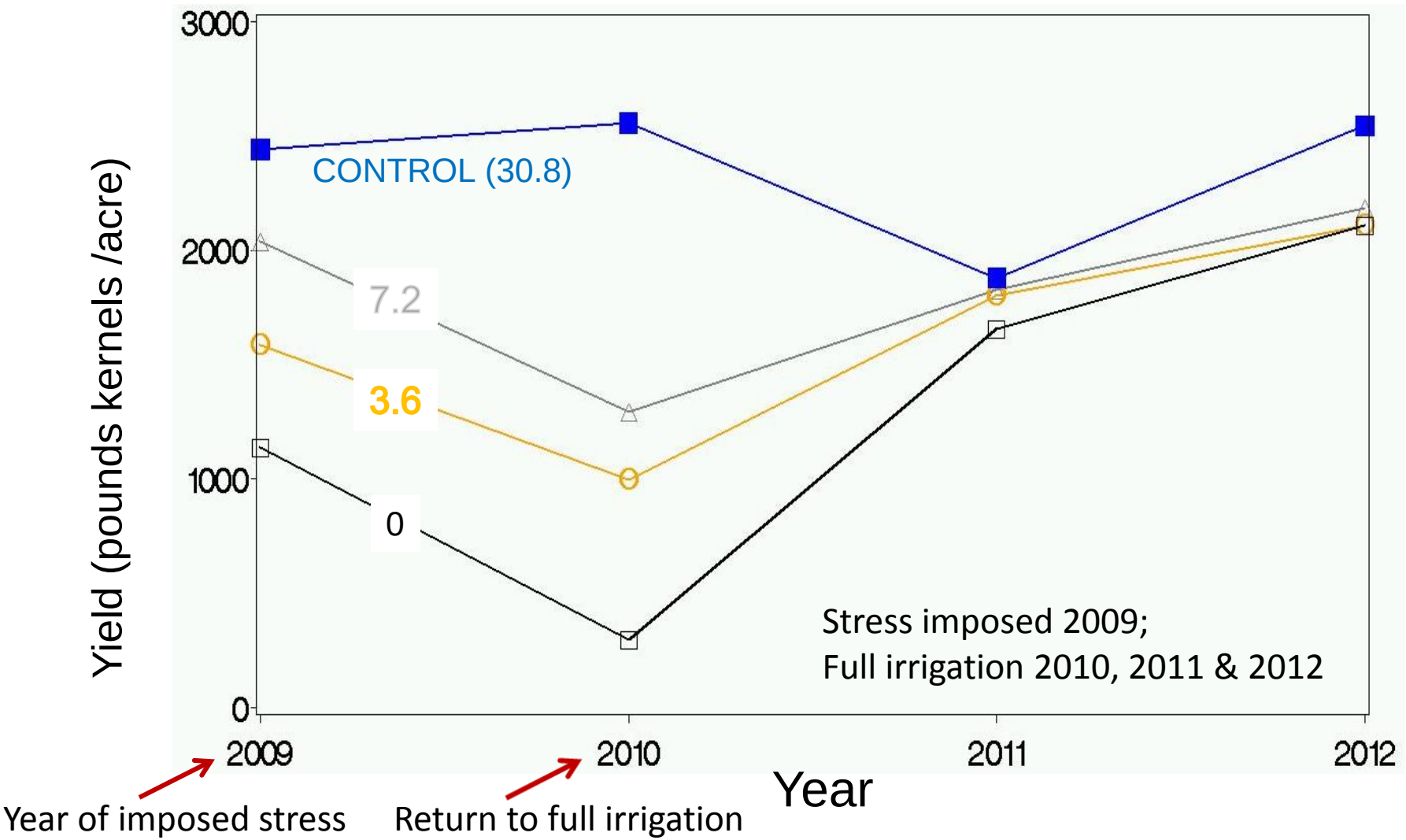
- 9.8 bars SWP

July 21, 2009

0” tree

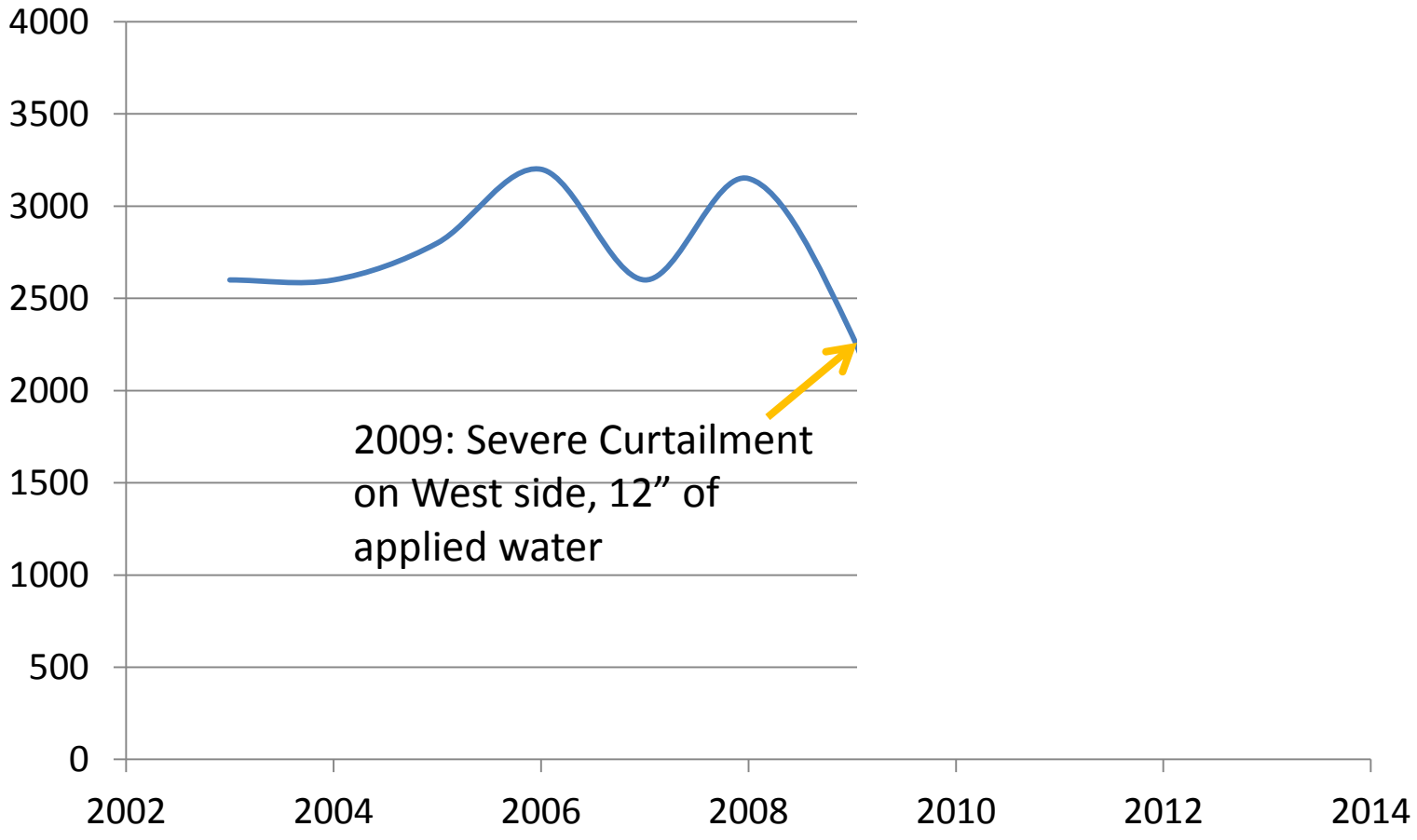
- 39 bars SWP

Yield: The biggest reduction occurred in the year <u>following</u> the stress (i.e. carryover effect)



Grower Experience. “Drought” Scenario - 2009

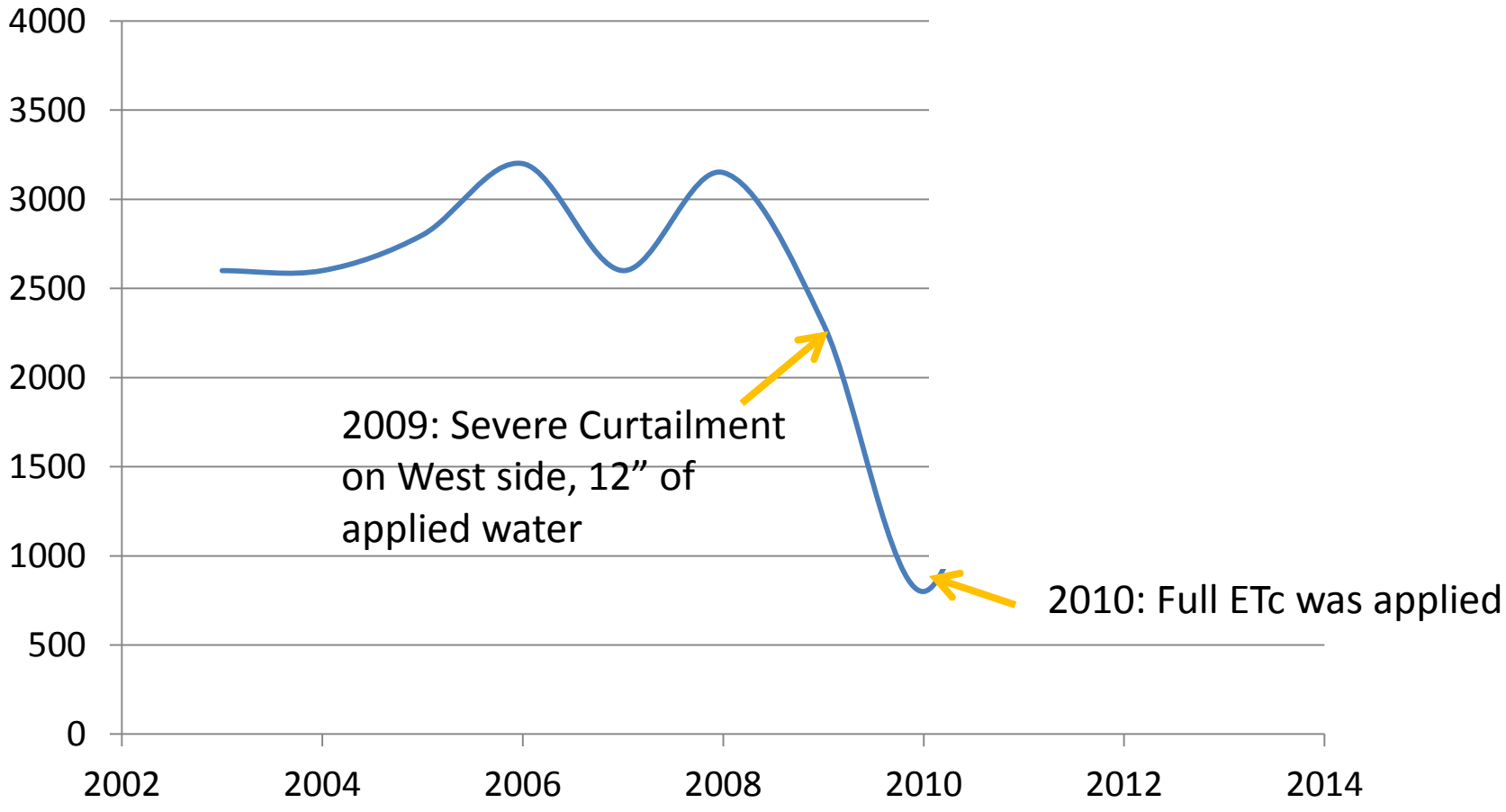
Mature Orchard near Firebaugh, 2003-2012



David Doll; UCCE Merced

Grower Experience. “Drought” Scenario - 2009

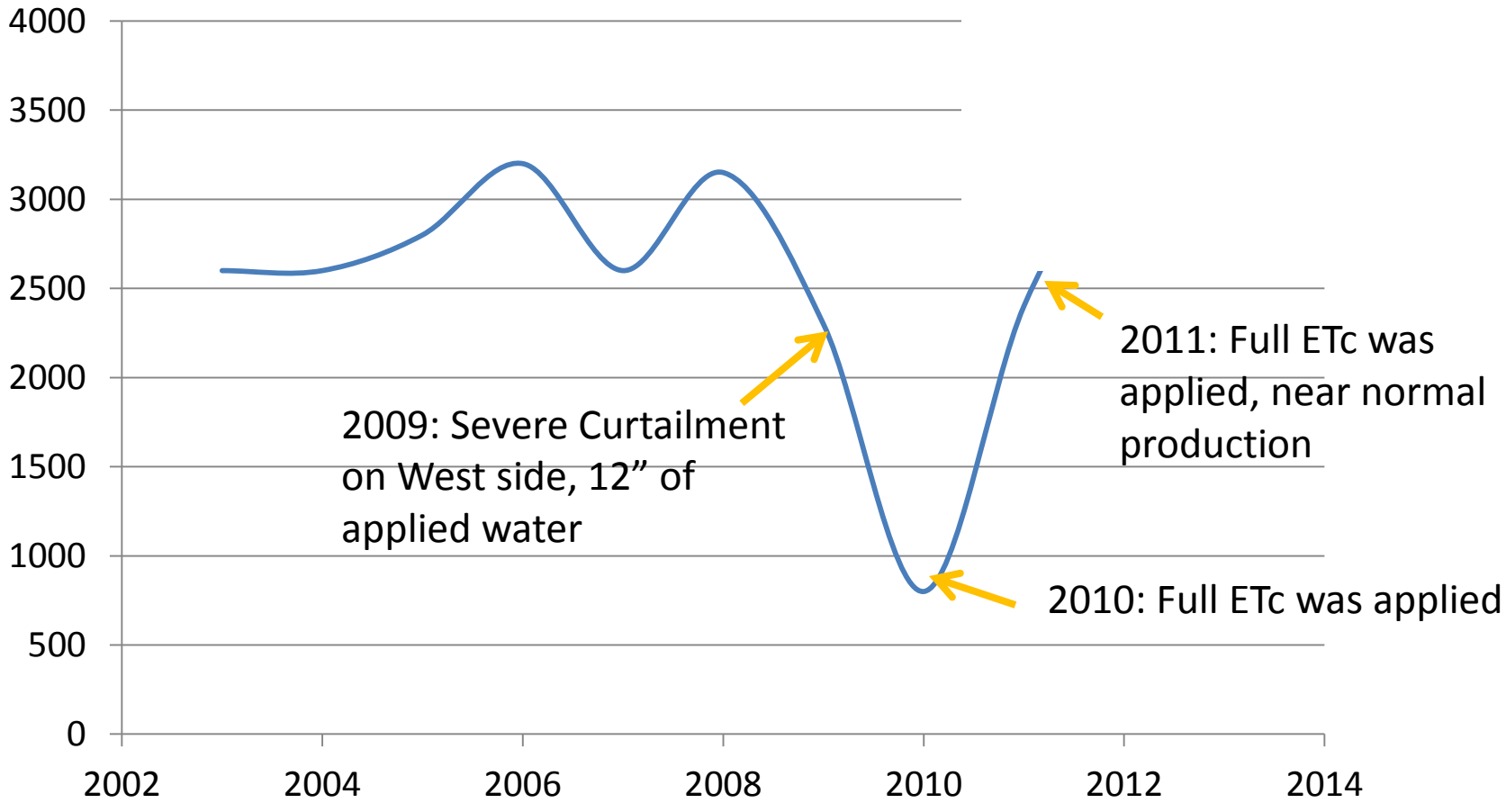
Mature Orchard near Firebaugh, 2003-2012



David Doll; UCCE Merced

Grower Experience. “Drought” Scenario - 2009

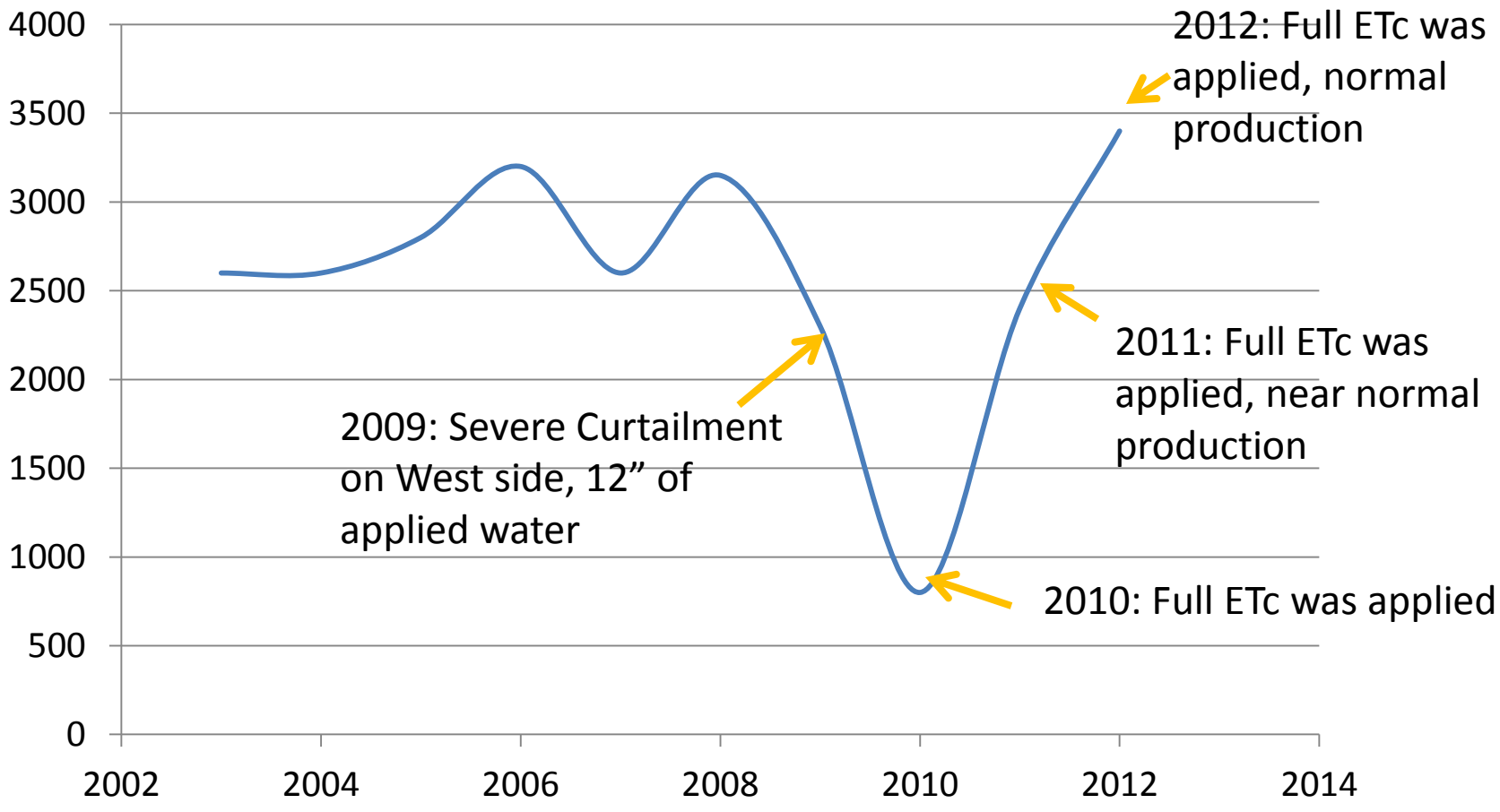
Mature Orchard near Firebaugh, 2003-2012



David Doll; UCCE Merced

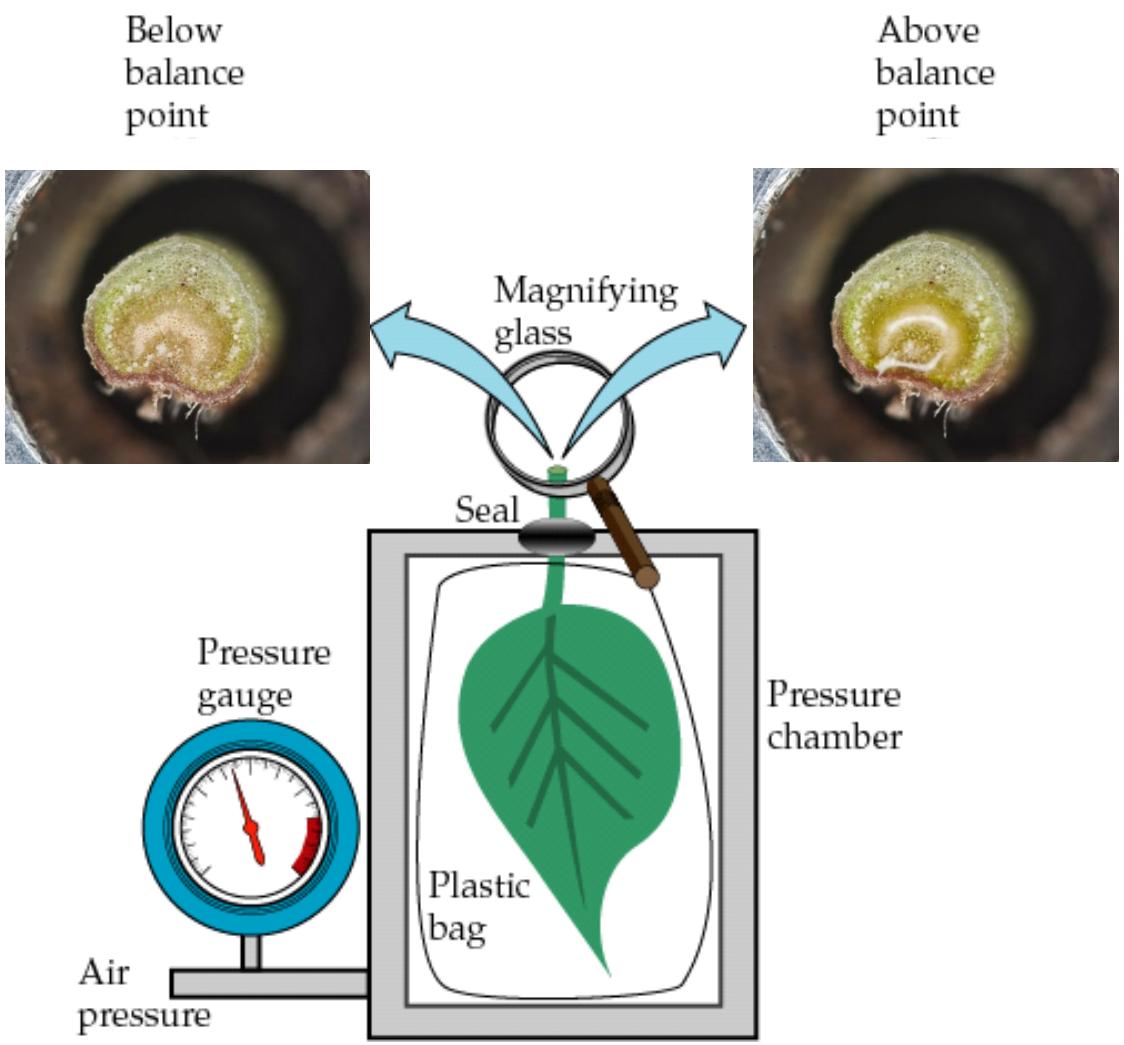
Grower Experience. “Drought” Scenario - 2009

Mature Orchard near Firebaugh, 2003-2012

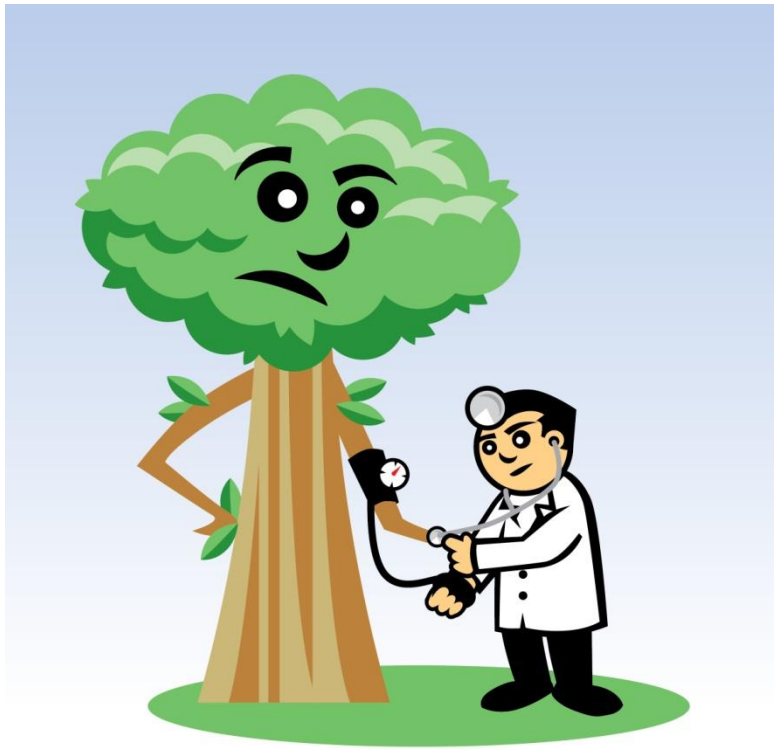


David Doll; UCCE Merced

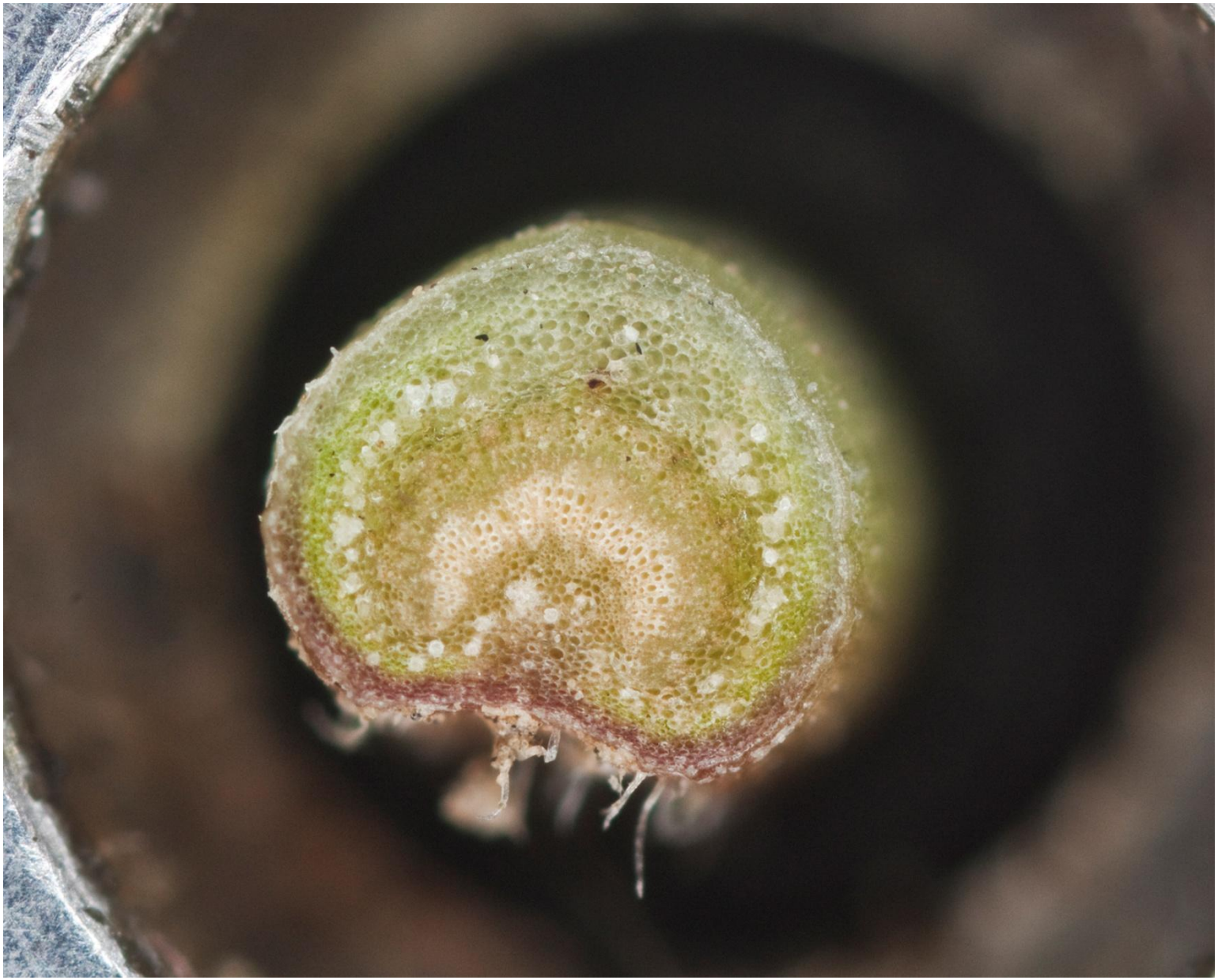
Pressure chamber method for measuring water stress



Like measuring the "blood pressure" of the plant



Stem Water Potential (SWP)



Resources to help with the pressure chamber

For Almond

SWP range (bars)	Stress level
-5 to -10	Minimal
-10 to -16	Mild
-16 to -24	Moderate
-24 to -30	Severe
-60	(complete defoliation)

(For other crops)

TENTATIVE GUIDELINES FOR INTERPRETING PRESSURE CHAMBER READINGS (MIDDAY STEM WATER POTENTIAL-SWP) IN WALNUT, ALMOND, AND DRIED PLUM. UPDATED MAY 2007.

Allan Fulton and Richard Buchner, UCCE Farm Advisors, Tehama County, Joe Grant, Farm Advisor, San Joaquin County, Terry Prichard, Bruce Lampinen, Larry Schwankl, Extension Specialists, UC Davis, and Ken Shackel, Professor UC Davis.

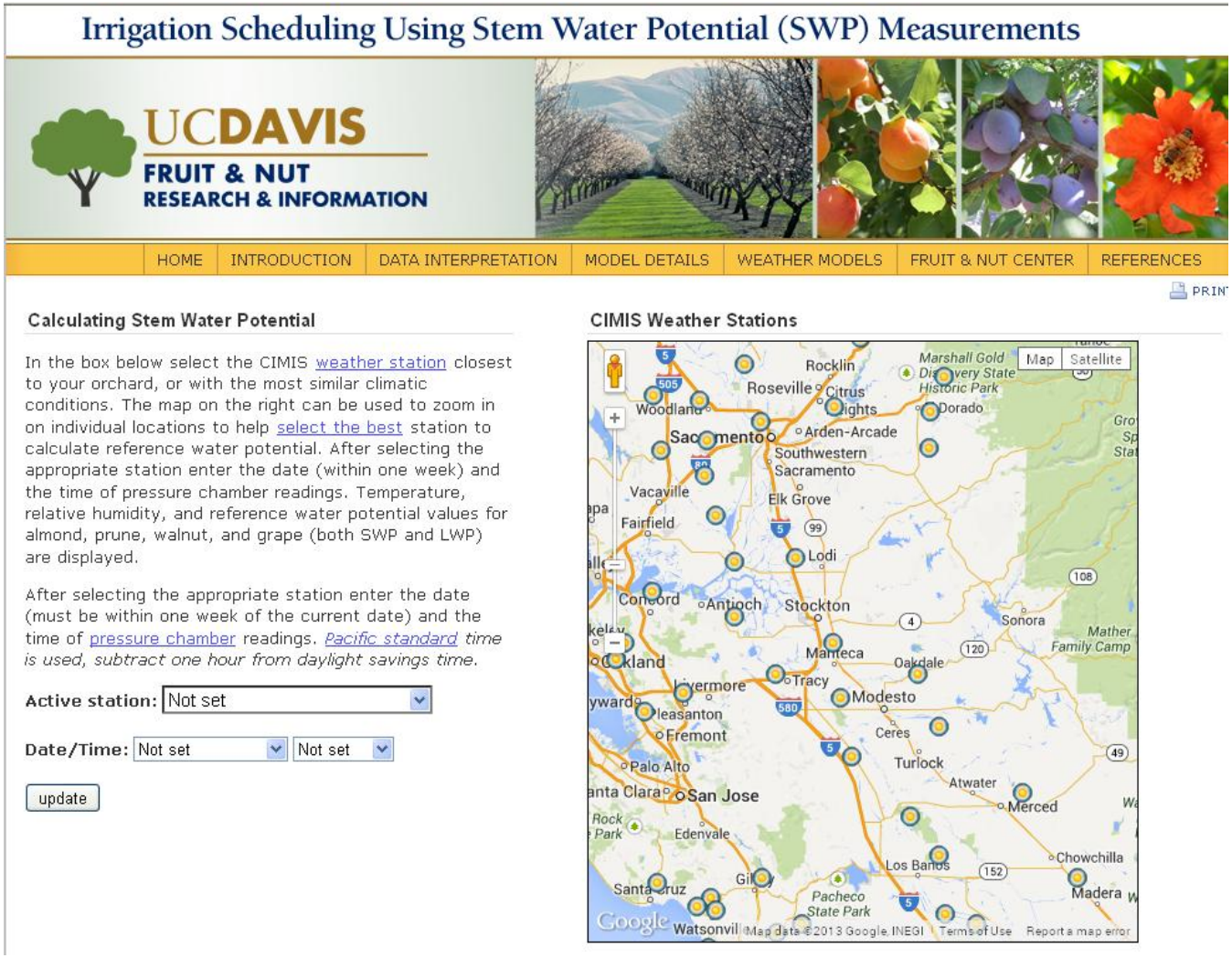
Pressure Chamber Reading (- bars)	WALNUT	ALMOND	PRUNES
0 to –2.0	Not commonly observed	Not commonly observed	Not commonly observed
-2.0 to –4.0	Fully irrigated, low stress, commonly observed when orchards are irrigated according to estimates of real-time evapotranspiration (ETc), long term root and tree health may be a concern, especially on California Black rootstock.		
-4.0 to –6.0	Low to mild stress, high rate of shoot growth visible, suggested level from leaf-out until mid June when nut sizing is completed.		
-6.0 to –8.0	Mild to moderate stress, shoot growth in non-bearing and bearing trees has been observed to decline. These levels do not appear to affect kernel development.	Low stress, indicator of fully irrigated conditions, ideal conditions for shoot growth. Suggest maintaining these levels from leaf-out through mid June.	Low stress, common from March to mid April under fully irrigated conditions. Ideal for maximum shoot growth.
-8.0 to –10.0	Moderate to high stress, shoot growth in non-bearing trees may stop, nut sizing may be reduced in bearing trees and bud development for next season may be negatively affected.		Suggested levels in late April through mid June. Low stress levels enabling shoot growth and fruit sizing.
-10.0 to –12.0	High stress, temporary wilting of leaves has been observed. New shoot growth may be sparse or absent and some defoliation may be evident. Nut size likely to be reduced.	Mild to moderate stress, these levels of stress may be appropriate during the phase of growth just before the onset of hull split (late June).	Suggested mild levels of stress during late June and July. Shoot growth slowed but fruit sizing unaffected.
-12.0 to –14.0	Relative high levels of stress, moderate to severe defoliation, should be avoided.		Mild to moderate stress suggested for August to achieve desirable sugar content in fruit and to reduce "dry-away" (drying costs).
-14.0 to –18.0	Severe defoliation, trees are likely dying.	Moderate stress in almond. Suggested stress level during hull split, Help control diseases such as hull rot and alternaria, if diseases are present. Hull split occurs more rapidly	Moderate stress acceptable in September.
-18.0 to –20.0	Crop stress levels in English walnut not observed at these levels.	Transitioning from moderate to higher crop stress levels	Moderate to high stress levels. Most commonly observed after harvest. Generally undesirable during any stage of tree or fruit growth. Most appropriately managed with post-harvest irrigation
-20 to -30		High stress, wilting observed, some defoliation	
Less than – 30		Extensive defoliation has been observed	High stress, extensive defoliation

* These guidelines are tentative and subject to change as research and development with the pressure chamber and midday stem water potential progress. This table should not be duplicated without prior consent by the authors.

Resources to help with the pressure chamber

New ‘baseline’ website:

http://informatics.plantsciences.ucdavis.edu/Brooke_Jacobs/index.php



Resources to help with the pressure chamber

New ‘baseline’ website:

http://informatics.plantsciences.ucdavis.edu/Brooke_Jacobs/index.php

Active station: 6 - Davis

Date/Time: Wed, 01-15-2014 2:00 PM

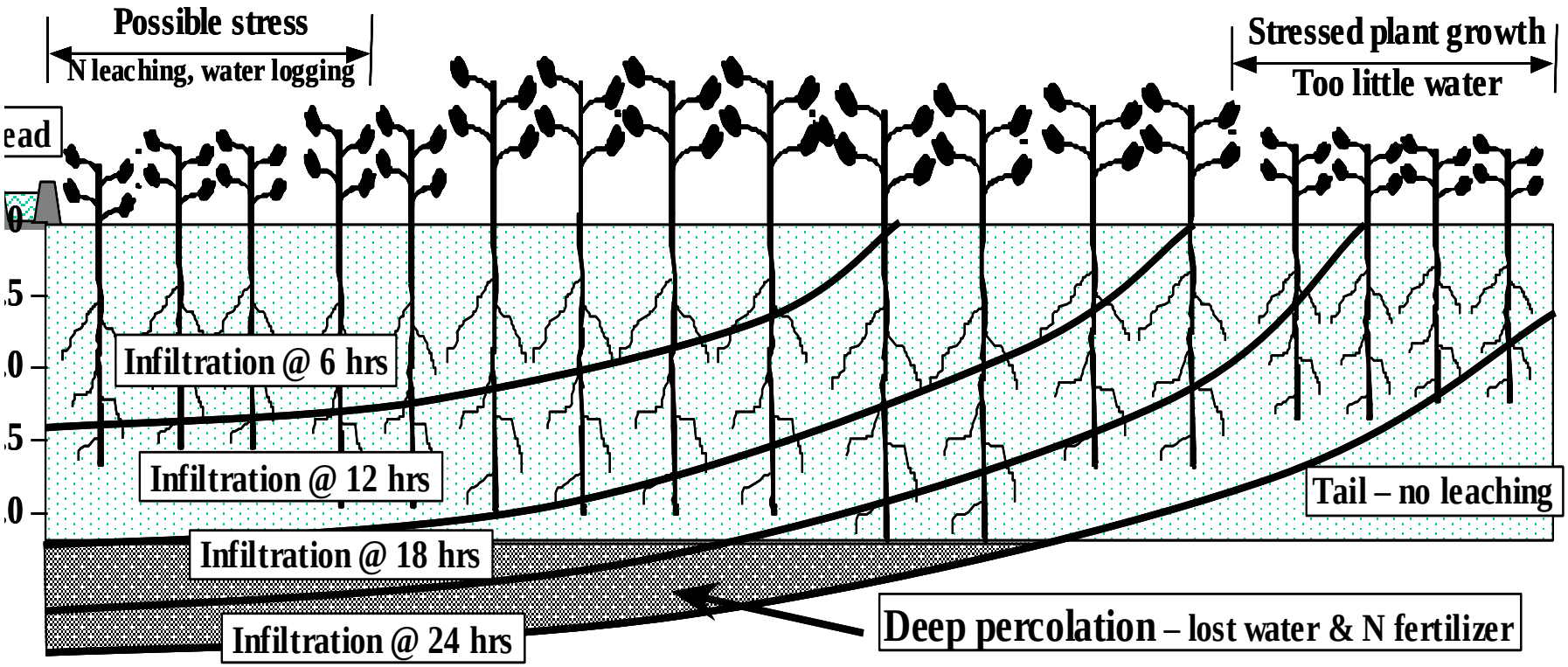
update

Time	Temperature (F)	Relative humidity	Almond/Prune	Walnut	Grape(SWP)	Grape(LWP)
12:00 PM	60.1	33.0	-5.5	-3.5	-3.1	-5.8
1:00 PM	63.5	27.0	-5.9	-3.7	-3.3	-6.1
2:00 PM	65.7	25.0	-6.0	-3.8	-3.4	-6.2
3:00 PM	67.7	24.0	-6.2	-3.9	-3.5	-6.3
4:00 PM	68.6	25.0	-6.2	-3.9	-3.5	-6.3

Strategies to reduce water loss and improve distribution uniformity in flood irrigated orchards

Irrigation distribution uniformity (DU) in surface irrigation is determined by soil infiltration rate, flow down the check and set duration.

$$DU\ (\%) = 100 * \frac{\text{“low quarter” infiltration}}{\text{Average field infiltration}}$$



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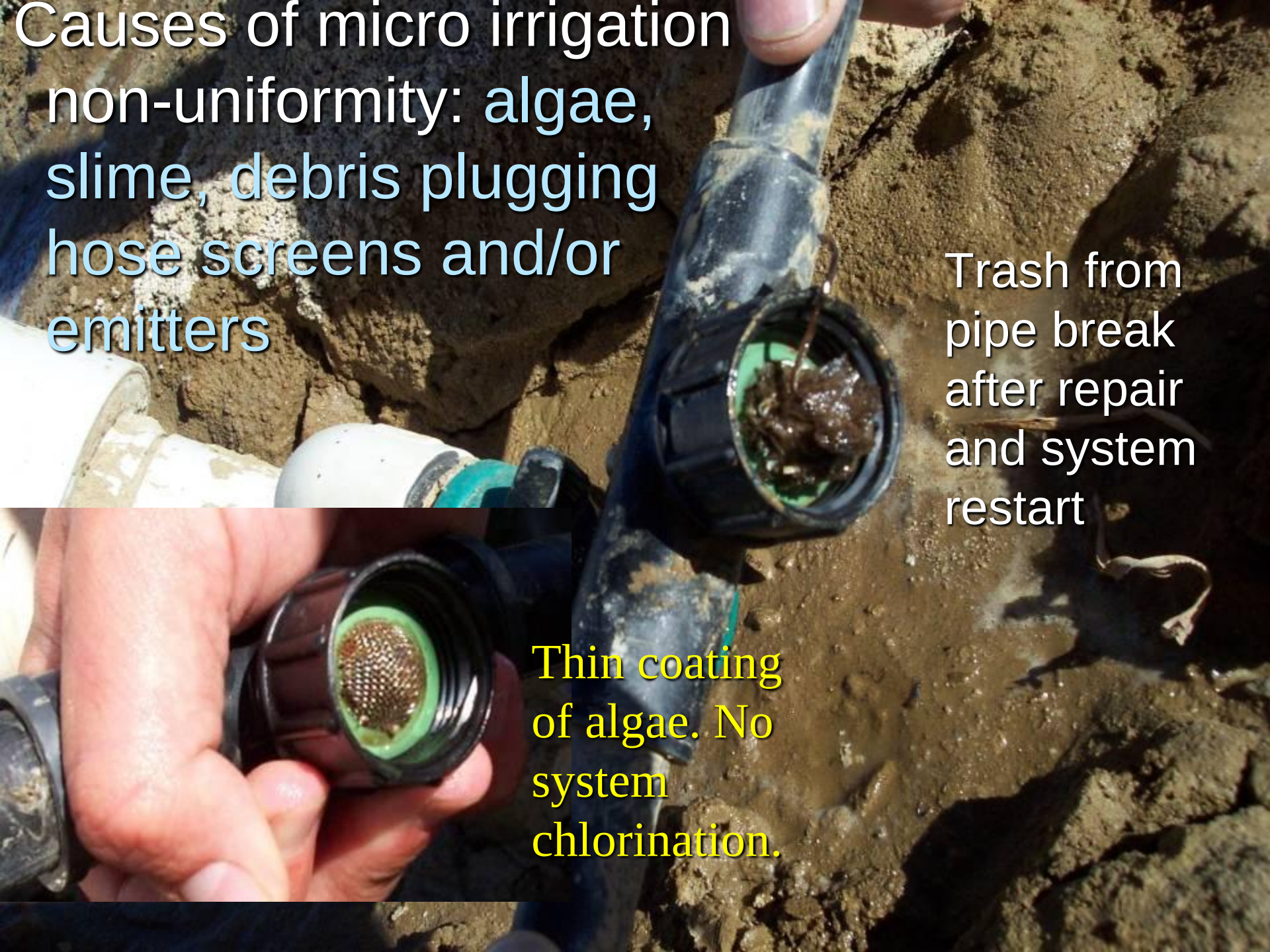
Causes of micro irrigation non-uniformity: algae, slime, debris plugging hose screens and/or emitters



Causes of micro irrigation non-uniformity:

chemical precipitates clogging drippers or altering flow rates. Check fertilizer mixes, gypsum injection, maybe use acid.

Microsprinklers may show precipitation but rarely lose flow.

Saving water: some general recommendations

1) Control weeds.

2) Maintain irrigation system and try to improve uniformity.

3) No evidence that heavy pruning or kaolin/whitewash sprays do any economic good to mitigate drought conditions.

4) Mild to moderate stress at the start of hull split is a good idea to speed up hull split and reduce hull rot.

5) Use a pressure chamber to identify areas of severe stress and adjust your irrigation approach before these areas become a problem.

6) Expect a reduced kernel size this year, and reduced bloom and set next year.

Thanks for funding and/or cooperation from:

Almond Board of California
USDA-SCRI
Nickels Estate

Thanks to Ken Shackle, David Doll, Bruce Lampinen, & Allan Fulton for sharing slides

Thank you for your attention.

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University of California
Agriculture and Natural Resources

APPENDIX G

STRATEGIES FOR FARMING IN A DROUGHT

Strategies

Joe Mullinax
Denele Analytical Inc.

Direct Strategies for Forage Crops

Planting Options

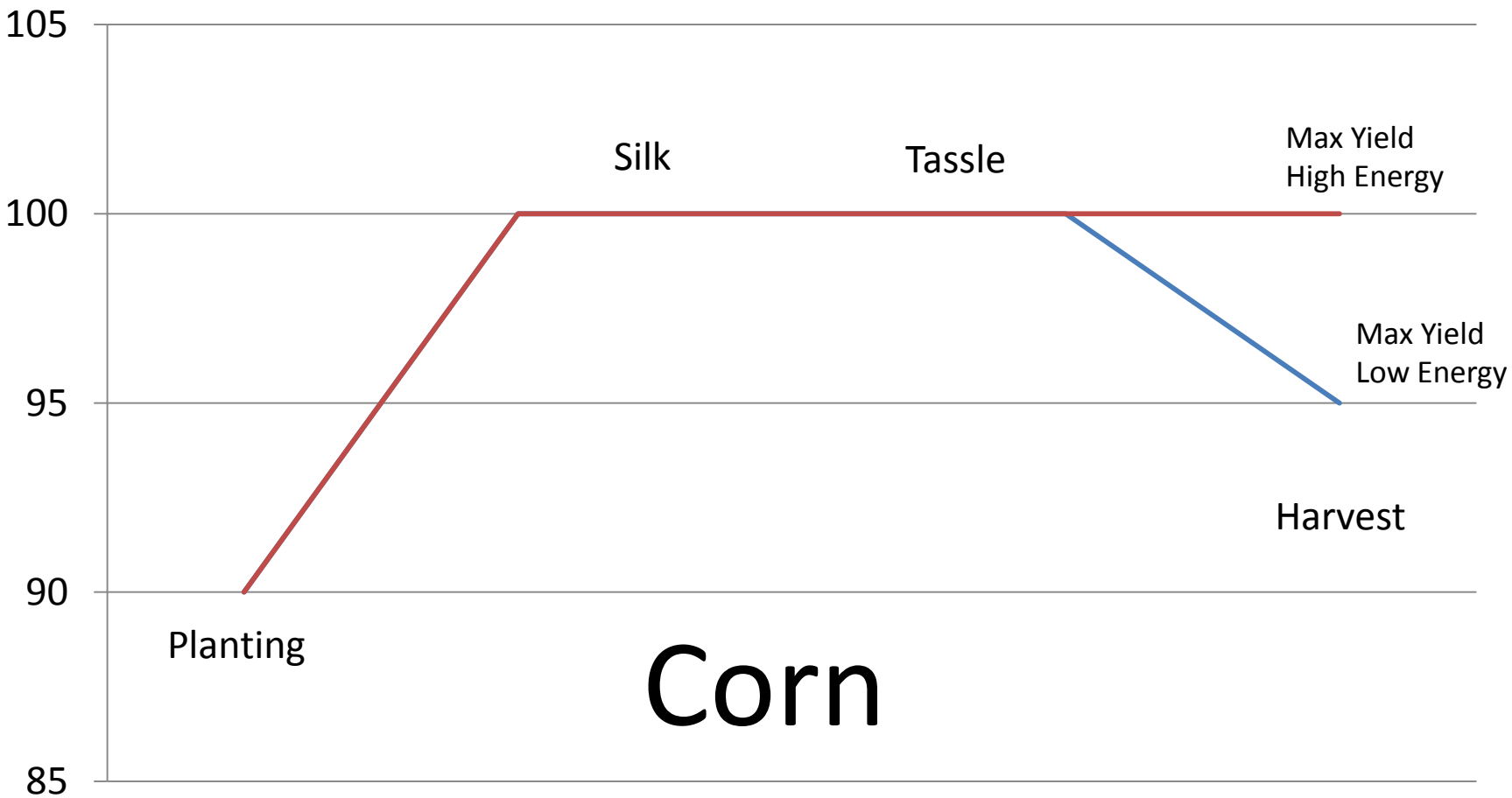
- Corn
- Sudan/Sorghum
- Alfalfa

Corn NEL under Drought Conditions

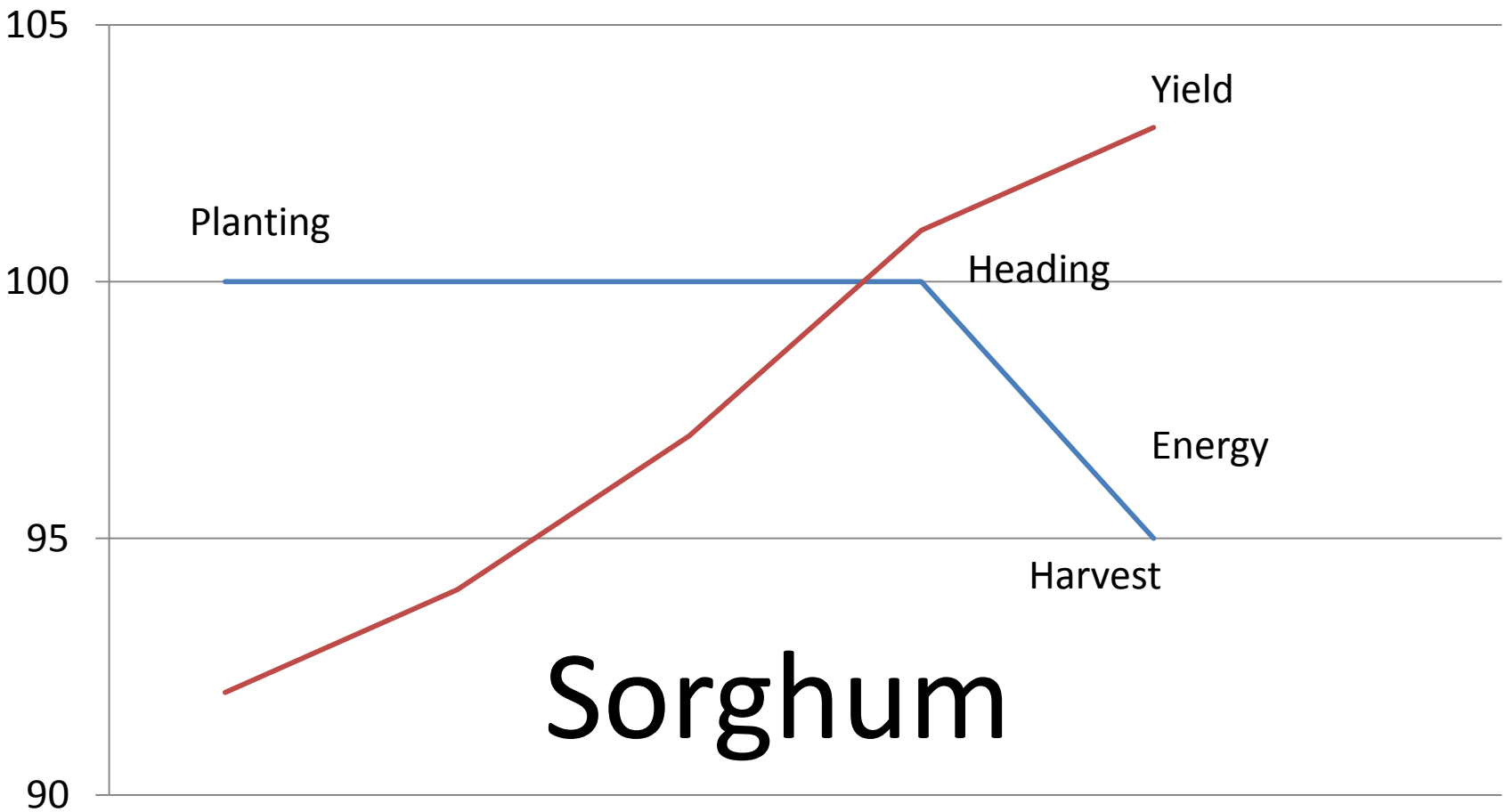
Statewide Total Average Energy for corn silage is down for the past year

	Hanford	Turlock	Woodland
Drought Extent	More	Slight	Less
2013 Corn NE/LAC Mcal/Lb	.65	.71	.72

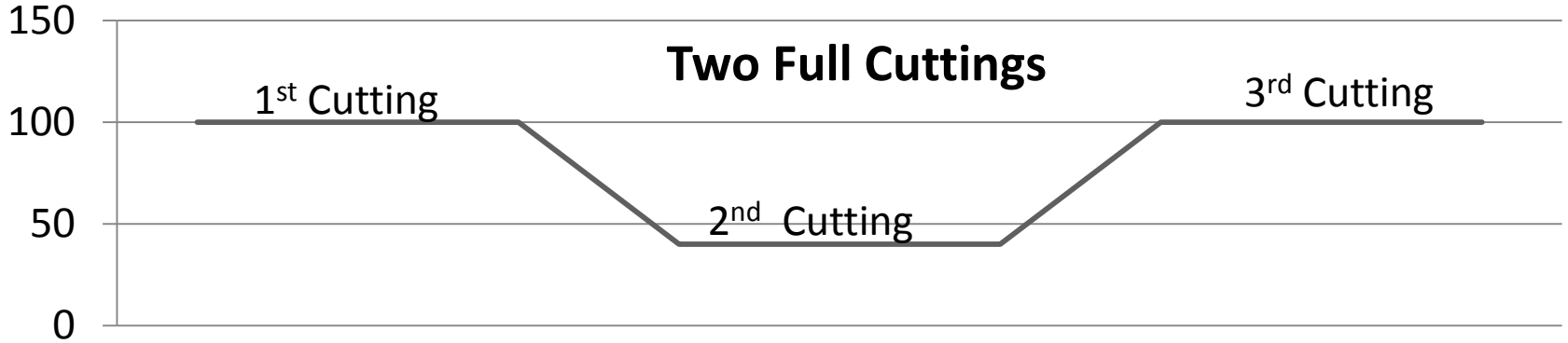
Effects of Cutting Water on Yields and Energy

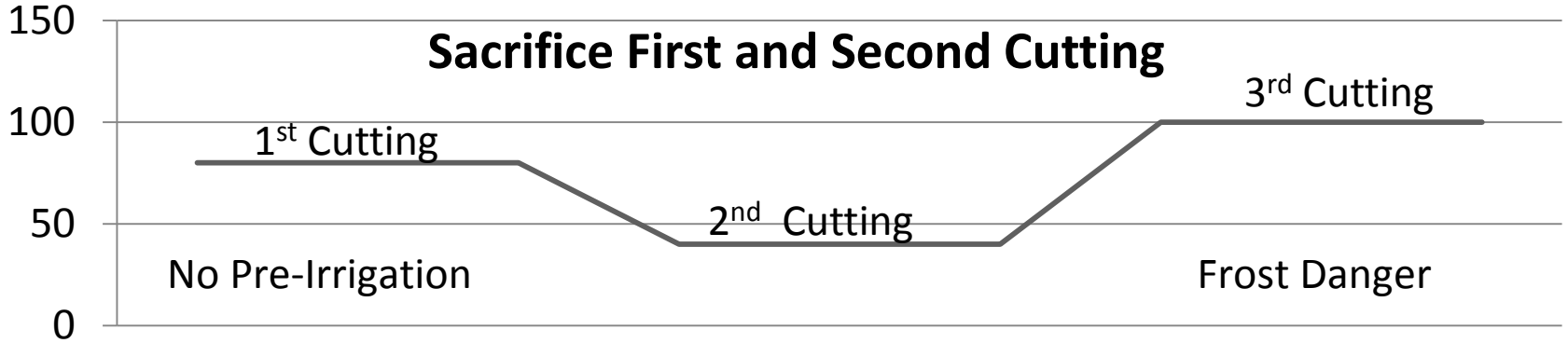


Effects of Cutting Water on Energy



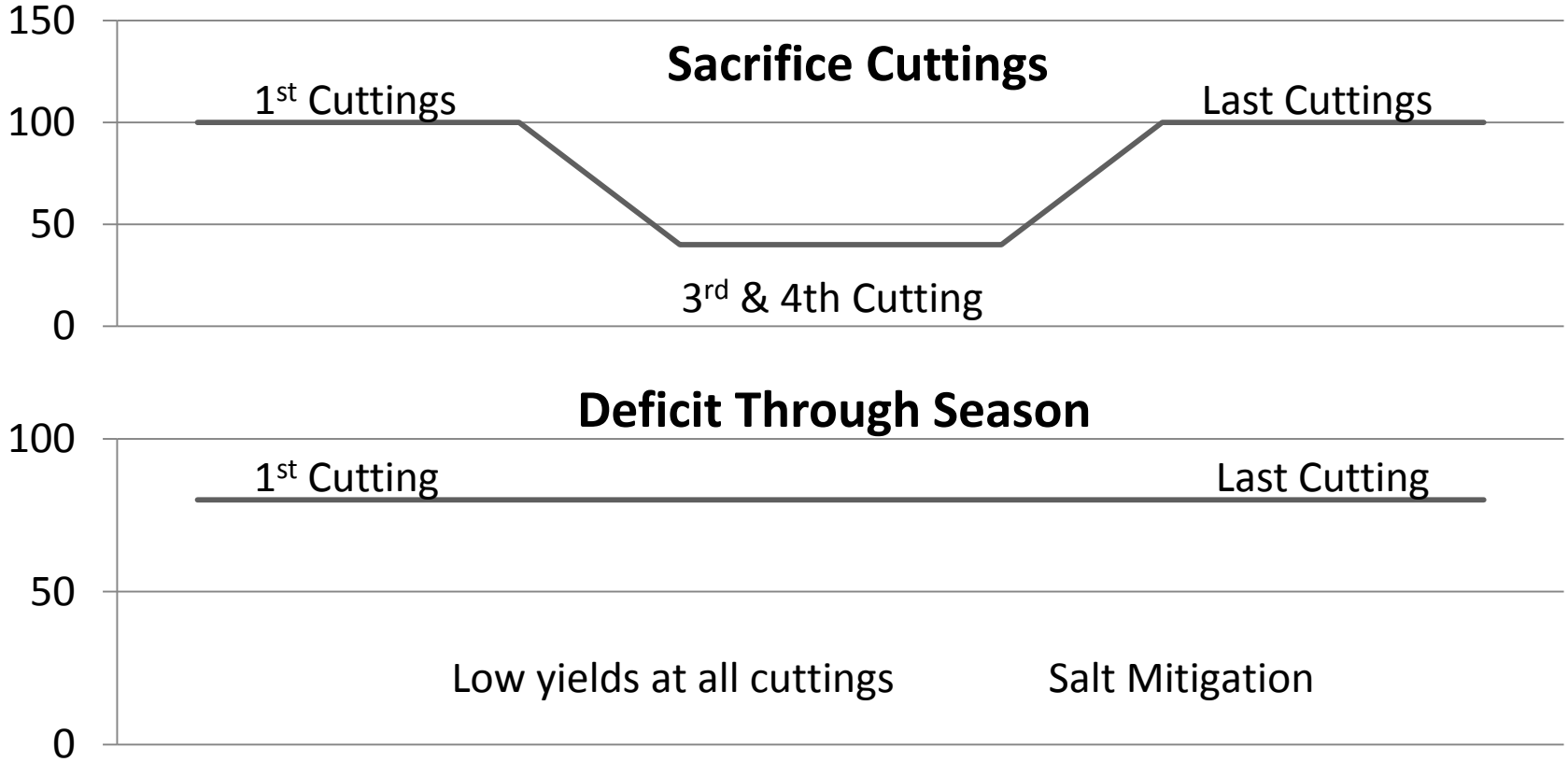
Cutting Strategies
Sorghum/Sudan





Cutting Strategies

Alfalfa



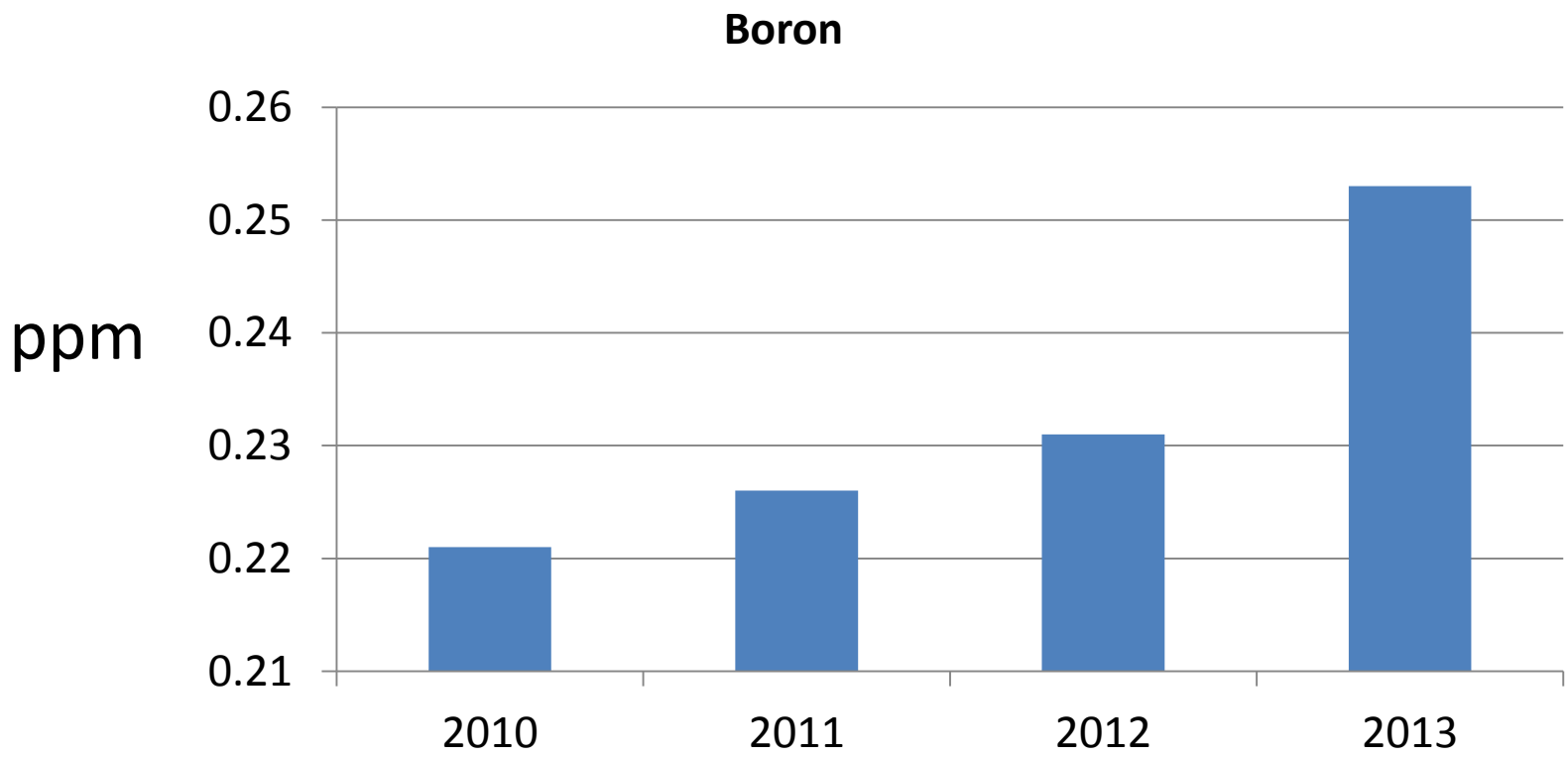
Mitigating Factors That Influence Irrigation Strategies

- Sodium Levels
  - Salt Dome
  - Leaching
  - Leaf Burn
- Nitrate levels

Irrigation Suitability 3 Year average

	PPM – NO3-N	Lb/Acre/in	Lb/Acre/ft	Lb/3 Acre/ft
2012-2013-2014	41	9.26	111.48	336.36
2010-2011-2012	23	5.21	52.64	187.56

Mitigating Factors in Dry Years
ZN – B – CU - MN



Any Questions?

UNIVERSITY OF CALIFORNIA DROUGHT MANAGEMENT PAGE

University of California
UC Drought Management

Introduction

When there is insufficient irrigation water to meet the water demands of a crop, the available irrigation water must be applied in the most efficient manner possible.

There are available strategies for maximizing irrigation water efficiency.

Agriculture

- Deficit irrigation strategies may be available to make the best use of limited water supplies. Click here for Crop Irrigation Strategies for almonds, pistachios, stone fruit, walnuts, alfalfa, olives, winegrapes, corn, and processing tomatoes.
- Quality Irrigation Scheduling can be critical to efficient irrigation water use. Evapotranspiration (ET) irrigation scheduling, soil moisture monitoring, and plant-based irrigation scheduling are all discussed.

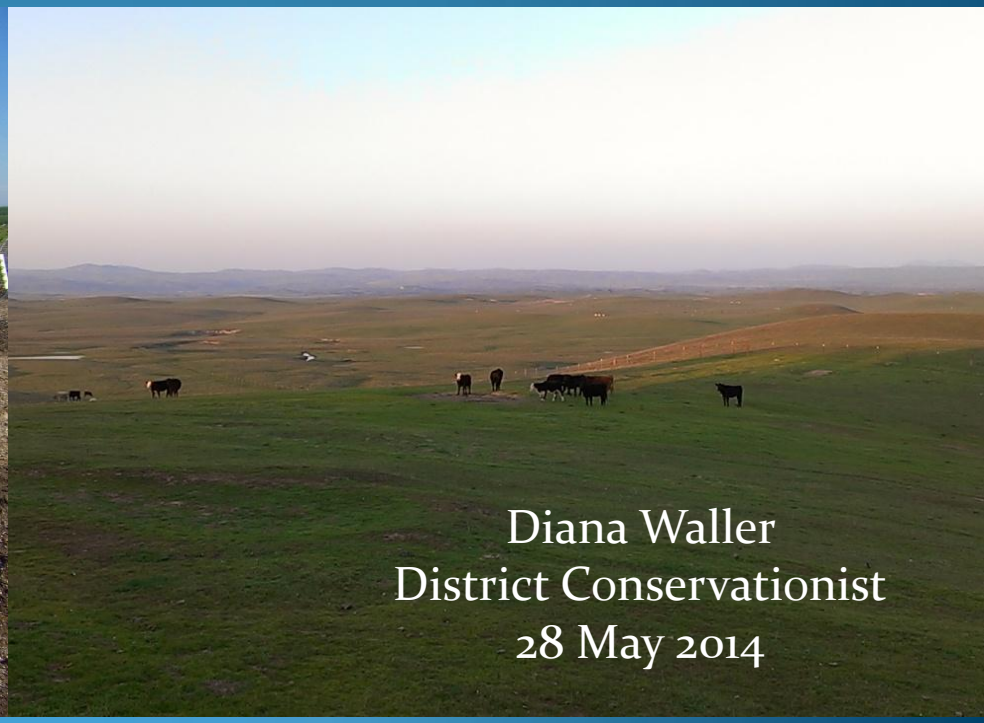
For further California drought information, experts, and resources, please visit the California Institute for Water Resources drought pages.

Division of Agriculture and Natural Resources, University of California

Webmaster Email: ljschwankl@ucanr.edu

HOW NRCS CAN HELP?

What does NRCS do? How can we help?



Diana Waller
District Conservationist
28 May 2014

USDA NRCS Who Are We?

- United States Department of Agriculture (Federal)
- Natural Resources Conservation Service
  - Implement Conservation Title Funding Programs
  - Provide Technical Assistance to Farmers and Ranchers
  - Responsible for Soil Surveys on Private Lands
  - Conduct the National Resource Inventory on Private Lands
- Non-Regulatory, Voluntary
- Most Counties Have a Local Office
- Helping People Help The Land

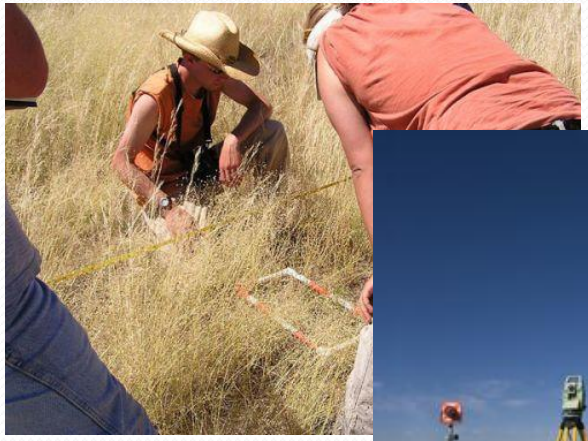
USDA NRCS &Partnership

- **Locally-led conservation through local work groups**
  - Comprised of stakeholders from local, state and federal government along with private land operators (farmers) and non-government agencies (everybody)
  - Primary stakeholders are farmers and ranchers (foresters)
  - Local, State, Federal Government (RCDs & others)
  - Non-Governmental Organizations (NGOs)
- **Resource Conservation Districts (RCDs)**

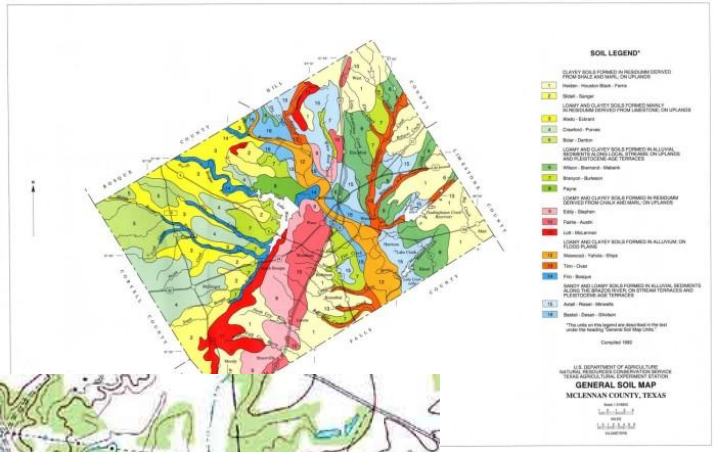
  RCDs are a board of volunteer farmers (and others) that live and work in their areas of influence
- **We can leverage funding and resources with other agencies**

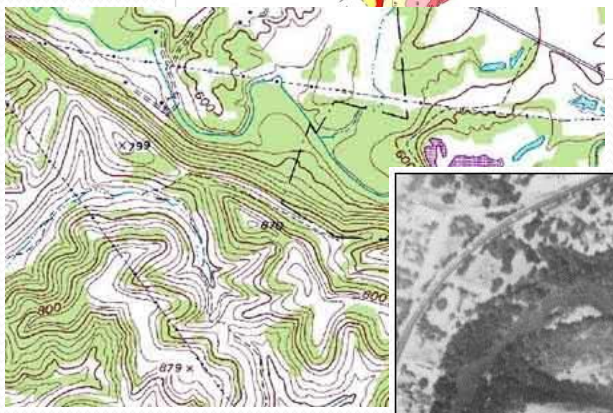
Technical Assistance

- Conservation planning
- Management Workshops (IWM, NM, IPM)
- Engineering feasibility
- Access to technical specialists (Geologists, Biologists, Agronomists, Soil Scientists, Archeologists, etc.)
- Non-regulatory assistance, protected by the Privacy Act



Resource Inventory





- Soil surveys & soils information
- Topographic & watershed maps
- National wetland inventory
- Historical aerial photography
- Species occurrences

First Step – Your Conservation Plan

- Request Assistance Year-Round
- Identify Your Goals & Resource Concerns
- Planners and Engineering Staff Develop Alternative Practices to Meet Your Goals
- You Decide On Your Approach → May Be Submitted for Funding Consideration Under a Our Funding Programs

Cost-Share Incentives Programs

- Many projects on farmland, forestland, and rangeland have environmental benefits
- Our programs aim to share the cost of doing these projects
- Public benefits = public funding available
- Emergency resource protection (ex. drought)

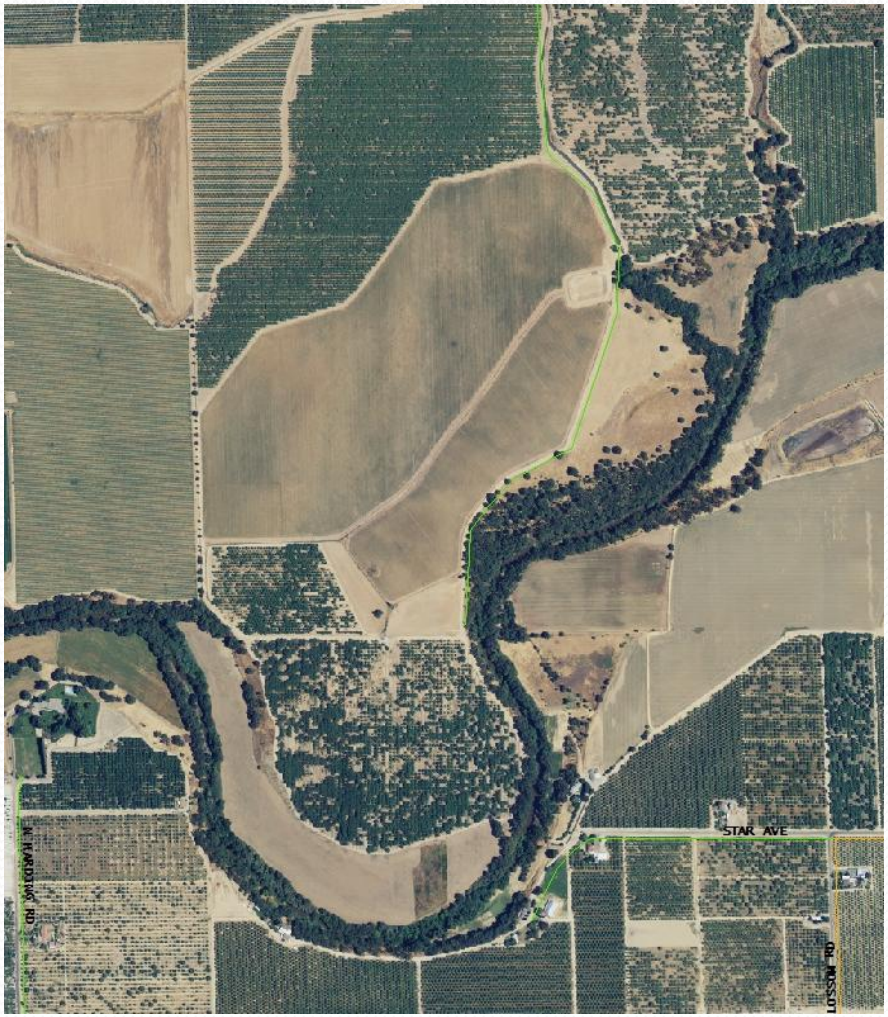
NRCS Programs

Environmental Quality Incentives Program (EQIP)

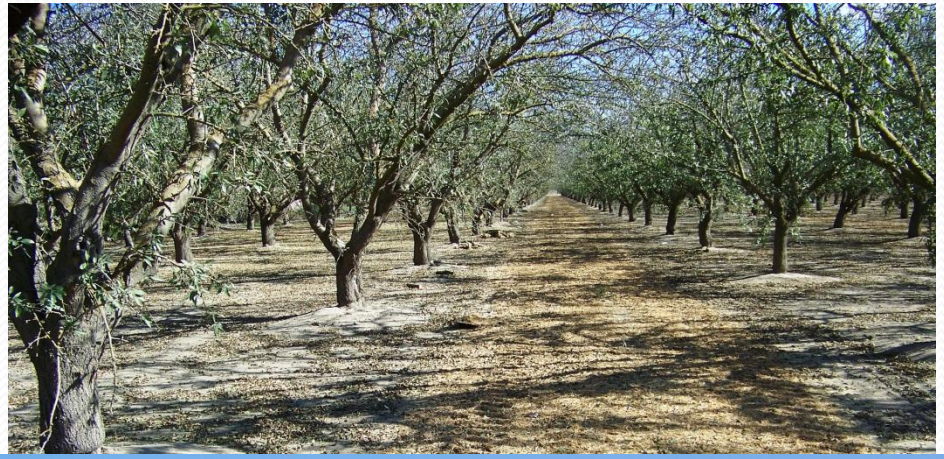
Conservation Stewardship Program (CSP)

Environmental Quality Incentives Program (EQIP)

- Cost-share incentive to adopt environmentally beneficial projects
- Applications accepted year-round with periodic funding 'cut-off' dates
- Contracts must be finalized before a project is begun
- Competitive! Selection is based on resource benefits as outlined in funding pool



Air Quality



Project examples include:

- Tub grinding removed orchards
- Dust control on unpaved roads
- NOx emissions from diesel engines
- VOC reductions through precision technology

Water Quality/Quantity

Project examples include:

- Micro-irrigation systems
- Irrigation system evaluations
- Irrigation water management
- Nutrient management
- Concrete stacking pads for silage/manure
- Irrigation/manure transfer pipelines
- Tailwater re-use systems
- Ditch Lining
- Flow meters
- Irrigation Reservoirs, Sediment Basins
- And More!

Soil Quality/Soil Erosion

Project examples include:

- Cover crops
- Reduced tillage/no-till
- Nutrient management
- Irrigation improvements
- Erosion mitigation plans
- Prescribed grazing

Highly Erodible Land Treatment*
*Drought/Flood Resiliency

Plants and Animals

Project examples include:

-Wildlife-

- Pollinator plantings
- Riparian plantings
- Fish screens on existing river intakes

Many wildlife projects require permits

-Rangeland/Pasture-

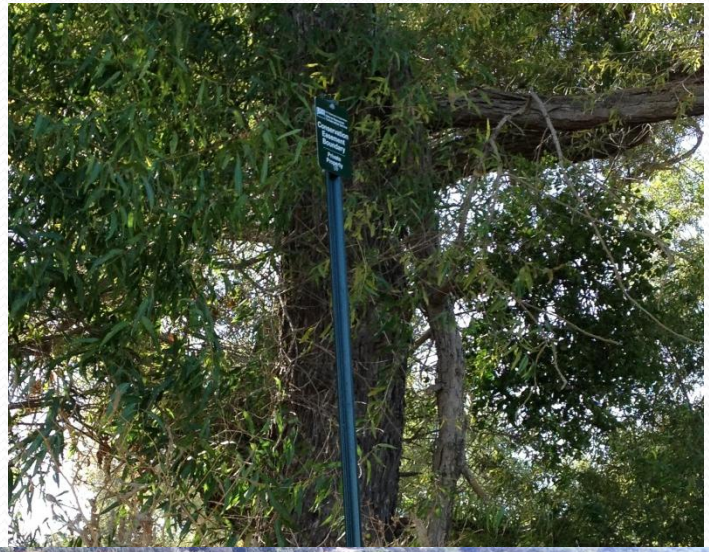
- Stock watering systems
- Spring development
- Grazing management
- Noxious weed management
- Cross-fencing

Eligibility Requirements

- Must Produce an Agricultural Product on the Land
- Must be Owner or Operator of the Land
- Average Adjusted Gross Income Maximum is $900,000
- Contracts Limited to $300,000
- $450,000 maximum over Farm Bill period
- Highly Erodible Land/Wetland Compliance
- Contracts typically 2 years in length (or less)
- Irrigation History (2/5 years) for Irrigation Improvements
- Special Rates for Historically Underserved Groups, Beginning Farmers & Limited Resource Farmers
- Veteran's Preference for Beginning Farmers that have served.

Agricultural Conservation Easement Program

- New with the 2014 Farm Bill - rolled together many of our previous easement programs
- Agricultural Land Easements – just development rights
- Wetland Reserve Easements – agricultural and development rights



Questions???

Local Office:
USDA - NRCS
Modesto Service Center
3800 Cornucopia Way Suite E
Modesto, CA 95358
(209)491-9320 x 3

California NRCS Website:

http://www.nrcs.usda.gov/wps/portal/nrcs/site/ca/home/

Attachment G.4. Grower Meeting Information

January 2014
February 2014
January 2015
February 2015

APPENDIX G

DROUGHT MANAGEMENT PLAN

JANUARY 2014

Informational Meetings

January 29 & 30, 2014

WATER & POWER

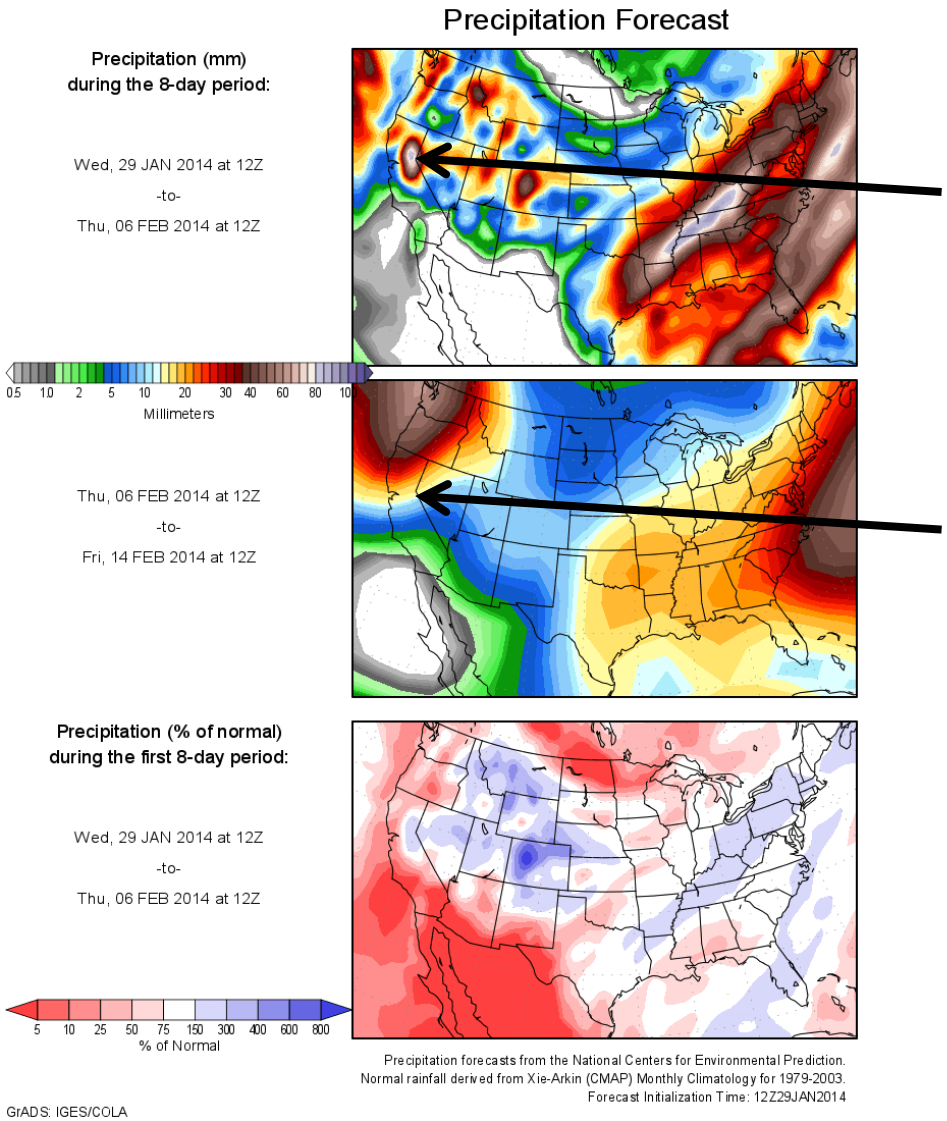
Serving Central California since 1887

Agenda

- Current Hydrology
- Irrigation Season Operations
- Outreach

WATER & POWER
Serving Central California since 1887

Current Hydrology



- 2.0 Inches
- 0.47 Inches

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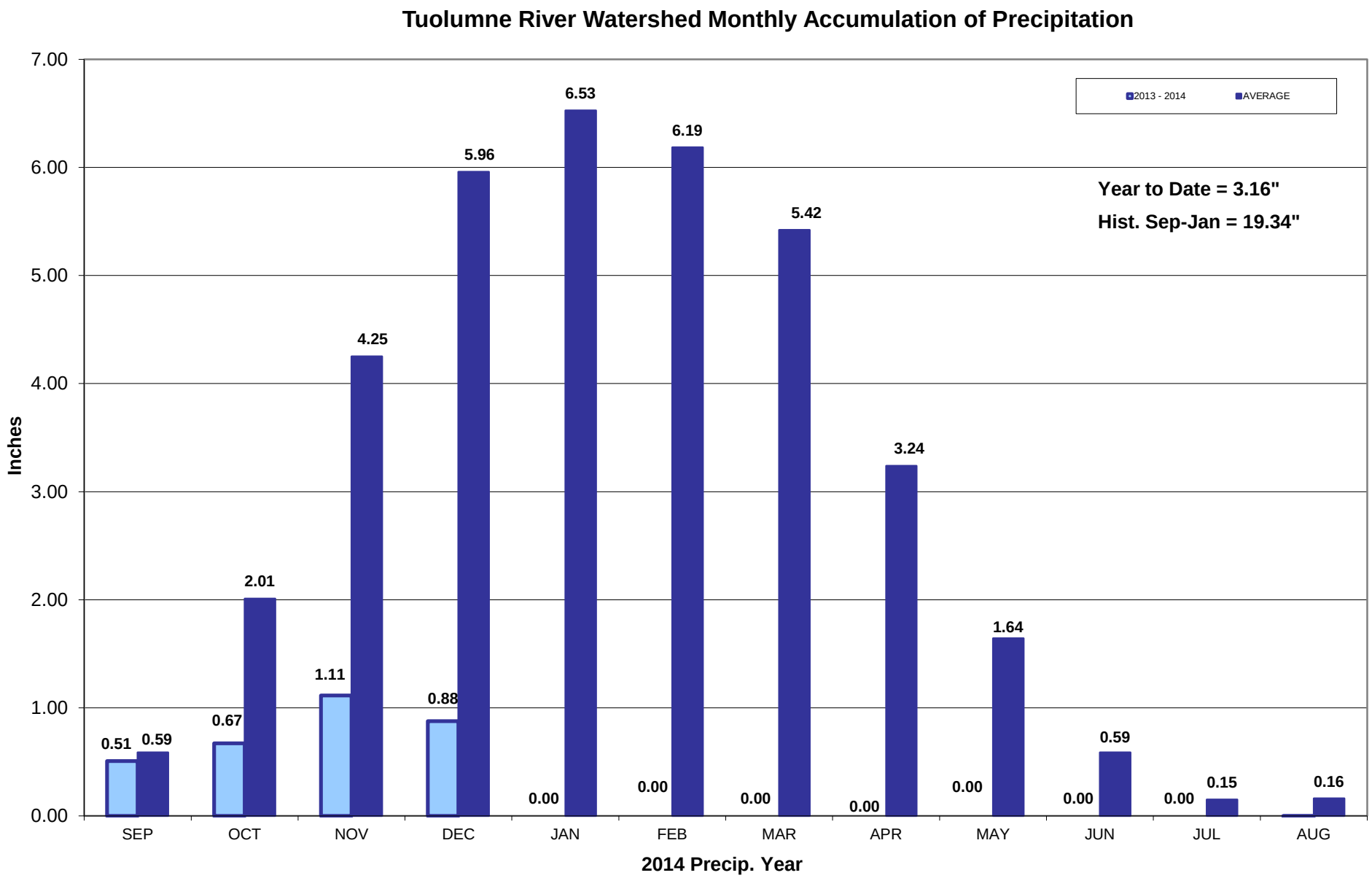
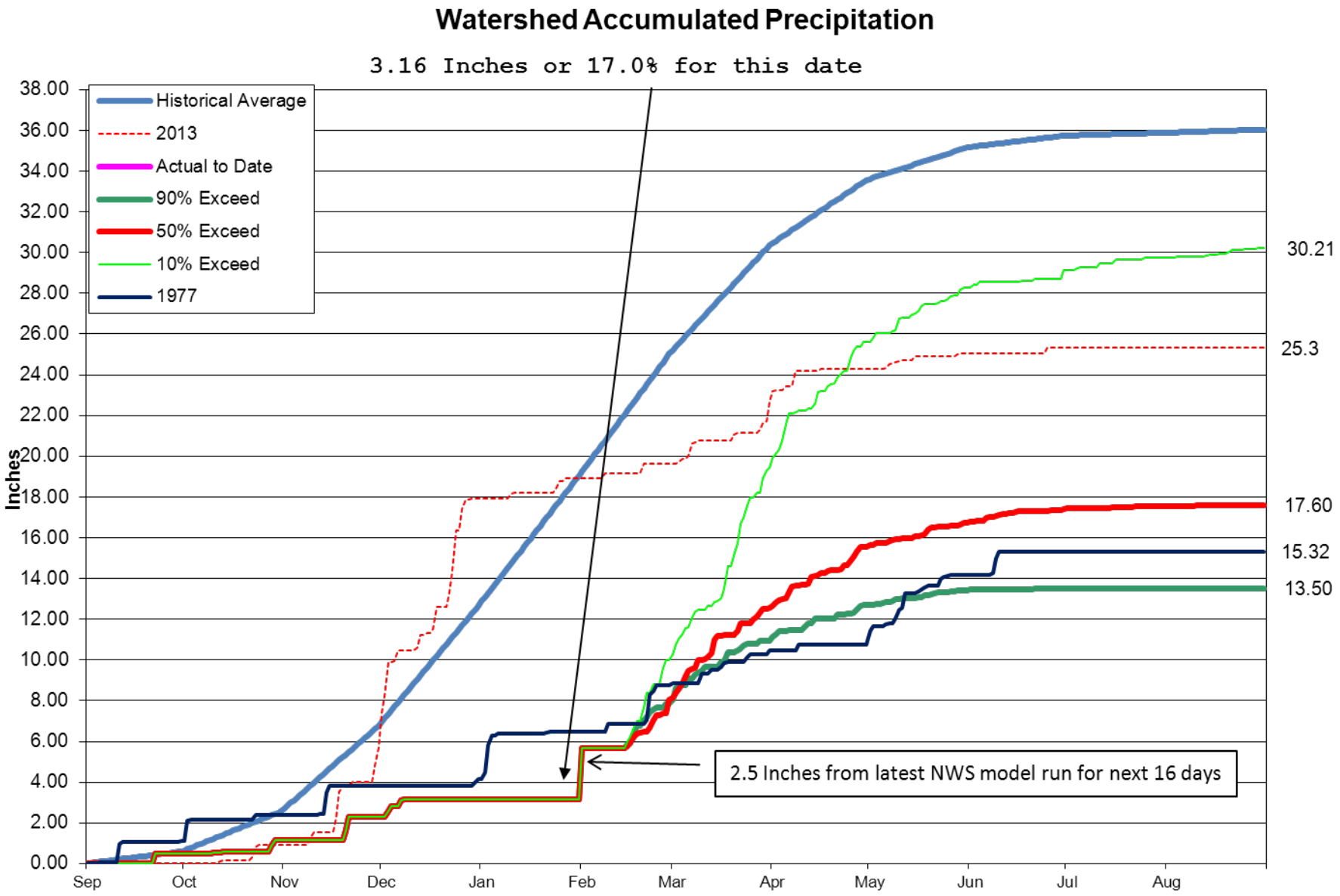
Current Hydrology



Current Hydrology



Current Hydrology

- The Exceedence definition
  - Probability that an event of specified magnitude will be equaled or exceeded in any defined period of time, on average. In the context of natural resource management, examples of events include storms, floods, earthquakes, algal blooms and droughts
  - 10% exceedence means that 10% of the years are wetter
    - **10% exceedence is a "wet" year**
  - 90% exceedence means that 90% of the years are wetter
    - **90% exceedence is a "dry" year**

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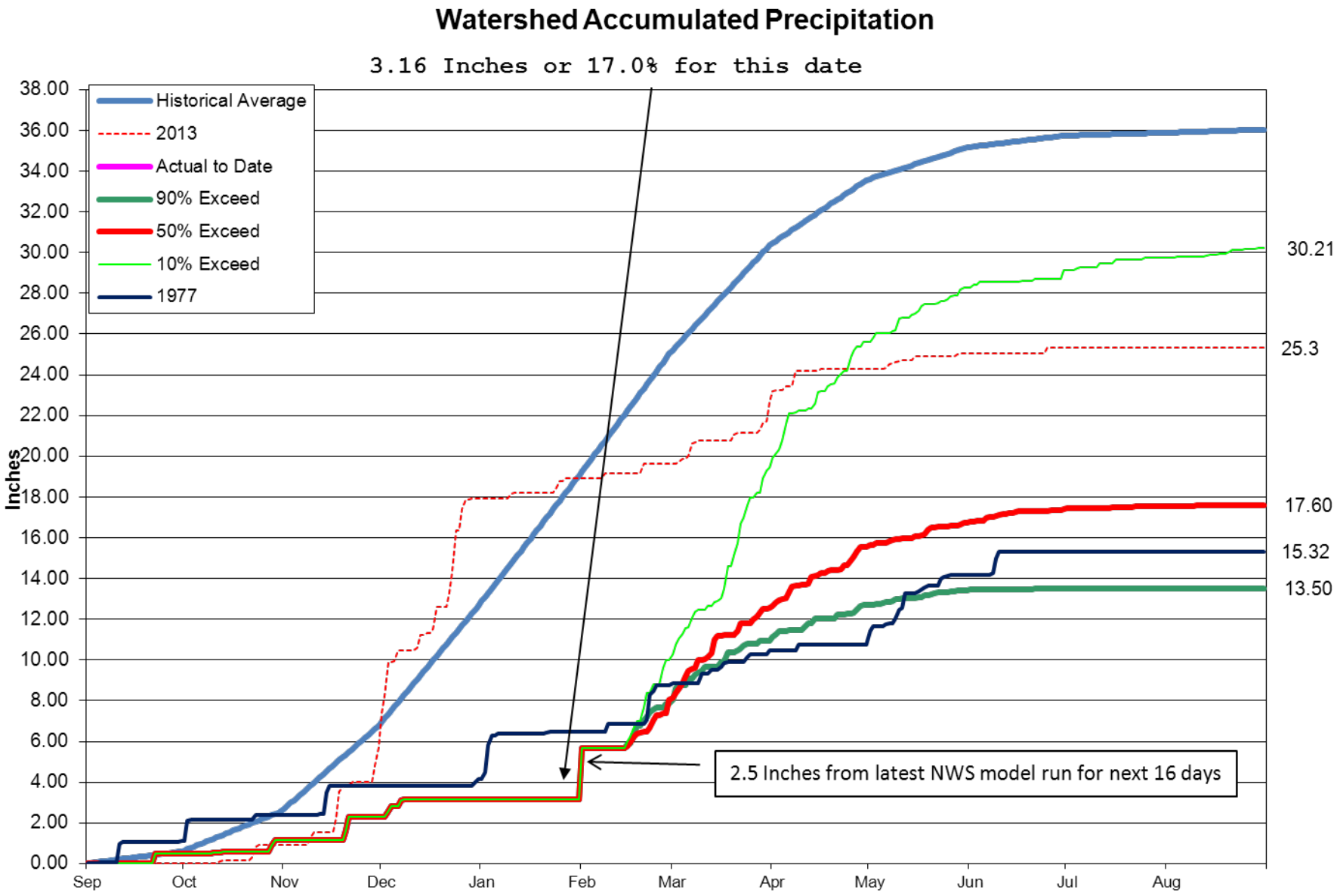
Current Hydrology



CCSF Reduction of FNF or Impact on Don Pedro Inflow

CCSF Water Bank 2/1/2014-12/31/2014	
CCSF Water Bank In Beginning	501,031
CCSF Diversions (230 MGD)	232,894
CCSF Empty Storage	252,436
Total Depletion From CCSF	485,330

- **CCSF's impact is equivalent to 14 inches of rainfall to both Districts at 35,000 af per inch.**

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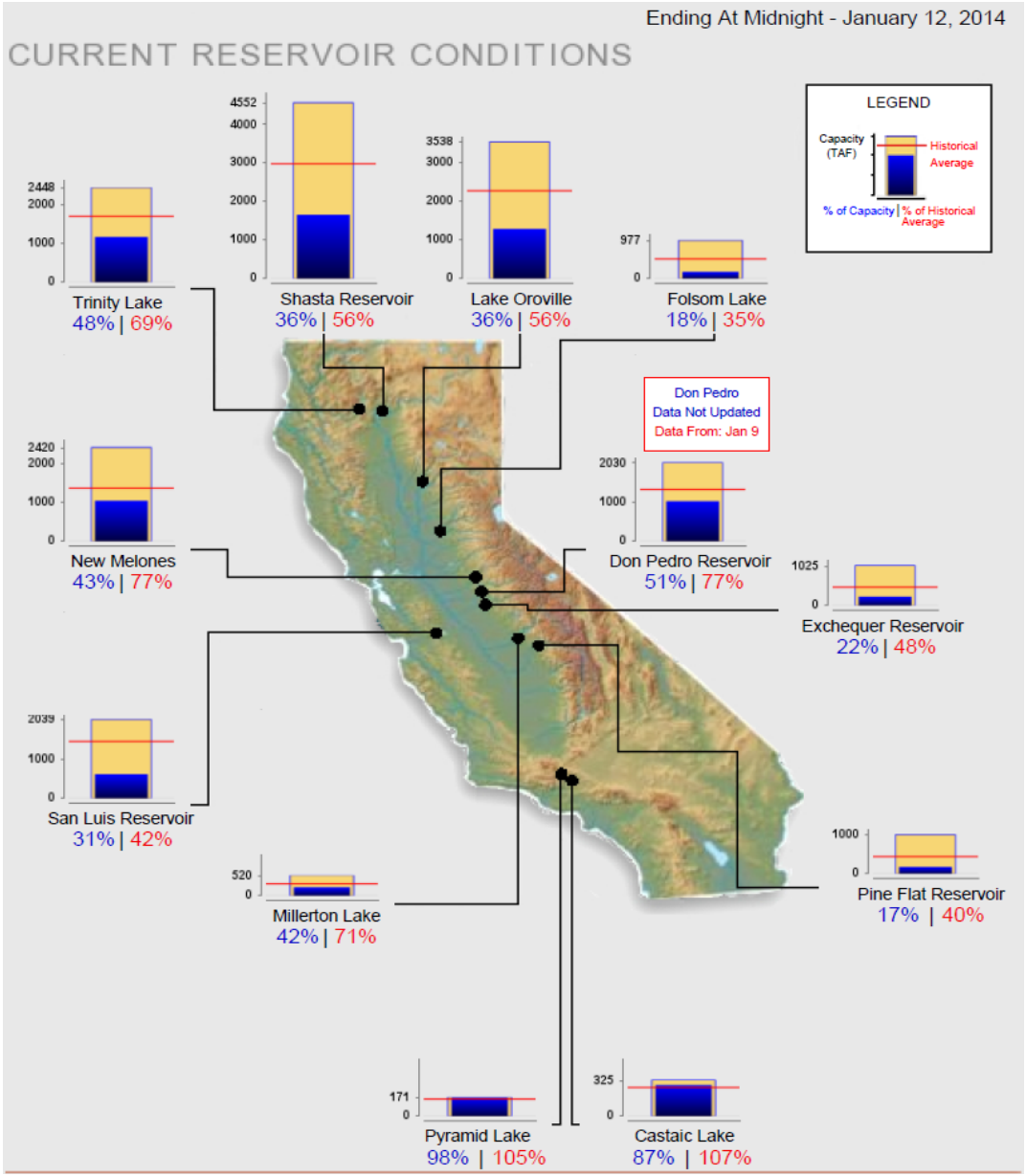
Current Hydrology



- % of Capacity: **51%**
- Available Water: **42%**
- Available Water Minus Advance Releases by CCSF: **14%**

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Current Hydrology

2014 Precipitation (1/1/2014-10/31/2014)

	90% Exced. Low		50% Exced. Average		10% Exced. High	
	A.F.	Inches	A.F.	Inches	A.F.	Inches
1. Present Storage	571,298	30.5	571,298	30.5	571,298	30.5
2. Less Fish	(52,327)	-2.8	(54,706)	-2.9	(83,658)	-4.5
3. Less WID Entitlement	(23,961)	-1.3	(23,961)	-1.3	(23,961)	-1.3
4. Current Water Available	495,010	26.4	492,632	26.3	463,680	24.7
5. Additional Inflow	46,792	2.5	99,386	5.3	707,884	37.8
6. Evaporation	(7,347)	-0.4	(8,445)	-0.5	(11,441)	-0.6
7. Total Available Releases	534,455	28.5	583,573	31.1	1,160,122	61.9
8. Projected Irrigation Releases	(422,676)	-22.5	(423,676)	-22.6	(552,567)	-29.5
9. Subsequest Year's Obligations	(95,000)	-5.1	(95,000)	-5.1	(95,000)	-5.1
10. Carry Over Storage	0	0.0	64,897.1	3.5	512,555.3	27.3

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Irrigation Season Operations

WATER & POWER
Serving Central California since 1887

Outreach

- Informational Meetings
  - January 29, 2014 in TID Board Room, 7:00 p.m.
  - January 30, 2014 in TID Board Room, 7:00 p.m.
- Board Meeting to set 2014 Irrigation Season
  - February 25, 2014 in TID Board Room, 9:00 a.m.
- Grower Meetings
  - February 26, 2014 in TID Board Room, 7:00 p.m.
  - February 27, 2014 in TID Board Room, 7:00 p.m.
- Grower Newsletters
- Letters & Postcards
- Email

TID WATER & POWER
Serving Central California since 1887

APPENDIX G

DROUGHT MANAGEMENT PLAN

FEBRUARY 2014

Informational Meetings

February 26 & 27, 2014

WATER & POWER

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Agenda

- Current Hydrology
- 2014 Irrigation Season
- SBx7-7 (Sidegate Measurement)

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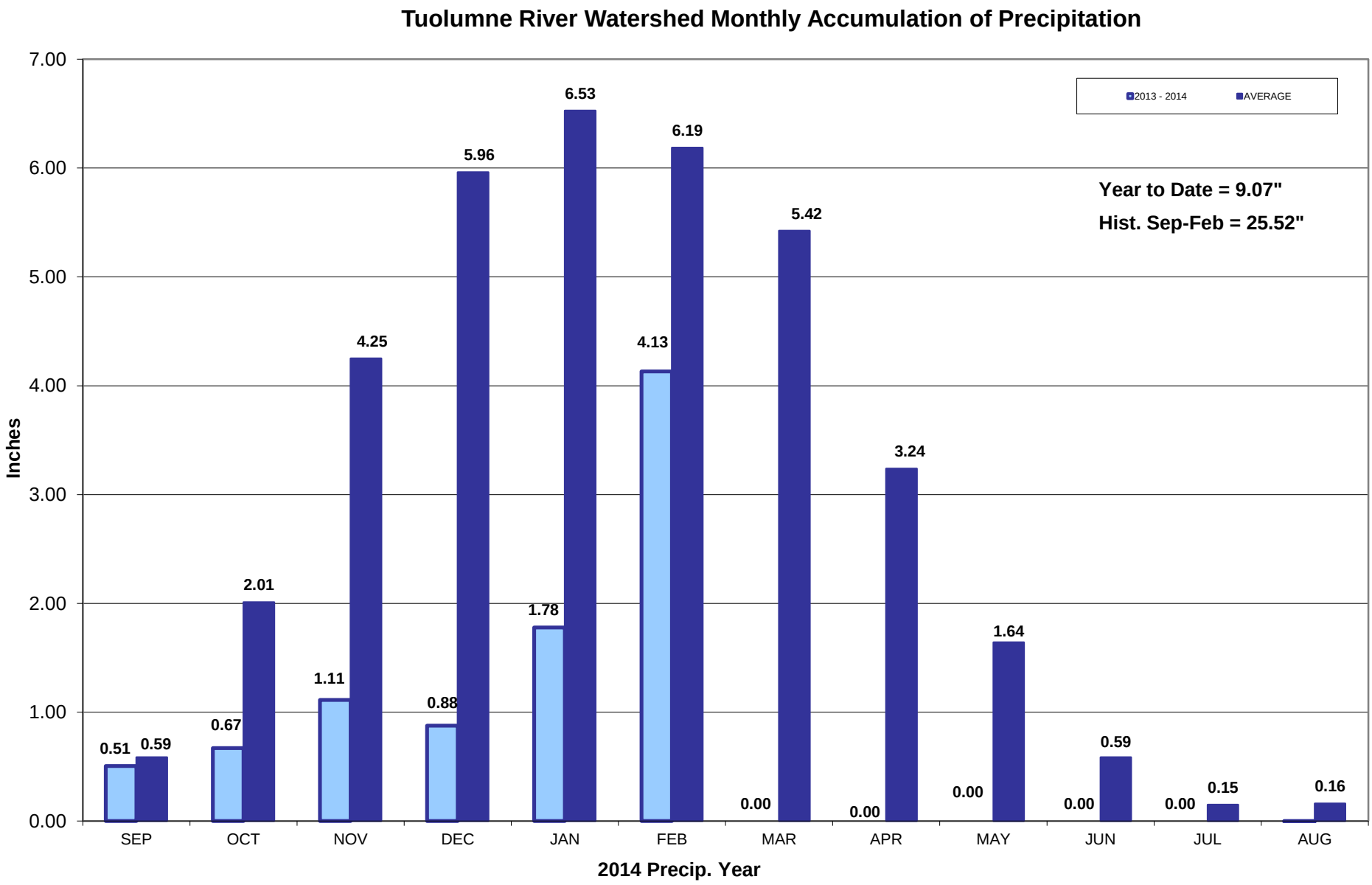
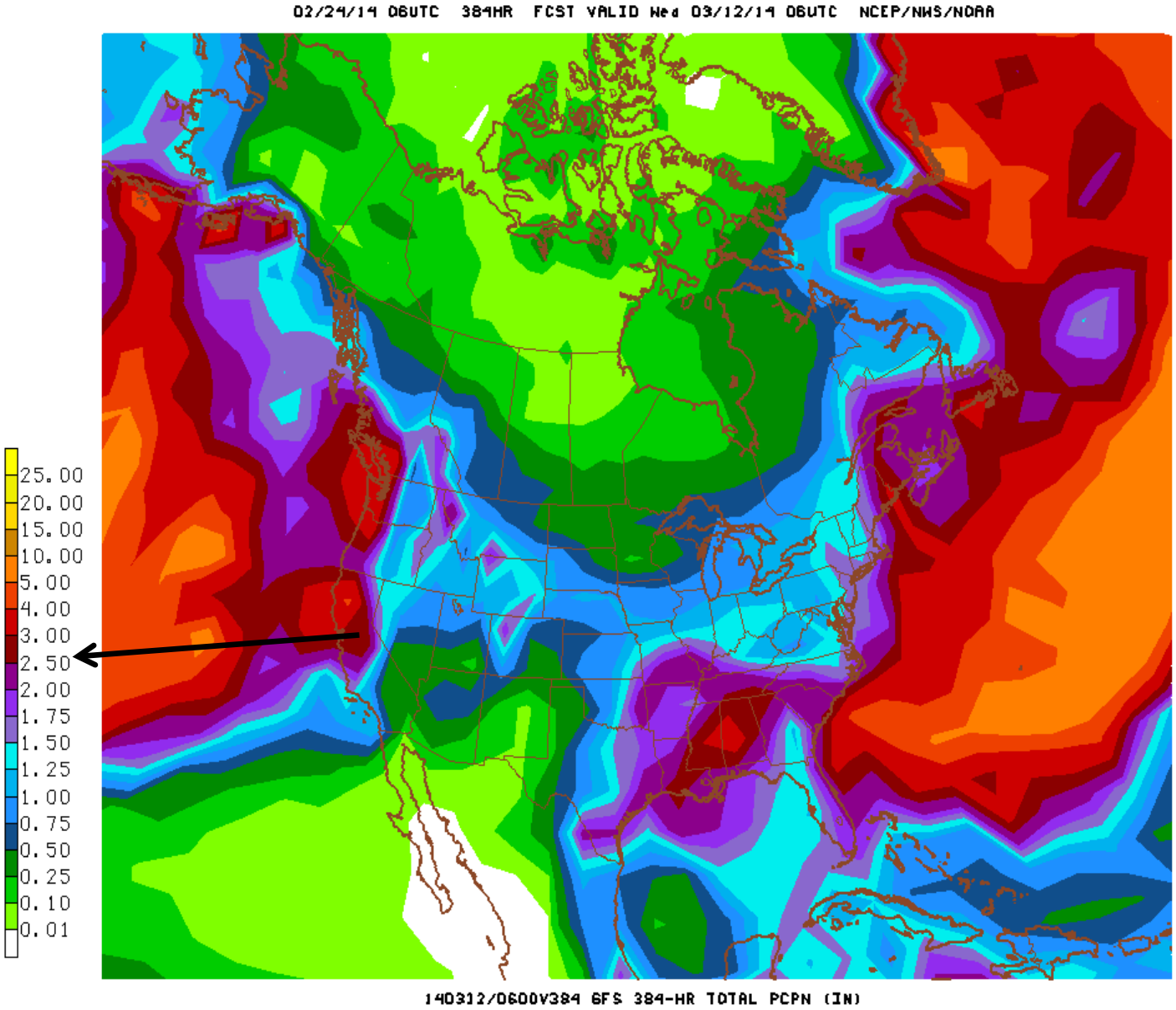
Current Hydrology



Current Hydrology: NWS 16 Day Forecast



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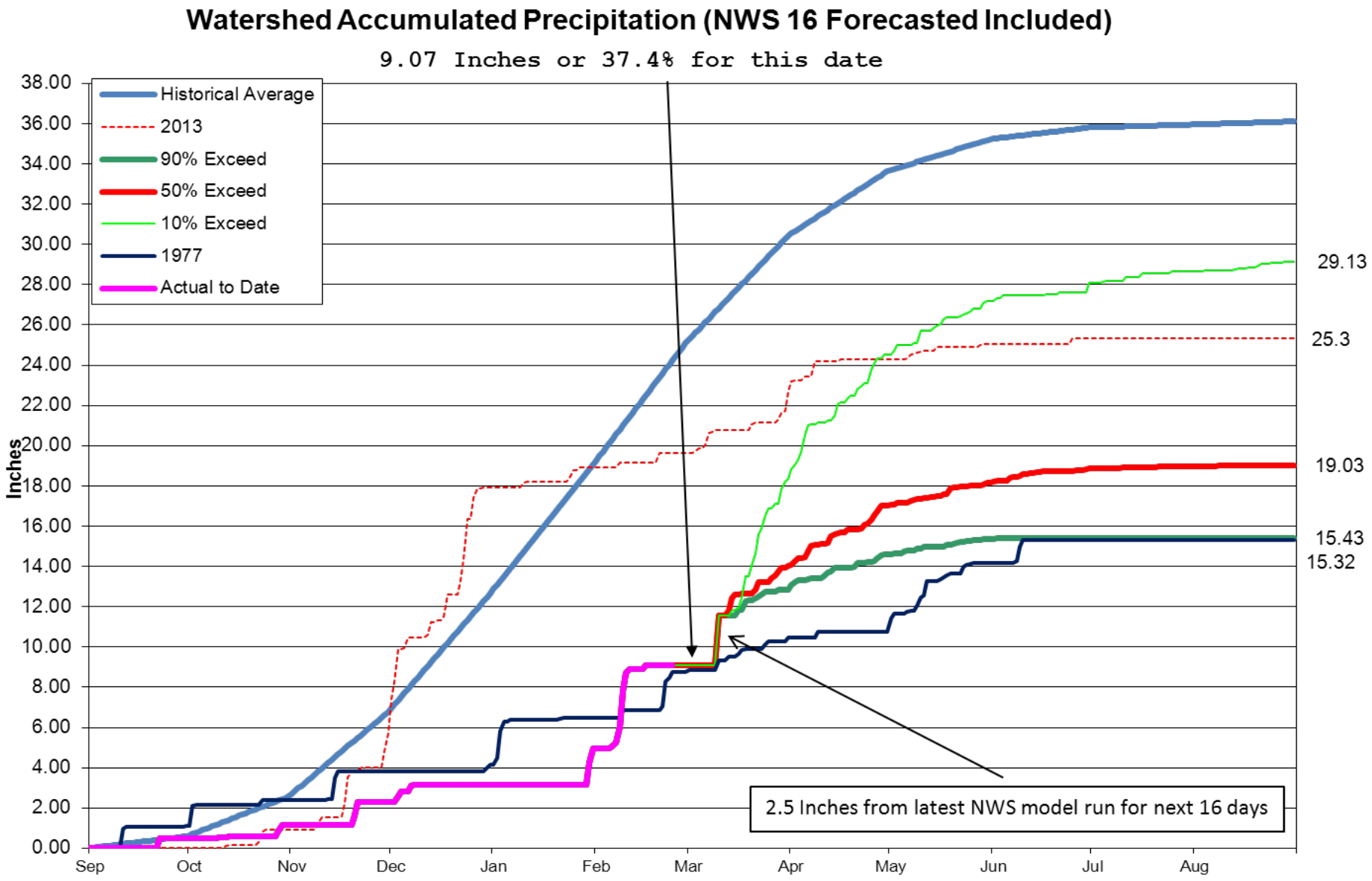
Current Hydrology



TID Drought Resolution

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Serving Central California since 1887

Outreach

Customer Service: 209-883-8222 | My Electric Account

WATER & POWER
Serving Central California since 1887

Search...

Drought Information | Careers | Customer Service | Suppliers & Vendors | About TID | Contact Us

For Home | For Business | Water | Power | Environment & Conservation | Education & Safety | News & Resources

Home › Drought Information

Drought Information

Governor Brown's Emergency Drought Declaration on Jan. 17, 2014 brought further statewide and national attention to one of the driest periods in California's history.

Specific to TID and its history of developing water as a resource from the Tuolumne River, the 2012, 2013 and 2014 water years have the potential to be the three driest consecutive years on record. And 2014 may very well be worse than the infamous 1977 drought period for the Tuolumne.

While the District monitors hydrology and weather 365 days a year regardless of water year type, and also prudently plans to make it through tough times like these, there are extensive, multiple ongoing drought efforts taking place currently at TID. These efforts come in the form of planning and operational decisions, as well as information gathering and outreach.

This page is intended to be one of many growing resources for TID irrigation customers and others interested in following the drought and its impacts on TID customers, as well as those interested in a sampling of TID's drought efforts.

TID Resources

- TID Drought Resolution, adopted by TID Board of Directors on Feb. 25, 2014 (pdf)
- Jan. 29-30 Informational Presentation to Growers (pdf)
- TID Water Management page
- TID Irrigation Tips page
- TID Irrigation Rules document (pdf)
- TID Water Usage page for irrigators (login required)
- TID Water Reports, presented at TID Board Meetings

Customer Service

- My Electric Account
- Irrigation Water Usage
- Start, Stop or Transfer Service
- Electric Rates
- Outages

2014 Irrigation Season

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Irrigation Season Resolution

- **The 2014 irrigation season shall begin on Thursday, March 27, 2014 and end on Wednesday, October 8, 2014.**
- **Gardenhead parcels shall be delivered irrigation water once every four weeks.**
- **Irrigation water shall be available for purchase using the Dry Year Rate Schedule, pursuant to Resolution 2012-34, adopted June 12, 2012.**
- **The water available for each acre of irrigated land during the 2014 irrigation season shall be limited to 20-inches per acre. The maximum amount of water a grower will be allowed to go over their available water will be four (4) inches. Growers will be allowed to go over their available water to complete their final irrigation at a tier rate to be determined at a later date.**
- **All irrigated parcels are required to place water orders through the District Irrigation Call Center to receive irrigation water from the District.**
- **Customers are allowed to transfer water from parcels that they rent or lease this season even though they did not rent or lease the parcel during the 2013 Irrigation Season, provided the District's records indicate that the parcel received irrigation water during the previous year.**
- **The Water Distribution Department Manager may adjust the season, as necessary, due to weather conditions and crop requirements.**

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SBx7-7 Water Measurement Project

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APPENDIX G

DROUGHT MANAGEMENT PLAN

JANUARY 2015

Informational Meetings

January 20 2015

WATER & POWER

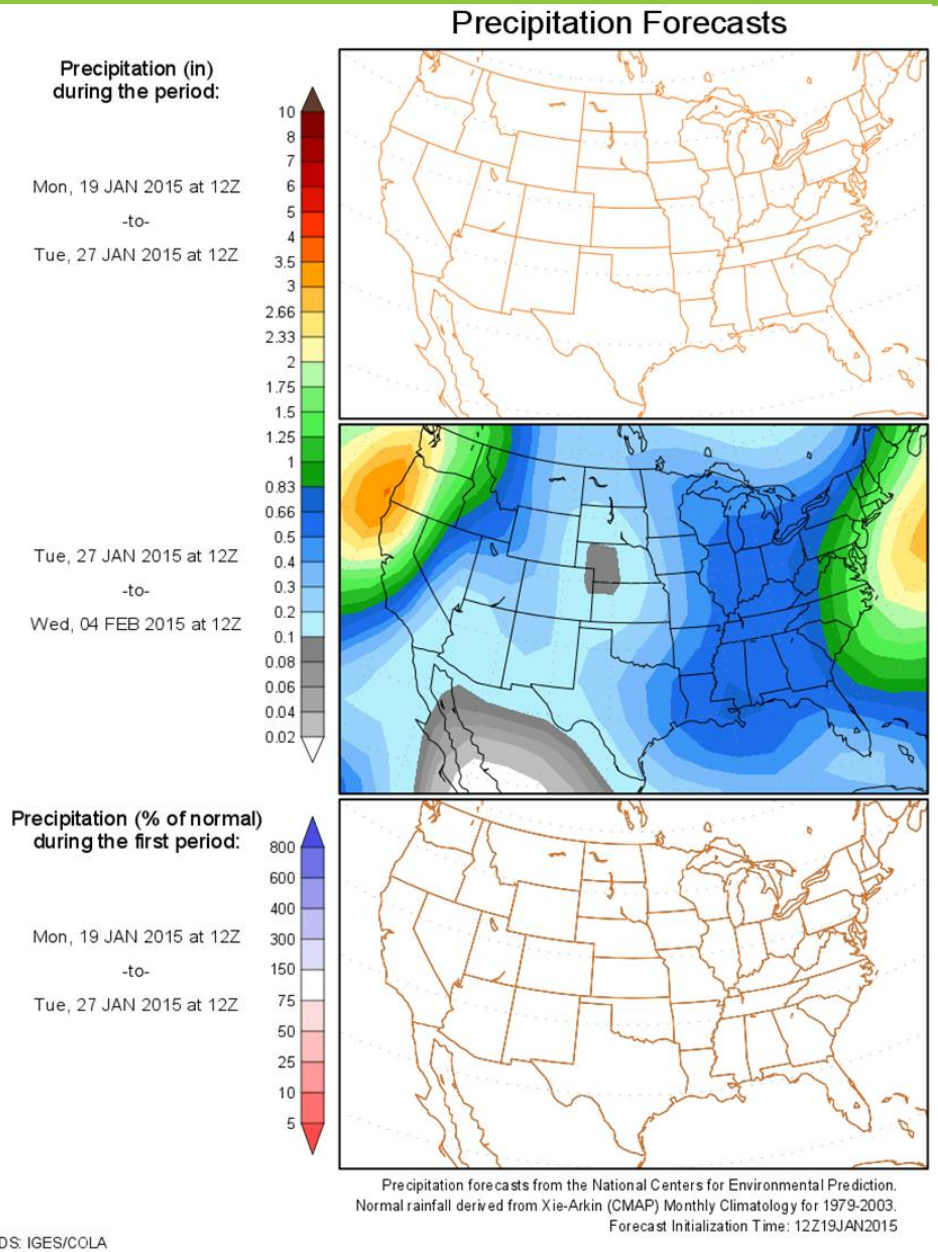
Serving Central California since 1887

Agenda

- Current Hydrology
- Irrigation Season Operations
- Outreach

WATER & POWER
Serving Central California since 1887

Current Hydrology



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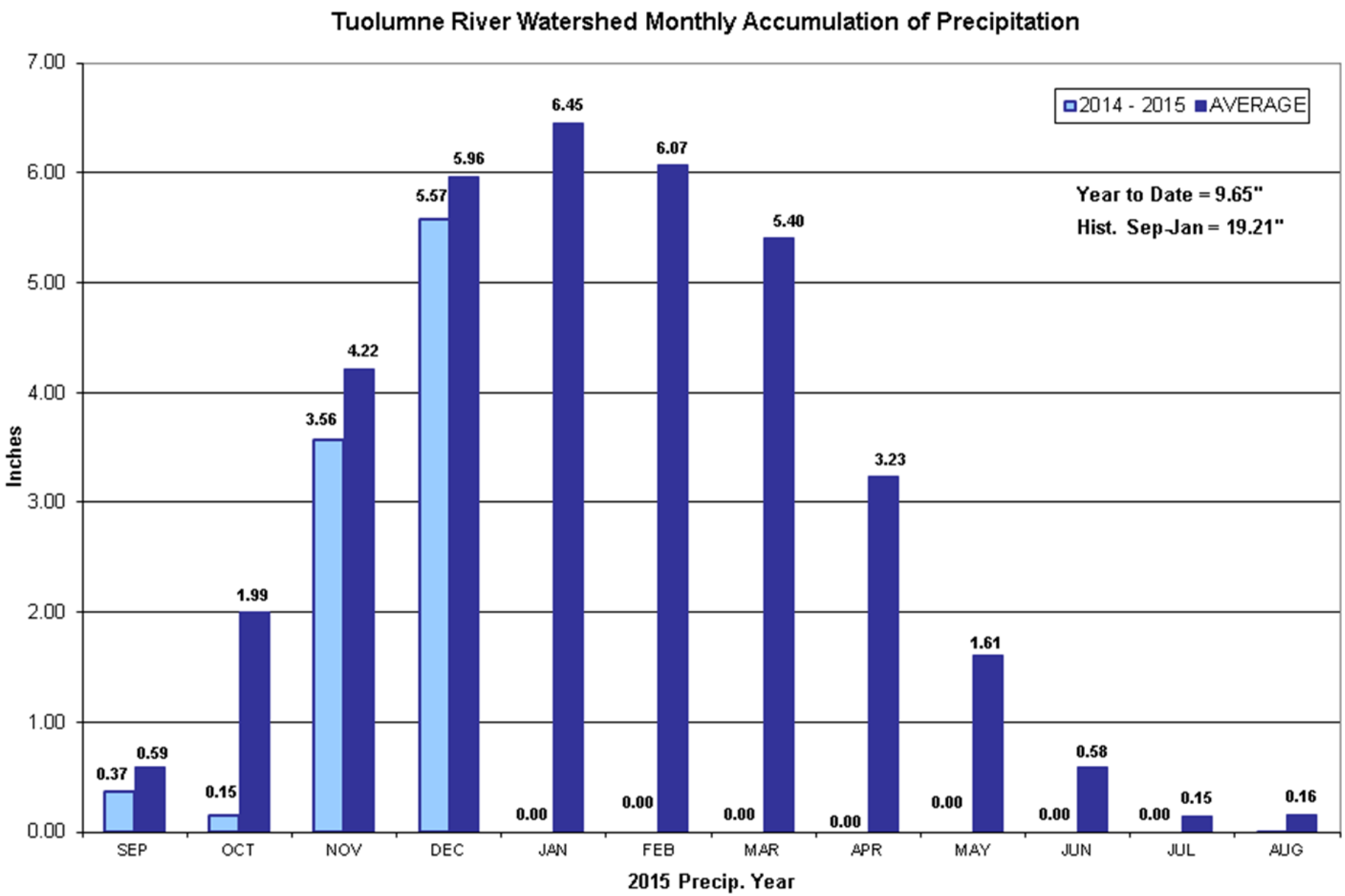
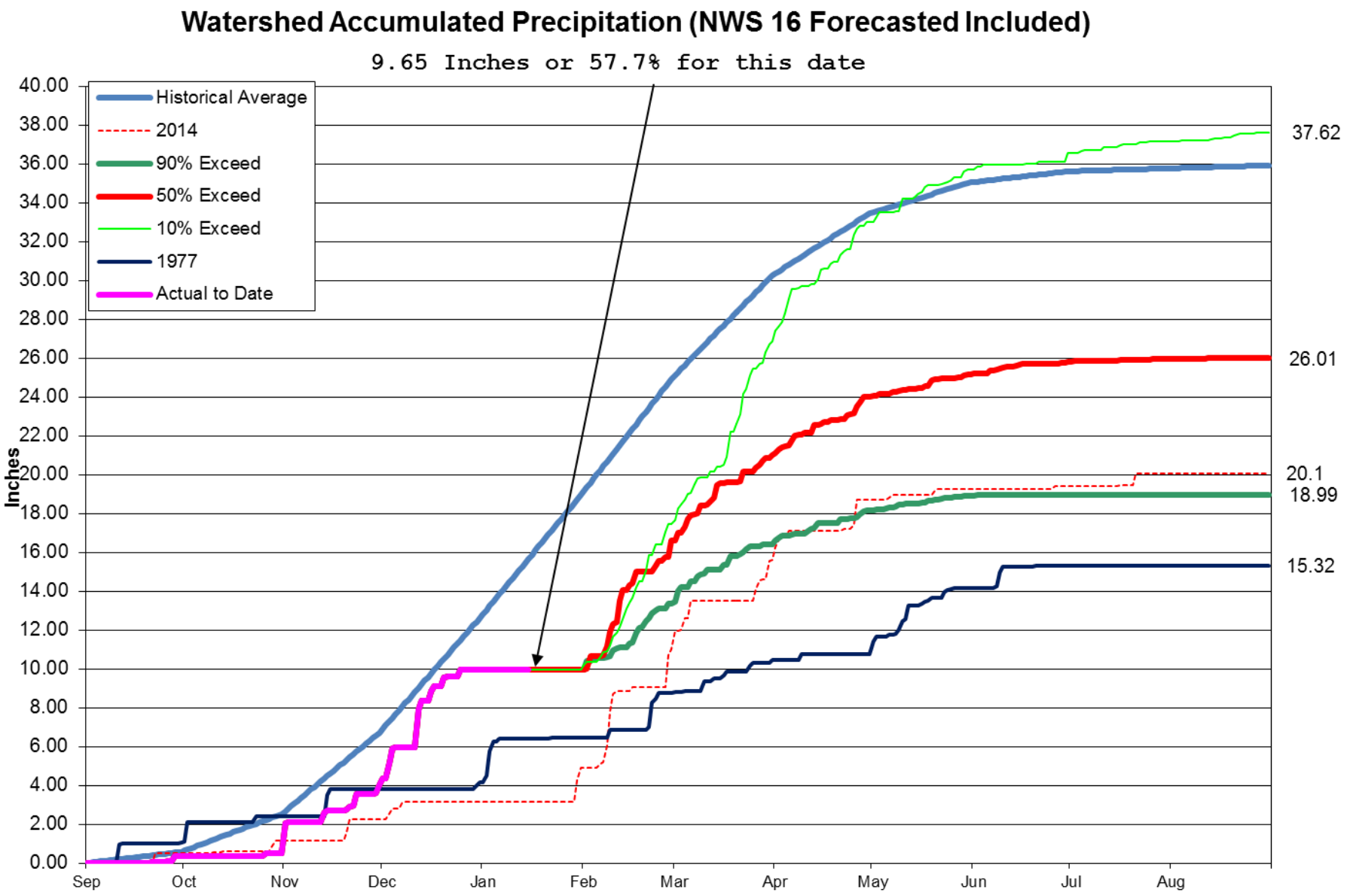
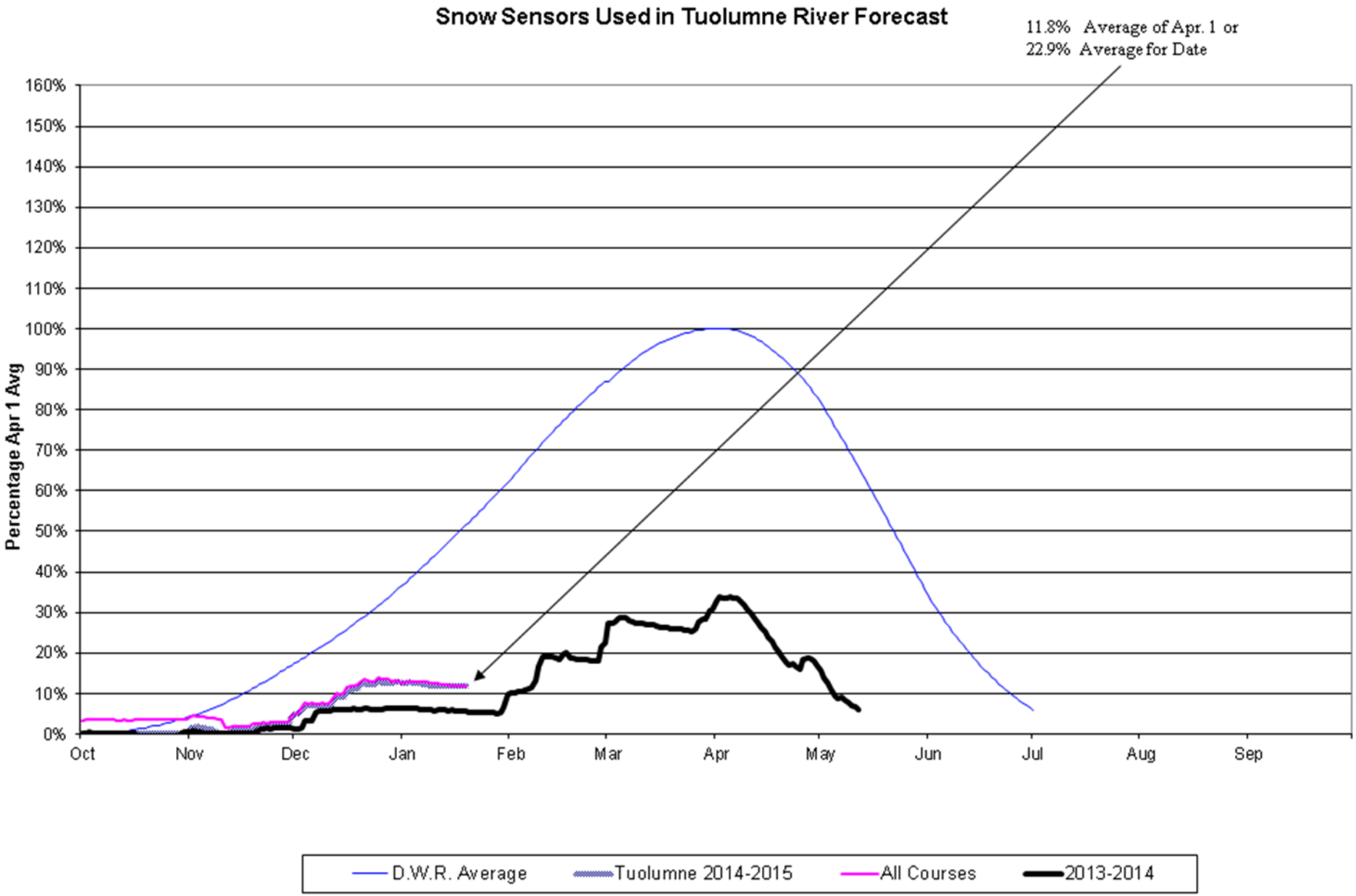
Current Hydrology



Current Hydrology



Current Hydrology



Current Hydrology

CCSF Reduction of FNF or Impact on Don Pedro Inflow

CCSF Water Bank 1/1/2015-12/31/2015	
CCSF Water Bank In Beginning	252,955
CCSF Diversions (230 MGD)	254,066
CCSF Empty Storage	226,421
Total Pot. Depletion From CCSF	480,487

- **CCSF's impact is equivalent to 7 inches of rainfall to both Districts at 35,000 af per inch.**
- **This is also equivalent to 9 inches of irrigation for TID.**
- **(252,000 x .6846) / 18,750 AF per inch from Don Pedro for TID.**

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Serving Central California since 1887

Irrigation Season Operations

	2015 Precipitation (1/1/2015-12/31/2015)					
	90% Exced. Low		50% Exced. Average		10% Exced. High	
	A.F.	Inches	A.F.	Inches	A.F.	Inches
1. Present Storage	378,496	20.2	378,496	20.2	378,496	20.2
2. Less Fish	(70,788)	-3.8	(74,005)	-3.9	(164,931)	-8.8
3. Less WID Entitlement	(23,961)	-1.3	(23,961)	-1.3	(23,961)	-1.3
4. Current Water Available	283,747	15.1	280,529	15.0	189,604	10.1
5. Additional Inflow	163,313	8.7	358,188	19.1	954,595	50.9
6. Evaporation	(7,693)	-0.4	(8,361)	-0.4	(12,510)	-0.7
7. Total Available Releases	439,367	23.4	630,356	33.6	1,131,689	60.4
8. Projected Irrigation Releases	(336,711)	-18.0	(432,069)	-23.0	(561,642)	-30.0
9. Subsequest Year's Obligations	(95,000)	-5.1	(95,000)	-5.1	(95,000)	-5.1
10. Carry Over Storage	7,656.3	0.4	103,286.5	5.5	475,046.9	25.3
Fish Requirement=	103,400		108,100		240,916	
TID share=	70,788		74,005		164,931	
MID share=	32,612		34,095		75,985	

APPENDIX G

DROUGHT MANAGEMENT PLAN

FEBRUARY 2015

Informational Meeting

February 25, 2015

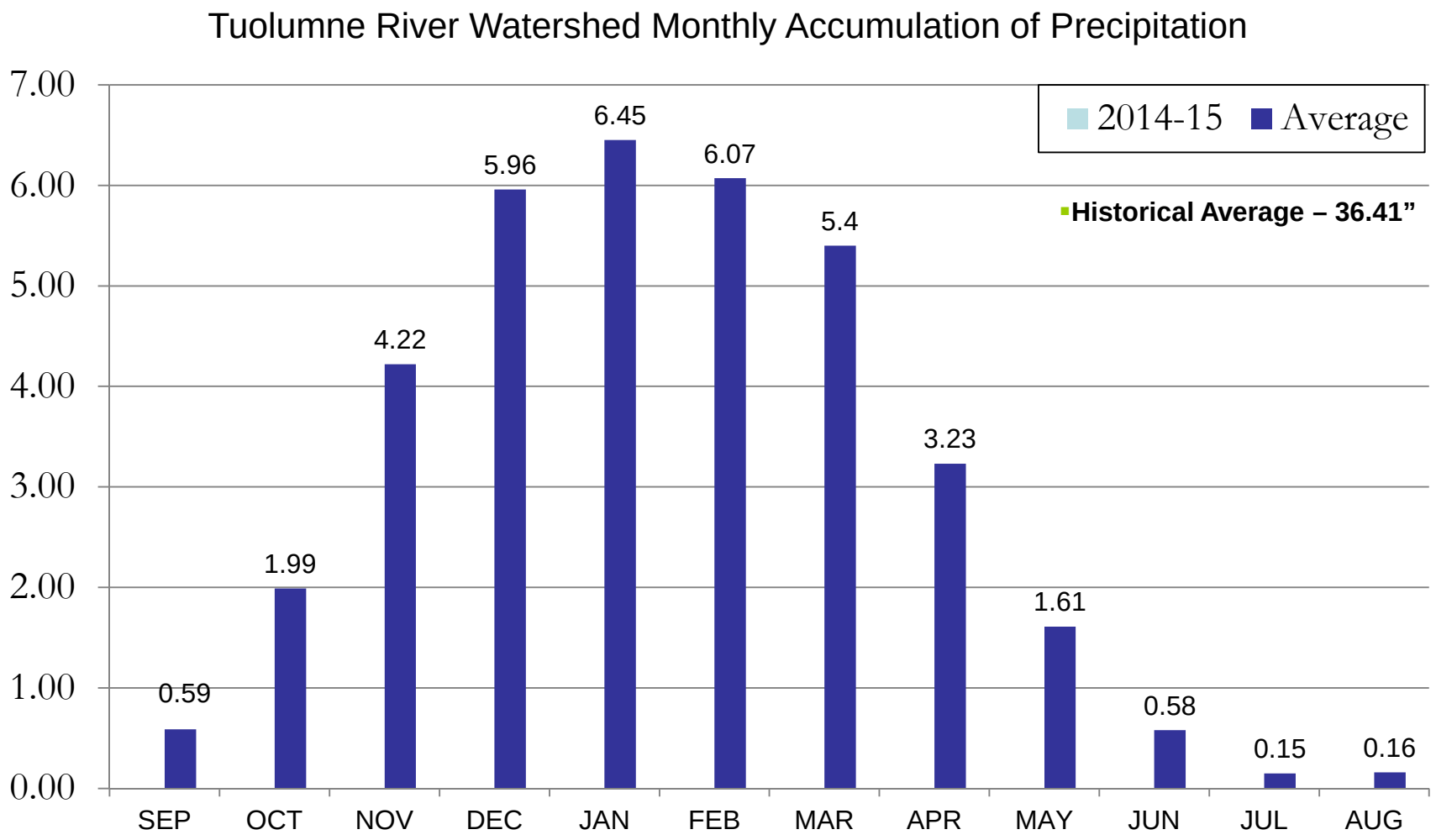
WATER & POWER
Serving Central California since 1887

Agenda

- Current Hydrology
- Irrigation Season Operations

WATER & POWER
Serving Central California since 1887

Current Hydrology



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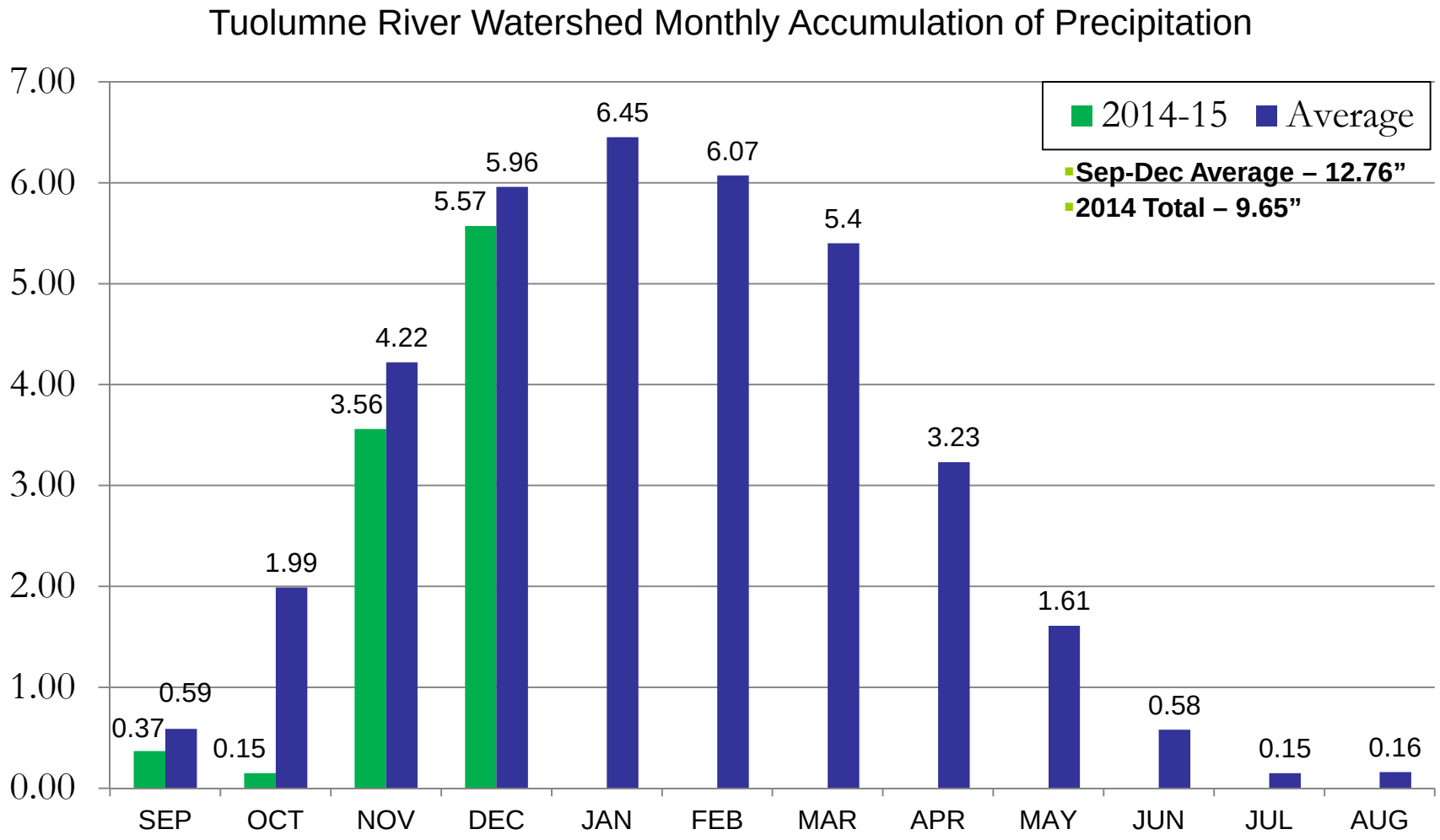
Current Hydrology



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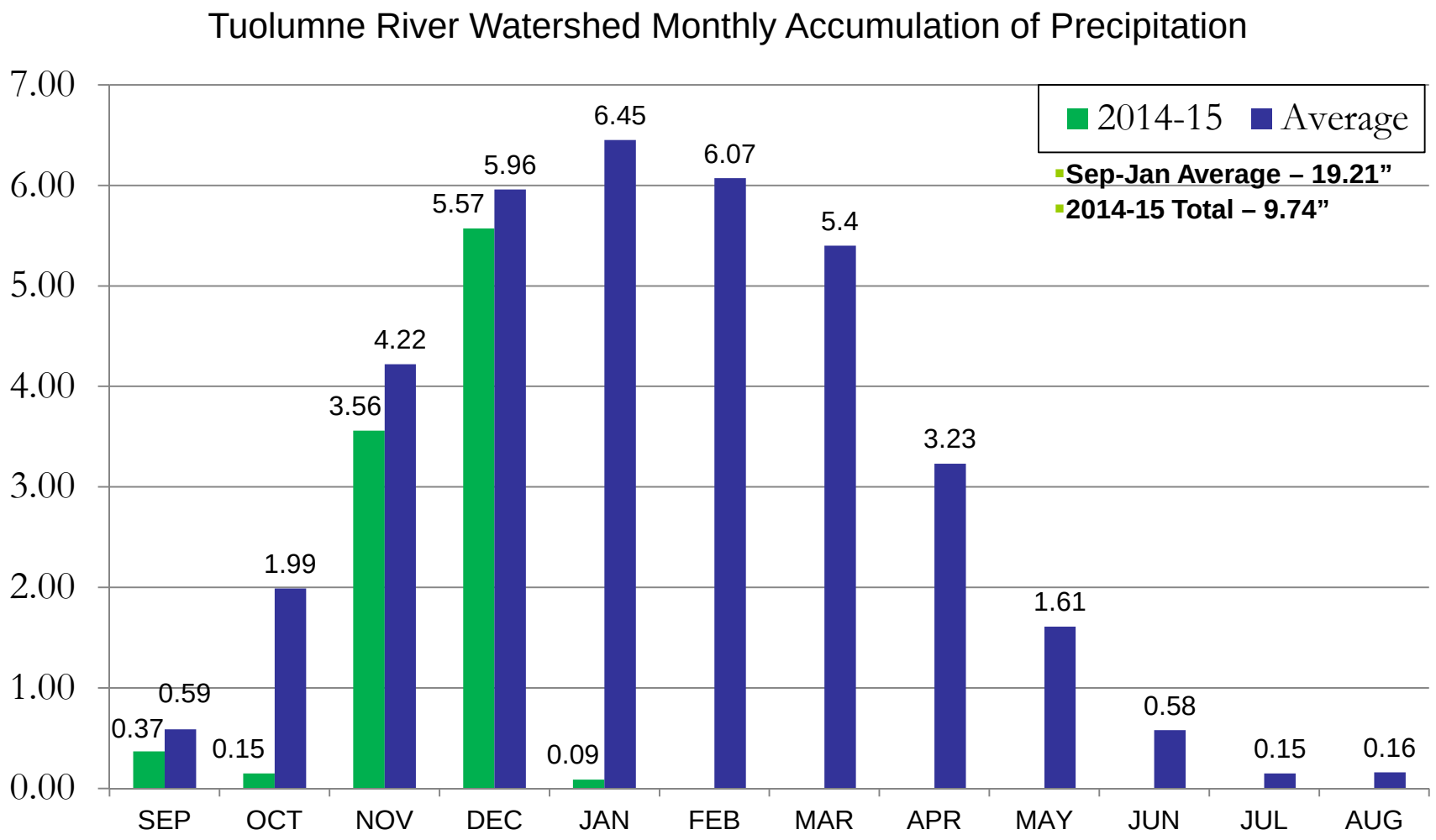
Current Hydrology



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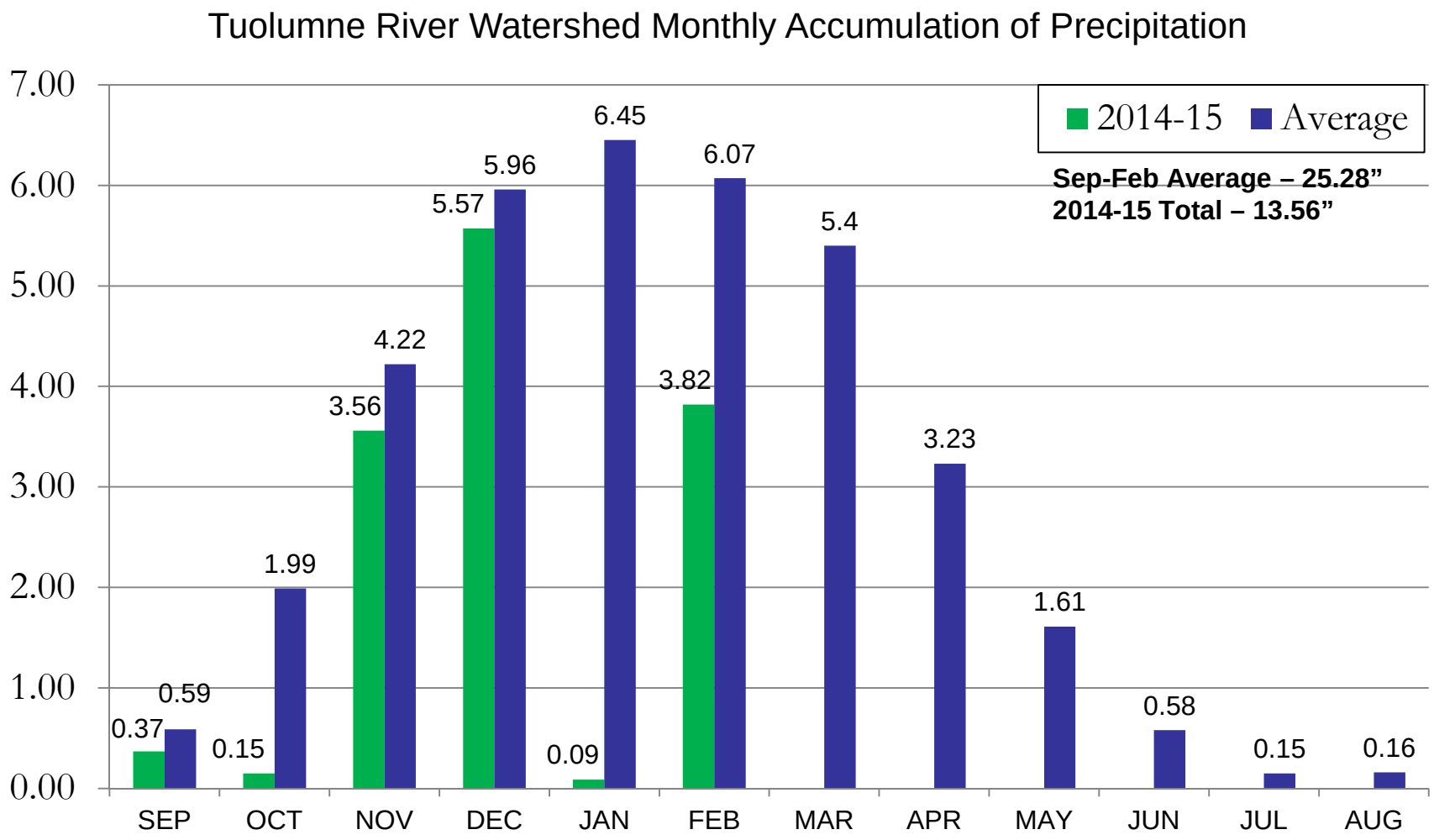
Current Hydrology



WATER & POWER
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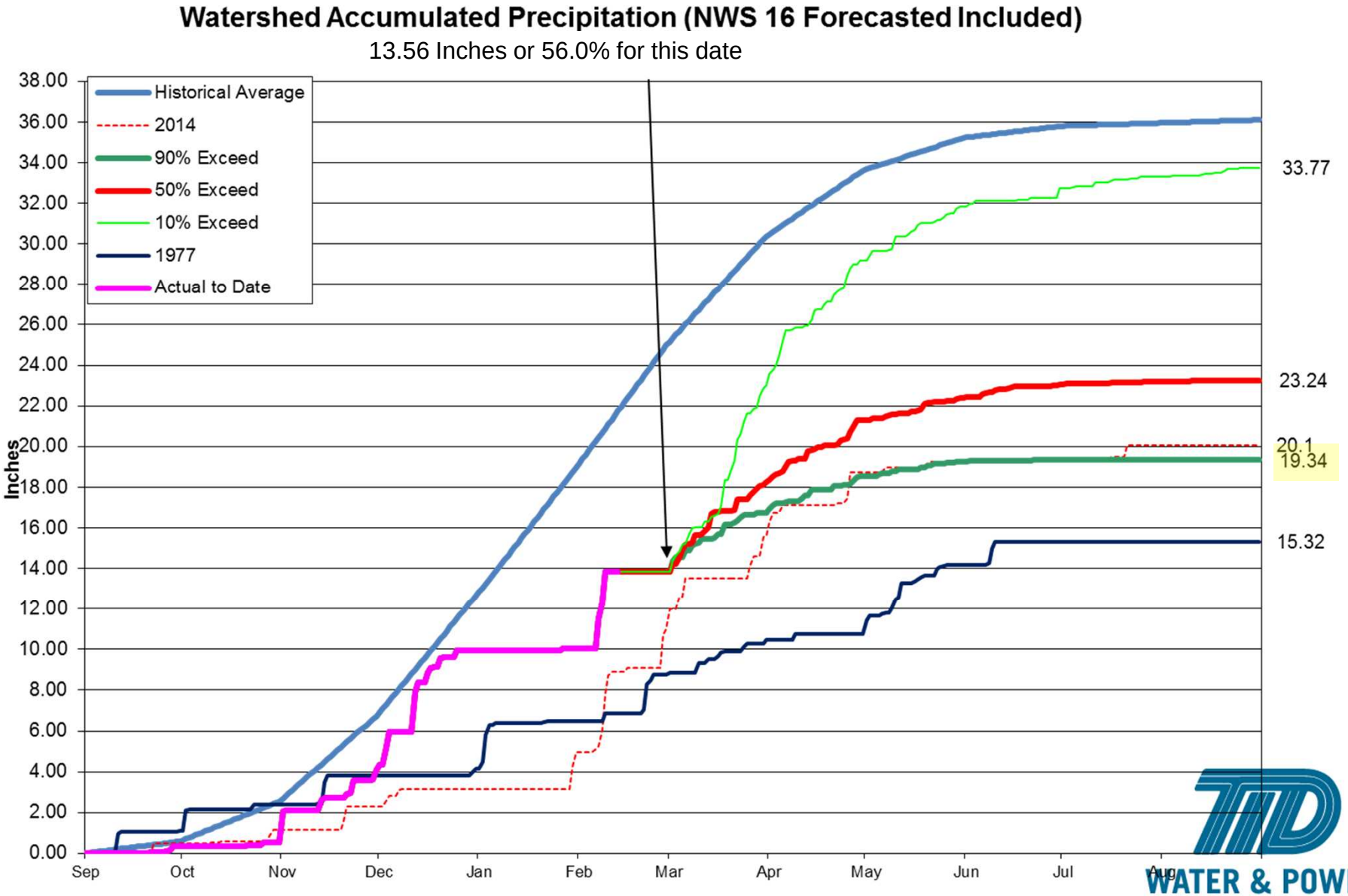
Current Hydrology



TID WATER & POWER
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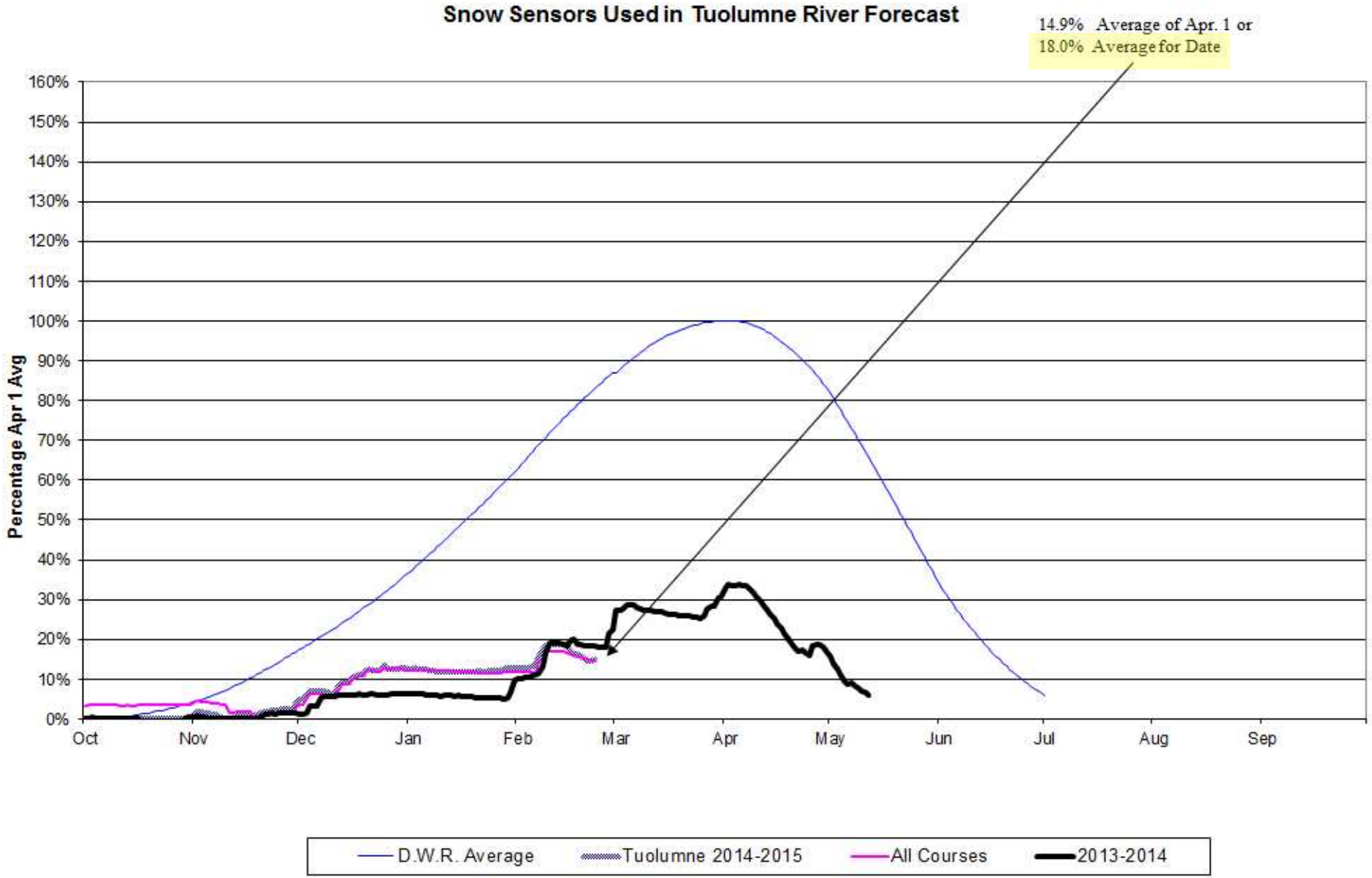
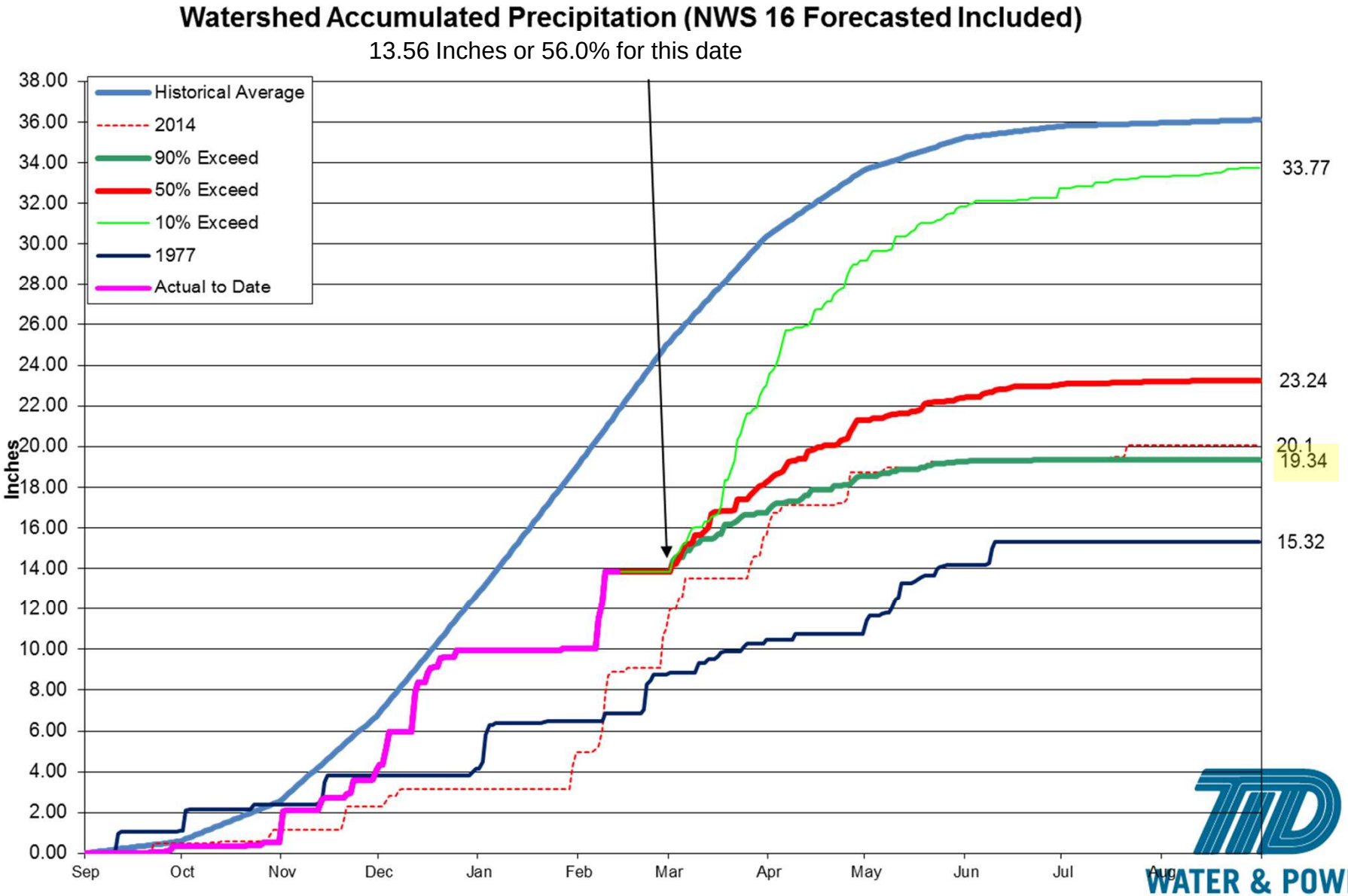
Current Hydrology



Current Hydrology



TID WATER & POWER
Serving Central California since 1887

Available Water

	90% Exced. Low	
	A.F.	Inches
1. Present Storage	408,633	21.8
2. Less Fish	(63,842)	-3.4
3. Less WID Entitlement	(23,961)	-1.3
4. Current Water Available	320,829	17.1
5. Additional Inflow	141,252	7.5
6. Evaporation	(7,665)	-0.4
7. Total Available Releases	454,416	24.2
8. Projected Irrigation Releases	(344,886)	-18.4
9. Subsequest Year's Obligations	(95,000)	-5.1
10. Carry Over Storage	14,530.3	0.8

WATER & POWER
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2015 Irrigation Season Operations

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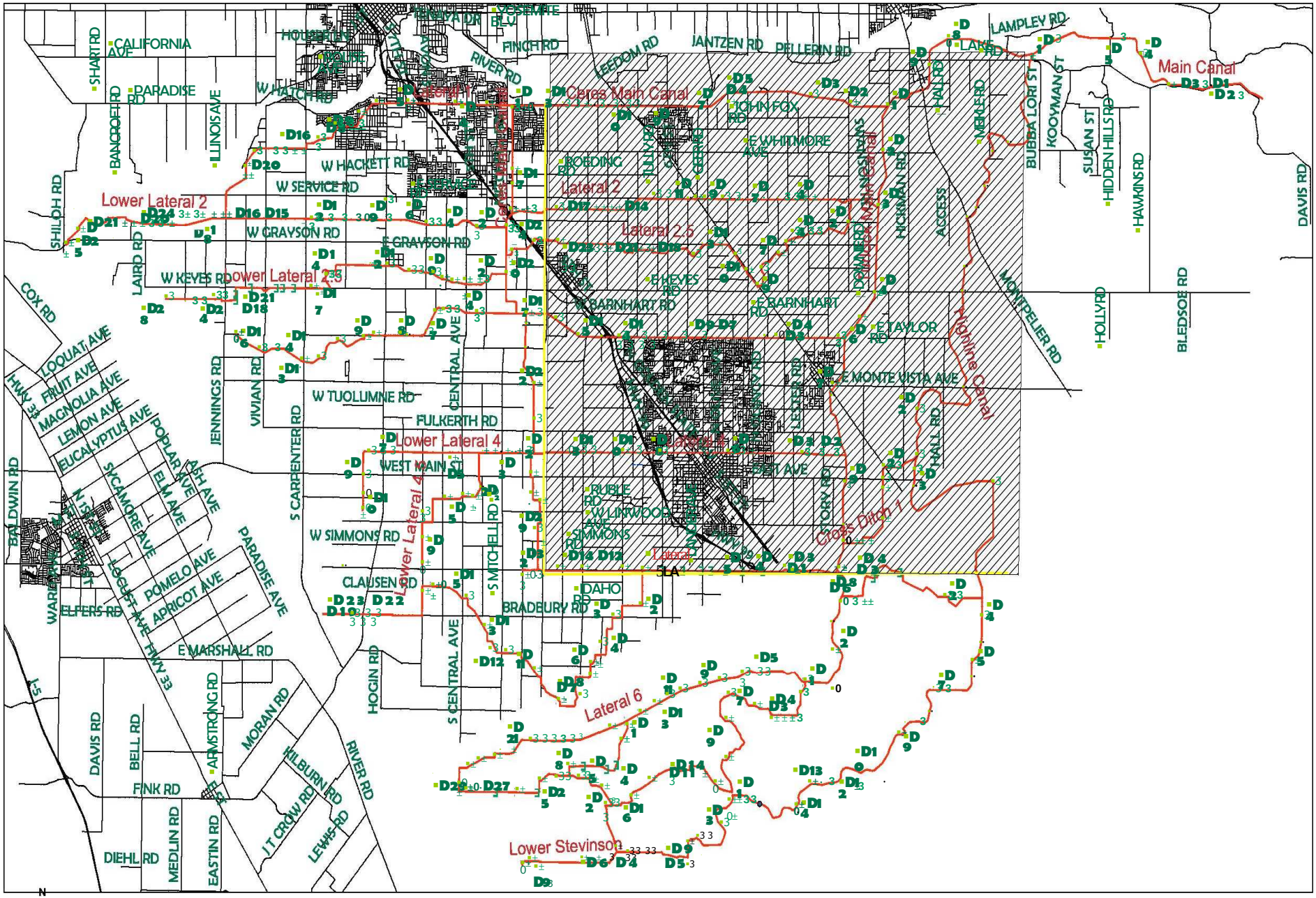

PUMPING LINE

Date
1/21/2015