

YUBA COUNTY WATER AGENCY

Agricultural Water Management Plan

DECEMBER 2015

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PREFACE

This Agricultural Water Management Plan (AWMP or Plan) has been prepared by the Yuba County Water Agency (YCWA or Agency) in accordance with the requirements of the Water Conservation Act of 2009 (SBx7-7) and the Governor's Executive Order B-29-15. 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 AWMP as set forth in the CWC and the California Code of Regulations (CCR) on or before December 31, 2012. The Plan must be updated by December 31, 2015 and then every 5 years thereafter (§10820 (a)). Additionally, the CWC requires suppliers to implement certain efficient water management practices (EWMPs). Executive Order B-29-15, issued April 1, 2015 further requires 2015 AWMP updates for agricultural water suppliers serving more than 25,000 acres to include in their Plan a detailed drought management plan describing actions and measures to manage water demand during drought, along with quantification of water supplies and demands for 2013, 2014, and 2015 (to the extent available).

In preparing the Plan, YCWA and its technical consultant have relied on guidance provided in the California Department of Water Resources (DWR) Guidebook to Assist Agricultural Water Suppliers to Prepare a 2015 Agricultural Water Management Plan (Guidebook), which was released in June 2015. Other primary resources used to develop this 2015 Plan were YCWA's 2012 AWMP, the CWC itself, the relevant sections of the CCR, and Executive Order B-29-15.

A cross-reference identifying the location(s) in the AWMP within which each of the applicable requirements of SBx7-7, the corresponding sections of the CWC, and Executive Order B-29-15 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 TO REQUIREMENTS OF SBX7-7, THE CALIFORNIA WATER CODE, AND EXECUTIVE ORDER B-29-15.

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).	**7**
	(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)	**7.2**
		(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	**7.3**
	(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.	**7.4.1**
		(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.	**7.4.2**
		(3)	Facilitate the financing of capital improvements for on-farm irrigation systems.	**7.4.3**
		(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.	**7.4.4**
		(5)	Expand line or pipe distribution systems, and construct regulatory reservoirs to increase distribution system flexibility and capacity, decrease maintenance, and reduce seepage.	**7.4.5**
		(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	**7.4.6**
		(7)	Construct and operate supplier spill and tailwater recovery systems.	**7.4.7**
		(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	**7.4.8**
		(9)	Automate canal control structures.	**7.4.9**
		(10)	Facilitate or promote customer pump testing and evaluation.	**7.4.10**
		(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress reports.	**7.4.11**
		(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.	**7.4.12**
		(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.	**7.4.13**
		(14)	Evaluate and improve the efficiencies of the supplier’s pumps.	**7.4.14**
	(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.	**7**

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, 2**
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.	**2**
	(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).	**2**

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:	**3**
		(1)	Size of the service area.	**3.2**
		(2)	Location of the service area and its water management facilities.	**3.3**
		(3)	Terrain and soils.	**3.4**
		(4)	Climate.	**3.5**
		(5)	Operating rules and regulations.	**3.6**
		(6)	Water delivery measurements or calculations.	**3.7**
		(7)	Water rate schedules and billing.	**3.8**
		(8)	Water shortage allocation policies.	**3.9**
10826	(b)		Describe the quantity and quality of water resources of the agricultural water supplier, including all of the following:	**4, 5**
		(1)	Surface water supply.	**4.2**
		(2)	Groundwater supply.	**4.3**
		(3)	Other water supplies.	**4.4**
		(4)	Source water quality monitoring practices.	**4.5**
		(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.	**5.6**
		(6)	Drainage from the water supplier's service area.	**5.7**
		(7)	Water accounting, including all of the following: (A) Quantifying the water supplier's water supplies. (B) Tabulating water uses. (C) Overall water budget.	**5.8**
		(8)	Water supply reliability.	**5.9**
	(c)		Include an analysis, based on available information, of the effect of climate change on future water supplies.	**6**
	(d)		Describe previous water management activities.	**1, 3, 4, 7**
	(e)		Include in the plan the water use efficiency information required pursuant to Section 10608.48.	**7**

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.	**2**
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.	**7**
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.	**2**
	(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:	**2**
		(1)	The department.	**2**
		(2)	Any city, county, or city and county within which the agricultural water supplier provides water supplies.	**2**
		(3)	Any groundwater management entity within which jurisdiction the agricultural water supplier extracts or provides water supplies.	**2**
		(4)	Any urban water supplier within which jurisdiction the agricultural water supplier provides water supplies.	**2**
		(5)	Any city or county library within which jurisdiction the agricultural water supplier provides water supplies.	**2**
		(6)	The California State Library.	**2**
		(7)	Any local agency formation commission serving a county within which the agricultural water supplier provides water supplies.	**2**
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.	**2**
	(b)		An agricultural water supplier that does not have an Internet Web site shall submit to the department, not later than 30 days after the date of adopting its plan, a copy of the adopted plan in an electronic format. The department shall make the plan available for public review on the department's Internet Web site.	**Not Applicable**

Governor Edmund G. Brown Executive Order B-29-15

Item 12. Agricultural Water Suppliers (more than 25,000 acres)		
Item	**Order 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.	**3.9, 4, 5**

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TABLES

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ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

AB3030	Assembly Bill 3030
ac	Acres
af	Acre-Feet
AWMP	Agricultural Water Management Plan
bgs	Below Ground Surface
BMO	Basin Management Objective
BVID	Browns Valley Irrigation District
BWD	Brophy Water District
CALFED	California Bay-Delta Program
CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	California Code of Regulations
CCR 23 §597	California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597
CCUF	Crop Consumptive Use Fraction
CDEC	California Data Exchange Center
CDM	Camp Dresser & Mckee
CEQA	California Environmental Quality Act
cfs	Cubic-Feet per Second
CID	Cordua Irrigation District
CIMIS	California Irrigation Management Information System
CNRA	California Natural Resources Agency
CPI	Consumer Price Index
CUA	Conjunctive Use Agreement
CVP	Central Valley Project
CWC	California Water Code
D-1644	SWRCB Decision 1644
DCMWC	Dry Creek Mutual Water Company
DF	Delivery Fraction
DLA	Draft License Application
DWR	California Department of Water Resources
ET	Evapotranspiration
ETa	Actual Evapotranspiration
ETaw	Evapotranspiration of Applied Water
ETc	Crop Evapotranspiration
ETo	Reference Evapotranspiration
ETpr	Evapotranspiration of Precipitation
EWA	Environmental Water Account
EWMP	Efficient Water Management Practice
FA	Fisheries Agreement
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
GCID	Glenn-Colusa Irrigation District
GMP	Groundwater Management Plan
GMROP	Groundwater Monitoring, Reporting, and Operations Program
GSA	Groundwater Sustainability Agency
HIC	Hallwood Irrigation Company
IDC	IWFM Demand Calculator
ILP	Integrated Licensing Process
in	inches
IPCC	Intergovernmental Panel on Climate Change
IRWMP	Integrated Regional Water Management Plan
IWFM	Integrated Water Flow Model
LAFCO	Local Agency Formation Commission
MIP	Measurement Improvement Plan
msl	Mean Sea Level
MU	Member Unit
NCWA	Northern California Water Association
NEPA	National Environmental Protection Act
NID	Nevada Irrigation District
NOI	Notice of Intent
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
NY31	Pumpline Canal Gaging Station (USGS#11420750)
NY32	Northside Diversion at Daguerre Point Dam Gaging Station (USGS# 11420770)

NY33	South Yuba Canal "Baker Gage" Gaging Station (USGS# 11420760)
NYI	North Yuba Index
O&M	Operations and Maintenance
OPUD	Olivehurst Public Utilities District
PAD	Pre-Application Document
PG&E	Pacific Gas and Electric Co.
PLP	Preliminary Licensing Proposal
RD-1644	SWRCB Revised Decision 1644
RMT	River Management Team
RWD	Ramirez Water District
SBx7-7	Senate Bill x7-7, the Water Conservation Act of 2009
SCADA	Supervisory Control and Data Acquisition
SD1	Scoping Document 1
SD2	Scoping Document 2
SGMA	Sustainable Groundwater Management Act
SEBAL	Surface Energy Balance Algorithm for Land
SFWPA	South Feather Water and Power Agency
SWP	State Water Project
SWRCB	State Water Resources Control Board
SWSF	Surface Water Supply Fraction
SYWD	South Yuba Water District
TAF	Thousand Acre-Feet
TDS	Total Dissolved Solids
UCB	University of California at Berkeley
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WMF	Water Management Fraction
WPA	Water Purchase Agreement
WQCP	Delta Water Quality Control Plan
WUE	Water Use Efficiency
WWD	Wheatland Water District
YCWA	Yuba County Water Agency
YRI	Yuba River Index

EXECUTIVE SUMMARY

INTRODUCTION

Yuba County Water Agency (YCWA) has prepared this Agricultural Water Management Plan (AWMP) in accordance with the requirements of the Water Conservation Act of 2009 (SBx7-7) and the Governor's Executive Order B-29-15. This AWMP updates the Agency's 2012 AWMP. YCWA is a leader in water management in Yuba County, and its roles include the long term reliability, quality, and affordability of local surface water and groundwater supplies; flood protection; fisheries enhancement; development and sale of hydroelectric power; and recreation. This leadership, along with the contributions and cooperation of YCWA's member units and various other stakeholders in the County and State as a whole, has led to the reversal of potentially serious groundwater level declines in the South Yuba Subbasin, improved water supply reliability locally and for the State, improved fishery conditions in the Yuba River, and an overall increase in water supply to meet agronomic, environmental, and other needs. Recent water management activities by the Agency include leadership in the development and implementation of the following water management initiatives:

- The Lower Yuba River Accord (2008)
- The Yuba County Integrated Regional Water Management Plan (2008)[1]
- The YCWA Groundwater Management Plan (2010)

Initial development and subsequent updates of the AWMP represent substantial efforts by YCWA to evaluate its water management, including the development of detailed water balances spanning the period from 2001 to 2014 for the distribution and drainage system of YCWA and its customers, the member units, and for the member unit farmed lands. Additionally, YCWA has evaluated the implementation of the full range of efficient water management practices (EWMPs) detailed in SBx7-7 with respect to its water management objectives and various water use efficiency improvements.

CONJUNCTIVE MANAGEMENT

A key aspect of YCWA's water management activities that supports the Agency's goal of ensuring an affordable, high quality water supply now and in the future is the conjunctive management of available surface water and groundwater supplies. To that end, YCWA has endeavored to make available surface water from the Yuba River for irrigation by its member units, reversing potentially serious overdraft in the South Yuba groundwater subbasin, resulting in the return of water levels to those of the 1950's, prior to overdraft conditions. Additionally, YCWA has actively facilitated the conjunctive use of groundwater by the member units to reduce demand for surface water in times of limited supply and to increase statewide water supplies by making surface water available for transfer to meet environmental or other demands through groundwater substitution. Building upon its history of leadership in protecting and restoring the groundwater supplies within the North Yuba and South Yuba subbasins, in 2015 YCWA chose to form a Groundwater Sustainability Agency (GSA) for each subbasin as part of implementation of the Sustainable Groundwater Management Act (SGMA) passed by the California Legisslature and signed into law in August 2014.

[1] As of 2015, a draft update of the Yuba County Integrated Regional Water Management Plan has been prepared that is anticipated to be adopted in the near future.

Continued sustainability of local water supplies and other future benefits of groundwater substitution depend upon recharge of the underlying aquifer with surface water from the Yuba River. This recharge is achieved through a combination of deep percolation of applied irrigation water on the farmed lands, along with seepage from the YCWA and member unit distribution and drainage system. As a result, strategies of the Agency and member units to conserve water are focused on reduction of losses to spillage and tailwater that leave the YCWA member unit service areas. Accordingly, extensive recovery and reuse of spillage and tailwater is practiced within the member unit service areas, and future efforts aim to both reduce and recover additional losses that would otherwise leave the area. The net effect of this conservation is to decrease Yuba River diversions and groundwater pumping, enhancing local supply and increasing the amount of water available to meet local, regional, and statewide water quality objectives.

IMPLEMENTATION OF EFFICIENT WATER MANAGEMENT PRACTICES

SBx7-7 describes sixteen EWMPs aimed at promoting efficient water management. Of these two are "critical" or mandatory and the remaining fourteen are to be implemented if technically feasible and locally cost effective. Of the fourteen conditional EWMPs, YCWA is implementing all of those that are technically feasible at locally cost effective levels and is seeking to increase implementation activities for key EWMPs that most effectively support the Agency's water management objectives through the pursuit of additional funding. The evaluation of EWMP implementation and Water Use Efficiency (WUE) improvements for YCWA considered how water balance changes relate to the Agency's water management objectives. For example, flows to deep percolation and seepage are critical to maintain the long-term sustainability of the underlying groundwater basin, and spillage from the YCWA and Member Unit (MU) distribution and drainage systems is available for beneficial use by downgradient water users. An implication of this is that very little "new" water can be made available through water conservation in YCWA's member unit service areas to increase the State's overall water supply. The EWMPs, along with past and future implementation activities by YCWA are described in Table ES-1.

CONCLUSION

Initial development of this AWMP in 2012 and update in 2015 has provided YCWA with an opportunity to evaluate and describe its ongoing agricultural water management practices and to evaluate how these actions support the Agency's local water management objectives, described above, as well as water use efficiency improvements from the State's perspective. As demonstrated in the Plan, YCWA is a local leader in water management and is committed to the ongoing evaluation and implementation of water management practices that meet local objectives while also increasing statewide water supplies. In the future, YCWA will continue to increase efforts to effectively manage available water supplies subject to the availability of funding.

Although the focus of this AWMP is necessarily on the Agency's agricultural water management practices, those practices must be considered in relation to the Agency's total water management mission to fully appreciate the Agency's effectiveness in optimizing overall water use efficiency. The Agency skillfully balances the often competing and dynamic needs of recreation, power generation, flood control and environmental stewardship, along with local, regional and statewide water supply, to maximize the efficient use of the surface water and groundwater supplies available to the Agency and its member units.

Table ES-1. Summary of YCWA Implementation Status for EWMPs Listed Under SBx7-7.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
Critical (Mandatory) EWMPs				
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 paragraph (2).	Implemented	1. Prepared a certification of compliance for existing compliant customer delivery measurement sites (Attachment A). 2. Developed and implemented a corrective action plan for non-compliant and new sites to achieve compliance with CCR 23 §597 by December 31, 2015 (Attachment A)	1. Continue delivery measurement program (measurement and SCADA improvements are described in Attachment G).
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Implemented	1. Existing charges for operations and maintenance and spill and tailwater outflow monitoring to member units based on volume of water delivered.	1. Continue implementing pricing structure for reimbursement based in part on volume of water delivered.
Additional (Conditional) EWMPs				
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	Lands with exceptionally high water duties or whose irrigation contributes to significant problems are not found within the MU service areas. Furthermore, provisions of YCWA's delivery contracts with the MUs 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.	Implemented	1. Recycled M&I water from Beale Air Force Base and Olivehurst Public Utilities District is available for reuse in the southside service area. 2. Identified potential additional sources of recycled M&I water.	1. Facilitate continued existing use of recycled water. 2. Consider requests from all qualifying permitted dischargers for additional use of recycled water.
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems.	Implemented	1. The District 10 well pump efficiency program administered by YCWA provides financing of improvements to on-farm irrigation wells. 2. YCWA has financed capital improvements by its customers, the MUs, including the Yuba Wheatland Canal.	1. Continue administration of District 10 well pump efficiency program. 2. Consider financing of other MU improvement projects that contribute to improved water management.
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.	Implemented	1. Existing pricing structure promotes use of available surface water supplies to provide beneficial groundwater recharge (Goal C). 2. Yuba Accord promotes groundwater production during dry years (Goal B). 3. Pricing structure based in part on volume delivered encourages more efficient water use by MUs (Goal A).	1. Continue to promote use of surface water supplies for beneficial recharge. 2. Continue to promote groundwater production during dry years. 3. Continue pricing structure based in part on volume delivered to encourage more efficient water use by MUs.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
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.	Not Technically Feasible	Lining or pipeline conversion of existing canals and drains would result in little if any seepage reduction. Additionally, to the extent that lining or pipeline conversion would result in a limited reduction in seepage, beneficial recharge would be additionally reduced. Pond 17 and Meadow Pond downstream of the Yuba River diversion to the Southside area at Daguerre Point Dam are operated as regulating reservoirs. Automation of the ponds has been evaluated under the canal automation EWMP.	
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	Implemented	1. Currently maximizing flexibility within operational limits. Deliveries are made with 24 hours advance notice. 2. Providing Agency staff to work to the specification of MUs in Southside area to deliver water to MU customers, providing seamless coordination between operation of YCWA and MU facilities, enhancing flexibility. 3. Implementing a SCADA system to provide real-time delivery data to YCWA and MU staff, supporting increased flexibility in water ordering and delivery. 4. Evaluated automation of YCWA facilities to further increase flexibility to MUs under canal automation EWMP.	1. Continue deliveries with 24 hour advance notice. 2. Continue to provide Agency staff to the specification of MUs in Southside area to deliver water to MU customers. 3. Continue to maintain SCADA system and real-time data access. 4. Automate YCWA facilities as funding becomes available to further increase flexibility as described under canal automation EWMP.
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems.	Implemented	1. Implementing MIP to provide increased monitoring of key locations to support spill and tailwater reduction by YCWA and MU operators. 2. MUs practice extensive tailwater and spillage recovery and reuse.	1. Continue implementation of MIP, focused initially on securing funding for improvement/establishment of high priority sites.
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	Implemented	1. Conducting effective, proactive conjunctive management program to meet multiple objectives and address potential impacts. 2. Developing a groundwater flow model. 3. Actively involved in implementation of SGMA as a GSA. 4. Serves as the designated CASGEM reporting entity in Yuba County.	1. Continue conjunctive management and seek opportunities to enhance activities to increase local and statewide benefits. 2. Continue to implement SGMA as a GSA 3. Continue to serve as CASGEM agency
10608.48.c(9)	Automate canal control structures.	Implemented	1. Implementing MIP to provide increased monitoring of key locations to support enhanced operation of YCWA and MU facilities by Agency and MU operators. 2. Constructed Yuba Wheatland Canal pump stations operating in automatic downstream level control and currently investigating enhanced remote automation and control. 3. Evaluated opportunities for additional automation to be considered for implementation.	1. Continue implementation of MIP, focused initially on securing funding for high priority sites. 2. Continue automated operation of Yuba Wheatland Canal pump stations. 3. Implement additional automation at locally cost-effective levels.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation.	Implemented	1. Provide information on available programs. 2. Employing a policy that encourages grower's to maximize pump efficiency by paying for groundwater substitutions on a volumetric basis. 3. Implementing District 10 well pump efficiency program to reimburse growers for pump improvements.	1. Continue to promote participation of MUs in available pump testing programs and employ current groundwater substitution payment policy. 2. Continue program to reimburse growers for pump improvements.
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implemented	1. Water Resources Manager serves as YCWA Water Conservation Coordinator.	1. Water Resources Manager will continue to serves as Water Conservation Coordinator.
10608.48.c(12)	Provide for the availability of water management services to water users.	Implemented	1. Conducting annual or semi-annual meetings with MUs to discuss water management. 2. Implementing MIP to provide improved monitoring of key locations to support enhanced operation of MU facilities. 3. Providing Agency staff for operation of MU facilities in Southside area. 4. Implementing District 10 well pump efficiency program to reimburse growers for pump improvements.	1. Continue to conduct meetings with MUs to discuss water management services. 2. Continue implementation of MIP, focused initially on securing funding for high priority sites. 3. Continue to provide Agency staff for operation of MU facilities. 4. Continue program to reimburse growers for pump improvements.
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.	Implemented	1. Evaluating policies of agencies that affect YCWA's ability to flexibly store and deliver water and seeking changes to increase flexibility.	1. Continue to evaluate policies of agencies that affect YCWA's ability to flexibly store and deliver water and seeking changes to increase flexibility.
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implemented	1. Evaluating pump efficiency and performing maintenance as needed.	1. Continue evaluating pump efficiency and performing maintenance as needed.

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CHAPTER 1.0 - INTRODUCTION

This Agricultural Water Management Plan (AWMP or Plan) has been prepared by the Yuba County Water Agency (YCWA) in accordance with the requirements of the Water Conservation Act of 2009 (SBx7-7) and the Governor's Executive Order B-29-15. 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 AWMP as set forth in the CWC and the California Code of Regulations (CCR) on or before December 31, 2012. The Plan must be updated by December 31, 2015 and then every 5 years thereafter (§10820 (a)). Additionally, the CWC requires suppliers to implement certain efficient water management practices (EWMPs). Executive Order B-29-15, issued April 1, 2015 further requires 2015 AWMP updates for agricultural water suppliers serving more than 25,000 acres to include in their Plan a detailed drought management plan describing actions and measures to manage water demand during drought, along with quantification of water supplies and demands for 2013, 2014, and 2015 (to the extent available).

The AWMP describes the public participation process to develop and adopt the Plan (Chapter 2) and provides a detailed description of the Agency and its service area (Chapter 3). At the core of the Plan are an inventory of available water supplies (Chapter 4) and detailed water balances describing water use by YCWA and its customers, the member units (MUs) north and south of the Yuba River ("Northside" and "Southside" areas, respectively) (Chapter 5). Within each area, water balances spanning the fourteen-year period from 2001 to 2014 have been prepared for two accounting centers: the combined distribution and drainage system and the farmed lands. Following the water balance, an analysis and discussion of potential climate change impacts and adaptation strategies is provided (Chapter 6). Finally, YCWA's implementation of two mandatory EWMPs and fourteen additional EWMPs is described in detail, along with an evaluation of water use efficiency (WUE) improvements achieved through EWMP implementation (Chapter 7).

This Plan updates YCWA's previous AWMP adopted in 2012.

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CHAPTER 2.0 - PLAN PREPARATION

2.1. REGULATORY COMPLIANCE

As described previously, this AWMP has been prepared in accordance with SBx7-7, the CWC, and the Governor's Executive Order B-29-15 issued April 1, 2015. More fundamentally, this Plan describes the effective, proactive management of surface water and groundwater supplies in Yuba County by the Yuba County Water Agency as a wholesaler of agricultural irrigation water.

2.2. PUBLIC PARTICIPATION

The public participation process for review and adoption of this AWMP was conducted in accordance with CWC and Government Code 6066. Public participation in the development of this Plan included:

- Notification of the County of Yuba, the City of Marysville, and the City of Wheatland of YCWA's intent to prepare an AWMP on December 7, 2015;
- Publication in the Marysville Appeal Democrat on December 7, 2015 and December 14, 2015 of the time and place of a hearing to review the draft Plan;
- Posting of the draft AWMP for public review on December 8, 2015;
- Review of the publicly noticed presentation of the draft Plan at a regular meeting of the Board of Directors on December 22, 2015;
- Adoption of the final AWMP at a regular meeting of the Board of Directors on December 22, 2015; and
- Provision of copies of the adopted AWMP to the following parties by January 21, 2016:
    - Cities of Marysville and Wheatland
    - County of Yuba
    - Yuba County Library
    - Local Agency Formation Commission (LAFCO) of Yuba County
    - California Department of Water Resources
    - California State Library

The public is invited to attend all Board meetings with time reserved on each agenda for public comments. The Board members are accessible to the public by phone and at Board meetings. The Agency has a web site where the agendas of all Board meetings are published along with the most recent Board minutes, Agency news and other important information. Comments can be submitted via e-mail.

The Agency maintains an open exchange of information with local newspapers and, if necessary, issues press releases on matters of importance to the public. In the future, the Agency may consider developing a newsletter to further inform interested parties on Agency activities. The Agency also relies on its operational staff to keep customers informed of the latest water management information.

2.3. REGIONAL COORDINATION

The Agency operates the Yuba River Development Project in coordination with various federal, state, and local agencies, as well as with other stakeholders. Regional coordination efforts by YCWA are described in greater detail in Chapter 3 of this AWMP. Because of YCWA's role as a wholesaler of water for irrigation to its member units, this Plan could be considered a regional AWMP. The Agency has coordinated with its member units in the preparation of this Plan, including holding an AWMP workshop with the member units on December 8, 2015.

CHAPTER 3.0 - BACKGROUND AND DESCRIPTION OF SERVICE AREA

3.1. BACKGROUND AND HISTORY

3.1.1. Agency Formation and History

The Yuba County Water Agency was formed in 1959 by a special act of the California State Legislature in response to repeated and at times severe flooding of the Yuba River, which demonstrated a need for coordinated flood control in Yuba County. Additionally, growers realized that declining groundwater levels in the Yuba South subbasin signaled an unsustainable irrigation supply. Accordingly, the original mission of the Agency was to provide flood protection and to develop and conserve the available surface water and groundwater supply in the Area (see inset). The Agency's functions also include the development and sale of hydroelectric power, fisheries enhancement, and recreation, in addition to water supply and flood protection.

> ***Excerpts from the Yuba County Water Agency Act***
>
> ***(California Water Code Appendix §84)***
>
> "A district hereinafter called an agency is hereby created for the purpose of accomplishing a function of statewide importance. Said agency shall be known as Yuba County Water Agency…."
>
> "The agency shall have the power to control the flood and storm waters of the agency and the flood and storm waters of streams that have their sources outside of the agency, which streams and flood waters flow into the agency, and to conserve such waters for the beneficial and useful purposes of said agency …."
>
> "The agency shall have the power as limited in this act to do any and every lawful act necessary in order that sufficient water may be available for any present and future beneficial use …."

A key component of the Agency's infrastructure is New Bullards Bar Dam (Figure 3-1) and Reservoir on the North Yuba River. Old Bullards Bar Dam was built between 1922 and 1924 by the Yuba Power Company, but was insufficient to adequately control flooding on the Yuba River. The construction of New Bullards Bar Dam and, eventually, additional facilities to divert and convey water from the Yuba River to growers within YCWA's member units is a story of fortitude and perseverance. Prior to the formation of the Agency, the State had begun planning the State Water Project (SWP) including the construction of Oroville Dam on the Feather River. Simultaneously, and in response to the great Yuba River Flood of 1955, residents of Yuba County had been working to develop a program to control flooding on the Yuba River and to develop surface water supplies to counter overdraft of the groundwater basin.

In January 1959, the Yuba County Water Resources Board, formed by the county Board of Supervisors, developed a proposal for the State Legislature to pass a bill creating the Yuba County Water Agency, which would have the authority to develop the Yuba River Project. The bill was almost lost in committee and then contensiously debated on the Assembly and Senate floors. Lobbying against the bill continued in the governor's office until it was signed on June 1, 1959 by Governor Edmond G. Brown. It is believed that the fact that Governor Brown was working to develop the SWP at the same time helped his decision to support the Yuba Project, a much more modest effort. The creation of the Agency was a significant milestone in the development of the Yuba River Project, but was merely one step in a long process.

Figure 3-1. New Bullards Bar Dam.

Initially, there was opposition to the Yuba River Project by the Johnson Rancho Water District in Yuba County, which had developed an alternative plan and contended that the Agency's plan was in conflict with the California Water Plan. Ultimately, after a lengthy battle resolved by the State Appellate Court, YCWA prevailed and was able to proceed with development of the project.

A feasibility study was conducted to evaluate the proposed project. It was found that the project would cost approximately $185 million. Key components of the project included development of sufficient hydropower to repay bond financing without tax obligation on local landowners and negotiation of a long term contract for the sale of power to Pacific Gas and Electric Co. (PG&E) at a guaranteed annual payment amount, the sole security of the bond issue. Additionally Federal and state support was based on flood control benefits and statewide benefits to recreation and fisheries. Despite these funding sources, planning and implementation of the project was a substantial financial burden to the county and Agency. Despite this challenge, Yuba County voters approved the required revenue bonds by an 11 to 1 margin in 1961.

Securing funding was but one challenge to building the project. Political and regulatory obstacles also had to be surmounted. A recreation plan suitable to the U.S. forest service was required along with a fire control plan. An agreement with the California Department of Fish and Game laying out actions to protect and enhance fisheries was also required, as well as an agreement with the U.S. Bureau of Reclamation and the State of California for future downstream development. Negotiations with PG&E for a 50-year contract for the sale of power also proved complex and included acquisition of existing power generation plants owned by PG&E at Old Bullards Bar Dam and Colgate.

By 1964 final designs were prepared, and the Agency decided to go to bid to avoid risking losing the project to a slow bond market and reduced power rates. Unfortunately, contractors chose not to bid due to contingencies and constraints that posed risk on the construction and, in their perception, insufficient funding. In response, YCWA reformulated the project to increase power generation and remove the irrigation diversion dam and canals, as well as other features. The irrigation facilities would be built at a future time when additional funding was available.

The reformulated project went to bid in late 1965 with all of the necessary contracts, licenses, and permits in place. Unfortunately, by this time costs had risen substantially, power rates had fallen, and bond rates had increased, posing additional challenges to project financing. The only viable bid received was $26 million greater than the available funding. Fortuitously, the bidder was willing to negotiate the contract, and the Agency was able to obtain special legislative authority to negotiate the largest single public works contract in California history at that time.

Intensive negotiation led to concessions by the Agency, contractor and PG&E, however these concessions were not enough to close the gap between costs and funding for the project, with $8.7 million in additional funding needed as interest rates continued to rise, with each 0.1% increase in interest representing over $3 million less funding available for construction. A novel arrangement was reached, in which the contractor (Perini-Yuba Associates), engineer (International Engineering Co.), and PG&E jointly agreed to purchase long-term bonds to close the funding gap realized at the end of construction. Following the sale of bonds for the project in 1966, the project was underway.

Approximately 3,000 workers were hired for the construction of New Bullards Bar Dam and other project components. The contract called for completion of the work within four years, a daunting challenge given steep, rocky terrain with limited access to the dam site and the risk of torrential rains that could destroy months of earthwork in a matter of hours. A half mile of lights was strung across the canyon, and work was completed day and night for over two years. By the end of 1969 New Bullards Bar Dam was completed, and in 1970 the New Colgate Powerhouse (Figure 3-2) was ready to come online. The Dam has a height of 635 feet with a length of 2,350 feet and a reservoir storage capacity of 960,000 acre-feet. The powerhouse includes the two largest Pelton wheel turbines ever built. With a 1,300 foot drop of water from the Dam to the powerhouse, each turbine can produce upwards of 212,000 horsepower. The New Narrows powerhouse below Englebright Dam was also completed in 1970.

Figure 3-2. New Colgate Powerhouse.

Over the following 34 years, contracts were entered into by the Agency to provide wholesale water supplies for agricultural use to irrigation and water districts north and south of the River in Yuba County. Today, YCWA provides water to 8 member units (MUs) representing 79,590 gross acres[2]. The newest member unit, Wheatland Water District (WWD) began to receive water in 2009. The MUs served by YCWA and the year in which delivery agreements were entered include the following:

- Cordua Irrigation District (CID)—1972
- Ramirez Water District (RWD)—1972
- Hallwood Irrigation Company (HIC)—1980
- Browns Valley Irrigation District (BVID)—1981
- Brophy Water District (BWD)—1985
- South Yuba Water District (SYWD)—1985
- Dry Creek Mutual Water Company (DCMWC)—1996
- Wheatland Water District (WWD)—2004

[2] Note that there are approximately 48,000 additional acres in the Browns Valley Irrigation District above the YCWA irrigation command area.

Historically, MUs south of the Yuba River, namely BWD, SYWD, DCMWC, and WWD used groundwater exclusively for irrigation. Sustained use of groundwater led to severe overdraft in the South Yuba Groundwater Subbasin. Provision of surface water by YCWA first to BWD and SYWD and later to DCMWC and WWD has reversed overdraft, resulting in groundwater levels that are currently similar to those in the early 1950's (Figure 3-3). This success story of effective conjunctive water management is sustained as YCWA continues to protect the long-term sustainable yield of the basin.

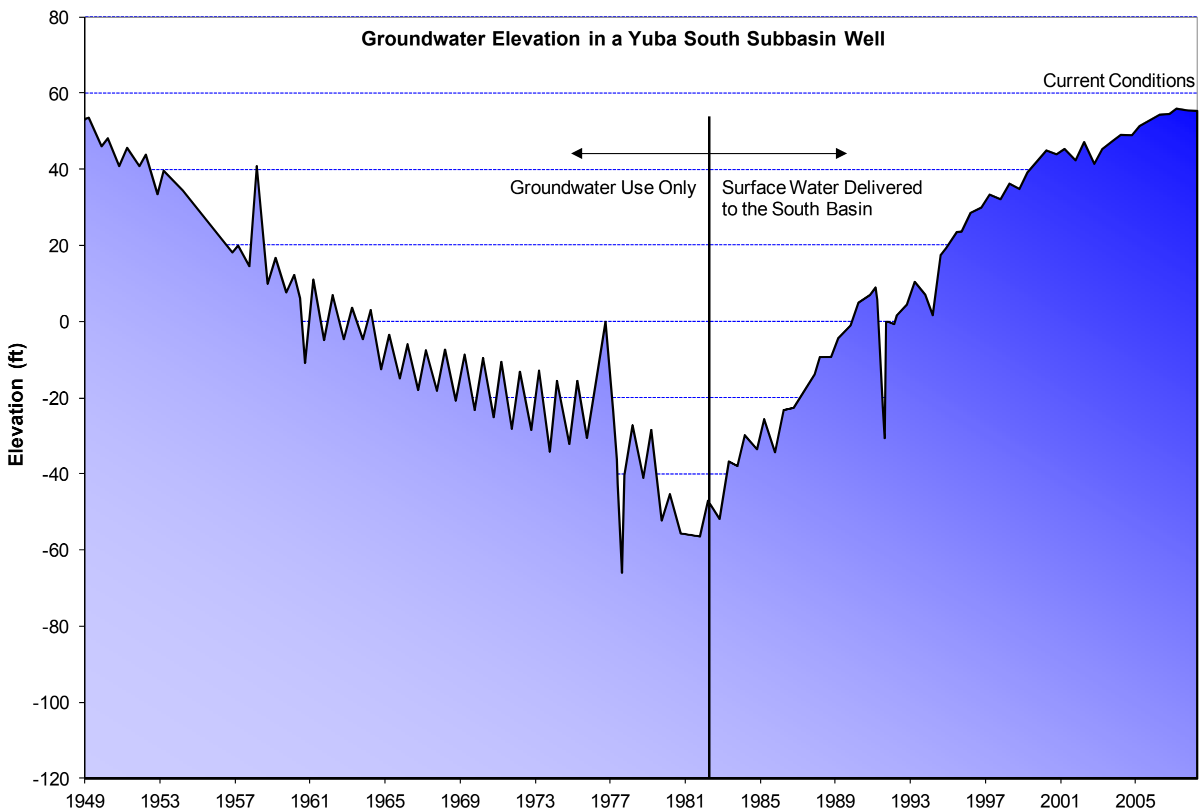

Figure 3-3. Hydrograph Showing Historical Groundwater Elevations for a Typical South Yuba Subbasin Well (Grinnell 2011[3]).

Groundwater management by YCWA is embodied in the implementation of its Groundwater Management Plan (GMP), developed and adopted in 2005 and updated in 2010, and through the Agency's active monitoring of groundwater levels and quality as part of its groundwater substitution transfer program, which increases and enhances local and statewide water supplies while maintaining the long term sustainable yield of the basin. In 2015 YCWA chose to form a Groundwater Sustainability Agency (GSA) for the North Yuba subbasin in Yuba County and the South Yuba Subbasin as part of implementation of the Sustainable Groundwater Management Act (SGMA) passed by the California Legislature and signed into law in August 2014.

Along with sustaining local surface water and groundwater supplies, YCWA has been and continues to be a leader in the protection and enhancement of habitat for fish in the lower Yuba River and the

[3] Grinnell, S. 2011. Personal Communication.

enhancement and protection of regional and statewide water supplies. Between 1987 and 2014, YCWA provided water through 36 individual surface water and groundwater substitution transfers representing more than 2.4 million acre-feet.

In 2008, YCWA in collaboration with 17 agricultural, environmental, and fisheries interests, including State and federal agencies, entered into the Lower Yuba River Accord (Yuba Accord), a series of agreements resolving 15 years of controversy and litigation over instream flow requirements. Key outcomes of the Accord include providing for conjunctive management of surface and groundwater supplies to maintain local and statewide water supply reliability, enhancement and protection of habitat in the Yuba River for fish, and increases in statewide water supplies that can be used to meet additional environmental, irrigation, municipal, industrial, or other needs locally or in other regions.

The management of water by YCWA and its active involvement in local and statewide water management initiatives is described in greater detail in subsequent chapters of this AWMP.

Table 3-1. YCWA Historical Water Transfers, 1987 through 2014.

Year	Sacramento Valley Index[i] Water Year Type	Buyer	Stored Water Transfer (af)	Groundwater Substitution Transfer (af)
1987	Dry	California Department of Water Resources	83,100	
1988	Critical	California Department of Water Resources	135,000	
1989	Dry	California Department of Water Resources	90,000	
		California Department of Water Resources for California Department of Fish and Game	110,000	
		City of Napa	7,000	
		East Bay Municipal Utilities District	60,000[a]	
1990	Critical	City of Napa	6,700	
		California Department of Water Resources	109,000	
		Tudor Mutual Water Company/Feather Water District	2,951	
1991	Critical	State Water Bank	99,200[b]	84,840
		State Water Bank - California Department of Fish and Game	28,000	
		City of Napa	7,500	
1992	Critical	State Water Bank	30,000[c]	
1994	Critical	California Department of Water Resources		26,033
1997	Wet	Reclamation for Refuge Water	25,000[d]	
		Sacramento Area Flood Control Agency for American River Fishery	48,857	
2001	Dry	Environmental Water Account	50,000[e]	
		California Department of Water Resources	52,912	61,140
2002	Dry	Environmental Water Account	79,742	55,258
		California Department of Water Resources	22,050	
		Contra Costa Water District	5,000	
2003	Above Normal	Environmental Water Account	65,000[f]	
		Contra Costa Water District	5,000	
2004	Below Normal	Environmental Water Account	100,000[f]	
		California Department of Water Resources	487	
2005	Above Normal	Environmental Water Account	6,086[f]	
2006	Wet	Environmental Water Account	60,000[a]	
2007	Dry	Yuba Accord Water Purchase Participants	65,000[f,g,h]	
2008	Critical	Yuba Accord Water Purchase Participants	117,212[f,g]	48,875
2009	Dry	Yuba Accord Water Purchase Participants	91,100[f,g]	
		DWR Drought Water Bank		88,900[j]
2010	Below Normal	Yuba Accord Water Purchase Participants	74,179[f,g]	
		Yuba Accord Water Purchase Participants		66,213
2012	Below Normal	Yuba Accord Water Purchase Participants	81,681	
2013	Dry	Yuba Accord Water Purchase Participants	112,544	64,730
2014	Critical	Yuba Accord Water Purchase Participants	104,663	56,984

Notes:
a. Sold but not delivered.
b. In 1991, BVID transferred an additional 5.5 TAF to the State Water Bank through conservation.
c. In 1992, BVID transferred an additional 5.5 TAF to the State Water Bank through conservation.
d. In 1997, the transfer included 5 TAF from BVID.
e. In 2001, BVID transferred an additional 4.5 TAF to DWR (stored water transfer) and 3.5 TAF to the EWA (groundwater substitution pumping).
f. In 2002, 2003, 2007, 2008, 2009, and 2010, BVID transferred an additional 3.1 TAF to SCVWD through conservation.
g. Transfers to the Yuba Accord Water Purchase Participants include 60 TAF of stored water for the EWA.
h. The 2007 transfer was under the Yuba Accord Pilot Program. It also included 60 TAF transferred to the EWA purchased in 2006.
i. Sacramento Valley Index as defined in SWRCB RD-1641.
j. In 2009, CID transferred an additional 8.3 TAF to the DWR Drought Water Bank.

3.1.2. Organization

YCWA is governed by a 7-member Board of Directors comprised of the five members of the Yuba County Board of Supervisors and two members elected at large. The Agency's legal counsel, auditor, and general manager report directly to the Board. The general manager is responsible for the day-to-day operations of the Agency, and supervises the managers of the finance, water resources, and power systems departments. The water resources department staff is comprised of five individuals, including the water resources manager, hydrographer, ditch tender, and two assistant ditch tenders. Key staff positions and the overall organization of the Agency are shown in Figure 3-4, along with a more detailed description of the organization of the water resources department.

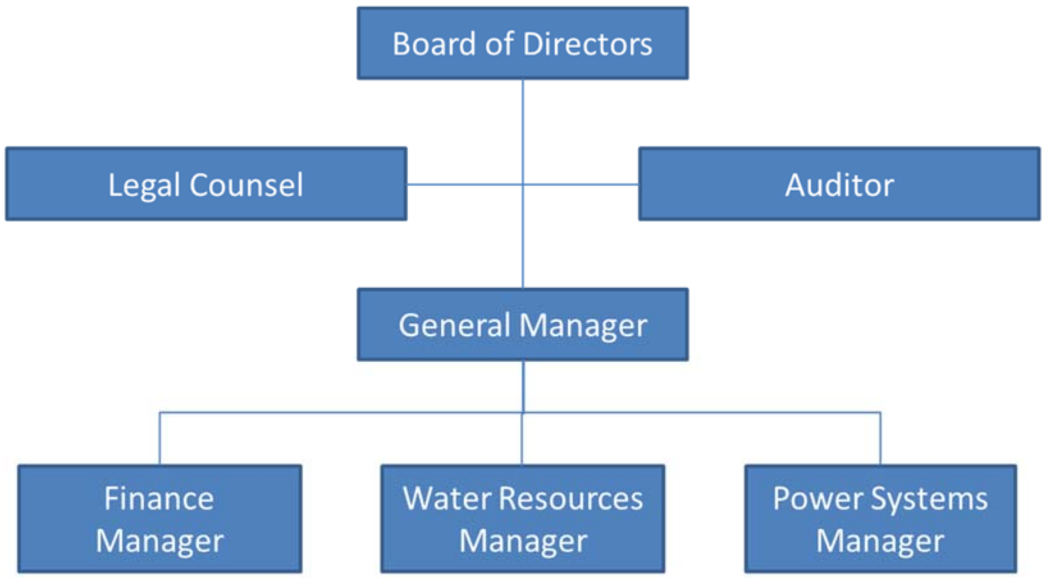

Figure 3-4. YCWA Organizational Chart.

Within the water resources department, the water resources manager is responsible for the day to day management of the Agency's groundwater and surface water supplies downstream of the diversions at Daguerre point Dam for irrigation. These duties include implementation of the GMP and AWMP as well as coordination with the MUs and other agencies and interests, as appropriate. Additionally, the manager supervises the hydrographer and ditch tenders.

The hydrographer's responsibilities include implementation of customer delivery measurement improvements to satisfy the requirements of SBx7-7, development of ratings for canal sections to support accurate flow measurement, monitoring of deliveries to member units, monitoring of key operational spills and boundary outflows, groundwater level and quality monitoring, completion of special studies, and other support activities.

The supervising ditch tender's primary responsibility is to operate the YCWA facilities south of the Yuba River, including the diversion to the South Canal, the South Canal check structures, and the Yuba Wheatland Canal, including Yuba Wheatland Canal Pump Stations 1, 2, and 3. Additionally, the supervising ditch tender monitors key operational spills and boundary outflows, to support efficient management of the system. As part of his duties, he serves as lead person for two assistant ditch tenders that also support operation of YCWA facilities south of the River.

In addition to their duties for YCWA, the supervising ditch tender and assistant ditch tenders operate and maintain the MU distribution systems and provide deliveries to individual fields to the member units' specification in the southern service area. As a result of this arrangement, the Agency does not have direct control over the management of member unit facilities. The operation and maintenance costs of serving water to the member units through YCWA and member unit facilities are paid directly by the member units to the Agency on the basis of the quantity of water delivered each year.

3.1.3. Distribution System

As a wholesaler, YCWA's distribution system for agricultural irrigation is limited to the main canals used to deliver water to the south MUs and three pumping plants used to lift water for conveyance to Wheatland Water District. North of the Yuba River, deliveries are made directly to the MUs, and no Agency facilities exist. South of the Yuba River, YCWA owns and operates the YCWA South Canal, the Yuba Wheatland Canal, and Yuba Wheatland Canal Pump Stations 1, 2, and 3. Agency facilities are described in greater detail in Section 3.3.

3.1.4. Member Units

As mentioned previously, YCWA serves eight member units, including four north of the Yuba River and four south of the Yuba River. Water is provided to each MU according to individual water service contracts. The MUs and their approximate gross service areas are:

- North of Yuba River
    - Browns Valley Irrigation District (7,062 acres[4])
    - Cordua Irrigation District (11,534 acres)
    - Hallwood Irrigation Company (11,996 acres)
    - Ramirez Water District (5,876 acres)
- South of Yuba River
    - Brophy Water District (17,204 acres)
    - Dry Creek Mutual Water Company (4,605 acres)
    - South Yuba Water District (9,966 acres)
    - Wheatland Water District (11,330 acres)

The member units are described in greater detail in Section 3.2.2.

3.1.5. Lower Yuba River Accord

In 1988, a complaint by a coalition of fisheries groups was filed against YCWA with the State Water Resources Control Board (SWRCB) contending that existing instream flow requirements in the Yuba River did not provide adequate protection for migratory fish in the lower Yuba River. In response to the complaint, SWRCB issued Water Right Decision 1644 (D-1644) in March 2001 and Revised Decision 1644 (RD-1644) in July 2003 updating minimum instream flow requirements for the lower Yuba River.

[4] As noted previously, there are approximately 48,000 additional acres in the Browns Valley Irrigation District above the YCWA irrigation command area.

YCWA believed these requirements were excessive, would negatively impact anadromous fish in some years, and would adversely affect project operations. Five separate legal challenges were filed against the decision by YCWA and conservation groups.

In 2003, the SWRCB encouraged YCWA and other parties embroiled in the water rights dispute to collaboratively develop a settlement agreement. YCWA embarked on a broad collaborative process involving 17 agricultural, environmental, and fisheries interests, including State and federal agencies, to develop a series of agreements referred to as the Lower Yuba River Accord to resolve 15 years of controversy and litigation over the instream flow requirements. The Yuba Accord provides for conjunctive management of surface and groundwater supplies in the North Yuba and South Yuba Groundwater Subbasins to maintain local and statewide water supply reliability while enhancing habitat in the Yuba River for fish. Under the Accord, MUs agree to produce groundwater in lieu of surface water in some years in order to reduce surface water demand for irrigation. Groundwater may be produced to provide instream habitat benefits in the lower Yuba River, to provide water for transfer elsewhere in the State, or both. Revenues from groundwater pumping and transfer provide funding for program administration and compensate landowners for pumping groundwater.

The innovative, comprehensive, consensus-based Accord process resulted in development of the following agreements:

- Memorandum of Understanding (April 2005) – Specifies the terms of the Accord to enhance aquatic habitat downstream of the U.S. Army Corps of Engineers (USACE) Englebright Dam on the Yuba River
- Draft and Final EIR/EIS (October 2007) – Environmental review prepared in accordance with the requirements of the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA), considering a range of reasonable alternatives that could feasibly attain the purpose and need and most of the basic objectives of the Accord, but would avoid or substantially lessen any significant adverse impacts.
- Lower Yuba River Fisheries Agreement (November 2007) – Specifies the Accord's minimum streamflows and defines an in-depth program for evaluation and monitoring of the fishery.
- Water Purchase Agreement (December 2007) – Defines water purchases by DWR from YCWA for the California Bay-Delta Program (CALFED) Environmental Water Account, for the Central Valley Project (CVP), and for the State Water Project.
- Conjunctive Use Agreements (May 2008[5]) – Agreements between each MU and YCWA in which the MU agrees to utilize groundwater in lieu of surface water to allow YCWA to satisfy the requirements of the Fisheries Agreement and Water Purchase Agreement. Each agreement specifies, among other things, the percent share of total groundwater to be provided by each MU and the basis for the amounts paid to each MU to compensate for groundwater pumping, along with the amount per acre-foot to be retained by YCWA.

[5] The conjunctive use agreements became effective May 20, 2008, when the SWRCB adopted its Corrected Order WR 2008-0014, approving the amendments to YCWA's water-right permits needed to allow for implementation of the Accord.

- Amendments to 1966 Power Purchase Contract between YCWA and PG&E (January 2008) – Specifies changes to the operation of New Bullard's Bar Reservoir required to implement the Accord. Specifically, the amendment modifies target storage amounts for the Reservoir.

YCWA and its collaborators in developing and implementing the Yuba Accord have received substantial recognition for their efforts to maintain local and statewide water supplies while enhancing the environment for fish on the lower Yuba River. Honors received include the 2009 Governor's Environmental and Economic Leadership Award, 2009 National Hydropower Association Award for Outstanding Stewardship of America's Waters, and the 2008 Association of California Water Agencies Theodore Roosevelt Environmental Award for Excellence in Conservation and Natural Resources Management.

The Accord is described in greater detail as part of the discussion of YCWA's conjunctive management in Section 4.3.2.

3.1.6. FERC Relicensing

The Federal Power Act of 1920 provides the Federal Energy Regulatory Commission (FERC) with the authority to license non-federal hydroelectric projects on navigable waterways or federal lands. Many YCWA Yuba River Development Project (Yuba Project) facilities are located on such lands. Licenses typically have a term of 30 to 50 years and regulate project operation and mitigate adverse impacts. All of the irrigation facilities are outside of the FERC project boundary and are not part of the FERC relicensing process.

YCWA's existing license was issued in 1966 and will expire at the end of April 2016. There is the potential for the relicensing process to result in changes to the operation of the Yuba Project by YCWA, which could have implications to the Agency's water supply and flood control operations.

In order to apply for a new license prior to the expiration of the existing license, YCWA began planning and completing the relicensing process in 2008, which currently remains underway. YCWA's specific objective of the relicensing process is to obtain a new license for the project with minimal adverse impact to proceeds from the project and at minimum cost to the Agency while fostering relationships with the community, resource agencies, and other interested parties. The new license should protect and enhance water supply and flood control benefits of the project, while maximizing benefits from electrical power generation as well as benefits to environmental, recreational, and other non-power uses of the resource.

The FERC relicensing process is complicated, and in the case of YCWA is more complex than some other processes due to the concurrent process of relicensing three other hydroelectric projects in the Yuba River watershed, namely the South Feather Water and Power Agency's (SFWPA) South Feather Power Project on Slate Creek, Nevada Irrigation District's (NID) Yuba-Bear Hydroelectric Project on the Middle and South Yuba Rivers, and PG&E's Drum-Spaulding Project on the South Yuba River.

The selected relicensing approach, termed the Integrated Licensing Process (ILP), consists of two parts, Pre-Application Activities and Post-Filing Activities[6]. ILP provides a more efficient and timely licensing

[6] Code of Federal Regulations, Chapter 18, Part 5.

process than other licensing processes. Pre-Application Activities can be divided into the following five phases:

- NOI and PAD Filing – Preparation and filing of a Notice of Intent (NOI) and a Pre-Application Document (PAD) with FERC, providing existing, relevant, and reasonably available information to help identify potential impacts, issues, and information needs. YCWA issued its NOI and PAD in November 2010.
- FERC NEPA Scoping – Preparation of Scoping Documents 1 and 2 (SD1 and SD2, respectively) by FERC. SD1 serves to notify potentially interested parties of the license application and invite comments. SD2 addresses the public comments. FERC issued SD1 in January 2011 and SD2 in April 2011.
- Study Plan Development – Development of Proposed and Revised Study Plans, including the following steps:
    - YCWA filing of Proposed Study Plan for public comment (April 2011)
    - YCWA filing of Revised Study Plan addressing comments (August 2011)
    - FERC issuance of Study Plan Determination describing studies YCWA is required to perform (September 2011)
- Study Performance – Performance of two field seasons of studies, followed by filing of a Study Report by YCWA identifying variances, modifications, and new studies. This is followed by additional public comment and FERC determination regarding the proposed modifications. YCWA filed an Initial Study Report in December 2012 and an Updated Study Report in December 2013.
- DLA/PLP – Filing of Draft License Application (DLA) or Preliminary Licensing Proposal (PLP) by YCWA. YCWA filed a Draft Application for a New License, Major Project, Existing Dam in December 2013.

Following filing of the Draft Application, YCWA filed a Final License Application (FLA) in April 2014, which initiated the Post-Filing Activities part of the relicensing process. Under the Post-Filing Activities process, FERC will do the following:

- Review the FLA for completion and request additional information as needed,
- Prepare an Environmental Assessment or Environmental Impact Statement consistent with NEPA, and
- Make a final decision on issuance of the new license.

Concurrently, YCWA is also preparing environmental documents as required by CEQA, with the SWRCB anticipated as the Responsible Agency in the process.

3.1.7. Water Rights and Operational Considerations

Appropriative rights for consumptive use of water by YCWA are embodied by SWRCB Permits 15026, 15027, and 15030. Permit 15026 allows for direct diversion of up to 1,593 cfs from the lower Yuba River during September through June of each year. Together, the three permits allow for storage of up to 1,250,000 acre-feet of water in New Bullards Bar Reservoir on the North Yuba River during October through June of each year, and rights for re-diversion on the lower Yuba River during July through

December of each year. The rights allow for the water to be used for irrigation, domestic, industrial, or other uses. In addition to these rights, YCWA possesses several rights to divert water for power generation.

Diversion and storage of water by YCWA to meet agricultural demands are constrained by several factors including but not limited to runoff in the watershed, available storage in reservoirs, minimum instream flow requirements, operational requirements for flood control, and the Agency's power purchase agreement with PG&E. Minimum instream flow requirements, originally established by agreement between YCWA and DFG in agreements signed in 1962 and 1965, have been superseded by SWRCB RD-1644, mentioned previously in Section 3.1.5 and are described in greater detail in Section 4.3.2.

Some YCWA member units possess their own appropriative rights for the consumptive use of water from the Yuba River. Water rights possessed by the member units are described in greater detail in Section 3.2.2.

3.2. SIZE OF SERVICE AREA (§10826.A(1))

3.2.1. Wholesaler Perspective

As a wholesaler of water to individual irrigation districts, water districts, and irrigation companies that make up YCWA's member units, the service area of the Agency consists of the combined service areas of each MU.

3.2.2. Description of Member Units

As described previously, YCWA serves eight member units, including four north of the Yuba River and four south of the Yuba River. Water is provided to each MU according to individual water service contracts. The MUs and their approximate gross service areas are:

- North of Yuba River
  - Browns Valley Irrigation District (7,062 acres[7])
  - Cordua Irrigation District (11,534 acres)
  - Hallwood Irrigation Company (11,996 acres)
  - Ramirez Water District (5,876 acres)
- South of Yuba River
  - Brophy Water District (17,204 acres)
  - Dry Creek Mutual Water Company (4,605 acres)
  - South Yuba Water District (9,966 acres)
  - Wheatland Water District (11,330 acres)

Brief descriptions of each MU are provided below. The locations of the MUs are shown in Figure 3-4.

North Member Units

<u>Browns Valley Irrigation District.</u> BVID was formed in 1888 and is one of the longest continually operating irrigation districts in California. The service area of BVID covers more than 55,000 acres in the

[7] As noted previously, there are approximately 48,000 additional acres in the Browns Valley Irrigation District above the YCWA irrigation command area.

Sierra foothills and Sacramento Valley, with approximately 7,100 acres served via the Pumpline Canal diversion approximately 1 mile upstream of Daguerre Point Dam on the Yuba River. The district also diverts water from Dry Creek at Collins Lake, which was built by BVID in 1963. In total, BVID serves over 1,500 agricultural and domestic irrigation customers in the Browns Valley and Loma Rica area of Yuba County. BVID continues to expand its distribution system within its service area, and to annex new lands. Of the 7,100 acres in the YCWA command area, approximately 3,700 acres are cropped. Rice is the primary crop within the YCWA command area (Table 3-2).

In addition to water rights to divert 24,462 acre-feet of water from the Yuba River for agricultural use, BVID has a contract with YCWA for diversion of a base project water supply of up to 9,500 acre-feet annually at the Pumpline diversion. BVID has received water from YCWA since 1971. Additionally, BVID receives a small amount of water through tributary inflow to the Pumpline Canal.

Cordua Irrigation District. CID first began diverting water from the Yuba River in the late 1890s. Diversions are made at Daguerre Point Dam into the Cordua-Hallwood Canal (NY32). CID serves approximately 11,500 acres north of the Yuba River, with approximately 9,100 cropped acres and approximately 100 delivery locations. Rice is the primary crop in CID (Table 3-2).

The district holds various water rights totaling 60,000 acre-feet annually as well as a contract with YCWA for a base project water supply of up to 12,000 acre-feet annually.

Hallwood Irrigation Company. HIC began diverting water for irrigation from the Yuba River in 1909. HIC's service area covers approximately 12,000 acres south of CID, west of BVID, and immediately north of the Yuba River, of which approximately 9,400 acres are cropped. Diversions are made at Daguerre Point Dam into the Cordua-Hallwood Canal. It is estimated that HIC provides water at approximately 80 delivery locations. Primary crops include rice, walnuts and prunes, and pasture (Table 3-2). Rice is grown primarily in the northwest portion of the district, north of Highway 20, while orchard crops are grown south of Highway 20 along the Yuba River.

In addition to pre-1914 rights to divert 150 cfs from the Yuba River, HIC holds a 1940 appropriative right to divert 100 cfs from the River. As part of a settlement agreement with YCWA, HIC agreed in 1971 to receive up to 78,000 acre-feet per year based on their water rights. HIC does not receive base or supplemental project water.

Ramirez Water District. RWD began diverting water for irrigation from the Yuba River in 1978. RWD's service area covers approximately 5,900 acres north of CID and west of BVID, of which approximately 4,500 acres are cropped. Diversions are made at Daguerre Point Dam into the Cordua-Hallwood Canal. Then, water is conveyed through the Cordua-Ramirez Canal downstream of the delivery points to HIC on the Cordua Hallwood Canal. Water is delivered to RWD at the Cordua-Ramirez Split. It is estimated that RWD provides water at approximately 40 delivery locations. The primary crop is rice (Table 3-2).

Water is supplied to RWD under base and supplemental project water supply contracts with YCWA for up to 14,790 and up to 10,311 acre-feet per year, respectively. Additionally, RWD receives some water through tributary inflow from Wilson Creek and Honcut Creek.

Table 3-2. North Member Unit Land Use and Cropping, 2005[8].

2005 Land Use	Acres by Member Unit within YCWA Command Area				
	BVID	CID	HIC	RWD	TOTAL
Corn	8	-	2	-	10
Grain	104	21	46	53	224
Idle	291	4	763	23	1,082
Melons	-	-	32	-	32
Native Vegetation	2,133	930	1,003	476	4,542
Olives	-	-	50	-	50
Pasture	291	56	1,086	70	1,504
Pond	110	108	411	264	893
Prunes	248	336	833	0	1,418
Rice	2,664	8,660	5,655	4,316	21,295
Riparian	677	121	286	212	1,297
Urban	133	430	907	49	1,519
Walnuts	49	0	905	30	984
Wetlands	355	867	15	382	1,619
Total Cropped/Idle	3,654	9,078	9,373	4,493	26,598
Total Non-Cropped	3,408	2,456	2,622	1,384	9,869
Grand Total	7,062	11,534	11,996	5,876	36,467

South Member Units

Brophy Water District. BWD began receiving Yuba River water for irrigation in 1983 under YCWA's water rights through a joint arrangement with SYWD. Since 1985, all water delivered to BWD is by contract with YCWA and provided through the South Canal. Irrigation deliveries began to be documented separately from SYWD in 1992. BWD's service area covers approximately 17,200 acres south of the Yuba River between the Olivehurst/Linda area on the west and Beale Air Force Base on the east (Figure 3-4), of which approximately 12,700 acres are cropped. Diversions are made at Daguerre Point Dam and conveyed through the South Canal. It is estimated that BWD provides water at approximately 100 delivery locations. The primary crops are rice, pasture, and prunes (Table 3-3).

Water is supplied to BWD under base and supplemental project water contracts with YCWA for up to 43,470 and up to 32,177 acre-feet per year, respectively.

Dry Creek Mutual Water Company. DCMWC began receiving Yuba River water for irrigation in 1998 under agreement with YCWA. Water is provided to DCMWC by YCWA through the South Canal. DCMWC's service area covers approximately 4,600 acres north of the Bear River and west of Highway 65 (Figure 3-4), of which approximately 4,200 acres are cropped. Diversions are made at Daguerre Point Dam and conveyed through the South Canal. It is estimated that DCMWC provides water at approximately 70 delivery locations. The primary crops are walnuts, pasture, and rice (Table 3-3).

[8] Source: DWR land use survey information for Yuba County from 2005. (www.water.ca.gov/landwateruse/lusrvymain.cfm)

Water is supplied to DCMWC under base and supplemental project water contracts with YCWA for up to 13,682 and up to 3,061 acre-feet per year, respectively.

South Yuba Water District. SYWD began receiving Yuba River water for irrigation in 1983 under a joint agreement with BWD. Irrigation deliveries began to be documented separately from BWD in 1992. SYWD's service area covers approximately 10,000 acres north of the Bear River and east of Highway 70 (Figure 3-4), of which approximately 7,500 acres are cropped. Diversions are made at Daguerre Point Dam and conveyed through the South Canal. It is estimated that SYWD provides water at approximately 40 delivery locations. The primary crops are rice and pasture (Table 3-3).

Water is supplied to SYWD under base and supplemental project water contracts with YCWA for up to 25,487 and up to 18,843 acre-feet per year, respectively.

Wheatland Water District. WWD began receiving Yuba River water for irrigation in 2009 under agreement with YCWA. WWD's service area covers approximately 11,300 acres north of the Bear River and east of Highway 65 (Figure 3-4), of which approximately 7,400 acres are cropped. Diversions are made at Daguerre Point Dam and conveyed approximately 9.1 miles through the South Canal to the head of the Bechtel Canal, and then an additional 0.6 miles through the Bechtel Canal to the head of the Yuba Wheatland Canal. Then, the irrigation supply is conveyed an additional 5.3 miles and through two lift pump stations on the Yuba Wheatland Canal to the northern border of the district. The primary crops are rice, prunes, walnuts, and pasture (Table 3-3).

Currently, water is supplied to WWD under base and supplemental contracts with YCWA for up to 23,092 and up to 17,138 acre-feet, respectively. WWD's distribution system is being constructed in phases. The existing agreement is to construct Phases 1 and 2 of the distribution system to serve Project Zones 1 and 2 (Phase 1) and Project Zone 3 (Phase 2). Project Zones 1 and 2 represent approximately 5,540 gross acres. Currently, phase 1 has been completed, and the agreed YCWA surface water supply is for a base project water supply of up to 14,310 acre-feet and a supplemental supply of up to 7,850 acre-feet.

Table 3-3. South Member Unit Land Use and Cropping, 2005[9].

2005 Land Use	Acres by Member Unit within YCWA Command Area				
	BWD	DCMWC	SYWD	WWD	TOTAL
Corn	81	0	139	19	240
Grain	231	37	673	167	1,109
Idle	169	109	343	340	961
Melons	-	9	-	-	9
Native Vegetation	3,110	195	1,324	3,458	8,087
Olives	42	-	-	-	42
Pasture	1,744	911	1,735	847	5,237
Pond	175	28	119	5	327
Prunes	1,419	181	0	2,000	3,601
Rice	8,944	787	4,290	2,188	16,209
Riparian	162	-	165	131	458
Urban	974	141	328	378	1,820
Walnuts	80	2,144	271	1,796	4,291
Wetlands	73	64	578	1	715
Total Cropped/Idle	12,710	4,178	7,453	7,357	31,697
Total Non-Cropped	4,494	427	2,513	3,973	11,407
Grand Total	17,204	4,605	9,966	11,330	43,104

3.3. LOCATION OF SERVICE AREA AND WATER MANAGEMENT FACILITIES (§10826.A(2))

3.3.1. Wholesaler Perspective

As a wholesaler of irrigation water, YCWA's distribution system for agricultural irrigation is limited to the main canals used to deliver water to the MUs and three pumping plants used to lift water for conveyance to Wheatland Water District. North of the Yuba River, deliveries are made directly to the MUs, and no Agency facilities exist. South of the Yuba River, YCWA owns and operates the YCWA South Canal, the Yuba Wheatland Canal, and Yuba Wheatland Canal Pump Stations 1, 2, and 3.

3.3.2. YCWA Irrigation Facilities

Lengths, approximate capacities, and number of YCWA facilities are summarized in Table 3-4. The locations of YCWA facilities are shown in Figure 3-5.

[9] Source: DWR land use survey information for Yuba County from 2005. (www.water.ca.gov/landwateruse/lusrvymain.cfm)

Table 3-4. YCWA Irrigation Facilities.

Facility	Description		
South Canal			
	Length:	15.6	mi
	Capacity at heading[1]:	600	cfs
	Number of check structures:	12	
Yuba Wheatland Canal			
	Length:	8.2	mi
	Capacity at heading:	206	cfs
	Number of check structures:	0	
Yuba Wheatland Canal Pump Station 1			
	Number of pumps:	5	
	Type(s):	Vertical turbine, (3) single speed and (2) variable frequency drive	
	Design capacity:	205	cfs
Yuba Wheatland Canal Pump Station 2			
	Number of pumps:	4	
	Type(s):	Vertical turbine, (2) single speed and (2) variable frequency drive	
	Design capacity:	116	cfs
Yuba Wheatland Canal Pump Station 3			
	Number of pumps:	2	
	Type(s):	2 variable frequency drive, vertical turbine	
	Design capacity:	25	cfs

Over time, ownership of the facilities associated with the Yuba Wheatland Canal that lie within WWD's boundary will be transferred to WWD. The process of repaying and gaining ownership of these facilities by WWD is described in the District's water service contract with YCWA.

In general, conveyances within YCWA's service area (those owned by either YCWA or the MUs) consist of open, unlined canals and drains. The age of facilities varies greatly, with some canals being over 100 years old and some canals being constructed in the last 10 years (i.e., Yuba Wheatland Canal).

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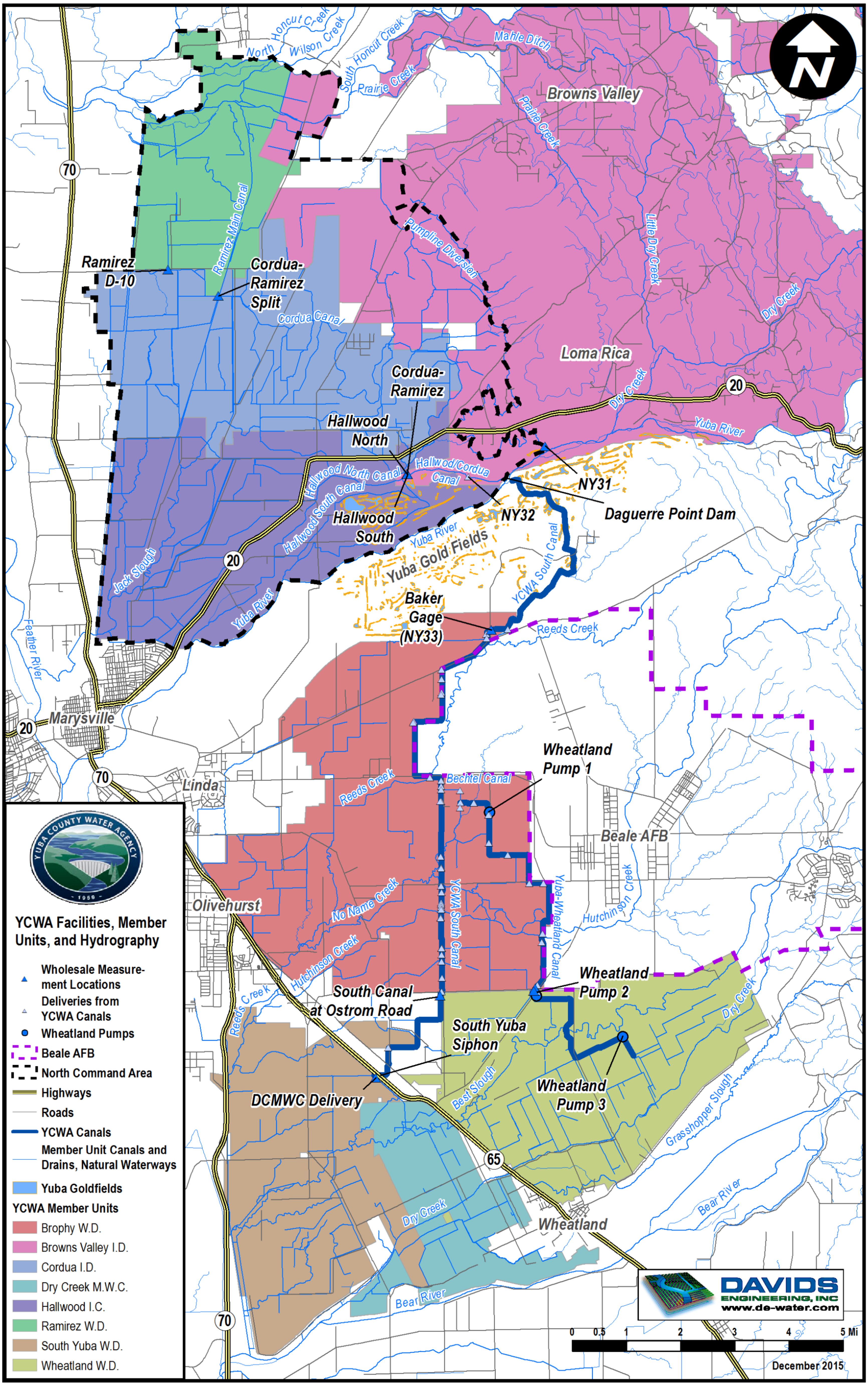

Figure 3-5. YCWA Facilities, Member Units, and Hydrography.

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3.3.3. Water Ordering and Delivery Procedures

Deliveries are made to MUs on a daily basis during the irrigation season. MUs call in orders to YCWA with 24 hours advance notice, and adjustments are made at the Narrows 2 powerhouse below Englebright Dam as needed to meet agricultural demands and maintain instream flows. This arrangement provides a great deal of flexibility to the MUs in ordering water. The YCWA project operators and ditch tenders track deliveries to individual MUs on a daily basis through a daily water report. YCWA has made substantial improvements to MU delivery measurement as described in Sections 3.7, 7.2, and Attachment A of this AWMP. YCWA operations are described in greater detail in Section 3.6.2.

3.4. TERRAIN AND SOILS (§10826.A(3))

YCWA's MU service areas lie north and south of the Yuba River in the eastern Sacramento Valley. The topography of irrigated fields is generally flat, with many fields leveled for rice production. Land surface elevation varies from approximately 50 feet along the western edge of SYWD to over 200 feet in the foothills separating BVID and CID in the northeast portion of the command area north of the Yuba River. The average elevation within the MU service areas is approximately 86 feet. In general, the area falls in a southwesterly direction toward the Feather River.

Based on the Natural Resources Conservation Service (NRCS) soil survey for Yuba County, the dominant soil within the MU service areas is San Joaquin Loam, the California State Soil, which represents approximately 39 percent of the MU service areas. Other common soils within the MU service areas include Kimball Loam (11% of area), Redding Gravelly Loam (9% of area), Conejo Loam (8% of area), and Hollenbeck silty clay loam (4% of area). Characteristics of these soils are summarized in Table 3-5. The distribution of dominant soils (e.g. "map units") in YCWA is shown in Figure 3-6.

The area in Hallwood I.C. south of Highway 20 and north of the Yuba River where the dominant crops are orchards and pasture is underlain by lighter textured, flood plain soils consisting of loamy sands and sandy loams. These soils have no restrictive layer and approximately seven inches of available water holding capacity in the surface five feet of the profile.

Soils with a restrictive layer and low water holding capacity are well suited for growing rice. Deeper, lighter-textured soils without a restrictive layer and with moderate to high water holding capacity may be suitable for rice or may also be used to grow the variety of other, non-ponded crops grown within the MU service areas. The distribution of soil depth to a restrictive layer in YCWA is shown in Figure 3-7.

Table 3-5. Characteristics of Dominant Soils in MU Service Areas.

Soil Map Unit	Percent of Area	Landform(s)	Slope Range	Parent Material	Available Water Holding Capacity	Drainage	Restrictive Layer	Depth to Water Table	Typical Profile	
San Joaquin Loam	39%	fan terraces, valleys	0 to 3 percent	mixed alluvium	very low, 2.9 inches in top 5 feet	moderately well drained	duripan at 20 to 40 inches	greater than 5 feet	0 - 16 inches:	loam
									16 - 25 inches:	clay
Kimball Loam	11%	fan terraces, valleys	0 to 1 percent	mixed alluvium	moderate, 7.1 inches in top 5 feet	well drained	abrupt textural change	greater than 5 feet	0 - 16 inches:	loam
									16 - 42 inches:	clay
									42 - 60 inches:	sandy clay loam
Redding Gravelly Loam	9%	fan terraces, valleys	0 to 8 percent	mixed alluvium	low, 3.1 inches in top 5 feet	moderately well drained	abrupt textural change; duripan at 20 to 40 inches	greater than 5 feet	0 - 6 inches:	gravelly loam
									6 - 19 inches:	gravelly loam
									19 - 33 inches:	clay
Conejo Loam	8%	stream terraces, valleys	0 to 2 percent	mixed alluvium	high, 11.0 inches in top 5 feet	well drained	none	greater than 5 feet	0 - 6 inches:	loam
									16 - 60 inches:	clay loam
Hollenbeck Silty Clay Loam	4%	basin floors, valleys	0 to 1 percent	clayey alluvium	moderate, 7.3 inches in top 5 feet	moderately well drained	duripan at 47 to 65 inches	greater than 5 feet	0 - 8 inches:	silty clay loam
									8 - 43 inches:	silty clay
									43 - 47 inches:	clay loam

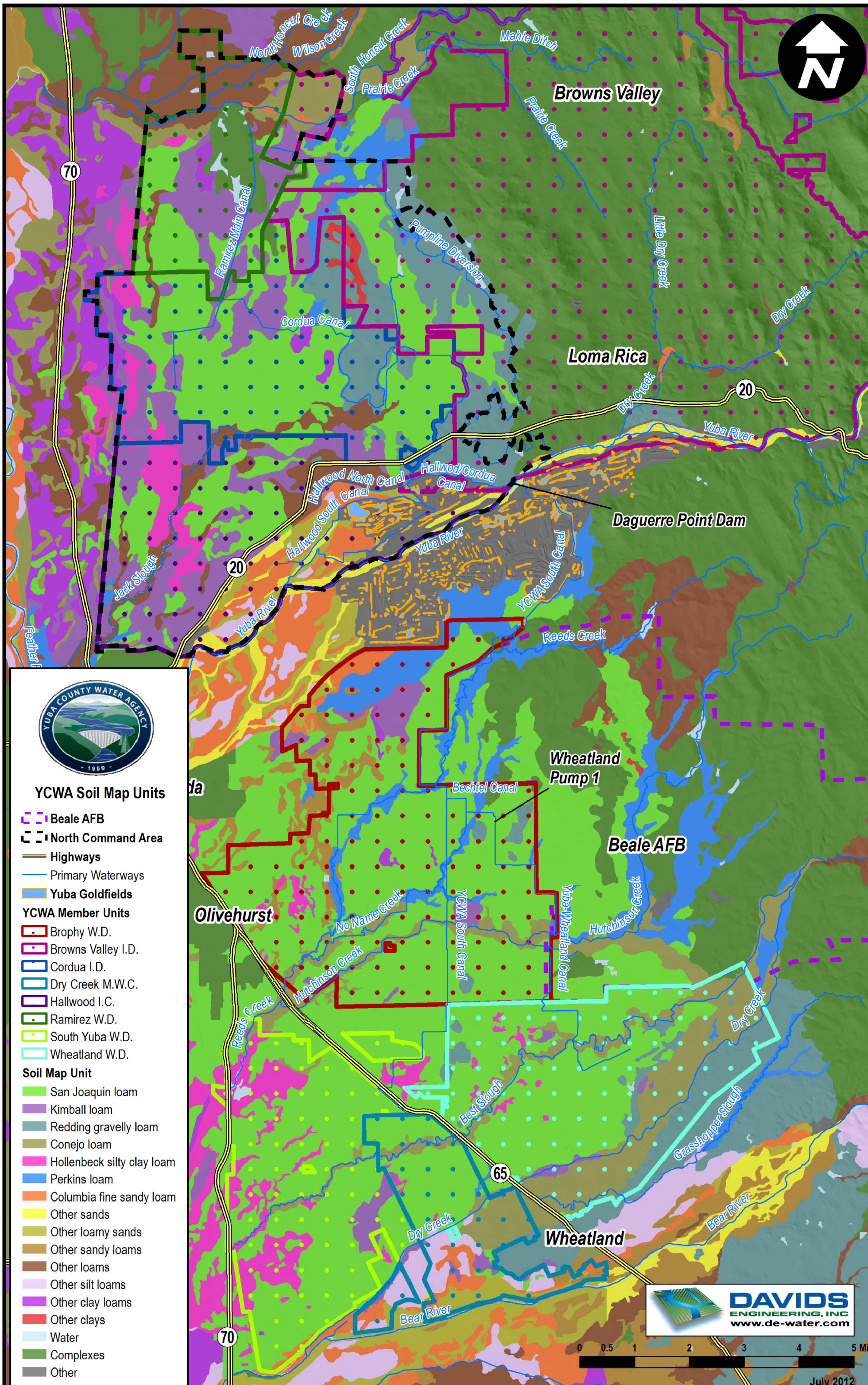

Figure 3-6. YCWA Soil Map Units.

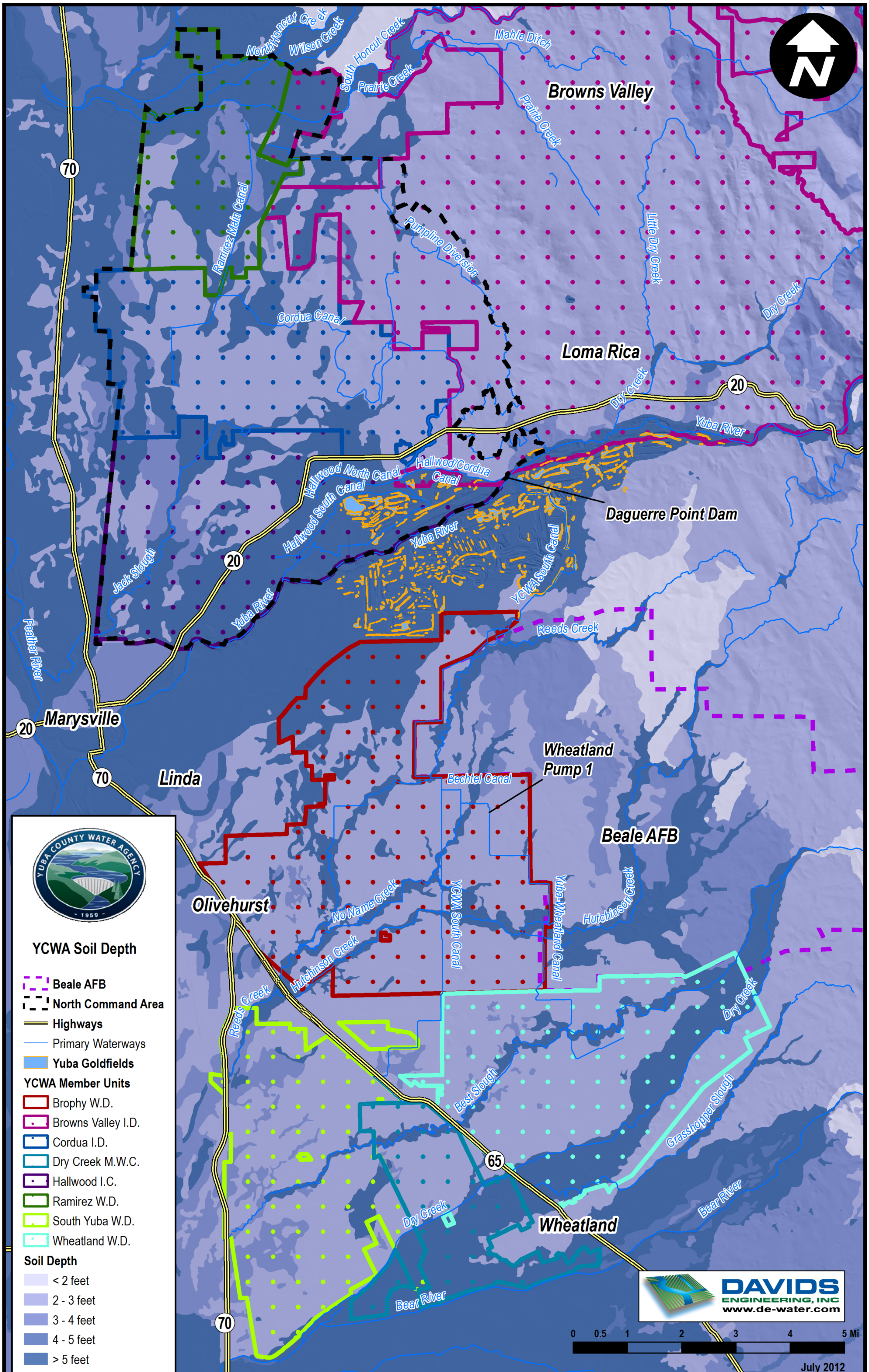

Figure 3-7. YCWA Soil Depth to Restrictive Layer.

3.5. CLIMATE (§10826.A(4))

Climate within the MU service areas has been evaluated based on the California Irrigation Management Information System (CIMIS) station at Nicolaus (#30) and the National Weather Service (NWS) weather station at the Yuba County Airport, immediately south of Marysville. Precipitation was obtained from the NWS station in Marysville, while the remaining weather parameters were obtained from the CIMIS station, located approximately 19 miles south of Marysville. All data were reviewed for data quality and corrected as needed based on the procedures of Allen et al (2005)[10].

The MU service areas have a climate typical of the Sacramento Valley, with mild winters with moderate precipitation and warm, dry summers. Average daily maximum temperatures range from a low of about 55°F in December and January to a high of nearly 93°F in July (Table 3-6). Mean daily minimum temperatures range from a low of 36°F in January to a high of about 59°F in July. Average annual reference evapotranspiration (ETo) is approximately 52 inches, ranging from a low of one inch in December and January to a high of more than eight inches in July. Approximately three quarters of the annual ETo occurs in the six-month period from April through September. Average annual precipitation is 20.8 inches, with 19.4 inches, or more than ninety percent, occurring between October and April.

Even during the peak summer period, the average maximum relative humidity reaches 86%, which is indicative of an irrigated area, and exceeds 95% between November and March. Minimum relative humidity ranges between approximately 31% during the summer and roughly 70% during the wet winter months.

Average wind speed is lowest between September and November (approximately 4.4 miles per hour) and highest in the summer (5.9 mph in June).

There are no significant microclimates within the district that affect water management or operations.

[10] Allen, R.G., Walter. I. A., Elliot, R., Howell, T., Itenfisu, D., Jensen, M. (2005). "The ASCE Standardized Reference Evapotranspiration Equation." Publication. American Society of Civil Engineers.

Table 3-6. Mean Daily Weather Parameters by Month at Nicolaus CIMIS Station and Yuba County Airport NWS Station (January 2001 through December 2010).

Month	Total ETo (in)	Total Precip. (in)	Average Daily Temperature (F)			Average Relative Humidity (%)			Average Wind Speed (mi/hr)
			Average	Min.	Max.	Average	Min.	Max.	
January	1.1	3.4	45.1	36.3	54.7	88	70	97	4.9
February	1.8	3.1	49.2	38.6	60.7	82	59	97	5.4
March	3.5	1.9	53.4	40.0	67.2	75	49	96	5.4
April	4.6	2.0	56.4	42.1	70.7	67	42	94	5.3
May	6.8	1.1	65.7	50.4	81.4	58	34	90	5.4
June	7.8	0.1	71.7	56.3	87.7	55	31	86	5.9
July	8.1	0.0	74.8	58.8	92.8	57	33	86	5.4
August	7.0	0.0	72.3	56.6	90.7	59	33	90	5.1
September	5.2	0.2	68.3	52.4	87.2	59	33	90	4.4
October	3.5	1.4	60.1	45.5	77.0	63	37	91	4.5
November	1.7	2.3	51.1	39.4	64.4	79	54	96	4.4
December	0.9	5.3	45.8	37.4	54.6	87	70	97	5.6
Annual	51.9	20.8	59.5	46.1	74.1	69	45	93	5.1

3.6. OPERATING RULES AND REGULATIONS (§10826.A(5))

3.6.1. Wholesaler Perspective

The rules and regulations governing the distribution of water to each member unit are embodied in the individual water service contracts between each MU and the Agency. These contracts specify the available base and supplemental Yuba Project water supply for each MU, provide water shortage allocation policies, and require that Project water must be used reasonably and beneficially.

3.6.2. General Description of Operations

As described previously, deliveries are made to MUs on a daily basis during the irrigation season. MUs call in orders to YCWA with 24 hours advance notice, and adjustments are made at the Narrows 1 or Narrows 2 powerhouses below Englebright Dam as needed to meet downstream agricultural demands and maintain instream flows. This arrangement provides a great deal of flexibility to the MUs in ordering and receiving water. The YCWA project operators and ditch tenders track deliveries to individual MUs on a daily basis through a daily water report (Figure 3-8). YCWA is currently integrating real time monitoring of MU deliveries into its Supervisory Control and Data Acquisition (SCADA) which is being upgraded to support power operations. These improvements are described in greater detail in Sections 3.7, 7.2, and Attachment A of this AWMP.

As a wholesaler of irrigation water, YCWA does not own or operate any facilities north of the Yuba River and only operates the South Canal and Yuba Wheatland Canal south of the Yuba River. As a result, MUs north of the River receive and deliver water using staff employed by the individual MUs. South of the River, YCWA's ditch tenders operate YCWA facilities and deliver water to the MUs at individual delivery locations. Delivery volumes to MUs are determined through measurement of flows at key locations within the Agency and MU distribution systems by the YCWA hydrographer and ditch tenders. Operation and maintenance of MU facilities south of the River are performed by YCWA staff at YCWA direction. Operation and maintenance within the MU boundaries are by YCWA staff under the direction of the MU. Deliveries to individual fields are performed by YCWA staff, working under the direction of the individual MUs. As a result of this arrangement, the Agency does not have direct control over the management of MU facilities. The operation and maintenance costs of serving water to the MUs through YCWA and MU facilities are paid directly by the MUs to the Agency on the basis of the pro-rated quantity of water delivered to each MU each year.

Due to the large portion of the MU cropped areas that are in rice production, aggregate irrigation demand tends to vary according to rice irrigation practices. Typical management of rice irrigation in YCWA is as follows[11]:

- In April to early May, fields are flooded and seeded to initiate growth.
- Following seeding, ponds are drained in mid-May to encourage deep rooting.
- In mid to late May, fields are re-flooded and herbicides are applied. Drainage from the fields is ceased to protect downstream waters by cutting off irrigation.
- In early June, irrigation is resumed and ponded water levels are gradually increased to late July
- Pond level is maintained through small inflows through mid-August, at which point water is cut off.
- Ponds drop gradually until early September (or may be held constant), when any remaining water is drained from the field to prepare for harvest.
- Fields are harvested between mid-September and mid- to late-October.
- In mid to late October, many fields are re-flooded to provide wildlife habitat and facilitate rice straw decomposition.
- Ponds are maintained through January by precipitation and supplemental irrigation, as needed.

The specific timing of irrigation and cultural practices varies annually based on weather and among different rice varieties grown. Additionally this description of rice irrigation practices represents a change in rice irrigation management in recent years. Historically, it was common to maintain pond levels through the end of August and into early September, requiring additional irrigation. The cessation of irrigation in mid-August on many fields results in decreased aggregate irrigation demands. These changes are being adopted over time. A consequence of the practice is potentially a relatively small decrease in deep percolation, which provides beneficial recharge of the groundwater system.

[11] Adapted from "Efficient Water Management for Regional Sustainability in the Sacramento Valley." Northern California Water Association. July 2011.

Yuba County Water Agency
Daily Water Report - Draft

Report Date: 06/21/2012 Printed on: 06/22/2012
Alarm Message:

Bullards Bar Reservoir					
Max Flood Pool:	**1918.32**	**Max. Operating Elevation** **Min. Operating Elevation**	**1956** **1732**	**Max Storage:** **Min. Pool:**	**966,103 AF** **234,000 AF**
Elevation (Ft):	1945.55	Flood Space Reqd (AF):	0	No. Yuba Inflow (CFS):	401
Storage (AF):	916744	Flood Space Avail (AF):	49359	Cg Tunnel Flow (CFS):	1104
24 Hr Stor Change (AF):	-1396	Flood Space Reqd (%):	0	Sluice/Spill (CFS):	0
24 Hr. Elev Change (AF):	-0.30	Excess Flood Space (AF):	49359	Total Outflow (CFS):	1104
		PGE Critical Stor. (AF):	**902000**	Fish Flow (CFS):	7
Our House Diversion (CFS)					
OH (NY 17)	100	OH Fish Flow:	36	OH Fish Flow Reqd:	30
OH Tunnel Flow:	64			OH Flow Difference:	6
Log Cabin Diversion (CFS)					
LC (NY19) Camp Flow:	8	LC Fish Flow:	10	LC Fish Flow Reqd:	8
LC Tunnel Flow:	51			LC Flow Difference:	2
Englebright Reservoir					
		Max. Operating Elevation **Min. Operating Elevation**	**527** **450**	**Useable Storage:**	**36,618 AF**
Englebright Elev (Ft):	521.24	Englebright Inflow (CFS):	300	Jones Bar NY 29 (CFS):	104
Englebright Stor (AF):	32393	Engle Outflow NY28 (CFS):	1816	Eb Stor Spc Avail (AF):	4225
24 hr stor change (AF):	-810	Narrows 1 Releases (CFS):	635	NY28 Flow Reqd (CFS):	0
24 hr elev change (AF):	-1.14	Narrows 2 Releases (CFS):	1145	NY28 Flow Diff (CFS):	1816
Generation (MWH)				**PGE Entitlement:**	**n/a**
Colgate 24 Hr:	2791	Colgate Mo to Date:	77664	Colgate Yr to Date:	494017
Narr 2 24 Hr:	386	Narr 2 Mo to Date:	8098	Narr 2 Yr to Date:	77731
Colgate Meteorological Data					
Precip 24 Hr:	0.00	Precip Mo to Date:	0.44	Precip Yr to Date:	34.04
Temp Extreme Lo:	58	Temp Extreme Hi:	90		
Irrigation (CFS)		**North Ditch Flows**		**South Ditch Flows**	
Mv Yuba River Flow:	866	Cordua ID Flow:	224	Brophy WD Flow:	257
Mv Fish Flow Reqd:	500	Ramirez WD Flow:	66	SYWD Flow:	81
Mv Flow Difference:	366	Hallwood IC Flow:	205	DCMWD Flow:	29
		Main Ditch Flow: **NY32**	503	**River Flow:**	**250**
River Balance:	**52**	BVID Flow: **NY31**	59	**Ponds:**	**178**
		North Total Flow:	562	South Total Flow: **NY33**	440
				NS Total Diversion:	1002

Member Unit Deliveries

Figure 3-8. YCWA Daily Water Report for June 22, 2012.

3.7. WATER DELIVERY MEASUREMENTS AND CALCULATIONS (§10826.A(6))

As part of preparation of its 2012 AWMP, YCWA prepared a comprehensive Measurement Improvement Plan (MIP), included as Attachment E. The MIP described existing measurement of MU deliveries, boundary inflows, boundary outflows, and internal flows and water levels at key operational sites at that time. As part of the 2012 AWMP, the MIP served the following functions:

- Documentation of existing water measurement by YCWA as of December 2012
- Identification and prioritization of measurement improvements at boundary inflow, boundary outflow, and internal operational sites
- Identification of corrective actions to be undertaken to comply with CCR Title 23 Division 2 Chapter 5.1 Article 2 Section 597 Title 23 §597 et seq. (CCR 23 §597)

YCWA has implemented improvements in measurement of the volume of water delivered to its customers, the MUs, according to the requirements of CCR 23 §597, which became effective July 11,

2012. Implementation included preparation of a compliance certification document (Certification). The Certification is included as Attachment A to this AWMP and documents YCWA's compliance with the regulation. As required by CCR 23 §597, the certification includes a description of water measurement best professional practices, including documentation of the conversion of flow rate measurements to volume.

The MIP identified twelve customer delivery measurement sites that required compliance certification to satisfy CCR 23 §597. Seven sites were found to be compliant, and five sites required additional improvements. Since that time, two sites (the Wheatland and South Yuba measurement sites) were relocated, eliminating the need for two other sites (the Beukleman measurement site and the Rue Pump measurement site) by consolidating measurement sites. YCWA has completed the efforts to bring the remaining measurement sites into compliance, as described in Section 7.2 and Attachment A.

3.8. WATER RATE SCHEDULES AND BILLING (§10826.A(7))

3.8.1. Wholesaler Perspective

As a wholesaler of water for irrigation, YCWA has separate water service contracts with each of the MUs. The specific terms of these agreements vary by MU. This differs from a retailer such as a water district or irrigation district in which case a single rate structure is typically applied to all irrigation customers of a particular type.

3.8.2. Summary of Rate Structures and Water Rates by Member Unit

Each delivery contract specifies the amount of base and supplemental Project water supply for each MU on a monthly basis, provides water shortage allocation policies, and requires that Project water must be used reasonably and beneficially. Separate water rates are applied for base and supplemental supplies, with the supplemental water rate defined as the base rate, plus $2 per acre-foot additional charge. The base rate is adjusted over time based on the Bureau of Labor Statistics California Composite of the Consumer Price Index (CPI). The current base rate is $2.12 per acre-foot. These are wholesale rates to the member unit. The retail price to the end user may be significantly greater. These contracts require that each MU reimburse the Agency for the full base and supplemental project supplies, regardless of whether the supplies are used in a given year. MUs are billed twice annually, in May and November. Yuba Project contract water volumes and individual MU water rights are summarized in Table 3-7.

Table 3-7. Member Unit Water Rights and Base and Supplemental Yuba Project Contract Volumes.

Member Unit	Water Supply			
	MU Water Right	Yuba Project Contract Volumes		Total
		Base	Supplemental	
Brophy Water District	-	43,470	32,177	75,647
Browns Valley Irrigation District	24,462	9,500	-	33,962
Cordua Irrigation District	60,000	12,000	-	72,000
Dry Creek Mutual Water Company	-	13,682	3,061	16,743
Hallwood Irrigation Company	78,000	-	-	78,000
Ramirez Water District	-	14,790	10,311	25,101
South Yuba Water District	-	25,487	18,843	44,330
Wheatland Water District	-	14,310	10,620	24,930
TOTALS	162,462	133,239	75,012	370,713

In addition to the charges for base and supplemental water supplies under each delivery contract, MUs are required to reimburse YCWA for operations and maintenance costs based on the volume of water delivered. For the MUs south of the Yuba River, these costs include the operations and maintenance of YCWA and MU facilities south of the River and costs of monitoring spillage and tailwater outflows. These charges are applied to each MU on a pro-rated basis according to the actual volume of water delivered in a given year. Additionally, WWD and BWD both receive water downstream of Yuba Wheatland Canal Pump Station 1 and are required to additionally share in the cost of operating and maintaining the pumps. WWD is also responsible for reimbursing YCWA for the cost of operating and maintaining Yuba Wheatland Canal Pump Stations 2 and 3.

For member units north of the Yuba River, YCWA does not operate or maintain YCWA or Member Unit facilities. As a result, volumetric charges are limited to costs of monitoring spillage and tailwater outflows.

3.8.3. Compliance with California Water Code 10608.48

CWC 10608.48 states the following:

> *(a) On or before July 31, 2012, an agricultural water supplier shall implement efficient water management practices pursuant to subdivisions (b) and (c).*
>
> *(b) Agricultural water suppliers shall implement all of the following critical efficient water management practices:*
>
>> *… (2) Adopt a pricing structure for water customers based at least in part on quantity delivered.*

YCWA has historically measured deliveries to individual MUs and has evaluated the ability of these practices to comply with regulatory requirements defined in CCR 23 §597, which was approved by the State and put into effect on July 11, 2012. YCWA has implemented improvements to existing customer delivery measurements to comply with CCR 23 §597, as described in Section 7.2, Attachment A, and Attachment E of this AWMP.

As described above, YCWA is currently implementing a pricing structure based in part on the volume delivered for MUs north and south of the Yuba River. MUs south of the Yuba River pay YCWA based on the actual volume of water delivered for reimbursement of operations and maintenance costs of YCWA and MU facilities and for monitoring of spillage and tailwater outflows in addition to their base and supplemental water charges under the delivery contracts. Additionally, WWD and BWD are required per their contracts to reimburse for the operational costs of the Yuba Wheatland Canal pump stations, which are determined based on the volume of water delivered to each MU via the pumps. North of the Yuba River, the MUs pay YCWA based on the actual volume of water delivered for reimbursement of cost of monitoring spillage and tailwater outflows in addition to their base and supplemental water charges under the delivery contracts. The provisions for these charges are described in the individual MU delivery contracts.

Due to the provisions of YCWA's existing delivery contracts with the MUs, it is anticipated that additional modifications to the contracts affecting current volumetric charges may not commence until the agreements expire, or until YCWA and the MUs are able to reach mutual agreement on the pricing structure and amend the delivery agreements accordingly. All MU agreements will expire April 30, 2016, except the agreement with WWD, which will not expire until January 27, 2034.

In order to evaluate alternative means of implementing volumetric pricing in the future, YCWA has, based on consultant recommendations, identified several objectives that could be considered when designing an alternative volumetric pricing structure. The potential objectives are described below. A new volumetric price structure could be implemented in addition to, or to replace the existing volumetric charges designed to recover operations and maintenance costs, including monitoring of spillage and tailwater outflows. The pricing objectives may help facilitate discussion with the MUs to negotiate modifications to the existing delivery contracts, as appropriate, or to establish provisions of new delivery contracts to be entered once the existing contracts expire.

Volumetric Pricing Objectives

Beyond the need to comply with legal requirements to adopt a pricing structure based at least in part on the quantity of water delivered to its customers (the eight MUs), YCWA has considered, based consultant recommendations, several objectives in designing potential future volumetric rate structures:

- Maintain revenue reliability—the provisions of the existing Agency-Member Unit water supply and delivery agreements ensure that the amount of revenue generated by Agency water sales is relatively constant from year to year. The Agency may desire to retain this feature to the extent possible by avoiding price structures that could cause large revenue fluctuations due to variable water supply and demand conditions or other factors.
- Maintain revenue neutrality—the Agency may not want to increase the total cost of water to the Member Units relative the costs paid under the existing agreements and costs to deliver water.
- Avoid adverse hydrologic effects—water balances recently prepared for the Northside and Southside service areas confirm that canal seepage and deep percolation of applied water are significant sources of recharge that help to sustain the health of the regional groundwater system

in and surrounding the Agency's service area. The Agency does not want to send inappropriate price signals that would significantly reduce beneficial recharge or reduce the profitability of agriculture.

- Maintain equitability among Member Units—the existing Agency-Member Unit agreements are different with respect to the quantities of water provided to the different Member Units due to their different service area sizes, cropping patterns and other factors. However, all of the agreements are based on the same rates per acre-foot of base and supplemental water available under the agreements. This arrangement is considered by the Agency and Member Units to be fair and equitable, qualities the Agency may carry forward into any new volumetric price structure.
- Retain the distinction between base and supplemental project water supplies—the existing Agency-Member Unit agreements distinguish between base project supplies and supplemental supplies, with the quantities of each being different in each Member Unit agreement. The Agency will likely maintain this distinction under any future volumetric pricing structure to minimize changes to the existing agreements and to maintain the same degree of base water supply reliability offered by the existing contracts.

Conceptual Volumetric Rate Structure to Satisfy Objectives

An important parameter to be defined in designing a volumetric rate structure is determining the proportion of revenues to be derived through a fixed payment (often a land area-based assessment) versus through payment for the volume of water used. One option is a price structure where all of the revenue is derived from water sales and none from a fixed payment. However, this option results in the greatest revenue variability over time and sends the strongest possible conservation signals with attendant risk of unintended hydrologic consequences such as reduction in beneficial recharge to groundwater.

Another option is a rate structure where a large portion of revenue is derived from the fixed payment, and a small portion is derived from actual water sales. This structure may be more compatible with the Agency's objectives, because the Agency would have nearly stable revenue across years regardless of total water use by MUs and it would avoid an overly large price signal that could discourage the beneficial use of available surface water supplies. Such a structure would allow the Agency to continue to satisfy the requirements of SBx7-7 by pricing water at least in part based on the volume delivered for all Member Units.

3.9. WATER SHORTAGE ALLOCATION POLICIES AND DROUGHT MANAGEMENT PLAN (§10826.A(8) AND EXECUTIVE ORDER B-29-15)

YCWA has established detailed and comprehensive policies and procedures to allocate available water supplies during periods of shortage and drought. These activities are described in this section, which expands upon the description of shortage allocation policies included in YCWA's 2012 AWMP to provide a drought Management Plan as required by the Governor's Executive Order B-29-15, issued April 1, 2015. Section 3.9.1 describes the determination of available water supply and process for allocating water during periods of shortage based on the Lower Yuba River Accord and MU delivery contracts. Section 3.9.2 describes policies to prevent wasteful use of water and control demands. Section 3.9.3 describes impacts of drought on Agency operations. Section 3.9.4 provides a summary of 2015 supply and demand conditions.

3.9.1. Lower Yuba River Accord and Member Unit Delivery Contracts

The water supplies of YCWA and the MU's are highly reliable as a result of the following factors:

- Senior water rights
- Certainty in required instream flows in the Yuba River for fish resulting from the Lower Yuba River Accord
- Available storage in New Bullards Bar Reservoir and snowpack
- Available groundwater storage and pumping capacity by MUs
- Efficient water management including substantial recycling and reuse of available water supplies by YCWA and the MUs

YCWA's water shortage allocation policies are defined by provisions of delivery contracts with the MUs and by the Accord. The MU delivery contracts include provisions that allow for the allocation of limited water supplies in certain years. Under the Accord, provisions exist to allow for a supplemental groundwater supply in dry years for irrigation of MU farmland while retaining storage in New Bullards Reservoir to meet minimum instream flow requirements. Specifically, the Fisheries Agreement of the Accord calls for groundwater substitution by MUs of 30,000 af in Schedule 6 years, as determined based on the North Yuba Index. These provisions are described in greater detail in Section 4.3.2, as part of the discussion of YCWA's conjunctive management program.

Provisions for the allocation of limited Project surface water supplies are included in the delivery contracts with each MU and are summarized as follows:

- CID and HIC Pre-1914 Water Rights Settlements
  - When the April 1 DWR unimpaired runoff forecast for the Yuba River near Smartsville is greater than or equal to 40% of the 50-year average, 100% of the settlement is available, and
  - When the forecast is less than 40%, 80% of the settlement is available.
- BVID Pre-1914 Water Rights Settlement
  - 100% of the settlement is available in all years.[12]
- YCWA Yuba Project Base and Supplemental Supply Contracts
  - Base Supply
    - When the April 1 DWR unimpaired runoff forecast for the Yuba River near Smartsville is greater than 85% of the 50-year average, 100% of the base supply is available,
    - When the forecast is less than or equal to 85% and greater than 50%, 85% of the base supply is available,
    - When the forecast is less than or equal to 50% and greater than or equal to 40%, 70% of the base supply is available,
    - When the forecast is less than 40%, 50% of the base supply is available,
  - Supplemental Supply

[12] When DWR's April 1 forecast of unimpaired runoff at Smartsville is 25 percent or less of normal, BVID is responsible for monitoring the flow in the North Fork Yuba River below Goodyears Bar. If the flow is less than 47.2 cfs, as dictated by BVID's Pre-1914 water rights, the District must reduce its Pumpline diversion amount accordingly.

- The available supplemental supply is determined annually by YCWA in its reasonable discretion considering forecasted runoff and operational considerations.
- DCMWC and WWD supplemental supplies are junior to those of other MUs. DCMWC's supplemental supply is senior to WWD's supplemental supply.

Despite the provisions for allocation of the base and supplemental Project supplies, YCWA may make additional water available in any given year at its discretion based on consideration of whether adequate storage is available to meet the irrigation demands of the MUs. As part of evaluating its ability to supply contracted amounts in dry years, YCWA considers the following:

- Water supplies needed for carryover storage;
- Contractual requirements for power production and fish and wildlife habitat;
- Provisions of regulatory agency permits, licenses, agreements, decisions, and orders; and
- Requirements for prudent operation of the Project.

In any year in which the Agency determines that sufficient water is not available to fully meet demands, the first supplies reduced are the supplemental project supplies. The first supply reduced is WWD. If additional reductions are needed, the DCMWC supply is then reduced. If additional reductions are needed, then the supplemental supplies of BWD, RWD, and SYWD are reduced next.

If supplemental supplies are reduced to zero and additional reductions are needed, the base project supplies are reduced by up to 50 percent, as described above. For years in which a 50 percent reduction in base project supply is allowed (unimpaired runoff forecast less than 40% of average), Pre-1914 water rights settlement amounts for CID and HIC are additionally reduced by up to 20 percent. BVID Pumpline canal diversions are reduced in years in which unimpaired flows at Smartsville are less than 25% of average based on the amount of natural flow that would have been available at the diversion location. Additional reductions in available supplies to HIC and CID could occur during years of extreme shortage but have not been experienced historically.

3.9.2. Policies Addressing Wasteful Use

As described previously, delivery contracts between YCWA and the MUs specify that Project water provided by YCWA must be used reasonably and beneficially. Additionally, the agreements specify that YCWA has the right to capture any water discharged by the MUs as spillage or tailwater beyond the MU boundary. As part of the Agency's due diligence and normal operations, YCWA has historically monitored spillage and drainwater discharge resulting from its operations and those of the MUs. Moving forward, YCWA anticipates expanding these efforts by establishing continuous records of outflows at key sites as part of EWMP implementation, as discussed in Chapter 7 of this AWMP and described in detail in YCWA's Measurement Improvement Plan (MIP) included as Attachment E. In addition to supporting YCWA in ensuring the reasonable and beneficial use of water within its service area, expanded monitoring of surface outflows will support improved understanding of water use within the North Yuba and South Yuba subbasins, including beneficial groundwater recharge.

3.9.3. Agency Operations during Drought

This section provides a summary of extraordinary actions taken by YCWA during drought not otherwise described above.

Monitoring of Hydrologic Conditions

YCWA conducts extensive monitoring of hydrologic conditions in the Yuba River watershed during all years. These efforts are intensified to some extent during periods of drought to more precisely assess water supply conditions for Agency operations and to inform the public regarding drought severity and impacts. Information monitored includes projected inflows to New Bullards Bar; projected runoff for the Yuba River near Smartsville; storm events; snow accumulation; actual reservoir inflows, outflows, and storage; and groundwater pumping and levels.

Monitoring surface water conditions during periods of drought supports Agency analysis of available water supplies to meet agricultural, environmental, power generation, and recreational needs. This monitoring is also a key component of the Agency's flood management activities. Monitoring of groundwater levels is a key component of YCWA's conjunctive management and supports the evaluation of potential impacts from groundwater substitution.

Coordination and Collaboration

Active coordination and collaboration is a key component to YCWA's drought management strategy. During years of water transfers, YCWA actively coordinates and collaborates with others through the Lower Yuba River Accord to meet Accord objectives on the Yuba River. As part of the River Management Team with State and Federal fishery agencies, YCWA works with others to develop and implement operating plans to meet release requirements to meet multiple objectives while maintaining conditions for fish. YCWA also participates in active coordination with DWR and USBR project operators for through-Delta transfers.

Internally, YCWA increases coordination with MUs during drought to maximize water supply flexibility and availability. Specifically, YCWA staff keep MUs informed of water supply conditions and administer supply allocations, monitor and administer groundwater substitution pumping, and work closely with MUs to meet changing water demands over the course of the irrigation season.

Other Extraordinary Actions

YCWA may take other extraordinary actions during periods of drought. Examples include limiting the availability of winter water for habitat and rice straw decomposition and choosing not to participate in discretionary water transfers based on groundwater substitution.

Additionally, YCWA incurs additional, extraordinary costs during periods of drought. These may include payments to MUs required to pump groundwater for substitution in Schedule 6 years and increased costs for legal and technical experts to address specific issues relating to drought and surface water shortage.

3.9.4. 2015 Supply and Demand Conditions

Executive Order B-29-15 requires that water suppliers preparing a 2015 AWMP include a Drought Management Plan and description of water supplies and demands for 2013, 2014, and 2015, to the extent available. Section 5 of this plan includes a detailed description of water supplies and demands for 2013 and 2014. This section provides a preliminary description of supplies and demands for 2015 based on information available at the time of preparation of this AWMP.

2015 Water Supplies

2015 marks the first year that it was necessary to reduce surface water supplies since the completion of the Yuba Project. During 2015, the April 1 DWR unimpaired runoff forecast for the Yuba River near Smartsville was 40 percent of average, resulting in available water supplies of approximately 66 percent of normal year amounts, ranging from 43 percent to 86 percent among the MUs based on differences in water rights and priorities. Average monthly diversions for the north and south service areas for 2001-2014 are shown in Figures 3-9 and 3-10, respectively, along with preliminary diversion estimates for January through July 2015. For the northside, preliminary estimated diversions were

Under the Lower Yuba River Accord, 2015 was declared a Schedule 6 year, requiring groundwater substitution pumping of 30,000 af by MUs to allow for increased releases to meet instream flow needs under the Accord's Fisheries Agreement.

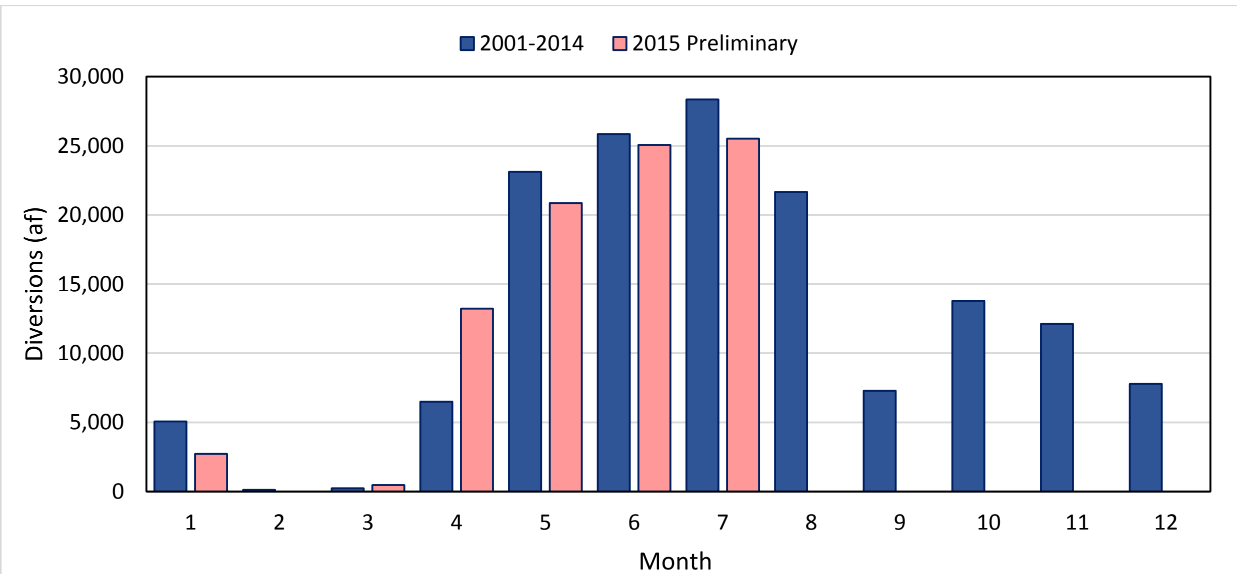

Figure 3-9. Northside Monthly Diversions, 2001-2014 Average and January-July 2015 Preliminary.

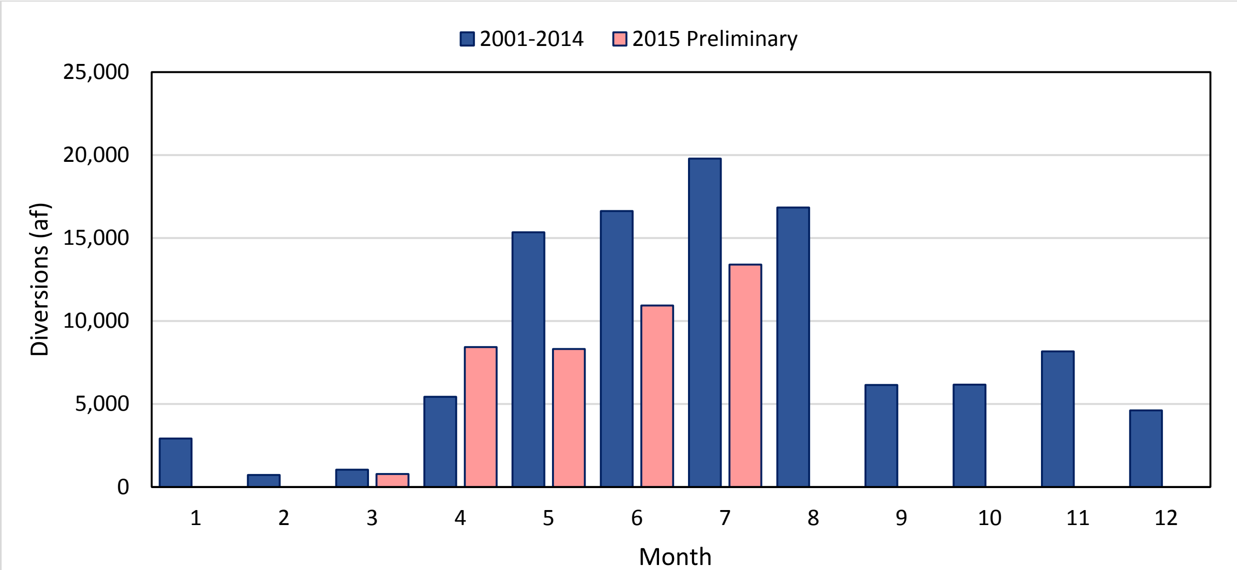

Figure 3-10. Southside Monthly Diversions, 2001-2014 Average and January-July 2015 Preliminary.

2015 Water Demands

Water demands were not substantially impacted during 2015 as compared to prior years within the MU services areas. Relatively reliable surface water supplies, coupled with available groundwater in the underlying aquifers and ample groundwater pumping capacity, allowed for similar acreage to be planted. Additionally, per-acre water requirements for rice, the dominant crop grown in the MU service areas are relatively similar across years due to the need to keep the fields ponded for much of the season and meet both evapotranspiration and deep percolation requirements. A more detailed analysis of annual irrigation demands for YCWA cropland will be included in the Agency's 2020 AWMP.

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CHAPTER 4.0 - INVENTORY OF WATER SUPPLIES

4.1. INTRODUCTION

The Agency and its MUs possess surface water rights that serve as the primary supply source. In addition, the MUs have varying levels of groundwater production capacity that can be used to supplement surface water supplies in dry and/or groundwater substitution years. Surface water and groundwater supplies are discussed in the following sections.

4.2. SURFACE WATER SUPPLY (§10826.B(1))

The Yuba River is the primary source of water supply for the Agency and MUs. The Agency's use of Yuba River water for irrigation is based on appropriative water rights held under Permits 15026, 15027, and 15030, which allow for direct diversion of up to 1,593 cfs from the lower Yuba River during September 1 through June 30 and diversion of up to 1.25 million acre-feet from the North Yuba River during October 1 through June 30 for storage in New Bullards Bar Reservoir. Additionally, YCWA holds rights for re-diversion on the lower Yuba River during July through December of each year. MUs including BVID, CID, and HID additionally hold individual pre- and/or post-1914 appropriative water rights for diversion from the Yuba River in addition to contracting for water from YCWA.

The ability of YCWA to exercise its water rights and deliver a reliable water supply is affected by instream flow requirements on the Yuba River. The Lower Yuba River Accord, described in Section 3.1.5, consists of a series of agreements implemented in May 2008 to end 15 years of controversy and litigation over the instream flow requirements. Under the Accord, MUs agree to produce groundwater in lieu of surface water in some years in order to reduce surface water demand for irrigation. SWRCB Revised Decision 1644, adopted in July 2003, defines minimum instream flow requirements for the lower Yuba River. SWRCB Corrected Order WR 2008-0014, adopted in May 2008, approves various amendments to YCWA's water-right permits, including modifications to RD-1644 instream flow requirements, needed to allow for implementation of the Accord.

Historical diversions of surface water by YCWA are described in detail in Chapter 5, which discusses the water balance for the north and south service areas.

Yuba River water is of excellent quality for irrigation of crops grown by the MUs.

4.3. GROUNDWATER SUPPLY (§10826.B(2))

4.3.1. Overview

YCWA lies over the North Yuba Groundwater Subbasin and the South Yuba Groundwater Subbasin (Figure 4.1), defined in DWR Bulletin 118 as basin 5-21.60 and basin 5-21.61, respectively[13]. As

[13] The North Yuba Subbasin has been depicted differently in past maps prepared by DWR and others. Recent maps are consistent with the Bulletin 118 definition of the subbasin's extent and include the area of alluvium north of Honcut Creek and east of the Feather River in Butte County. Maps presented in this AWMP show only the portion of the north Yuba Subbasin in Yuba County.

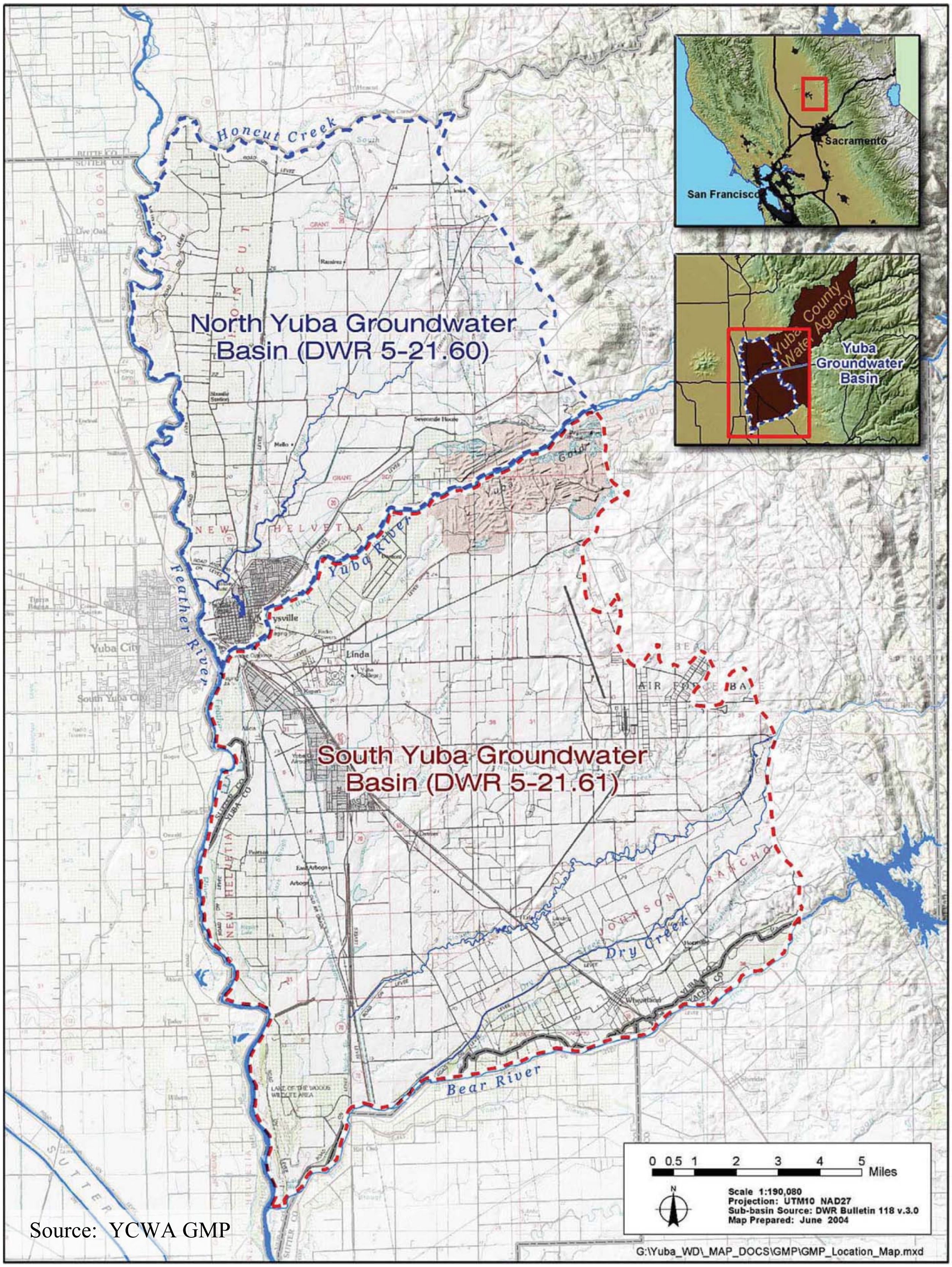


Figure 4-1. North and South Yuba Groundwater Subbasins.

indicated in the Figure, the two subbasins are divided north and south by the Yuba River and range from Honcut Creek in the north to the Bear River in the south and from the Sierra Nevadas in the east to the Feather River in the west. Groundwater in the Subbasins is of good to excellent quality for irrigation of crops grown by the MUs.

Both subbasins are within the Sacramento Valley groundwater basin, and are hydraulically distinguished from neighboring subbasins by the surface streams along their north, south, and west edges. The north subbasin encompasses approximately 50,000 acres, as compared to the south subbasin which encompasses 89,000 acres. Although the two subbasins are separated by the Yuba River, the underlying hydrogeology is similar; thus the two basins are described herein as one.

This section is based on the description of groundwater supplies included as part of YCWA's 2010 Groundwater Management Plan (GMP), included as Attachment C.

Regional Setting

More than 95 percent of the geologic formations making up the basin are significant water bearing formations. These formations consist of the Older Alluvium (Pleistocene), Laguna Formation (Pliocene), and Mehrten Formation (Late Miocene to Pliocene).

Older Alluvium. The Older Alluvium ranges from 100 feet thick in the south to approximately 150 feet thick near the Yuba River and is composed of floodplain deposits and alluvial fan deposits. Wells with depths of less than 150 feet below ground surface (bgs) have been found to yield 1,000 to 1,200 gallons per minute (gpm).

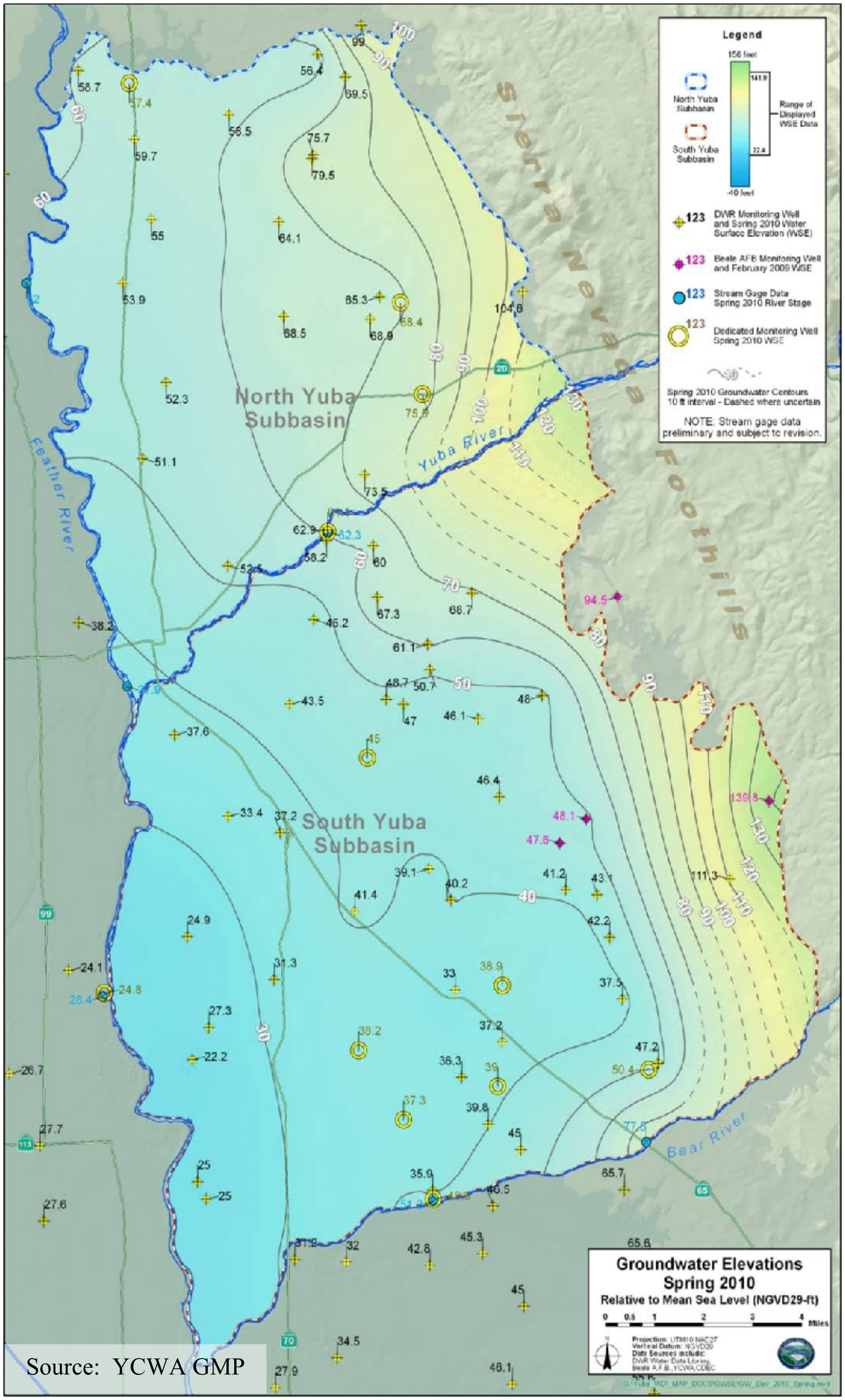
Laguna Formation. The Laguna Formation is exposed along the eastern boundary of the basin and ranges from 180 to 400 feet thick depending upon location. Wells in the Laguna Formation typically yield up to 2,000 gpm.

Mehrten Formation. The Mehrten Formation provides an important part of overall groundwater storage in the Central Valley, due to the large potential of yield for wells drawing from it; however, yield can vary substantially from location to location. Surficial exposures of the formation are limited within the basin.

Groundwater Elevations, Flow, and Storage

Based on available well hydrographs, groundwater levels have generally been stable along the Feather River since at least 1960, with seasonal fluctuations between spring and summer conditions, primarily due to pumping for irrigation. In the North Yuba Basin, groundwater levels have increased since the late 1970s, when surface water deliveries began to be made to RWD (surface water was available to CID, HIC, and BVID prior to this time). As previously described, groundwater levels in the central South Yuba Basin have recovered substantially since surface water became available from the Yuba River in the 1980s. Temporary reductions in water levels resulting from pumping for groundwater substitution transfers are apparent in groundwater hydrographs but show recovery to near pre-transfer levels within approximately 1 year.

Groundwater flow in the basin is from east to west, corresponding to recharge regions along the base of the mountains and discharge regions to the west moving toward the center of the valley (Figure 4.2).



Source: YCWA GMP

Figure 4-2. Spring 2010 Groundwater Elevations in North and South Yuba Basins.

Absolute groundwater elevations range from around 140 feet above mean sea level (msl) in the east to approximately 30 feet above msl near the Feather River.

Total freshwater storage in the basin is estimated to be 7.5 million acre-feet. The base of fresh water is estimated to range from less than 300 feet bgs in the east to approximately 700 feet bgs in the west, with depths as great as 900 feet bgs along the Feather River in the South Yuba Basin. Due to most wells being screened to a maximum depth of 300 feet bgs, the estimated available groundwater storage is 4 million acre-feet.

4.3.2. Conjunctive Management

The North Yuba Basin and South Yuba Basin are managed in conjunction with available surface water supplies to maintain local and statewide water supply reliability while enhancing habitat in the Yuba River for fish under the Lower Yuba River Accord. Under the Accord, MUs agree to produce groundwater in lieu of surface water in some years in order to reduce surface water demand for irrigation. Groundwater may be produced to provide instream habitat benefits in the lower Yuba River, to provide water for transfer elsewhere in the State, or both. Revenues from groundwater pumping and transfer provide funding for program administration and compensate landowners for groundwater pumping costs. The Accord was summarized previously in Section 3.1.5. Additional details of the Accord describing the conjunctive management of surface water and groundwater supplies are provided in this section.

Lower Yuba River Accord Agreements

The innovative, comprehensive, consensus-based Yuba Accord process resulted in development of numerous agreements as described previously in Section 3.1.5. The following agreements related to conjunctive management are discussed in this section:

- Lower Yuba River Fisheries Agreement
- Water Purchase Agreement
- Conjunctive Use Agreements

Fisheries Agreement

A key component of the Accord's Fisheries Agreement (FA) is the specification of minimum instream flows for various hydrologic conditions on the Yuba River. Instream flow requirements vary on a monthly basis and depending upon the hydrologic year type or "Flow Schedule Year Type," which is defined based on the North Yuba Index (NYI). Year types are defined on a water year basis (Oct.1 to Sept. 30) as Schedule 1 through Schedule 6, ordered according to decreasing NYI, with a "Conference Year" occurring when the NYI is less than 500 (corresponding to 500,000 acre-feet of combined annual inflow to New Bullards Bar Reservoir and active storage).

Monthly minimum instream flow requirements corresponding to each of the Schedule 1 to 6 year types are summarized in Figure 4-3 based on Exhibit 2 of the FA. Instream flow requirements apply at the Marysville gage below Daguerre Point Dam and at the Smartsville gage below Englebright Dam.

Marysville Gage (cfs)

Schedule	OCT		NOV	DEC	JAN	FEB	MAR	APR		MAY		JUN		JUL	AUG	SEP	Total Annual Volume (AF)
	1-15	16-31	1-30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
1	500	500	500	500	500	500	700	1000	1000	2000	2000	1500	1500	700	600	500	574200
2	500	500	500	500	500	500	700	700	800	1000	1000	800	500	500	500	500	429066
3	500	500	500	500	500	500	500	700	700	900	900	500	500	500	500	500	396722
4	400	400	500	500	500	500	500	600	900	900	600	400	400	400	400	400	361944
5	400	400	500	500	500	500	500	500	600	600	400	400	400	400	400	400	334818
6	350	350	350	350	350	350	350	350	500	500	400	300	150	150	150	350	232155

* Indicated flows represent average volumes for the specified time period. Actual flows may vary from the indicated flows according to established criteria.

* Indicated Schedule 6 flows do not include an additional 30 TAF available from groundwater substitution to be allocated according to established criteria.

Smartville Gage (cfs)

Schedule	OCT		NOV	DEC	JAN	FEB	MAR	APR		MAY		JUN		JUL	AUG	SEP	Total Annual Volume (AF)
	1-15	16-31	1-30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
A	700	700	700	700	700	700	700	700	-	-	-	-	-	-	-	700	-
B	600	600	600	550	550	550	550	600	-	-	-	-	-	-	-	500	-

* Schedule A used with Schedules 1, 2, 3 and 4 at Marysville.

* Schedule B used with Schedules 5 and 6 at Marysville.

Figure 4-3. Accord Monthly Minimum Instream Flows at Marysville and Smartsville by Flow Schedule Year Type.

In Schedule 6 years, YCWA is required to implement a groundwater substitution program to increase instream flows at Marysville by 30 taf. The timing of pumping is determined by the FA Planning Group.

Water Purchase Agreement

The Water Purchase Agreement (WPA) is an agreement between YCWA and DWR that provides for the purchase of certain amounts of water from the Agency by DWR to support operation of the EWA[14] and water sales through DWR to 22 state and federal contractors. The amount of water available for purchase in any given year is defined based on four "Components" (e.g., Component 1 water, Component 2 water, etc.). Specifically, the WPA provides for the following:

- Purchase of 60,000 acre-feet per year of Component 1 water
- Purchase of 15,000 acre-feet of Component 2 water in dry years and 30,000 acre-feet in critical years
- Purchase of up to 40,000 acre-feet of Component 3 water for CVP South of Delta agricultural contractors and for SWP contractors in years in which their allotments are less than 45 percent and 60 percent of their contractual entitlements, respectively
- Purchase of Component 4 water in an amount to be determined by YCWA based on assessment of available supply and agreed by DWR

Water purchases described in the WPA apply to the years 2008 to 2015 and any subsequent years during which YCWA is subject to an Annual FERC license (years after 2015, if any, during which YCWA has not secured a renewed long-term FERC license). YCWA is not obligated to make available for purchase any Component 1 through 4 water in Conference Years, as defined in the previous section; however, the 60,000 acre-feet of Component 1 water must be provided in subsequent years such that the total amount provided for the eight year period from 2008 to 2015 is 480,000 acre-feet.

[14] The agreement allows for continued water purchases in the event of termination of the EWA.

The WPA allows for the purchase of additional available water by third parties, provided that such purchases do not impede DWR from purchasing water according to the agreement terms. Additionally, the WPA provides for continuation of water purchases by DWR after YCWA secures a renewed long-term FERC license, subject to the terms of the license.

Water purchased under the WPA may be made available through groundwater substitution. In such cases, deliveries of Yuba River water to MUs are reduced, and the MUs pump groundwater to offset the reduced irrigation supply. Exhibit 3 of the WPA, the Groundwater Monitoring, Reporting, and Operations Program (GMROP), describes the process used to determine the quantity of groundwater substitution water in a given year and provisions for monitoring and reporting to be conducted by YCWA and MUs to manage the groundwater basin. The GMROP builds upon the groundwater monitoring program included as part of YCWA's GMP originally adopted in 2005 and updated in 2010. The overall purpose of the GMROP is to "assess effects of groundwater pumping on groundwater resources, and to provide reasonable assurances that any water pumped and accounted for as part of any groundwater substitution is in lieu of surface water delivered by [YCWA] to its member units." The GMP is described in greater detail in Section 4.3.3 and is included in Attachment C to this AWMP.

Conjunctive Use Agreements

Groundwater substitution by the MUs to make water available for purchase under the WPA or to meet minimum instream flow requirements under the FA is described in Conjunctive Use Agreements (CUAs) between individual participating MUs and YCWA. YCWA has entered into conjunctive use agreements with BWD, BVID, DCMWC, HIC, RWD, SYWD, and WWD. The CUAs also describe monitoring by YCWA to avoid long-term impacts from implementation of the Accord to the sustainable yield of the aquifer and impacts to domestic and municipal wells.

During Schedule 6 years, as described in the FA, YCWA is required to implement a groundwater substitution transfer of 30,000 af to increase instream flows. The CUAs specify the amount of groundwater to be provided by each MU, as follows:

- Brophy Water District – 6,750 af (22.5%)
- Browns Valley Irrigation District – 3,450 af (11.5%)
- Dry Creek Mutual Water Company – 2,700 af (9%)
- Hallwood Irrigation Company – 5,400 af (18%)
- Ramirez Water District – 3,600 af (12%)
- South Yuba Water District – 4,500 af (15%)
- Wheatland Water District – 3,600 af (12%)

In addition to groundwater substitution in Schedule 6 years, YCWA and the MUs (as provided in the CUAs) are obligated to provide 15 taf of groundwater in substitution for surface water in below normal, dry, critical, and possibly above normal years as defined in the Phase 8 Settlement Agreement to meet Sacramento-San Joaquin Delta water quality objectives (see inset). The CUAs specify the amount of groundwater to be provided by each MU. The CUAs allow for YCWA to fulfill all or part of the Phase 8 water from storage under certain conditions.

As mentioned in the previous section, water made available under the WPA may be made available under certain conditions through groundwater substitution transfers. The CUAs specify the terms and provisions of the groundwater substitution water transfer program. Under the program, MUs have the discretion to decide the amount of groundwater to be substituted for transferred surface water.

Each CUA specifies that YCWA will not carry out surface water supplemental transfers during years in which surface water supplies are deficient under each MU's water supply contract with the Agency. Additionally, the CUAs provide for reimbursement of the MUs by YCWA for groundwater pumping costs incurred to compensate for deficiencies in supplemental surface water supplies that occur as a result of YCWA's obligations under the FA and WPA.

The provisions for groundwater monitoring included in the CUAs include an estimate of 120,000 af as the maximum amount of pumping per year to avoid long-term impacts to the sustainable yield of the aquifer. The groundwater monitoring and reporting program includes the following activities:

- Monitoring of water levels in selected production wells by each MU,
- Monitoring of pumpage volumes for all participating wells by each MU,
- Monitoring of electrical conductivity in selected production wells by each MU,
- Performance of draw-down analyses for selected production wells by YCWA, and
- Semi-monthly reporting by MUs and preparation of an annual monitoring report by YCWA.

Phase 8 Settlement Agreement

(Source: www.svwmp.water.ca.gov)

"In 1997 the State Water Resources Control Board (SWRCB) issued a notice of the water rights hearings to allocate responsibility for meeting the 1995 Delta Water Quality Control Plan (WQCP) objectives. Because the issues were so complex, the SWRCB divided the water rights proceedings into eight phases.

Phase 8 was to allocate responsibility for satisfying the flow-related water quality objectives of the 1995 Delta WQCP among water right holders in the watersheds of the Sacramento, Cosumnes, and Calaveras Rivers.

To avoid the consequences of delay associated with resolving Phase 8 issues, over 40 water suppliers in the Sacramento Valley, DWR, US Bureau of Reclamation (USBR), and the Downstream Water Users developed a cooperative water management partnership to better manage water and provide a mechanism for satisfying Bay-Delta water quality and flow objectives.

This partnership led to the development of the Short-Term Settlement Agreement which continues the commitment of USBR and the DWR to meet the SWRCB D-1641 flow-related standards, and provides for a collaborative process among the parties to develop projects to meet water supply, water quality, and environmental needs in the Sacramento Valley, Bay-Delta, and throughout California. As a result of the parties' commitment, on January 31, 2003 the SWRCB dismissed Phase 8 of the Bay-Delta Hearings."

The groundwater operations component of the program describes procedures for determination of the amount of water that can be pumped within the sustainable yield of the basin without contributing to long-term overdraft, and without resulting in significant unmitigated impacts to other groundwater users. The procedure involves YCWA evaluation of the condition of the basin in the spring of the year in which pumping is planned and determination of the expected response of the basin to the proposed pumping based on basin response in prior years. The determination includes projection of groundwater levels in the spring of the year following the pumping year and comparison of those levels to water levels in 1991, a year in which YCWA participated in a groundwater substitution as part of the Governor's Emergency Drought Water Bank. If estimated levels are below Fall 1991 levels, YCWA consults with an advisory group formed as part of the GMP to further examine potential impacts and consider reductions in the proposed pumping amount. The MUs ultimately must approve the proposed pumping in their respective areas. The YCWA Board of Directors has the right to restrict the maximum amount of pumping and settle disputes among the parties.

YCWA and the MUs recognize that prompt response to and mitigation of potential impacts to third parties (other local groundwater users) is important to assure local support of the groundwater substitution program. As a result, the program includes an action plan for responses to third party impacts that occur as a result of groundwater substitution pumping. The action plan includes steps to ensure that pumping does not cause significant, unmitigated impacts to other local groundwater users. The initial steps are as follows:

- Each MU designates a contact person of first response for any reported impact,
- If either YCWA or an MU receive a report of a potential impact within an MU service area, the notified party immediately contacts the other,
- The MU promptly contacts the affected groundwater user and obtains all available information describing the potential impact and provides that information to YCWA, and
- The MU responds to the impact, keeping YCWA updated regarding its response.

In the event that the potential impact occurs outside of an MU service area, YCWA determines whether there is a groundwater substitution program well operating in the vicinity of the affected party and determines the MU or MUs responsible for responding, or consults with a groundwater management technical committee established as part of the CUAs to determine the responsible MU(s). Once one or more responsible MUs have been identified, they must develop an approach in consultation with the technical committee to determine whether an impact has occurred and mitigation actions, if any.

The CUAs specify requirements for MU participation in the program as follows:

- All wells must be pre-approved by YCWA and DWR,
- All wells must be equipped with a working flowmeter,
- Groundwater pumping under the program must not commence until notice is provided by YCWA and must occur during the time designated by YCWA,
- Groundwater pumped must be put to reasonable and beneficial use for irrigation of lands that would otherwise be irrigated with surface water, and
- MUs must provide to YCWA a schedule for pumping and monthly updates of the amount of groundwater pumped.

The CUAs also describe a program to be developed and implemented by YCWA to convert diesel pumps to electrical pumps to mitigate potential air quality impacts of the Accord.

4.3.3. Groundwater Management Planning

As described previously, YCWA prepared and adopted a groundwater management plan (GMP) in March 2005 and updated it in December 2010. The GMP was prepared in accordance with Assembly Bill 3030 (AB3030) and CWC Sections 10750 et seq. The GMP builds on and formalizes the successful management of the North Yuba and South Yuba basins in the past and provides a framework for implementation of future groundwater management activities. The update present basin conditions through spring 2010, describes the status of management actions described in the 2005 GMP, describes other YCWA water management activities in the basin, and presents an updated list of groundwater management actions.

The overarching goal of the GMP is to maintain a viable groundwater resource for the beneficial use of the people of Yuba County to meet both agricultural and municipal water demands. The vast majority of Yuba County residents (more than 80 percent) are solely dependent upon groundwater for reliable water supplies. The GMP includes seven specific basin management objectives (BMOs). GMP components are grouped into four general categories including stakeholder involvement, monitoring program, groundwater resource protection, and groundwater sustainability. Implementation of the GMP is realized through a variety of management actions. The organization of the GMP elements is depicted in Figure 4-4.

The stakeholder involvement component includes public outreach in GMP development, coordination with other agencies within and adjacent to YCWA's service area, formation of a stakeholder advisory committee, maintenance and expansion of relationships with state and federal agencies, and pursuit of new partnerships with local, state, and federal agencies. The GMP identifies 22 individual agencies within or adjacent to YCWA with groundwater interests including the MUs, other irrigators, public water suppliers, other agencies within the basin, and agencies adjacent to the basin. The stakeholder involvement strategies listed above translate into ten specific management actions to involve stakeholders in the management of the groundwater resource.

The monitoring program includes groundwater storage and elevation monitoring, groundwater quality monitoring, inelastic land subsidence monitoring, groundwater and surface water interaction monitoring, and data management. As described in various sections of this AWMP, YCWA has and continues to undertake extensive efforts to monitor the groundwater basin. The five monitoring categories listed above translate into 26 specific management actions detailed in the GMP.

Groundwater wells monitored for groundwater elevation by YCWA and DWR are shown in Figure 4-5. In total, approximately 122 wells are monitored for groundwater elevation as part of the GMP, plus up to 240 additional wells as part of additional monitoring associated with groundwater substitution transfers. Groundwater wells monitored for water quality are shown in Figure 4-6. The subsidence monitoring network for the Yuba Basin is shown in Figure 4-7.

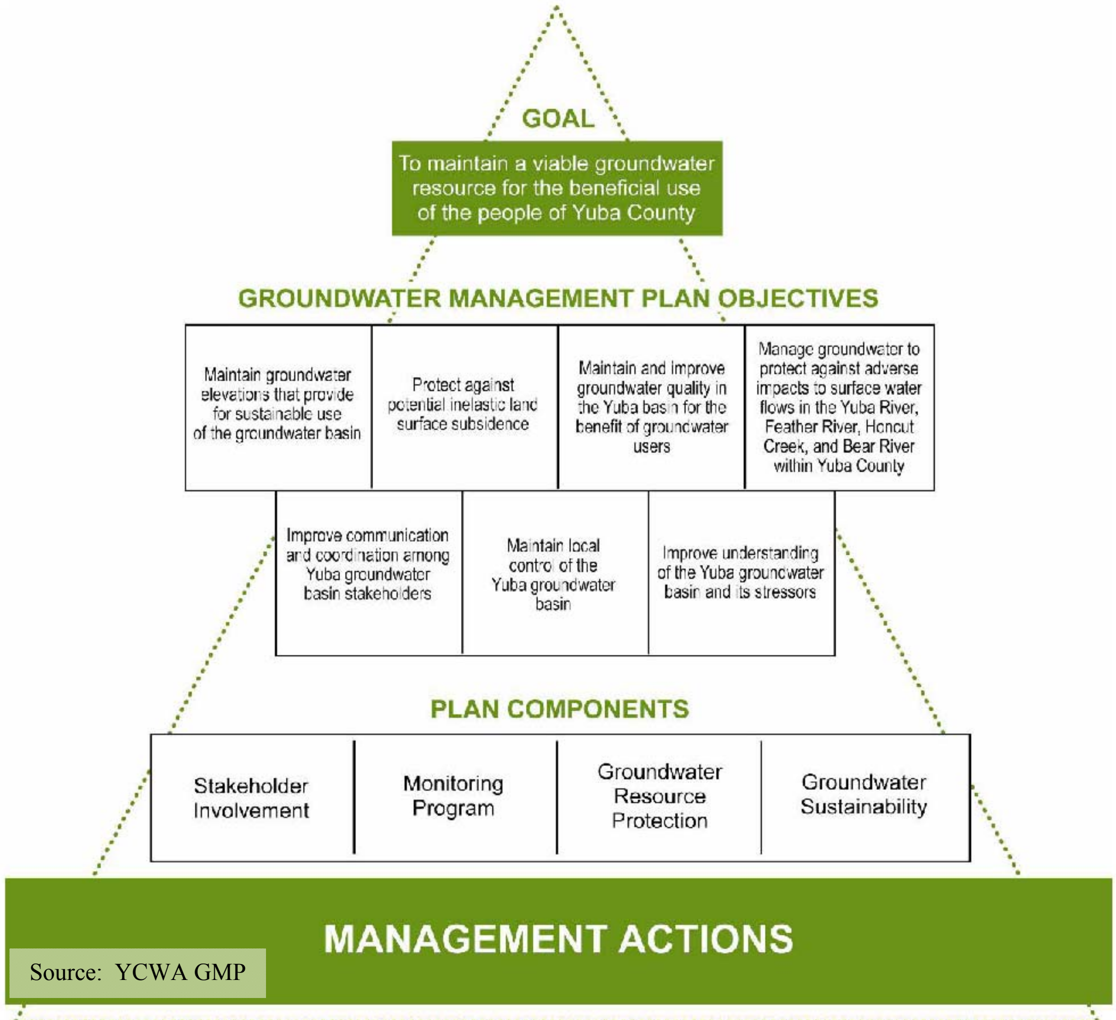


Figure 4-4. Organization of Groundwater Management Plan Elements.

Groundwater resource protection consists of well construction, abandonment, and destruction policies; wellhead protection measures; protection of recharge areas; control of migration and remediation of contaminated groundwater; fuel storage tanks; and control of saline water intrusion. Consideration of the six subcomponents of groundwater resource protection as part of YCWA's groundwater management results in thirteen specific management actions described in the GMP.

The groundwater sustainability component of the GMP includes sustainable management of the groundwater basin, increased understanding of groundwater stressors, and evaluation of future land use changes and impact to groundwater resources. Addressing these three subcomponents of groundwater sustainability results in seven specific management actions identified in the GMP.

Implementation of the GMP includes the preparation of an annual monitoring and measurement report; future review of the GMP and management actions, including potential refinements to the management actions; identification and procurement of funding for individual near-term actions; and integration with the Yuba County Integrated Regional Water Management Plan (IRWMP), completed in 2008 and currently being updated.

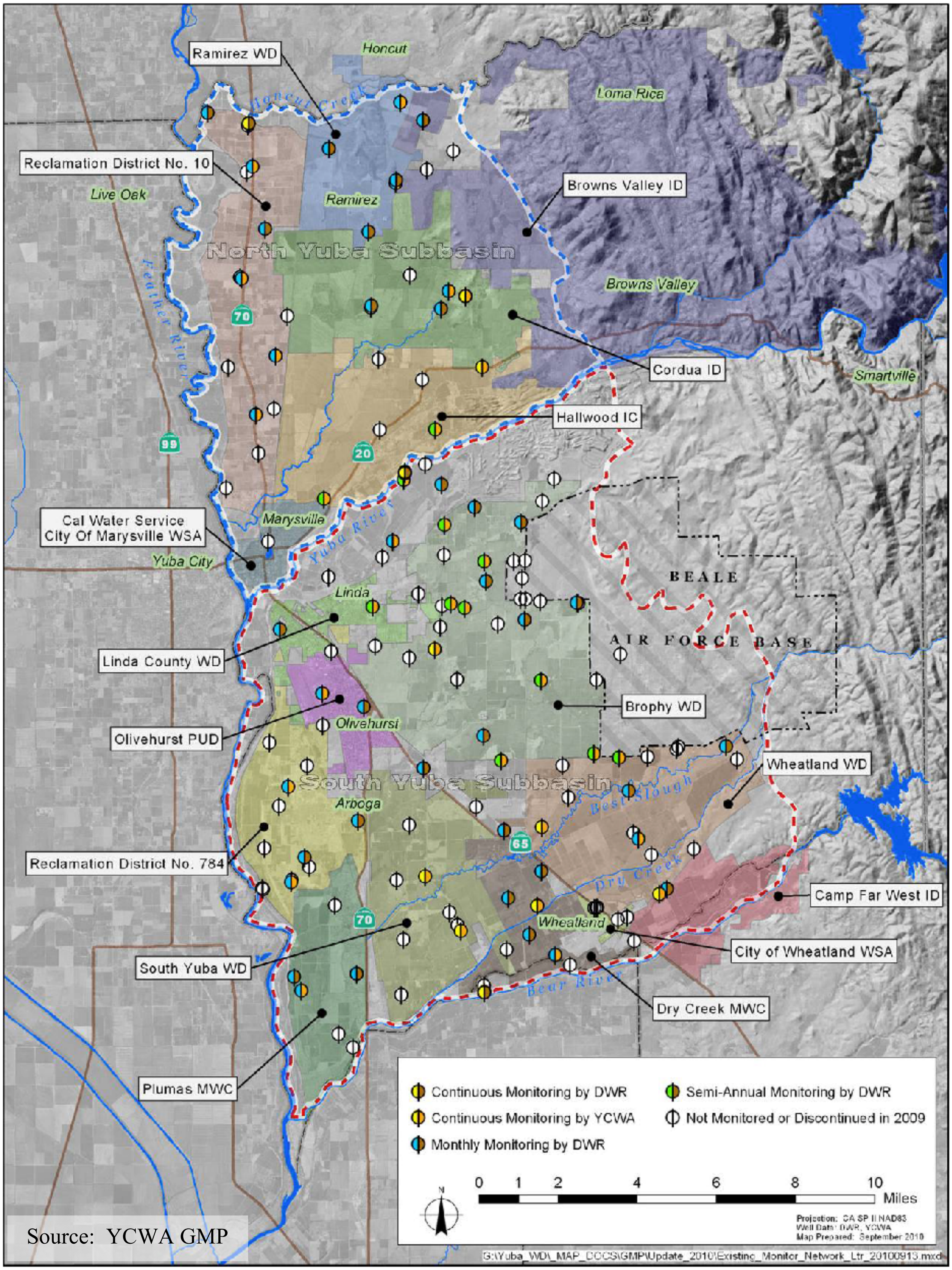


Figure 4-5. Yuba Groundwater Basin Wells Monitored by YCWA and DWR for Elevation.

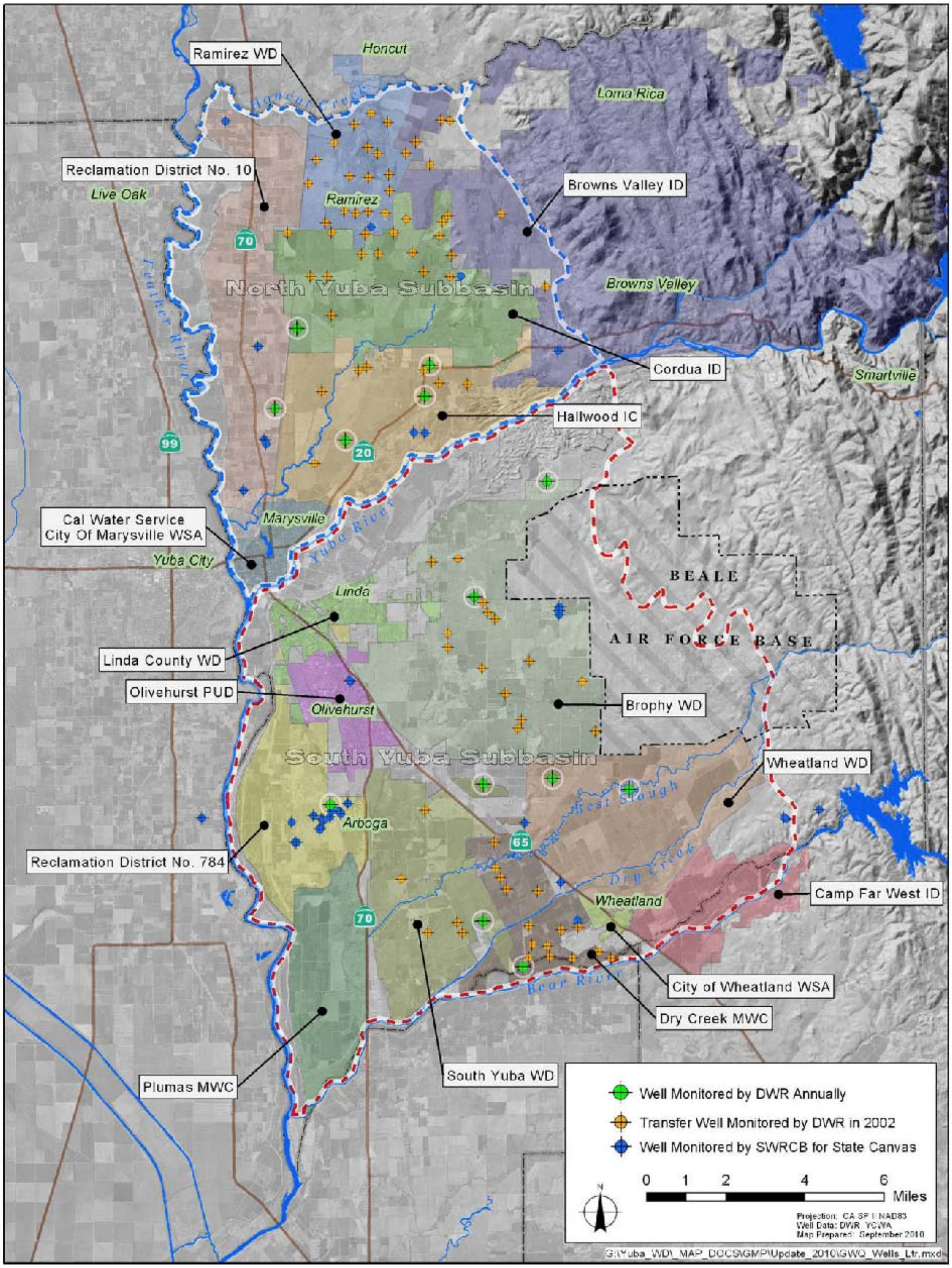


Figure 4-6. Yuba Groundwater Basin Wells Monitored for Water Quality.

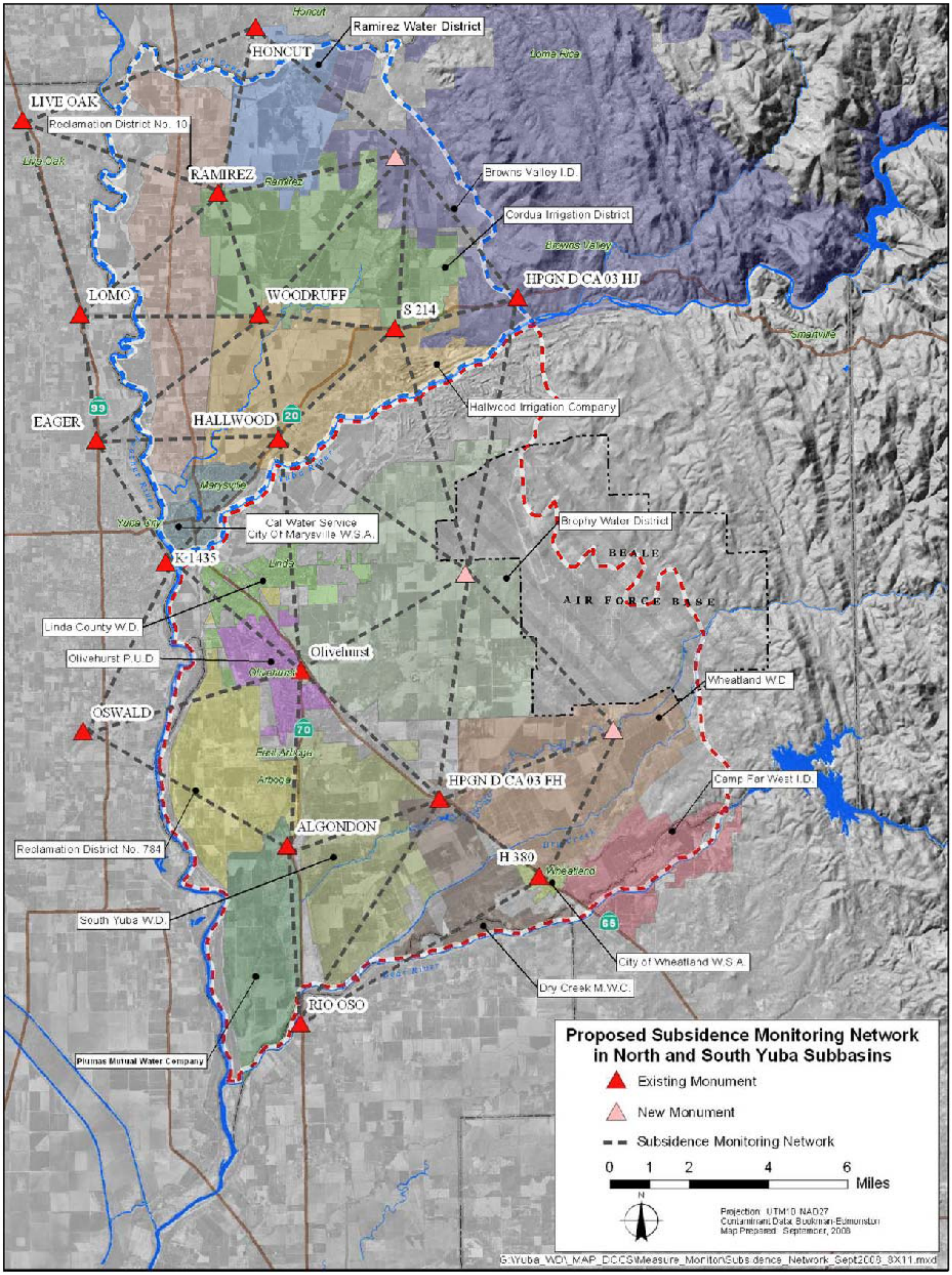


Figure 4-7. Yuba Basin Subsidence Monitoring Network.

Building upon its history of leadership in protecting and restoring the groundwater supplies within the North Yuba and South Yuba subbasins, in 2015 YCWA chose to form a Groundwater Sustainability Agency (GSA) for each subbasin as part of implementation of the Sustainable Groundwater Management Act (SGMA) passed by the California Legislature and signed into law in August 2014. SGMA represents a major shift in the management of California's groundwater resources, allowing local agencies to prepare and adopt Groundwater Sustainability Plans (GSPs) tailored to achieving sustainability of underlying groundwater basins and subbasins through local actions. For the North Yuba and South Yuba subbasins, which have been designated as medium priority basin under the Law, a GSP or combination of GSPs addressing the entirety of each subbasin must be prepared and adopted by January 31, 2022. Within each subbasin, several options exist, including the following:

- One GSA representing the entire subbasin preparing a single GSP,
- Multiple GSAs representing the entire subbasin preparing a single GSP,
- Multiple GSAs representing the entire subbasin preparing multiple, coordinated GSPs.

At the time of preparation of this AWMP, the following agencies had elected to form GSAs in the North Yuba and South Yuba subbasins:

- North Yuba Subbasin
    - Yuba County Water Agency (8/19/2015)[15]
    - Cordua Irrigation District (9/15/2015)
    - County of Butte (10/27/2015)[15]
    - City of Marysville (11/13/2015)
- South Yuba Subbasin
    - Yuba County Water Agency (8/19/2015)

Moving forward, YCWA will actively collaborate with other GSAs and eligible interested parties to sustainably manage available groundwater resources. The development and use of surface water supplies by YCWA and others over the past century has greatly contributed to the sustainability of the groundwater system through beneficial recharge and prevention of pumping that would otherwise have occurred.

The full GMP is included as Attachment C of this AWMP. The IRWMP is included as Attachment D of this AWMP.

4.4. OTHER WATER SUPPLIES (§10826.B(3))

In addition to Yuba River water and groundwater supplies, YCWA and its member units have access to tributary inflows from Honcut Creek, Wilson Creek, Reeds Creek, Hutchinson Creek, and Best Slough. These water sources are typically available only during the rainy season and are used to support waterfowl habitat and rice decomposition, which are the primary uses of irrigation water during that period.

[15] YCWA's GSA area includes the portion of the North Yuba subbasin in Yuba County. The County of Butte's GSA area includes the portion of the North Yuba subbasin in Butte County.

Another source of water is recycled water discharged to the YCWA and MU distribution/drainage systems from sources including Beale Air Force Base, the City of Wheatland, and Olivehurst Public Utilities District (OPUD). These recycled water sources are being reused to the extent they are available to meet irrigation demands, but have not been quantified at this time.

All other water supplies utilized for irrigation are of suitable quality for the crops irrigated.

4.5. WATER QUALITY MONITORING PRACTICES (§10826.B(4))

YCWA and the MUs monitor surface water and groundwater quality within their service areas and the surrounding areas under a combination of water management activities. These activities are described in greater detail below.

4.5.1. Surface Water

YCWA monitors surface water quality as summarized below:

- As part of developing the Yuba Accord, YCWA and its partners, in the preparation of the EIR/EIS for the Accord conducted temperature monitoring to calibrate a temperature model to evaluate the effects of Accord implementation on water temperature in the lower Yuba River.[16]
- YCWA is a member of the Yuba Accord's River Management Team (RMT), which continues to monitor and evaluate water temperature in the lower Yuba River to support water temperature objectives for fish. In particular, these activities aim to ensure that implementation of the Accord "… provides a suitable temperature regime for target species in the lower Yuba River."[17]
- that implementation of the Yuba Accord provides a suitable thermal regime for target species in the lower Yuba River
- As a member of the Northern California Water Association (NCWA), YCWA is a participant in the Sacramento Valley Water Quality Coalition, which conducts monitoring of surface and groundwater quality in compliance with the Central Valley Regional Water Quality Control Board's Irrigated Lands Program, also known as the Ag Waiver. The monitoring program includes sampling and testing of a host of parameters for hundreds of samples collected annually from sites strategically distributed throughout the Sacramento River basin, which includes the Yuba River watershed.
- YCWA monitors water in the South Canal as it leaves Beale Air Force Base to test for TDS and pesticides.

4.5.2. Groundwater

YCWA conducts extensive monitoring of groundwater quality as part of implementation of the Yuba River Accord as described in Section 4.3.2 and as part of implementation of the Agency's GMP described in Section 4.3.3.

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[16] Yuba County Water Agency, California Department of Water Resources, and Bureau of Reclamation. 2007. Draft Environmental Impact Report/Environmental Impact Statement for the Proposed Lower Yuba River Accord. Prepared by HDR|SWRI. June 2007.

[17] Yuba Accord River Management Team. 2010. Lower Yuba River Water Temperature Objectives Technical Memorandum. November 2010.

CHAPTER 5.0 - WATER BALANCE

5.1. INTRODUCTION

This chapter describes the various uses of water within YCWA and the member units, followed by a detailed description of YCWA's water balances for key accounting centers within the Agency. Separate water balances are provided for the area receiving wholesale water from YCWA on the north and south side of the Yuba River, referred to as the Northside and Southside, respectively. For each accounting center, a detailed, multi-year water balance covering the period from 2001 to 2014 is presented. The water balance quantifies all significant water inflows and outflows to and from the areas receiving water from the Agency each calendar year.

The water uses and water balances are discussed in relation to hydrologic conditions within the Agency, which vary from year to year. All results are presented on a calendar year basis. Key drivers of water management in a given year include available surface water supply under the Agency's water rights and water transfers under the Yuba Accord or other arrangements.

Historical estimates of water use may differ from those presented in YCWA's 2012 AWMP as a result of refinements to the analyses used to develop the estimates, but fall within the range of uncertainty presented in Table 5-1a and 5-1b. The most notable changes for the current water balance include improved accounting for winter water use for rice straw decomposition and waterfowl habitat and modification of the water balance structure to calculate tailwater as the closure of the member unit farmed lands water balance and spillage and tailwater outflow as the closure of the distribution and drainage system water balance.

5.2. WATER BALANCE OVERVIEW

The YCWA water balance includes separate accounting centers for the distribution and drainage system[18] and the member unit farmed lands for both the North and South sides of the Yuba River. A total of 43 individual flow paths are quantified as part of the water balance. Schematics of the water balance structures for the North and South sides are provided in Figures 5-1a and 5-1b, respectively.

The Northside water balance has two accounting centers, one representing the Northside distribution and drainage system and another representing a composite of the member unit farmed lands, each with its associated inflows and outflows. Often, irrigation water distribution and drainage systems are analyzed separately; however, in this case, portions of the drainage system are also sometimes used to deliver irrigation water, so the two are combined. Member unit laterals and farmed lands are also combined because sufficient data are not available to perform separate balances for them. Flow measurements are not available for all flow paths into and out of the member unit farmed lands accounting center. However, sufficient information is available to develop estimates of volumes of water associated with these flow paths. Together, the two accounting centers represent Agency and member unit agricultural water operations, shown within the dashed line in the figures. The Yuba River, Feather River, and

[18] For purposes of the water balance analysis, the distribution and drainage system includes both YCWA facilities (south of the Yuba River only) and member unit facilities (north and south of Yuba River).

Groundwater System accounting centers, shown outside the dashed line, are regarded as sources and destinations of water, and complete water balances have not been prepared for them.

The schematic of the Southside water balance is generally the same as the Northside (described above), except that it does not have a flow path for drainwater intercepted from upslope irrigation in BVID and includes return flows to the Bear River rather than the Feather River.

In general, flow paths are quantified on a monthly basis for the calendar year (January through December). 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 5-1), 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 5-2).

$$\text{Inflows} - \text{Outflows} = \text{Change in Storage (monthly time step)} \qquad [5\text{-}1]$$

$$\text{Inflows} - \text{Outflows} = 0 \text{ (annual time step)} \qquad [5\text{-}2]$$

The flow path that is calculated using Equation 5-2 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.

The primary outflow from YCWA is crop evapotranspiration (ET). Crop ET may be derived from applied irrigation water (ET_{aw}) or from precipitation (ET_{pr}). The Integrated Water Flow Model (IWFM) Demand Calculator (IDC) daily root zone water balance model developed by DWR was applied to partition total crop ET into ET_{aw} and ET_{pr}.

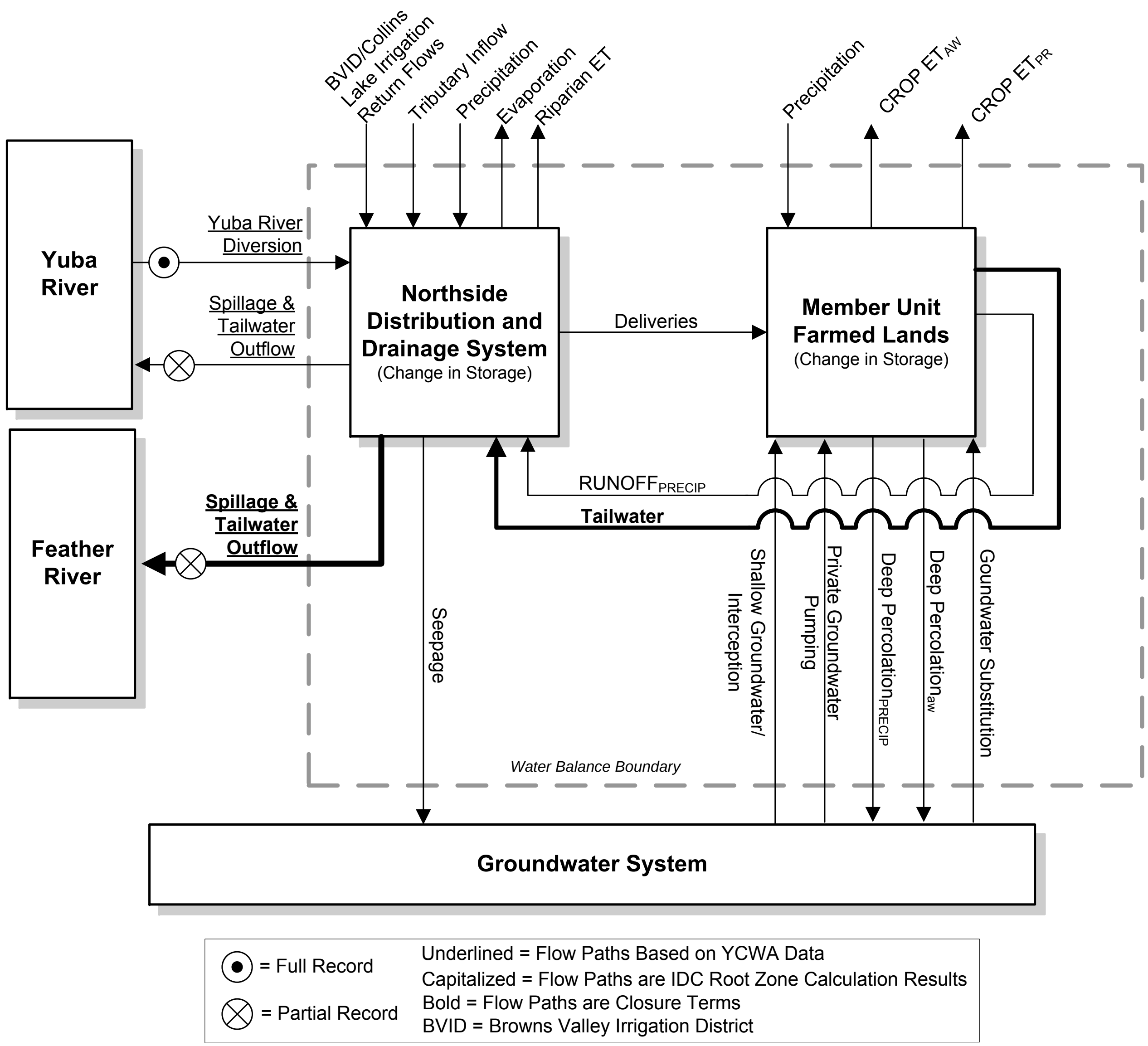

Figure 5-1a. Northside Water Balance Structure.

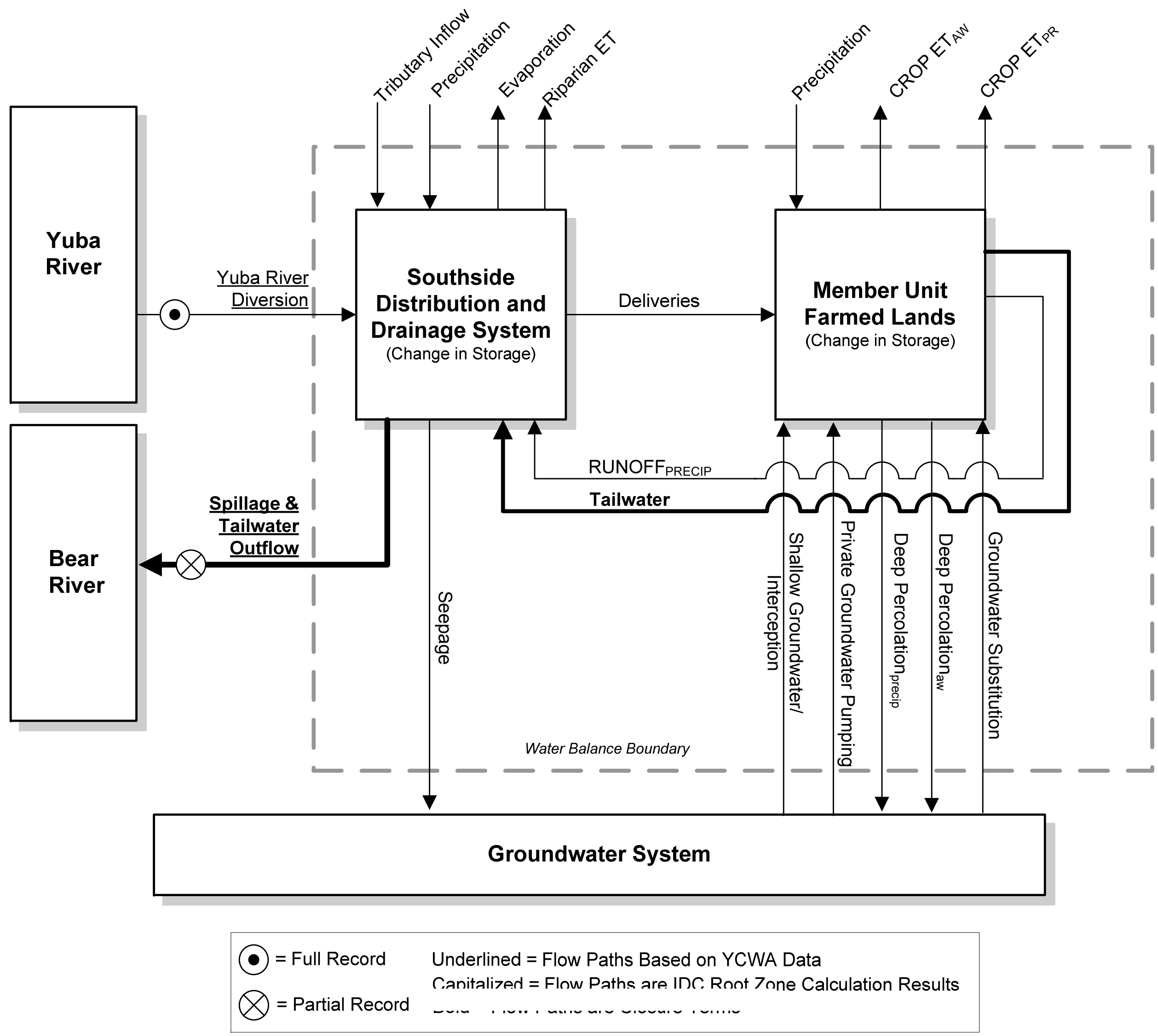

Figure 5-1b. Southside Water Balance Structure.

5.3. WATER BALANCE AREAS

The Agency delivers agricultural water to eight member units and, in some cases, directly to member unit farmers. Four member units are located in the Northside area, and four member units are located in the Southside area. Independent water balances were prepared for the Northside and Southside because the two areas are hydrologically distinct and have separate historical records. Available data are not sufficient to characterize each member unit individually. In particular, drainwater discharge and reuse that occurs across unit boundaries is difficult to quantify at this time. The Northside and Southside areas are described in the following sections.

5.3.1. Northside Water Balance Area Description

The Northside water balance area is defined as the irrigated area within the YCWA member unit service areas north of the Yuba River irrigated with Yuba River water (Figure 5-2a). This includes all of the irrigated lands within Cordua Irrigation District, Hallwood Irrigation Company and Ramirez Water District, and the irrigated lands within Browns Valley Irrigation District (BVID) served by the Pumpline Canal (which diverts from the Yuba River). Yuba River water is diverted and conveyed into the Northside via the Pumpline Canal (NY31, USGS#11420750) and Cordua-Hallwood Canal, which diverts at Daguerre Point Dam (NY32, USGS# 11420770).

The eastern boundary of the Northside water balance area is formed by the BVID Pumpline Canal, including a pump lift canal (the R Ditch) that branches from the Pumpline Canal. During the irrigation season, irrigation return flows cross the eastern boundary from upslope areas within BVID that are irrigated with water originating from Collins Lake. These upslope areas are not included in the water balance area (because their water supply source is not the Yuba River), but the return flows represent a significant inflow to the water balance area and are thus accounted for in the water balance.

Honcut Creek and Wilson Creek flow through northern portion of the area, with Honcut Creek being the larger of the two. Both creeks are believed to produce negligible natural runoff during the irrigation season; however, Honcut Creek reportedly conveys unknown amounts of irrigation return flows from upstream areas into the water balance area during the irrigation season. Those return flows originate from BVID lands irrigated with Collins Lake water. Both Creeks flow out of the area to the west carrying primarily irrigation return flows during the irrigation season. During the winter, stormwater enters and leaves the water balance area via the creeks.

The western boundaries of Ramirez Water District, Cordua Irrigation District and Hallwood Irrigation Company form the western boundary of the water balance area. This boundary coincides with the Southern Pacific Railroad along most of its length. Jack Slough collects irrigation tailwater and distribution system spillage within the area and flows out of the water balance area at the southwest corner before entering the Feather River. The southern boundary of the area follows the Yuba River.

5.3.2. Southside Water Balance Area Description

The Southside water balance area is defined as all of the irrigated area within the YCWA member unit service areas south of the Yuba River (Figure 5-2b). It includes all of the irrigated lands within Brophy Water District, Dry Creek Mutual Water Company, South Yuba Water District and Wheatland Water

District. The area's primary source of surface water is the South Yuba Canal, into which water is diverted from the Yuba River at Daguerre Point Dam (NY33, USGS# 11420760).

The eastern boundary of the area is formed by the eastern boundaries of Brophy Water District, Wheatland Water District, and Dry Creek Mutual Water Company. Several ephemeral streams cross the eastern boundary, including Reeds Creek, Hutchinson Creek, Best Slough and Dry Creek. Tributary inflow from the creeks during the irrigation season is believed to be negligible.

The western boundaries of Brophy and South Yuba Water Districts form the western boundary of the Southside water balance area. This boundary coincides approximately with Highway 70 along most of its length. Best Slough collects irrigation tailwater and distribution system spillage from within the area and discharges it to the "Interceptor," which lies along the western boundary of South Yuba Water District and drains to the south. Tailwater and spillage entering the Interceptor is discharged to the Bear River.

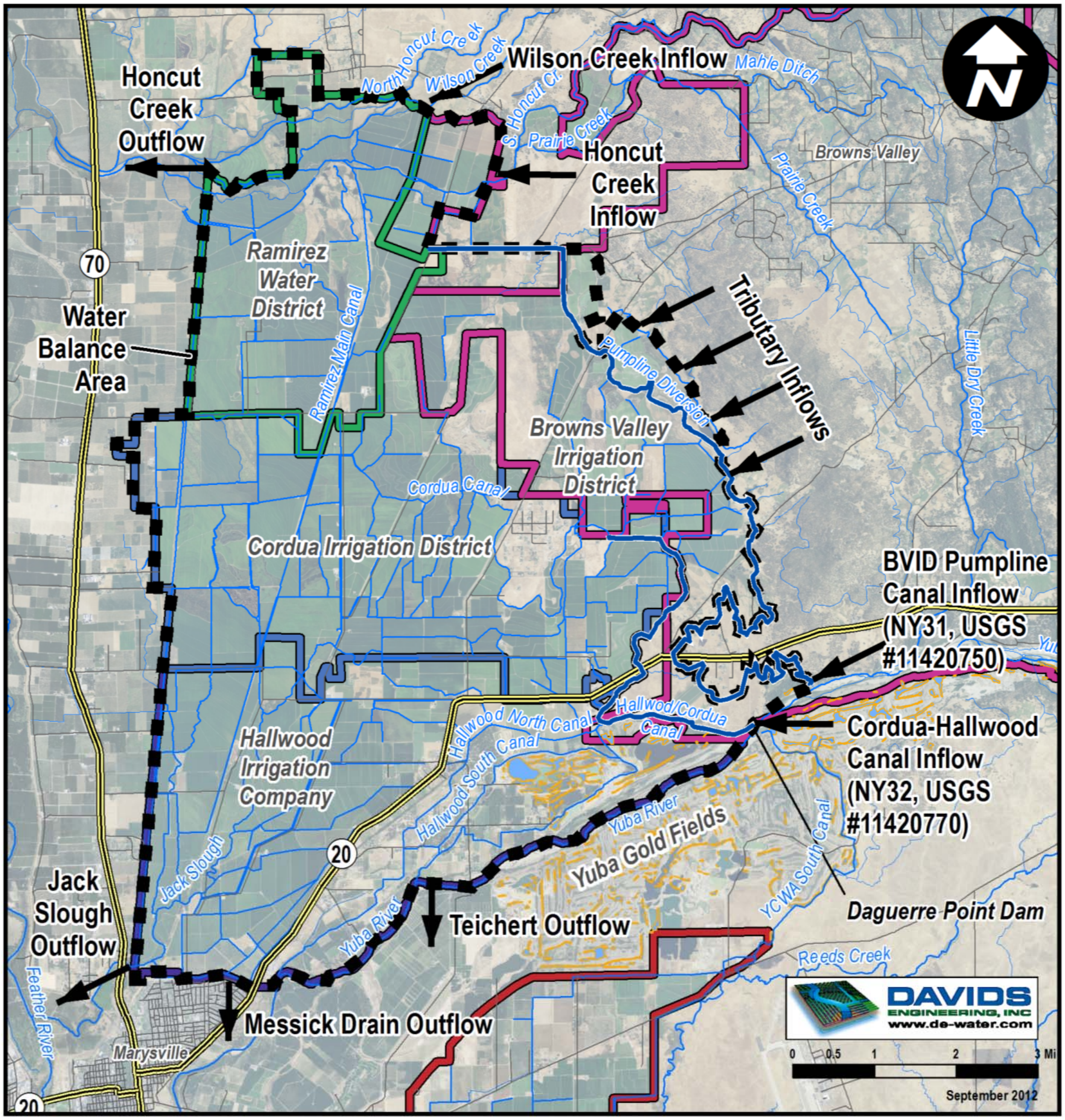

Figure 5-2a. YCWA Northside Water Balance Area, Inflows, and Outflows.

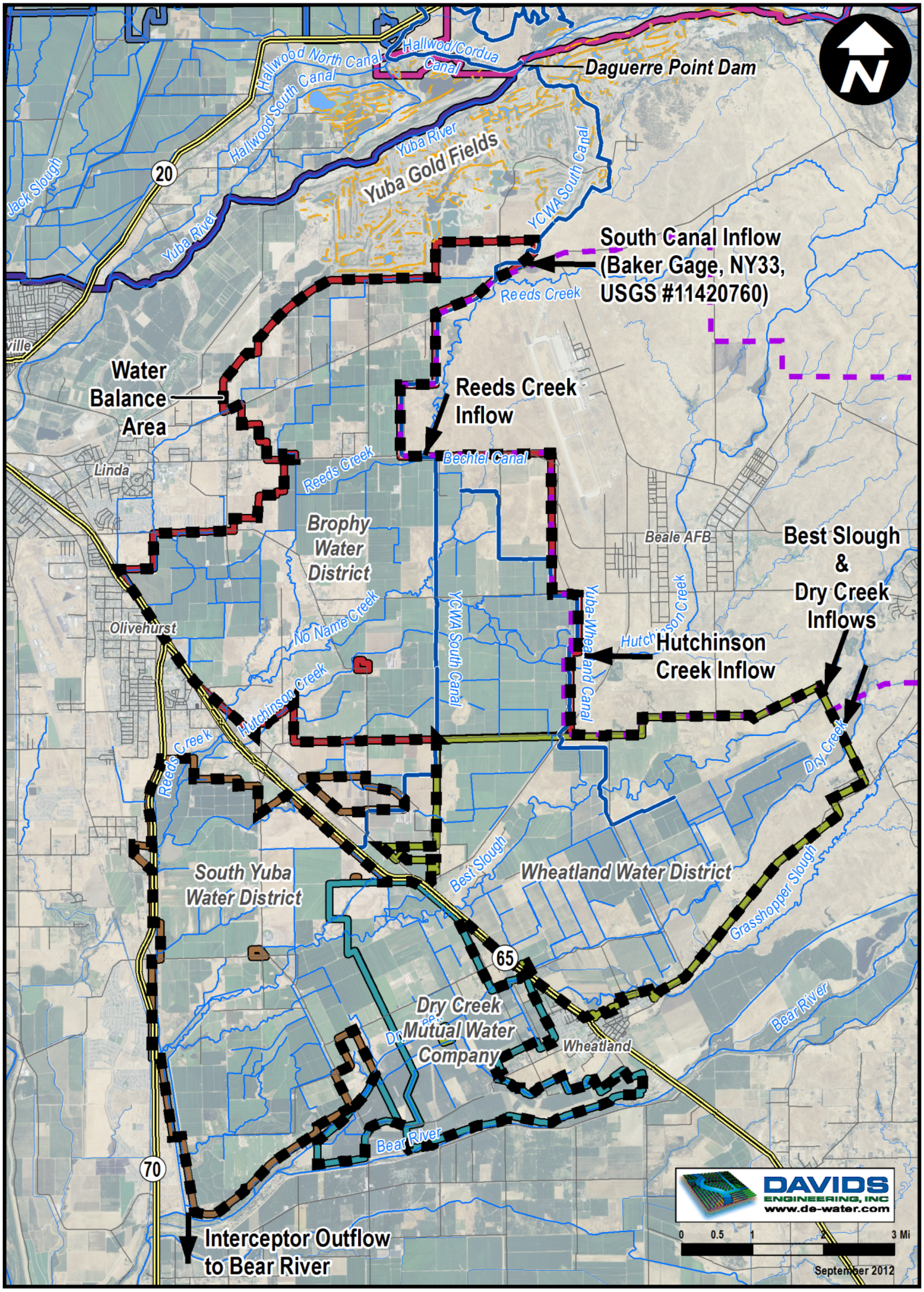

Figure 5-2b. Northside Water Balance.

5.4. 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 distribution and drainage system accounting centers, spillage and tailwater outflow volumes were calculated as the closure term. Spillage and tailwater outflow was selected because the volumes represent a large flow path with limited available measurement for the full period of analysis. The deliveries to member units are recorded by YCWA. For the member unit farmed lands accounting center, tailwater was calculated as the closure term. Tailwater was selected because it is a relatively large flow path and not directly measureable due to the distributed nature with which tailwater returns to the distribution and drainage system from individual fields.

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 greater degree of accuracy than is actually justified. While a detailed uncertainty analysis has not been conducted to assess potential error in the data and computed values, a 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)[19]. 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.

Tables 5-1a and b list each flow path for the North and South sides, respectively, 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, a typical annual value (average of 2001 to 2014 water balance results), and the estimated uncertainty, expressed as a percent. As indicated, estimated uncertainties vary by flow path from 5% to 100% 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.

The estimated uncertainty in tailwater outflows from the member unit farmed lands is 67% and 107% in the Northside and Southside areas, respectively. This uncertainty is relatively large due to the combination uncertainty in deliveries and precipitation, which represent the largest inflows in the member unit farmed lands balance and uncertainty in deep percolation outflows from the member unit farmed lands. The estimated uncertainty in spillage and tailwater outflows is 56% and 107% in the Northside and Southside areas, respectively. This relatively large percent uncertainty reflects that fact that spillage and tailwater outflows are a relatively small flow path as compared to diversions, and uncertainty in tailwater from the member unit farmed lands closure results in uncertainty in total surface water outflows. Despite appreciable uncertainty in some flow path quantities, the water balance provides useful insights into YCWA's water management. YCWA has worked to improve the estimation of the various flow

[19] Clemmens, A.J. and C.M. Burt. 1997. Accuracy of Irrigation Efficiency Estimates. ASCE Journal of Irrigation and Drainage Engineering. 123(6) 443-453.

paths since preparing its 2012 AWMP and will continue to increase the certainty of the water balance results to improved monitoring of water use in the future.

Table 5-1a. Northside YCWA Water Balance Flow Paths, Supporting Data, and Estimated Uncertainty.

Accounting Center	Flow-path Type	Flowpath	Source	Supporting Data	Typical Annual Volume (af)	Estimated Uncertainty (%)
Distribution and Drainage System	Inflows	Yuba River Diversions	Measurement	USGS measurements NY31 and NY32	152,000	5%
		Tributary Inflow	Calculation	Minimum tributary inflows needed to meet crop demands estimated based on Crop ET of applied water, described below	5,200	50%
		BVID/Collins Lake Irrigation Return Flows[1]	Calculation	Area draining to BVID canal and estimated tailwater from this area	1,700	50%
		Tailwater	**Closure (Member Unit Farmed Lands)**	**Difference of total outflows and measured/estimated inflows for Member Unit Farmed Lands accounting center**	**37,000**	**67%**
		Runoff of Precipitation	Calculation	Integrated Water Flow Model Demand Calculator (IDC) root zone simulation analysis, CIMIS precipitation data, NRCS curve number method	27,000	25%
		Precipitation	Calculation	Quality-controlled precipitation from Yuba County Airport NWS station, estimated canal surface area	500	15%
	Outflows	Deliveries	Measurement/Calculation	YCWA recorded deliveries	157,000	10%
		Riparian ET	Calculation	CIMIS reference ET, estimated crop coefficient based on SEBAL 2001 analysis, estimated riparian area	1,900	25%
		Seepage	Calculation	NRCS soils data, estimated wetted area, estimated wetted duration	6,600	35%
		Spillage and Tailwater Outflows	**Closure**	**Difference of total outflows and measured/estimated inflows for Distribution and Drainage System accounting center. Validated with available YCWA spot flow measurements.**	**56,000**	**56%**
		Evaporation	Calculation	CIMIS reference ET, estimated evaporation coefficient, estimated wetted surface area	1,200	15%
Member Unit Farmed Lands	Inflows	Deliveries	Measurement/Calculation	YCWA recorded deliveries	157,000	10%
		Private Groundwater Pumping	Calculation	Assumed to be negligible. Minor pumping estimated in some years based on unmet demands	4,700	35%
		Groundwater Substitution	Measurement	Flow meter records from groundwater wells included in program	14,000	5%
		Shallow Groundwater Interception	Calculation	Estimated as zero	0	100%
		Precipitation	Calculation	Quality-controlled precipitation from Yuba County Airport NWS station, MU cropped area	52,000	10%
	Outflows	Crop ET of Applied Water (ETaw)	Calculation	CIMIS reference ET, estimated crop coefficients based on SEBAL 2001 analysis, cropped area by crop (2005 DWR land use survey and County crop reports), IDC root zone simulation analysis to divide total ET into applied water and precipitation components	101,000	10%
		Runoff of Precipitation	Calculation	IDC analysis, CIMIS precipitation data, NRCS curve number method	26,000	25%
		Tailwater	**Closure (Member Unit Farmed Lands)**	**Difference of total outflows and measured/estimated inflows for Member Unit Farmed Lands accounting center**	**37,000**	**67%**
		Crop ET of Precipitation (ETpr)	Calculation	CIMIS reference ET, estimated crop coefficients based on SEBAL 2001 analysis, cropped area by crop (2005 DWR land use survey and county crop reports), IDC root zone simulation analysis to divide total ET into applied water and precipitation components	18,000	10%
		Deep Percolation of Applied Water	Calculation	IDC analysis, NRCS soils characteristics, CIMIS precipitation data	39,000	35%
		Deep Percolation of Precipitation	Calculation		7,100	35%
	Change in Storage	Change in Storage	Calculation		-500	50%

Table 5-1b. Southside YCWA Water Balance Flow Paths, Supporting Data, and Estimated Uncertainty.

Accounting Center	Flowpath Type	Flowpath	Source	Supporting Data	Typical Annual Volume (af)	Estimated Uncertainty (%)
Distribution and Drainage System	Inflows	Yuba River Diversions	Measurement	USGS measurements NY33 (Baker Gage)	104,000	5%
		Tributary Inflow	Calculation	Minimum tributary inflows needed to meet crop demands estimated based on Crop ET of applied water, described below	8,000	50%
		Tailwater	**Closure (Member Unit Farmed Lands)**	**Difference of total outflows and measured/estimated inflows for Member Unit Farmed Lands accounting center**	**25,000**	**107%**
		Runoff of Precipitation	Calculation	Integrated Water Flow Model Demand Calculator (IDC) root zone simulation analysis, CIMIS precipitation data, NRCS curve number method	15,000	25%
		Precipitation	Calculation	Quality-controlled precipitation from Yuba County Airport NWS station, estimated canal surface area	600	15%
	Outflows	Deliveries	Measurement/Calculation	YCWA recorded deliveries	112,000	10%
		Riparian ET	Calculation	CIMIS reference ET, estimated crop coefficient based on SEBAL 2001 analysis, estimated riparian area	2,400	25%
		Seepage	Calculation	NRCS soils data, estimated wetted area, estimated wetted duration	8,300	35%
		Spillage and Tailwater Outflows	**Closure**	**Difference of total outflows and measured/estimated inflows for Distribution and Drainage System accounting center. Validated with available YCWA spot flow measurements.**	**28,000**	**107%**
		Evaporation	Calculation	CIMIS reference ET, estimated evaporation coefficient, estimated wetted surface area	1,600	15%
Member Unit Farmed Lands	Inflows	Deliveries	Measurement/Calculation	YCWA recorded deliveries	112,000	10%
		Private Groundwater Pumping	Calculation	Estimated groundwater only area (Wheatland Water District), estimated ETaw and Crop Consumptive Use Fraction	33,000	35%
		Groundwater Substitution	Measurement	Flow meter records from groundwater wells included in program	20,000	5%
		Shallow Groundwater Interception	Calculation	Estimated as zero	0	100%
		Precipitation	Calculation	Quality-controlled precipitation from Yuba County Airport NWS station, MU cropped area	56,000	10%
	Outflows	Crop ET of Applied Water (ETaw)	Calculation	CIMIS reference ET, estimated crop coefficients based on SEBAL 2001 analysis, cropped area by crop (2005 DWR land use survey and County crop reports), IDC root zone simulation analysis to divide total ET into applied water and precipitation components	94,000	10%
		Crop ET of Precipitation (ETpr)	Calculation	CIMIS reference ET, estimated crop coefficients based on SEBAL 2001 analysis, cropped area by crop (2005 DWR land use survey and County crop reports), IDC root zone simulation analysis to divide total ET into applied water and precipitation components	26,000	10%
		Tailwater	**Closure (Member Unit Farmed Lands)**	**Difference of total outflows and measured/estimated inflows for Member Unit Farmed Lands accounting center**	**25,000**	**107%**
		Runoff of Precipitation	Calculation	IDC analysis, CIMIS precipitation data, NRCS curve number method	15,000	25%
		Deep Percolation of Applied Water	Calculation	IDC analysis, NRCS soils characteristics, CIMIS precipitation data	48,000	35%
		Deep Percolation of Precipitation	Calculation		15,000	35%
	Change in Storage	Change in Storage	Calculation		-1,100	50%

5.5. HYDROLOGIC YEAR TYPES

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 hydrology affecting YCWA and member unit (MU) water supply and demand over time. Specifically, a multi-year water balance that includes both dry and wet years supports planned conjunctive use of surface water and groundwater. To support review and interpretation of water uses and overall water balance results over time, Yuba River Index (YRI), total calendar year precipitation[20], and total water year reference evapotranspiration (ET_o) are presented, and year types are assigned.

YCWA developed the YRI as part of its proposal to the SWRCB for new instream flow requirements on the lower Yuba River. The YRI was implemented in 2001 as part of SWRCB D 1644 as a means of describing the hydrology of the Lower Yuba River and settling instream flow requirements. The YRI follows the principles of the Sacramento Valley Index and the San Joaquin River Index and is based on the unimpaired runoff of the Yuba River at Smartsville. The North Yuba Index (NYI), described in Section 4.3.2, was developed for the Yuba Accord, which became effective in 2008 with SWRCB orders WR 2008-25 and WR-2008-14. The NYI provides a measure of water available in the North Yuba River that can be used to meet instream flow requirements and MU irrigation demands and reflects the combined effect of hydrology and reservoir storage on surface water supply. The NYI is calculated based on available reservoir storage in New Bullards Bar at the end of September of the prior water year, plus actual and predicted New Bullards Bar inflows for the current year. The YRI is based on unimpaired flows, and historical values can be easily calculated using available data. Based on review of the YRI and NYI for the 2008 to 2014 period, the indices appear to track together in a relative, qualitative manner. Because the YRI is readily available for the full period of the water balance and provides a closer approximation of natural hydrology without the effects of previous year reservoir operations, it has been relied on to define wet and dry year types for purposes of evaluation of the water balance results.

Reduced inflows into New Bullards Bar Reservoir resulting from reduced precipitation in the watershed typically correspond to years with reduced precipitation and increased evaporative demand in the YCWA MU service areas. Based on the YRI, the years 2001 to 2014 have been assigned to wet or dry hydrologic year types for purposes of discussion of water management by YCWA and the MUs. In particular, assigning years a wet or dry hydrologic classification provides a relevant, intuitive framework for evaluating conjunctive management of groundwater and surface water and supports water management planning efforts. The YRI's five water-year classifications, quantified in thousands of acre-feet (TAF) are defined as follows:

- Wet (W)—Equal to or greater than 1,230 TAF
- Above Normal (AN)—Greater than 990 TAF and less than 1,230 TAF
- Below Normal (BN)—Equal to or less than 990 TAF and greater than 790 TAF
- Dry (D)—Equal to or less than 790 TAF and greater than 630 TAF
- Critical (C)—Equal to or less than 630 TAF

[20] Total calendar year precipitation refers to precipitation falling within YCWA during the calendar year.

For purposes of review of the 2001 to 2014 water balance results, Wet and Above Normal years were classified as "Wet" years and Below Normal, Dry and Critical were classified as "Dry" years. The YRI and related factors influencing demand along with the hydrologic year type classifications by year are listed in Table 5-2.

Table 5-2. 2001 to 2014 Yuba River Index, Water Year Precipitation, and Irrigation Season ET_o, and Hydrologic Year Type.

Year	Yuba River Index	Irrigation Start	Irrigation End	Season Length, days	Precipitation, in[1]	ET_o, in[2]	Hydrologic Year Type
2001	C	12-Apr	18-Sep	160	15.7	57.0	Dry
2002	C	16-Apr	7-Sep	145	22.3	55.2	Dry
2003	AN	11-May	16-Sep	129	20.1	48.3	Wet
2004	BN	8-Apr	11-Sep	157	18.6	51.9	Dry
2005	AN	21-Apr	20-Sep	153	24.1	47.0	Wet
2006	W	2-May	6-Oct	158	33.5	50.7	Wet
2007	D	5-Apr	16-Sep	165	13.4	54.5	Dry
2008	C	31-Mar	12-Sep	166	14.7	54.2	Dry
2009	BN	6-Apr	1-Sep	149	16.6	51.7	Dry
2010	BN	30-Apr	10-Sep	134	21.4	48.8	Dry
2011	W	12-Apr	21-Sep	163	28.7	48.9	Wet
2012	BN	2-May	17-Sep	139	14.8	51.5	Dry
2013	D	12-Apr	5-Sep	147	18.3	54.7	Dry
2014	C	15-Apr	2-Sep	141	10.3	53.7	Dry
			Minimum	129	10.3	47.0	
			Maximum	166	33.5	57.0	
			Wet Year Average	151	26.6	48.7	
			Dry Year Average	150	16.6	53.3	
			Overall Average	150	19.5	52.0	

1. Yuba County Airport NWS weather station.
2. Nicolaus CIMIS station.

Based on the analysis of the YRI, water-year precipitation[21], and ET_o, four years between 2001 and 2014 were assigned to wet year types, and ten years were assigned to dry year types. Average precipitation during the wet years of 2003, 2005, 2006, and 2011 was 10 inches more than the average during the dry years. Calendar year ET_o for the wet years averaged approximately 48.7 inches, approximately five inches less than the average during the dry years.

In addition to reduced surface water availability in dry years at the watershed scale, dry years, on average, have below normal precipitation and above normal ET demand, resulting in increased crop irrigation

[21] A water year is defined as the period from October 1 of the previous year to September 30 of the current year and is used to capture fall and winter precipitation that may be available to support crop evapotranspiration during the growing season.

requirements. These increased demands coupled with potential reductions in surface water supply under the Yuba Accord (see Section 4.3.2), have the potential to require groundwater pumping to meet the increased irrigation demand. In the future, updates of the water balance to include years with reduced supplies will allow for increased understanding of the implications of reduced surface water availability on YCWA's water resources and may support the identification and implementation of additional management actions to increase the reliability of surface water and groundwater supplies while maintaining or improving levels of service to the water users. Surface water supplies were reduced in 2015 for the first time since the completion of the Yuba Project. A description of surface water availability in 2015 has been included in Section 3.9 of this AWMP.

5.6. WATER USES (§10826.B(5))

The Agency supplies irrigation water for agriculture as a wholesaler to the MUs as well as managing instream flows for the Yuba River. The Agency owns the New Bullards Bar Dam and Reservoir that they manage in cooperation with PG&E for power generation, flood control, water supply, instream flow requirements, and recreation. The reservoir lies outside of YCWA's MU service area. Through the Agency's water conservation and conjunctive use efforts, water from the Yuba River has been made available for environmental enhancement and other purposes through water transfers. These water uses are described in greater detail in the remainder of this section.

5.6.1. Agricultural

Agricultural irrigation to produce crops is an important water use in the YCWA MU service areas. Crop acreages and acreages of other land uses were estimated based on a GIS-based DWR land use survey of Yuba County conducted in 2005. Spatial data providing detailed cropping information were not available for other years during the 2001 to 2014 water balance period. In order to estimate changes in crop acreages across the full period of analysis, crop acreages for each year were adjusted based on Yuba County Agricultural Commissioner crop reports for the years prior to and following the survey. In general, due to the large portion of the MU services areas dedicated to rice production, crop acreages have changed little over time. These findings have been further substantiated by review of available Landsat satellite imagery acquired between 2001 and 2014.

Between 2001 and 2014, there were an average of 64,210 acres of farmed land, including 30,910 acres in the Northside area and 33,300 acres in the Southside area. The farmed lands include an average of 958 acres of fallow or idle lands (529 and 429 acres on the Northside and Southside, respectively). As indicated in Table 5-3, the dominant crop in the service areas of the member units served by YCWA is rice (Figure 5-3), which was grown on an average of 22,049 acres (about 70% of farmed area) in the Northside area and 16,850 acres (about 50% of farmed area) in the Southside area. Pasture was grown on an average of 1,541 acres and 5,104 acres on the North and

Figure 5-3. Rice near Marysville in August

South side, respectively. Permanent crops in the YCWA member unit service areas are roughly equally split between walnuts and prunes and account for an average of 2,481 acres or 8% of the total cropped area in the Northside area and 7,737 acres or 23% of the total cropped area in the Southside area.

Riparian areas, wetlands, and ponds cover twelve percent or about 4,000 acres of the farmed area in the Northside and five percent or about 1,550 acres in the Southside[22]. The wetlands and ponds provide important environmental and recreational benefits. The area of these land use types reported by the 2005 land use survey was assumed to remain the same over the 2001 to 2014 water balance period. The total farmed area in the MU service areas varies little from year to year (Figures 5-4a and 5-4b), reflecting the reliability of irrigation water supplies. During the off season, water is diverted at YCWA's discretion and delivered to the MUs for rice decomposition and to maintain wildlife habitat.

Crop evapotranspiration (ET) was estimated using a crop coefficient approach, whereby crop- and time-specific coefficients were multiplied by reference ET (ET_o) to calculate the total consumptive use of water for the farmed lands over time. Local crop coefficients were developed based on actual ET estimates from a remote sensing analysis using the Surface Energy Balance Algorithm for Land (SEBAL®) for the 2009 irrigation season. The analysis used ground and satellite data to compute actual ET from April to October for individual 30-meter satellite pixels within Glenn and Colusa counties. Spatially distributed cropping data from 2009 obtained from DWR were combined with CIMIS ET_o to calculate crop coefficients representing actual ET over the course of the season. It was not possible to develop crop coefficients specifically for YCWA using the 2009 SEBAL dataset for most land use types due to lack of spatial cropping data for Yuba County for 2009.

To verify that the SEBAL-based crop coefficients from a nearby area provide reasonable results for the YCWA member unit service areas, the total April through September actual evapotranspiration (ET_a[23]) for the member unit service areas in 2001 was calculated based on quality-controlled ET_o data from the Nicolaus CIMIS station and the SEBAL crop coefficients to estimate total actual ET for the 2001 growing season. The results of this calculation were compared to the total April through September ET_a from an available SEBAL analysis for April to September 2001. Additionally, the total March through September actual evapotranspiration ET_a for the member unit service areas in 2009 was calculated based on quality-controlled ET_o data from the Nicolaus CIMIS station and the SEBAL crop coefficients to estimate total actual ET for the 2009 growing season. The results of this calculation were compared to the total March through September ET_a from the 2009 SEBAL analysis. The total ET_a calculated from the crop coefficient approach was two percent greater than the SEBAL ET_a (Table 5-4). Looked at individually, the crop coefficient approach results were approximately three percent greater and one percent greater than the SEBAL ET_a in 2001 and 2009, respectively. Differences between the crop coefficient approach and SEBAL were similar for the Northside and Southside areas. Coincidentally, the April to September 2001 ET_a volume is approximately equivalent to the March to September 2009 ET_a volume. This results from weather differences between the two years; the April to September 2001 ET_o is approximately equivalent to the March to September 2009 ET_o. The spatial distribution of the total April through

[22] Riparian areas, wetlands, and ponds are included as part of the farmed lands accounting center because although water is not applied directly to these lands in many cases, these areas are sustained by irrigation and may provide wildlife habitat or other benefits.
[23] Note that actual ET, or ET_a, is equivalent to crop ET, or ET_c, for purposes of this AWMP.

September ET_a for 2001 is shown in Figures 5-5a and 5-5b. The areas without data in the Figures are areas for which clouds were present in one or more satellite images spanning the growing season.

A root zone water balance simulation was run for each crop using the Integrated Water Flow Model (IWFM) Demand Calculation (IDC) developed by DWR to estimate the portions of total ET derived from applied water (ET_{aw}) and from precipitation (ET_{pr}). Unit ET values for each crop were multiplied by the corresponding acreage in each year to compute total water volumes consumed for agricultural purposes.

For rice, the IDC model simulates ponding during the growing season and during decomposition period in the fall and winter. As a result, precipitation occurring when ponds are full runs off of the fields and is not available to contribute to crop ET. Precipitation stored in the soil during the winter is available for extraction. For non-ponded crops, runoff and infiltration of precipitation are modeled for individual precipitation events. Precipitation entering the soil may be stored and available to support crop ET, or it may leave the root zone as deep percolation. The net result of the differences in irrigation and cultural practices between rice and non-ponded crops is that ET_{pr} is significantly less for rice.

Table 5-3. YCWA Crop Acreages, 2001 to 2014.

Crops	Crop Acreage by Year														Avg
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Northside															
Rice	22,050	21,837	21,895	21,579	21,293	21,564	21,952	21,631	22,333	22,487	22,426	22,414	22,433	22,793	22,049
Pasture	1,593	1,594	1,593	1,584	1,575	1,578	1,579	1,587	1,553	1,531	1,480	1,495	1,436	1,393	1,541
Walnuts	1,066	1,175	1,154	1,120	1,105	1,178	1,209	1,177	1,190	1,272	1,290	1,428	1,495	1,609	1,248
Prunes	1,573	1,547	1,524	1,441	1,449	1,255	1,249	1,159	1,132	1,126	1,042	937	974	856	1,233
Other (Grain, Olives, Melons, Corn)	381	335	335	321	269	299	299	386	296	343	284	271	232	216	305
Riparian, Wetlands, and Ponds	4,006	4,006	4,006	4,006	4,006	4,006	4,006	4,006	4,006	4,006	4,006	4,006	4,006	4,006	4,006
Idle	241	416	403	859	1,215	1,029	616	965	400	146	382	359	334	37	529
Not Cropped (Native Vegetation and Urban)	6,248	6,248	6,248	6,248	6,248	6,248	6,248	6,248	6,248	6,248	6,248	6,248	6,248	6,248	6,248
Total Area	37,158	37,158	37,158	37,158	37,158	37,158	37,158	37,158	37,158	37,158	37,158	37,158	37,158	37,158	37,158
Farmed Lands	30,910	30,910	30,910	30,910	30,910	30,910	30,910	30,910	30,910	30,910	30,910	30,910	30,910	30,910	30,910
Southside															
Rice	16,565	16,391	16,456	16,380	16,348	16,501	16,764	16,379	17,247	17,146	17,395	17,281	17,359	17,683	16,850
Pasture	5,191	5,189	5,193	5,216	5,243	5,235	5,230	5,210	5,203	5,063	4,979	4,999	4,820	4,686	5,104
Walnuts	3,941	4,341	4,272	4,187	4,176	4,440	4,546	4,387	4,524	4,778	4,926	5,421	5,697	6,148	4,699
Prunes	3,816	3,749	3,700	3,533	3,594	3,102	3,081	2,833	2,824	2,772	2,611	2,334	2,435	2,144	3,038
Grain	1,809	1,524	1,499	1,437	1,108	1,297	1,292	1,828	1,286	1,531	1,187	1,083	835	721	1,317
Other (Corn, Olives, Melon)	234	221	307	303	287	336	335	334	338	340	335	337	328	336	312
Riparian, Wetlands, and Ponds	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,551
Idle	192	332	322	693	991	837	500	777	328	118	315	294	275	31	429
Not Cropped (Native Vegetation and Urban)	9,968	9,968	9,968	9,968	9,968	9,968	9,968	9,968	9,968	9,968	9,968	9,968	9,968	9,968	9,968
Total Area	43,268	43,268	43,268	43,268	43,268	43,268	43,268	43,268	43,268	43,268	43,268	43,268	43,268	43,268	43,268
Farmed Land	33,300	33,300	33,300	33,300	33,300	33,300	33,300	33,300	33,300	33,300	33,300	33,300	33,300	33,300	33,300

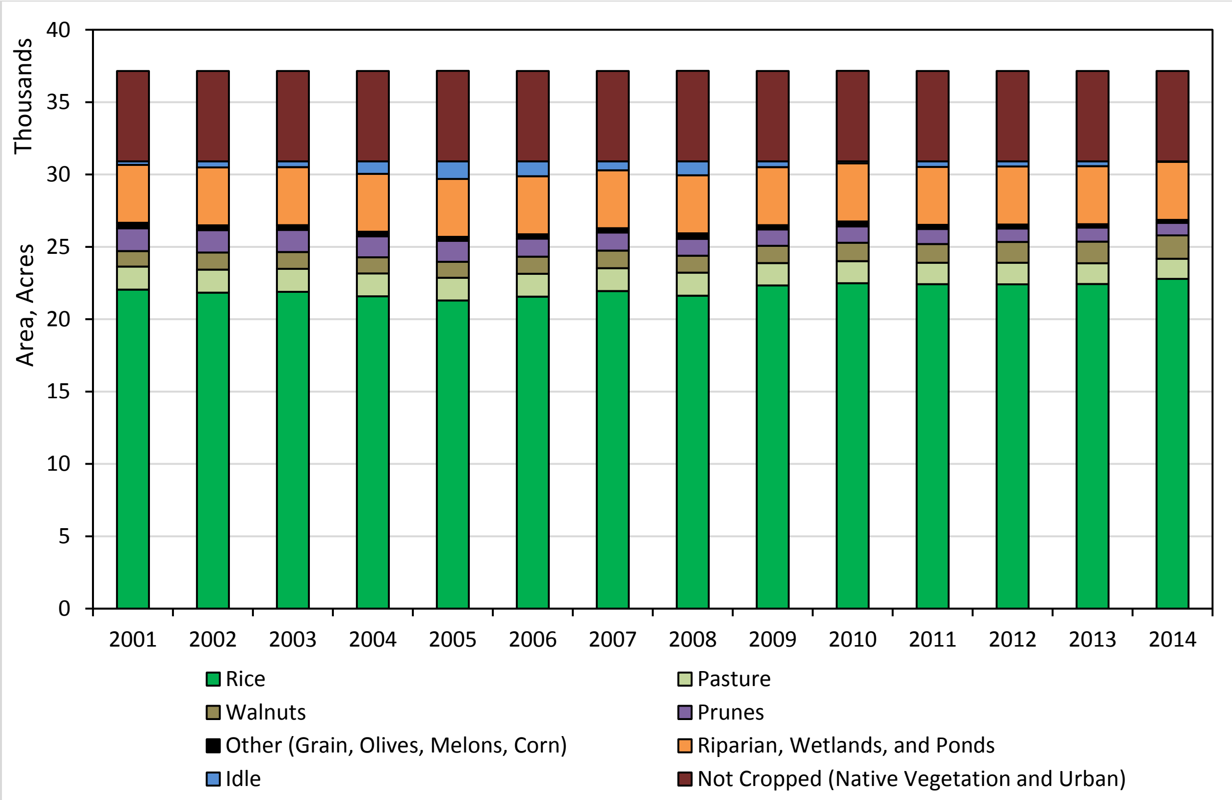

Figure 5-4a. Northside Land Uses, 2001 to 2014.

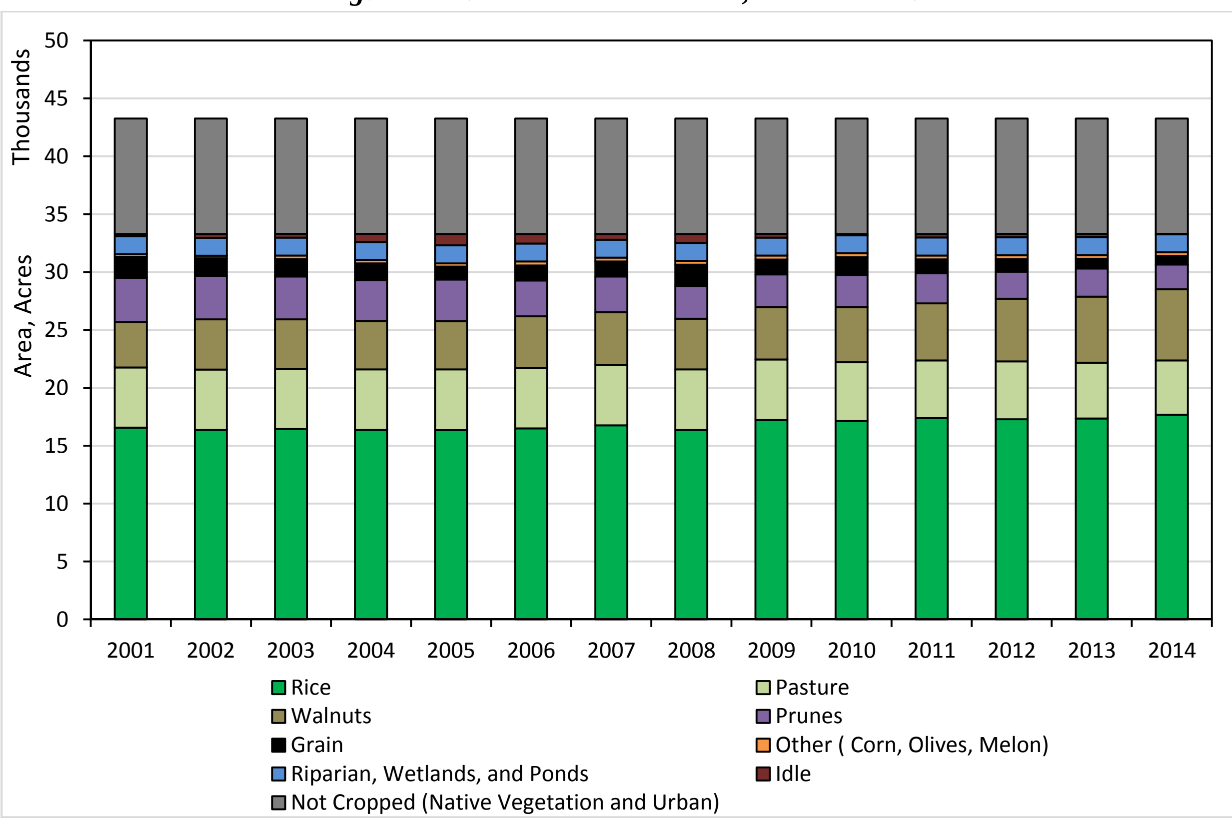

Figure 5-4b. Southside Land Uses, 2001 to 2014.

Table 5-4. Verification of SEBAL-Based Crop Coefficients for YCWA, 2001 and 2009.

Year	Irrigation-Season Crop ET_a (af)		Percent Difference
	CIMIS ET_o and SEBAL Crop Coefficient ET	SEBAL Crop ET_a	
2001 (Apr-Sep)	199,151	192,418	3.4%
2009 (Mar-Sep)	199,131	198,011	0.6%
Total	398,282	390,429	2.0%

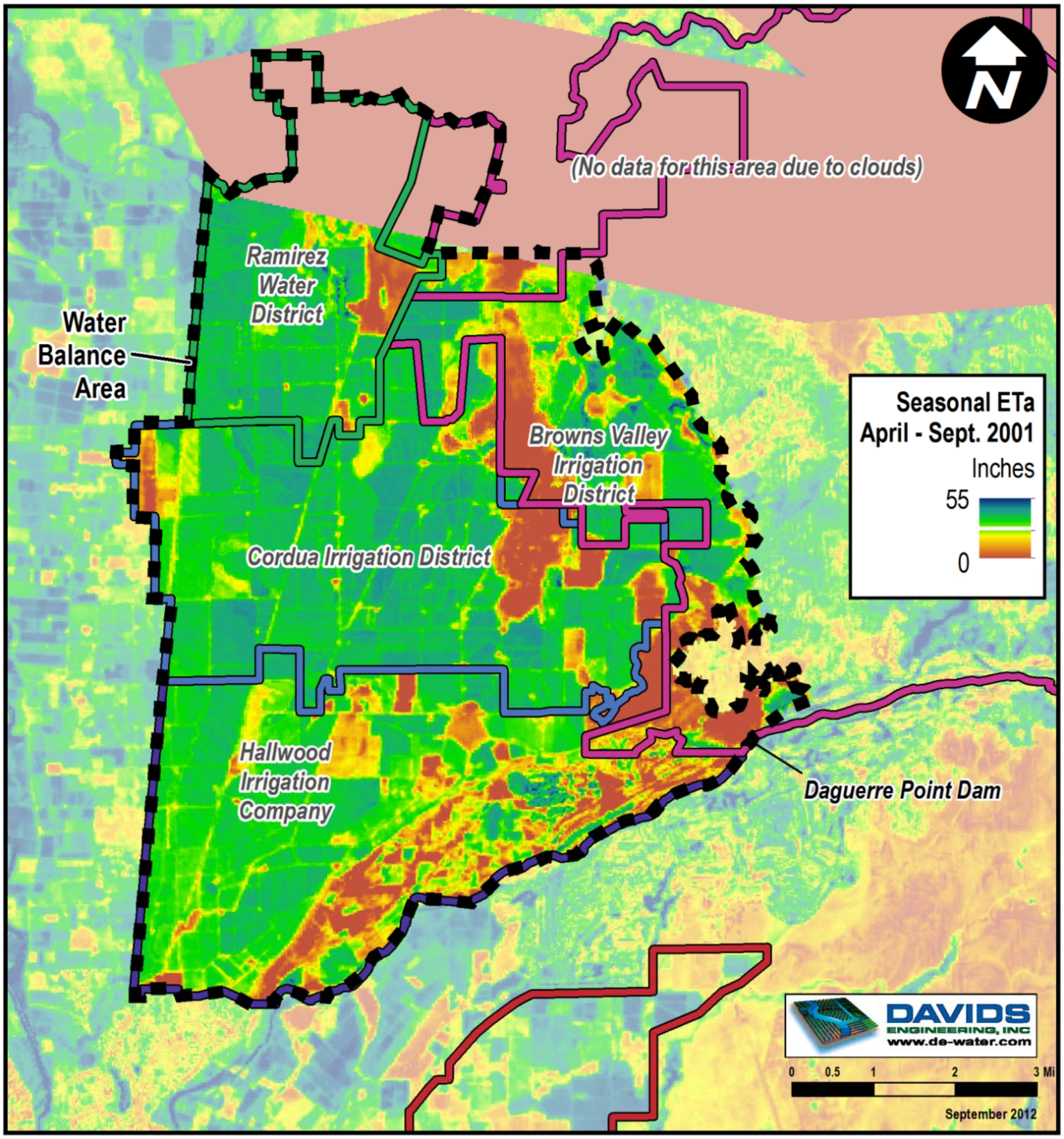

Figure 5-5a. YCWA Northside Spatially Distributed Seasonal Actual ET from SEBAL, 2001 Irrigation Season.

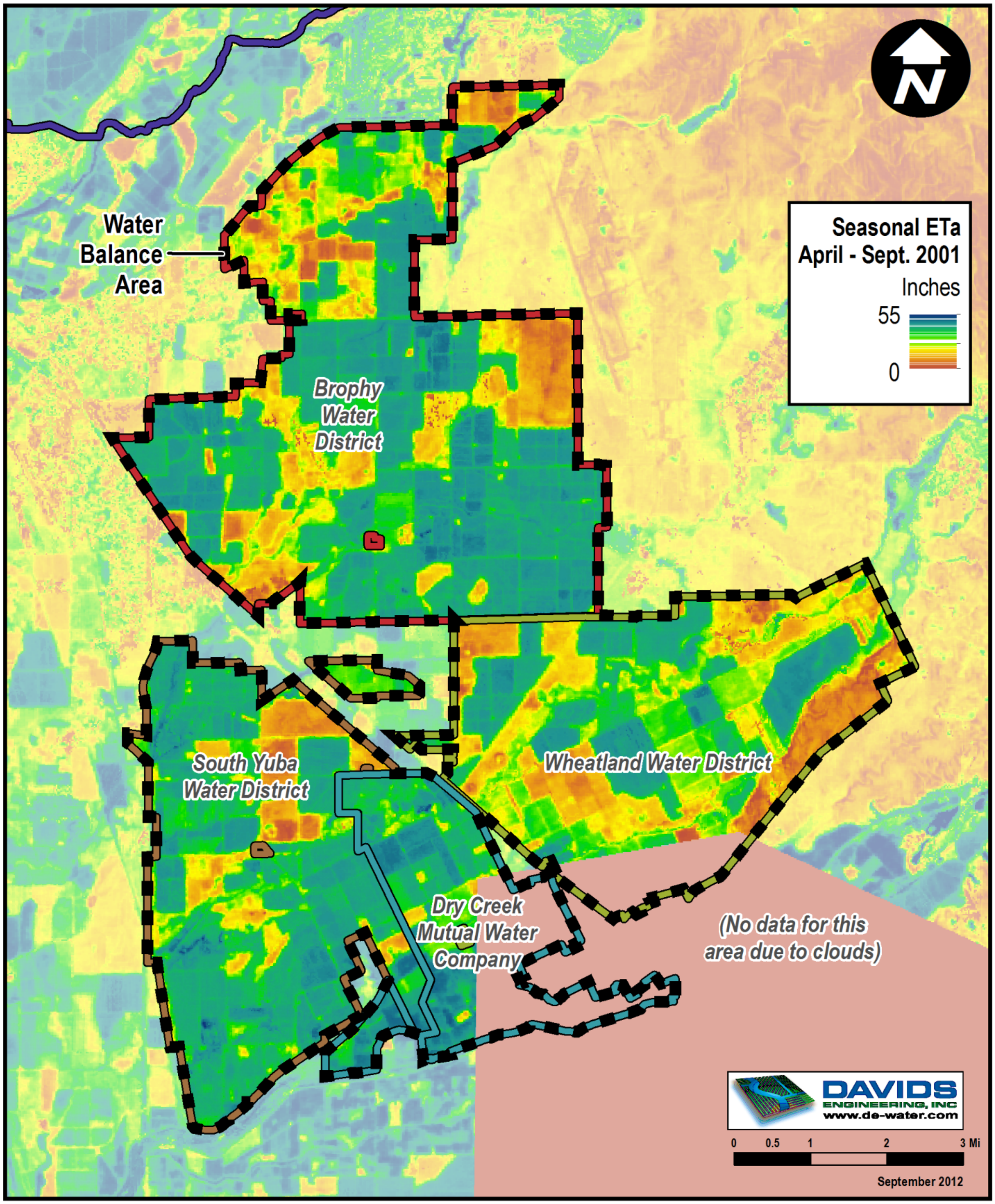

Figure 5-5b. YCWA Southside Spatially Distributed Seasonal Actual ET from SEBAL, 2001 Irrigation Season.

The consumptive use of water by crops in YCWA member unit service areas ranges from approximately 25 inches of total crop ET for olives to approximately 48 inches for rice (Table 5-5)[24]. ET_{aw} ranges from approximately 16 inches to 42 inches for the cropped area. Average total crop ET for rice, the primary crop, including estimates for evaporation from water ponded for rice straw decomposition and waterfowl habitat in the fall, is 48 inches with approximately 42 inches derived from applied irrigation water. As noted previously, the portion of total crop ET derived from applied water for rice tends to be greater than for other crops due to the fact that when the ponds are full during the growing season or fall and winter period, essentially all precipitation occurring runs off of the fields. Both riparian areas and wetlands ET_c average approximately 44 inches with 32 and 42 inches derived from water sources other than precipitation[25], respectively. Surprisingly, the ET for ponds on the Southside is shown to be about nine inches less than the ponds on the Northside. This is due to the crop coefficients for the area identified as ponds in the DWR land use survey in the Southside area being less than the pond area in the Northside area.

Table 5-5. Average Acreages and Annual Evapotranspiration Rates for YCWA Crops.

Crop	Average Acreage	Average Evapotranspiration (in)		
		ETpr	ETaw	ETc
Corn	277	9.2	27.7	36.9
Grain	1,524	9.8	19.2	29.0
Idle	958	10.2	0.0	10.2
Melons	40	9.0	24.0	32.9
Native Vegetation	12,843	13.3	0.0	13.3
Olives	93	9.0	16.3	25.3
Pasture	6,645	11.3	25.6	36.9
Pond (North)	803	11.9	37.4	49.3
Pond (South)	330	11.7	28.7	40.4
Prunes	4,271	11.2	26.5	37.7
Rice	38,899	6.7	41.7	48.4
Riparian	1,896	12.2	32.0	44.3
Urban	3,373	10.7	15.0	25.8
Walnuts	5,947	11.4	30.6	42.1
Wetlands	2,528	2.6	41.5	44.1
Totals	80,426	9.1	29.6	38.7

ET_c and ET_{aw} vary substantially between wet and dry years due to differences in overall evaporative demand and differences in the timing and amount of precipitation available to support crop growth and offset crop irrigation requirements. For the 2001 to 2014 period, Northside wet year ET_c averaged approximately 42.7 inches while dry year ET_c averaged 47.2 inches. Wet year ET_{aw} averaged 34.5 inches

[24] Crop ET values are presented in Table 5-4 on a calendar year basis to capture total ET_c, ET_{aw}, and ET_{pr} within YCWA member unit service areas. The vast majority of ET_c and ET_{aw} occur during the April to October irrigation season.

[25] May include uptake of shallow groundwater.

while dry year ET_{aw} averaged 40.9 inches. Similarly, Southside wet year ET_c averaged approximately 40.2 inches while dry year ET_c averaged 44.3 inches. Wet year ET_{aw} averaged 29.1 inches while dry year ET_{aw} averaged 35.7 inches.

On the Northside, annual crop ET varied between approximately 105,000 af and 130,000 af during the 2001 to 2014 period, with an average annual volume of 118,000 af. On average, approximately 101,000 af of ET were derived from applied irrigation water (85% of total ET), and 18,000 af of ET were derived from precipitation (15% of total ET).

On the Southside, annual crop ET varied between approximately 107,00 af and 131,000 af during the 2001 to 2014 period, with an average annual volume of 120,000 af. On average, approximately 94,000 af were derived from applied irrigation water (78% of total ET), and 26,000 af were derived from precipitation (22% of total ET).

Annual volumes of crop ET are provided in Section 5.8.

Note that the irrigated area on the Northside is about 3,000 acres less than the South, so when the slightly greater per area ET demand on the North is applied to a slightly smaller area the ET volume is about the same. The Northside has a greater percentage of ET derived from applied water because of a greater percentage of the area cropped with rice. The irrigation and cultural practices of rice production result in lower utilization of precipitation stored in the root zone during the growing season than other crops. This is not true during the fall decomposition period when precipitation is utilized to the maximum extent possible to keep many of the rice fields flooded.

Other uses of applied irrigation water include leaching of salts and frost protection for orchards. Due to the low salinity of YCWA irrigation water, the required leaching fraction is small for the crops grown in the service areas of the member units and has not been estimated as part of this Plan. Additionally, water applied for frost protection is typically applied outside of the irrigation season, is a minor use, and has not been estimated at this time.

5.6.2. Environmental

As noted previously, the Yuba River Accord provides required instream flows for fisheries. During a typical year, about 72% of the Yuba River total runoff volume remains in the stream and discharges to the Feather River. Approximately 4% of the total runoff volume is diverted by YCWA. A portion of the water diverted for irrigation also benefits riparian areas, wetlands and ponds. The remaining 24% of the total runoff volume is exported from the Yuba Basin by others (17%) or diverted by other water rights holders within the basin (7%).

5.6.3. Recreational

The District owns New Bullards Bar Dam and Reservoir that is managed for power generation, recreation and water sports. Water stored in the reservoir is not "used" for recreation, per se, as it is not consumed to support recreation activities. Rather, the storage of water in the reservoir supports recreation activities.

5.6.4. Municipal and Industrial

YCWA does not provide municipal or industrial water.

5.6.5 Groundwater Recharge

Groundwater recharge that occurs within YCWA member unit service areas consists of seepage from YCWA canals and from member unit laterals and drains and deep percolation of precipitation and applied irrigation water from member unit farmed lands. Distributed recharge through seepage and deep percolation provides a means to replenish the North and South Yuba Subbasins to the benefit of YCWA member unit water users, communities within YCWA, and surrounding areas that share the groundwater resource. As described in the YCWA Groundwater Management Plan (Attachment C), active management of Yuba County's water resources by YCWA and the member units has contributed to reversing potentially serious overdraft in the South Yuba Subbasin. Provision of surface water for irrigation beginning in 1984 reversed a decline in groundwater levels of approximately 130 feet.

Detailed estimates of recharge were developed as part of the water balance analysis. Specifically, canal and drain seepage estimates were calculated based on estimated soil hydraulic characteristics along with estimated canal and drain wetted perimeters, overall lengths, and wetting frequency. Deep percolation of applied irrigation water and precipitation were calculated using IDC. Seepage and deep percolation volumes for the 2001 to 2014 study period are provided in Tables 5-6a and 5-6b for the Northside and Southside areas, respectively, along with total recharge expressed as a volume and as a depth of water relative to the member unit cropped area in each year.

Table 5-6a. YCWA Northside Total Groundwater Recharge, 2001 to 2014.

Year	Yuba River Index	Hydrologic Year Type	Canal and Drain Seepage (af)	Deep Percolation of Precipitation (af)	Deep Percolation of Applied Water (af)	Total Recharge (af)	Total Recharge (af/ac)
2001	C	Dry	7,044	7,919	42,901	57,863	1.9
2002	C	Dry	6,648	7,012	40,256	53,916	1.7
2003	AN	Wet	6,549	7,279	36,637	50,465	1.6
2004	BN	Dry	7,090	7,555	42,313	56,958	1.8
2005	AN	Wet	6,290	9,623	39,880	55,793	1.8
2006	W	Wet	7,027	10,989	37,995	56,012	1.8
2007	D	Dry	5,743	3,621	37,098	46,462	1.5
2008	C	Dry	7,009	5,883	40,265	53,157	1.7
2009	BN	Dry	6,856	4,298	38,935	50,088	1.6
2010	BN	Dry	6,577	8,997	38,089	53,663	1.7
2011	W	Wet	6,868	8,804	36,945	52,617	1.7
2012	BN	Dry	6,600	6,917	36,869	50,385	1.6
2013	D	Dry	6,684	4,757	39,952	51,393	1.7
2014	C	Dry	5,841	5,402	39,656	50,898	1.6
		Minimum	5,743	3,621	36,637	46,462	1.5
		Maximum	7,090	10,989	42,901	57,863	1.9
		Wet Year Average	6,684	9,174	37,864	53,722	1.7
		Dry Year Average	6,609	6,236	39,633	52,478	1.7
		Overall Average	6,630	7,075	39,128	52,834	1.7

Table 5-6b. YCWA Southside Total Groundwater Recharge, 2001 to 2014.

Year	Yuba River Index	Hydrologic Year Type	Canal and Drain Seepage (af)	Deep Percolation of Precipitation (af)	Deep Percolation of Applied Water (af)	Total Recharge (af)	Total Recharge (af/ac)
2001	C	Dry	8,577	16,087	54,566	79,230	2.4
2002	C	Dry	8,017	15,128	51,262	74,407	2.2
2003	AN	Wet	7,735	14,742	45,393	67,871	2.0
2004	BN	Dry	8,674	16,112	52,018	76,804	2.3
2005	AN	Wet	7,994	20,037	49,845	77,875	2.3
2006	W	Wet	9,298	23,856	45,382	78,536	2.4
2007	D	Dry	7,997	6,653	42,454	57,103	1.7
2008	C	Dry	8,098	12,189	49,318	69,604	2.1
2009	BN	Dry	8,088	9,136	46,335	63,560	1.9
2010	BN	Dry	7,575	18,557	47,752	73,885	2.2
2011	W	Wet	9,293	18,216	42,925	70,434	2.1
2012	BN	Dry	8,491	14,240	48,489	71,221	2.1
2013	D	Dry	8,212	9,624	47,886	65,722	2.0
2014	C	Dry	8,729	10,632	50,414	69,775	2.1
		Minimum	7,575	6,653	42,454	57,103	1.7
		Maximum	9,298	23,856	54,566	79,230	2.4
		Wet Year Average	8,580	19,213	45,887	73,679	2.2
		Dry Year Average	8,246	12,836	49,049	70,131	2.1
		Overall Average	8,341	14,658	48,146	71,145	2.1

Total recharge between 2001 and 2014 on the Northside ranged from approximately 46,000 af to 58,000 af per year, or from 1.5 af to 1.9 af per acre per year. The overall average total deep percolation for the 2001 to 2014 period is 53,000 af per year (1.7 af/ac), with approximately 13% of recharge originating from canal and drain seepage, 13% of recharge originating from deep percolation of precipitation, and 74% of recharge originating from deep percolation of applied water. Wet year average total recharge is approximately 53,700 af (1.7 af/ac), and dry year average total recharge is 52,500 af (1.7 af/ac). There is not a substantial difference in total recharge in wet versus dry years.

On the Southside, total recharge between 2001 and 2014 ranged from approximately 57,000 af to 79,000 af per year, or from 1.7 af to 2.4 af per acre per year. The overall average total deep percolation for the 2001 to 2014 period is 71,000 af per year (2.1 af/ac), with approximately 12% of recharge originating from canal seepage, 21% of recharge originating from deep percolation of precipitation, and 68% of recharge originating from deep percolation of applied water. Wet year average total recharge is approximately 74,000 af (2.2 af/ac), and dry year average total recharge is 70,000 af (2.1 af/ac). Dry years average about 3,500 af less total recharge than wet years due to decreased deep percolation of precipitation as compared to wet years.

Deep percolation of applied water is often greater in dry years due to two primary factors. First, the irrigation season tends to begin earlier in dry years, resulting in an increased number of days during which irrigations occur. Second, increased crop irrigation requirements in dry years result in increased applied irrigation water and corresponding deep percolation of applied water not consumed by the crops. As expected there is less deep percolation of precipitation in dry years. Results show the increased deep percolation of applied water in dry years offsets for the reduced deep percolation of precipitation; thus, there is not a substantial difference in total recharge in dry years compared to wet years.

Groundwater recharge net of groundwater pumping[26] was calculated by subtracting pumping for groundwater substitution transfers and estimated additional private pumping volumes from total recharge volumes. Net recharge estimates for the study period are provided in Table 5-7a and 5-7b for the Northside and Southside areas, respectively.

Net recharge between 2001 and 2014 on the Northside ranged from approximately 6,300 af to 57,000 af per year, or from 0.2 af to 1.8 af per acre per year. The overall average net deep percolation for the 2001 to 2014 period is 34,000 af per year (1.1 af/ac). Wet year average net recharge is approximately 52,000 af (1.7 af/ac), and dry year average net recharge is 27,000 af (0.9 af/ac). Wet years average about 25,000 af more net recharge than dry years due to increased groundwater pumping as compared to wet years and decreased deep percolation of precipitation.

[26] Total groundwater pumping includes groundwater substitution transfer pumping and additional private pumping for irrigation.

Table 5-7a. YCWA Northside Net Groundwater Recharge, 2001 to 2014.

Year	Yuba River Index	Hydrologic Year Type	Total Recharge (af)	Groundwater Pumping (af)	Net Recharge (af)	Net Recharge (af/ac)
2001	C	Dry	57,863	51,528	6,335	0.2
2002	C	Dry	53,916	31,150	22,766	0.7
2003	AN	Wet	50,465	0	50,465	1.6
2004	BN	Dry	56,958	0	56,958	1.8
2005	AN	Wet	55,793	4,471	51,322	1.7
2006	W	Wet	56,012	3,000	53,012	1.7
2007	D	Dry	46,462	26,921	19,541	0.6
2008	C	Dry	53,157	27,636	25,521	0.8
2009	BN	Dry	50,088	35,901	14,187	0.5
2010	BN	Dry	53,663	15,627	38,036	1.2
2011	W	Wet	52,617	0	52,617	1.7
2012	BN	Dry	50,385	0	50,385	1.6
2013	D	Dry	51,393	29,653	21,740	0.7
2014	C	Dry	50,898	41,189	9,709	0.3
		Minimum	46,462	0	6,335	0.2
		Maximum	57,863	51,528	56,958	1.8
		Wet Year Average	53,722	1,868	51,854	1.7
		Dry Year Average	52,478	25,960	26,518	0.9
		Overall Average	52,834	19,077	33,757	1.1

Table 5-7b. YCWA Southside Net Groundwater Recharge, 2001 to 2014.

Year	Yuba River Index	Hydrologic Year Type	Total Recharge (af)	Groundwater Pumping (af)	Net Recharge (af)	Net Recharge (af/ac)
2001	C	Dry	79,230	59,772	19,458	0.6
2002	C	Dry	74,407	72,050	2,357	0.1
2003	AN	Wet	67,871	32,986	34,884	1.0
2004	BN	Dry	76,804	47,615	29,189	0.9
2005	AN	Wet	77,875	36,486	41,389	1.2
2006	W	Wet	78,536	33,986	44,550	1.3
2007	D	Dry	57,103	37,615	19,488	0.6
2008	C	Dry	69,604	65,966	3,638	0.1
2009	BN	Dry	63,560	90,269	-26,709	-0.8
2010	BN	Dry	73,885	73,976	-91	0.0
2011	W	Wet	70,434	20,178	50,257	1.5
2012	BN	Dry	71,221	21,606	49,614	1.5
2013	D	Dry	65,722	79,381	-13,658	-0.4
2014	C	Dry	69,775	77,884	-8,109	-0.2
		Minimum	57,103	20,178	-26,709	-0.8
		Maximum	79,230	90,269	50,257	1.5
		Wet Year Average	73,679	30,909	42,770	1.3
		Dry Year Average	70,131	62,613	7,518	0.2
		Overall Average	71,145	53,555	17,590	0.5

Net recharge between 2001 and 2014 on the Southside was substantially less than on the Northside, ranging from a net depletion of approximately 26,000 af (0.8 af/ac) in 2009 to net recharge of 50,000 af (1.5 af/ac) in 2011. The overall average net recharge for the 2001 to 2014 period is 18,000 af per year (0.5 af/ac). Wet year average net recharge is approximately 43,000 af (1.3 af/ac), and dry year average net recharge is 7,500 af (0.2 af/ac). Wet years average about 35,000 af more net recharge than dry years due to increased groundwater pumping and decreased deep percolation of precipitation as compared to wet years.

Net groundwater recharge tends to be less in dry years due to increased groundwater pumping and decreased deep percolation of precipitation. On the Northside, net wet year recharge averages approximately 52,000 af, while net dry year recharge averages approximately 27,000 af. Net wet year recharge on the Southside averages approximately 43,000 af, while net dry year recharge averages approximately 7,500 af. The relatively less net recharge in the Southside area reflects that many irrigators, particularly within Wheatland Water District, continue to rely on groundwater for irrigation. Relatively larger differences between wet year and dry year net recharge in the Southside area as compared to the Northside area likely reflect differences in both cropping and operational and irrigation practices.

5.6.6. Transfers and Exchanges

YCWA has participated in water transfers for several decades. Between 2001 and 2014, YCWA participated in twenty transfers, seven of which included groundwater substitution transfers (Tables 3-1 and 5-8). Over this period, YCWA and the member units made available a total of 1.57 million af of water available for transfer to numerous parties, including the State's Environmental Water Account, DWR, Contra Costa Water District, Yuba Accord water purchase participants, and Santa Clara Valley Water District. The average volume of water available for transfer in a given year was 112,000 af, ranging from 9,000 af to 191,000 af over the fourteen year period. Wet year transfer volumes averaged 36,000 af, while dry year transfer volumes averaged 143,000 af. Increased transfer volumes in dry years demonstrate the successful conjunctive management of the underlying groundwater system to supplement limited supplies in other areas to improve water supply reliability within the State.

Table 5-8. YCWA and Member Unit Water Transfer Volumes by Transfer Category, 2001 to 2014.

Year	Yuba River Index	Hydrologic Year Type	Transfer Category and Amount (af)			Total Transfer Volume (af)
			Stored Water	Groundwater Substitution	Other[1]	
2001	C	Dry	102,912	61,140	8,000	172,052
2002	C	Dry	106,792	55,258	0	162,050
2003	AN	Wet	70,000	0	3,100	73,100
2004	BN	Dry	100,487	0	3,100	103,587
2005	AN	Wet	6,086	0	3,100	9,186
2006	W	Wet	60,000	0	0	60,000
2007	D	Dry	65,000	0	3,100	68,100
2008	C	Dry	117,212	48,875	3,100	169,187
2009	BN	Dry	91,100	88,900	11,400	191,400
2010	BN	Dry	74,179	66,213	3,100	143,492
2011	W	Wet	0	0	0	0
2012	BN	Dry	81,681	0	0	81,681
2013	D	Dry	112,544	64,730	0	177,274
2014	C	Dry	104,663	56,984	0	161,647
TOTAL			1,092,656	442,100	38,000	1,572,756
Minimum			0	0	0	0
Maximum			117,212	88,900	11,400	191,400
Wet Year Average			34,022	0	1,550	35,572
Dry Year Average			95,657	44,210	4,543	143,047
Overall Average			78,047	31,579	3,455	112,340

1. Other includes transfers by individual member units, which may be based on stored water or groundwater substitution.

Groundwater substitution transfers are implemented by YCWA and the member units through pumping of groundwater for irrigation in lieu of using surface water from the Yuba River. The Yuba River water that would otherwise have been released and delivered to the member units by YCWA is stored in New Bullards Bar Reservoir. The stored water is released at a time when it can be delivered to the purchaser of the water, subject to purchaser demand and operational constraints. Planning for groundwater substitution transfers includes an assessment of groundwater conditions in the basin and determination of expected groundwater levels under various pumping scenarios. Planning commences early in the water year and continues through the winter and early spring. If it is determined that proposed transfers are not expected to result in either exceedance of the sustainable yield of the basin or substantial impacts to third parties, the transfer may be consummated. A substantial local benefit of transfers has been an improved understanding of groundwater basin conditions, including the development of relationships correlating groundwater pumping volumes to groundwater levels.

5.6.7. Other Water Uses

Other incidental uses of water within YCWA member unit service areas include watering of roads for dust abatement, agricultural spraying, and stock watering by member unit water users. The volume of water used for such purposes is small relative to other uses and has not been quantified as part of this AWMP.

5.7. DRAINAGE (§10826.B(6))

5.7.1. Tailwater

Runoff from precipitation and applied irrigation water is collected by member units in a system of distribution canals and laterals and constructed and natural drains that typically follow natural drainage paths. Tailwater, primarily from rice fields, flows into the distribution and drainage system comingling with the water diverted from the Yuba River for delivery to member units. This comingled Yuba River water and tailwater is delivered to member unit water users. Member units and individual water users rely on pumps located along these laterals/drains that are operated during the irrigation season to capture and reuse tailwater. The member unit farmed lands water balance is used to calculate the volume of tailwater entering the distribution and drainage system and available for reuse. Some tailwater leaves the member unit service areas and is available for reuse by downgradient water users. Tailwater leaving the member unit service areas is quantified as part of the spillage and tailwater outflow flow path discussed in the Section 5.7.2. Estimated tailwater volumes for the Northside and Southside areas between 2001 and 2014 are summarized in Tables 5-9a and 5-9b.

Table 5-9a. YCWA Northside Tailwater, 2001 to 2014.

Year	Yuba River Index	Hydrologic Year Type	Tailwater (af)
2001	C	Dry	47,239
2002	C	Dry	39,072
2003	AN	Wet	40,511
2004	BN	Dry	36,185
2005	AN	Wet	33,520
2006	W	Wet	39,420
2007	D	Dry	38,040
2008	C	Dry	39,145
2009	BN	Dry	34,648
2010	BN	Dry	36,472
2011	W	Wet	30,829
2012	BN	Dry	36,332
2013	D	Dry	37,824
2014	C	Dry	32,945
		Minimum	30,829
		Maximum	47,239
		Wet Year Average	36,070
		Dry Year Average	37,790
		Overall Average	37,299

Tailwater entering the distribution and drainage system between 2001 and 2014 in the Northside area ranged from approximately 31,000 af to 47,000 af per year. The overall average tailwater for the 2001 to 2014 period was 37,000 af per year. Wet year average tailwater was approximately 36,000 af, and dry year average tailwater was approximately 38,000 af.

Table 5-9b. YCWA Southside Tailwater, 2001 to 2014.

Year	Yuba River Index	Hydrologic Year Type	Tailwater (af)
2001	C	Dry	22,858
2002	C	Dry	20,223
2003	AN	Wet	19,577
2004	BN	Dry	21,892
2005	AN	Wet	25,214
2006	W	Wet	25,012
2007	D	Dry	22,289
2008	C	Dry	23,456
2009	BN	Dry	25,583
2010	BN	Dry	28,926
2011	W	Wet	29,109
2012	BN	Dry	25,900
2013	D	Dry	29,049
2014	C	Dry	28,765
		Minimum	19,577
		Maximum	29,109
		Wet Year Average	24,728
		Dry Year Average	24,894
		Overall Average	24,847

Tailwater entering the distribution and drainage system between 2001 and 2014 in the Southside area ranged from approximately 20,000 af to 29,000 af per year. The overall average tailwater for the 2001 to 2014 period was 25,000 af per year. Wet year and dry year average tailwater were essentially the same as the overall average of 25,000 af.

Tailwater production varies on a monthly basis based on irrigation practices. Tailwater within YCWA primarily reflects rice irrigation practices, described previously in Section 3.6.2. Estimated tailwater production for the Northside and Southside areas, expressed as a percentage of the average total annual volume for each area, respectively, are provided in Figure 5-6. As indicated, the relative portion of tailwater produced in a given month appears similar between areas, with the exception of July and August, when more tailwater is produced on the Southside, relative to the annual total for the area. Additionally, there is relatively greater tailwater production in the Northside than the Southside during the winter period.

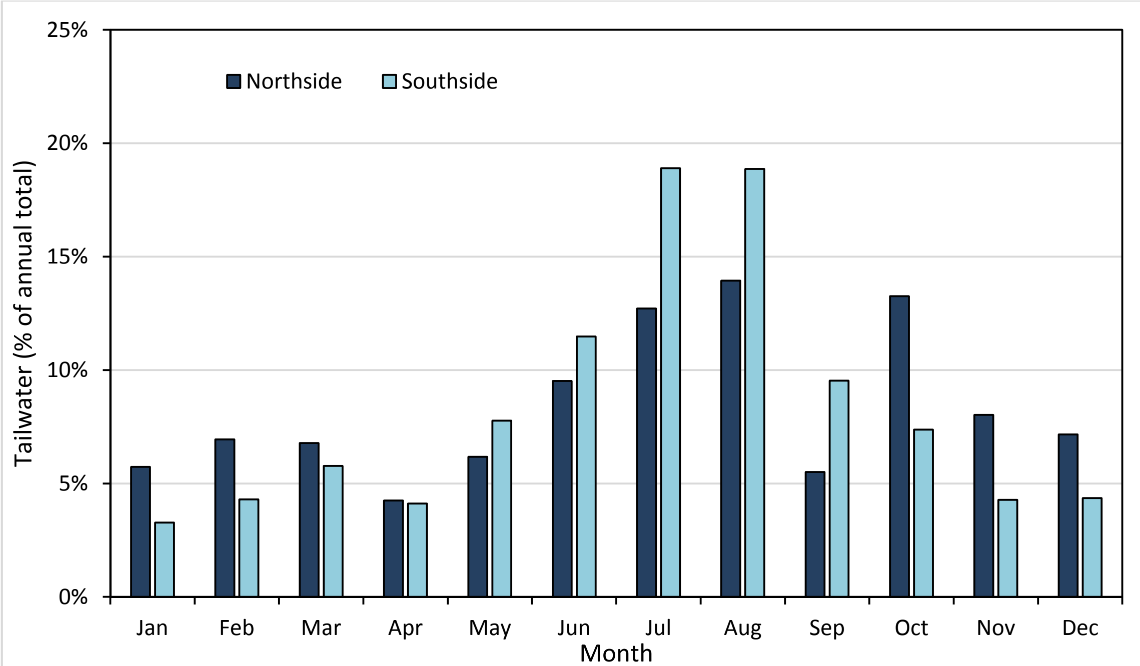

Figure 5-6. Estimated Average Monthly Tailwater Production as Percentage of Annual Total, 2001 to 2014.

5.7.2. Boundary Outflows

Estimated total boundary outflows[27] from YCWA for 2001 to 2014 are summarized in Tables 5-10a and 5-10b for the Northside and Southside areas, respectively.

Spillage and tailwater boundary outflows from the distribution and drainage system between 2001 and 2014 in the Northside area ranged from approximately 37,000 af to 72,000 af per year. The overall average boundary outflow for the 2001 to 2014 period was 56,000 af per year. Wet year average boundary outflows were approximately 60,000 af, and dry year average boundary outflows were approximately 54,000 af. Wet years averaged about 6,000 af more boundary outflow than dry years due to increased tailwater and runoff of precipitation.

Spillage and tailwater boundary outflows from the distribution and drainage system between 2001 and 2014 in the Southside area ranged from approximately 18,000 af to 43,000 af per year. The overall average boundary outflow for the 2001 to 2014 period was 28,000 af per year. Wet year average boundary outflows were approximately 32,000 af, and dry year average boundary outflows were approximately 26,000 af. Wet years averaged about 6,000 af more boundary outflow than dry years primarily due to increased runoff of precipitation.

[27] Surface water boundary outflows quantified as part of this AWMP include operational spillage, tailwater, and natural streamflow. Currently, only the minimum tributary inflows required to meet winter agronomic demands have been estimated. There may be substantial additional tributary inflows that pass through the distribution and drainage system and flow out of the member unit service areas during the rainy season. Since completion of the 2012 AWMP, YCWA has improved boundary inflow and outflow measurements to allow for quantification of these flows for potential inclusion in future water balance updates.

Table 5-10a. YCWA Northside Boundary Outflows, 2001 to 2014.

Year	Yuba River Index	Hydrologic Year Type	Spillage and Tailwater Boundary Outflow (af)
2001	C	Dry	71,734
2002	C	Dry	55,794
2003	AN	Wet	57,024
2004	BN	Dry	56,991
2005	AN	Wet	70,794
2006	W	Wet	63,319
2007	D	Dry	44,818
2008	C	Dry	50,933
2009	BN	Dry	49,537
2010	BN	Dry	65,041
2011	W	Wet	50,671
2012	BN	Dry	58,879
2013	D	Dry	37,313
2014	C	Dry	52,752
Minimum			37,313
Maximum			71,734
Wet Year Average			60,452
Dry Year Average			54,379
Overall Average			56,114

Table 5-10b. YCWA Southside Boundary Outflows, 2001 to 2014.

Year	Yuba River Index	Hydrologic Year Type	Spillage and Tailwater Boundary Outflow (af)
2001	C	Dry	27,555
2002	C	Dry	22,172
2003	AN	Wet	21,109
2004	BN	Dry	25,325
2005	AN	Wet	43,105
2006	W	Wet	30,354
2007	D	Dry	17,762
2008	C	Dry	22,041
2009	BN	Dry	27,931
2010	BN	Dry	37,892
2011	W	Wet	33,788
2012	BN	Dry	30,396
2013	D	Dry	20,122
2014	C	Dry	31,569
Minimum			17,762
Maximum			43,105
Wet Year Average			32,089
Dry Year Average			26,276
Overall Average			27,937

5.8. WATER ACCOUNTING (SUMMARY OF WATER BALANCE RESULTS) (§10826.B(7))

The Northside and Southside area water balance structures were shown previously in Figures 5-1a and 5-1b. The water balance was prepared for two accounting centers in each area: (1) the YCWA and member unit distribution and drainage systems and (2) member unit farmed lands. An accounting center representing the groundwater system is also included in Figures 5-1a and 5-1b to account for exchanges between the vadose zone and the underlying groundwater subbasins; however, a complete balance for the underlying aquifer has not been developed because not all subsurface inflows and outflows have been estimated. As depicted in Figures 5-1a and 5-1b, extensive interconnection occurs among the accounting centers due to recapture and reuse of water. Specifically, surface runoff of water applied to member unit farmed lands flows directly back into the distribution and drainage system and is available for recovery and reuse in many instances. Within the distribution and drainage system, reuse of water originating as surface runoff from farms is practiced extensively. This recovery and reuse results in higher levels of performance at the farm, member unit, and Agency scales than would otherwise occur.

The water balance is presented on an annual (calendar year) time step. Underlying the annual time step is a more detailed water balance in which all flow paths are determined on a monthly or more frequent time step. During the off season months tributary inflow is included when required to account for the ET_{aw} when precipitation is not sufficient to meet requirements as indicated by the root zone model. Thus, during the non-irrigation season, the water balance indicates the minimum unmeasured tributary inflow required to meet agronomic and other water demands.

Tabulated water balance results for calendar years 2001 through 2014 for the distribution and drainage system accounting center for the Northside and Southside areas are provided in Tables 5-11a and 5-11b, respectively. Water balance results for calendar years 2001 through 2014 for the farmed lands accounting center for the Northside and Southside areas are provided in Tables and 5-12a and 5-12b, respectively.

Table 5-11a. YCWA Northside Distribution and Drainage System Annual Water Balance Results, 2001 to 2014.

				Inflows (af)						Outflows (af)					Performance Indicators	
Year	Yuba River Index	Hydrologic Year Type	Number of Days	Yuba River Diversions	BVID/Collins Lake Irrigation Return Flows	Tributary Inflow	Precipitation	$Runoff_{precip}$	Tailwater	Deliveries to Member Units	Spillage and Tailwater Outflow	Seepage	Evaporation	Riparian ET	Delivery Fraction	Water Management Fraction
2001	C	Dry	160	149,678	1,700	4,590	610	32,741	47,239	154,268	71,734	7,044	1,302	2,212	1.03	0.99
2002	C	Dry	147	159,084	1,700	3,691	455	24,425	39,072	162,775	55,794	6,648	1,221	1,989	1.02	0.99
2003	AN	Wet	129	158,873	1,700	7,825	507	23,648	40,511	166,698	57,024	6,549	1,073	1,721	1.05	0.99
2004	BN	Dry	152	176,150	1,700	1,411	531	28,907	36,185	177,561	56,991	7,090	1,224	2,017	1.01	0.99
2005	AN	Wet	141	141,438	1,700	7,454	737	43,712	33,520	148,892	70,794	6,290	1,002	1,583	1.05	0.99
2006	W	Wet	134	157,133	1,700	6,296	588	31,746	39,420	163,429	63,319	7,027	1,158	1,949	1.04	0.99
2007	D	Dry	155	138,688	1,700	9,886	324	13,465	38,040	148,574	44,818	5,743	1,099	1,870	1.07	0.99
2008	C	Dry	159	160,844	1,700	4,292	387	20,023	39,145	165,136	50,933	7,009	1,258	2,055	1.03	0.99
2009	BN	Dry	149	139,953	1,700	745	414	22,707	34,648	140,698	49,537	6,856	1,145	1,931	1.01	0.98
2010	BN	Dry	130	138,357	1,700	1,983	701	35,527	36,472	140,340	65,041	6,577	1,064	1,717	1.01	0.99
2011	W	Wet	153	160,805	1,700	0	496	27,635	30,829	160,805	50,671	6,868	1,357	1,764	1.00	0.99
2012	BN	Dry	139	165,441	1,700	5,841	624	30,044	36,332	171,282	58,879	6,600	1,432	1,791	1.04	0.99
2013	D	Dry	147	155,261	1,700	11,866	181	7,875	37,824	167,127	37,313	6,684	1,518	2,065	1.08	0.98
2014	C	Dry	137	124,588	1,700	7,007	525	26,689	32,945	131,595	52,752	5,841	1,492	1,775	1.06	0.98
Minimum			129	124,588	1,700	0	181	7,875	30,829	131,595	37,313	5,743	1,002	1,583	1.00	0.98
Maximum			160	176,150	1,700	11,866	737	43,712	47,239	177,561	71,734	7,090	1,518	2,212	1.08	0.99
Wet Year Average			139	154,562	1,700	5,394	582	31,685	36,070	159,956	60,452	6,684	1,148	1,754	1.04	0.99
Dry Year Average			148	150,804	1,700	5,131	475	24,240	37,790	155,935	54,379	6,609	1,275	1,942	1.03	0.99
Overall Average			145	151,878	1,700	5,206	506	26,367	37,299	157,084	56,114	6,630	1,239	1,888	1.03	0.99

Table 5-11b. YCWA Southside Distribution and Drainage System Annual Water Balance Results, 2001 to 2014.

				Inflows (af)					Outflows (af)					Performance Indicators	
Year	Yuba River Index	Hydrologic Year Type	Number of Days	Yuba River Diversions	Tributary Inflow	Precip-itation	$Runoff_{precip}$	Tailwater	Deliveries to Member Units	Spillage and Tailwater Outflow	Seepage	Evaporation	Riparian ET	Delivery Fraction	Water Management Fraction
2001	C	Dry	148	97,755	14,126	767	16,832	22,858	111,881	27,555	8,577	1,636	2,688	1.14	0.97
2002	C	Dry	145	88,238	6,663	572	13,359	20,223	94,901	22,172	8,017	1,492	2,473	1.08	0.97
2003	AN	Wet	131	102,516	6,899	637	12,141	19,577	109,416	21,109	7,735	1,358	2,153	1.07	0.98
2004	BN	Dry	154	113,797	3,744	668	15,500	21,892	117,541	25,325	8,674	1,534	2,527	1.03	0.97
2005	AN	Wet	153	104,392	5,999	927	28,328	25,214	110,391	43,105	7,994	1,301	2,069	1.06	0.98
2006	W	Wet	158	118,151	7,489	739	18,103	25,012	125,640	30,354	9,298	1,607	2,594	1.06	0.98
2007	D	Dry	165	116,559	10,577	407	7,136	22,289	127,136	17,762	7,997	1,540	2,533	1.09	0.97
2008	C	Dry	166	100,028	10,104	486	10,259	23,456	110,132	22,041	8,098	1,551	2,512	1.10	0.97
2009	BN	Dry	139	72,361	5,699	521	13,666	25,583	78,060	27,931	8,088	1,353	2,397	1.08	0.97
2010	BN	Dry	131	77,732	4,105	881	18,996	28,926	81,836	37,892	7,575	1,266	2,070	1.05	0.97
2011	W	Wet	160	142,349	2,558	624	17,517	29,109	144,907	33,788	9,293	1,707	2,462	1.02	0.98
2012	BN	Dry	123	131,541	14,732	785	16,336	25,900	146,272	30,396	8,491	1,800	2,334	1.11	0.98
2013	D	Dry	141	95,824	12,674	228	3,570	29,049	108,498	20,122	8,212	1,909	2,603	1.13	0.97
2014	C	Dry	141	92,218	6,437	660	15,264	28,765	98,655	31,569	8,729	1,876	2,515	1.07	0.97
Minimum			123	72,361	2,558	228	3,570	19,577	78,060	17,762	7,575	1,266	2,069	1.02	0.97
Maximum			166	142,349	14,732	927	28,328	29,109	146,272	43,105	9,298	1,909	2,688	1.14	0.98
Wet Year Average			151	116,852	5,736	732	19,022	24,728	122,588	32,089	8,580	1,493	2,320	1.05	0.98
Dry Year Average			145	98,605	8,886	598	13,092	24,894	107,491	26,276	8,246	1,596	2,465	1.09	0.97
Overall Average			147	103,819	7,986	636	14,786	24,847	111,805	27,937	8,341	1,566	2,424	1.08	0.97

Table 5-12a. YCWA Northside Member Unit Laterals and Farmed Lands Annual Water Balance Results, 2001 to 2014.

				Inflows (af)				Outflows (af)						Change in Storage (af)		Performance Indicators	
Year	Yuba River Index	Hydro-logic Year Type	Number of Days	Deliveries to Member Units	Groundwater Substitution	Private Ground-water	Precip-itation	Crop ET_{aw}	Crop ET_{pr}	Tailwater	$Runoff_{precip}$	Deep $Percolation_{aw}$	Deep $Percolation_{precip}$	Change in Storage of Precipitation	Change in Rice Pond Storage	Surface Water Supply Fraction	Crop Consumptive Use Fraction
2001	C	Dry	160	154,268	46,528	5,000	62,232	113,322	16,367	47,239	32,741	42,901	7,919	5,206	2,334	0.75	0.55
2002	C	Dry	147	162,775	31,150	0	46,365	107,424	17,920	39,072	24,425	40,256	7,012	-2,992	7,173	0.84	0.55
2003	AN	Wet	129	166,698	0	0	51,697	88,774	20,317	40,511	23,648	36,637	7,279	453	775	1.00	0.53
2004	BN	Dry	152	177,561	0	0	54,196	102,475	15,514	36,185	28,907	42,313	7,555	2,220	-3,411	1.00	0.58
2005	AN	Wet	141	148,892	0	4,471	75,228	85,582	19,572	33,520	43,712	39,880	9,623	2,320	-5,619	0.97	0.56
2006	W	Wet	134	163,429	0	3,000	59,979	90,601	23,127	39,420	31,746	37,995	10,989	-5,884	-1,586	0.98	0.54
2007	D	Dry	155	148,574	0	26,921	33,022	110,065	15,375	38,040	13,465	37,098	3,621	561	-9,708	0.85	0.63
2008	C	Dry	159	165,136	27,636	0	39,462	109,661	14,148	39,145	20,023	40,265	5,883	-592	3,701	0.86	0.57
2009	BN	Dry	149	140,698	35,901	0	42,244	104,023	15,539	34,648	22,707	38,935	4,298	-300	-1,007	0.80	0.59
2010	BN	Dry	130	140,340	15,627	0	71,506	91,153	20,910	36,472	35,527	38,089	8,997	6,072	-9,745	0.90	0.58
2011	W	Wet	153	160,805	0	0	50,655	90,435	21,567	30,829	27,635	36,945	8,804	-7,350	2,596	1.00	0.56
2012	BN	Dry	139	171,282	0	0	63,696	97,855	18,656	36,332	30,044	36,869	6,917	8,079	226	1.00	0.57
2013	D	Dry	147	167,127	29,653	0	18,508	109,247	15,194	37,824	7,875	39,952	4,757	-9,318	9,758	0.85	0.56
2014	C	Dry	137	131,595	15,189	26,000	53,515	109,175	12,875	32,945	26,689	39,656	5,402	8,548	-8,993	0.76	0.63
Minimum			129	131,595	0	0	18,508	85,582	12,875	30,829	7,875	36,637	3,621	-9,318	-9,745	0.75	0.53
Maximum			160	177,561	46,528	26,921	75,228	113,322	23,127	47,239	43,712	42,901	10,989	8,548	9,758	1.00	0.63
Wet Year Average			139	159,956	0	1,868	59,390	88,848	21,146	36,070	31,685	37,864	9,174	-2,615	-958	0.99	0.55
Dry Year Average			148	155,935	20,168	5,792	48,475	105,440	16,250	37,790	24,240	39,633	6,236	1,748	-967	0.86	0.58
Overall Average			145	157,084	14,406	4,671	51,593	100,699	17,649	37,299	26,367	39,128	7,075	502	-965	0.90	0.57

Table 5-12b. YCWA Southside Member Unit Laterals and Farmed Lands Annual Water Balance Results, 2001 to 2014.

				Inflows (af)				Outflows (af)						Change in Storage (af)		Performance Indicators	
Year	Yuba River Index	Hydro-logic Year Type	Number of Days	Deliveries to Member Units	Groundwater Substitution	Private Ground-water	Precip-itation	Crop ET_{aw}	Crop ET_{pr}	Tailwater	$Runoff_{precip}$	Deep $Percolation_{aw}$	Deep $Percolation_{precip}$	Change in Storage of Precipitation	Change in Rice Pond Storage	Surface Water Supply Fraction	Crop Consumptive Use Fraction
2001	C	Dry	148	111,881	19,157	40,615	67,044	106,140	24,400	22,858	16,832	54,566	16,087	9,724	-11,910	0.65	0.62
2002	C	Dry	145	94,901	25,935	46,115	49,950	99,169	27,147	20,223	13,359	51,262	15,128	-5,684	-3,704	0.57	0.59
2003	AN	Wet	131	109,416	0	32,986	55,694	81,739	28,384	19,577	12,141	45,393	14,742	427	-4,307	0.77	0.57
2004	BN	Dry	154	117,541	0	47,615	58,386	95,020	24,158	21,892	15,500	52,018	16,112	2,616	-3,774	0.71	0.58
2005	AN	Wet	153	110,391	0	36,486	81,043	78,197	28,654	25,214	28,328	49,845	20,037	4,024	-6,379	0.75	0.53
2006	W	Wet	158	125,640	0	33,986	64,615	82,166	33,500	25,012	18,103	45,382	23,856	-10,843	7,067	0.79	0.51
2007	D	Dry	165	127,136	0	37,615	35,575	104,100	22,494	22,289	7,136	42,454	6,653	-706	-4,093	0.77	0.63
2008	C	Dry	166	110,132	22,351	43,615	42,513	102,549	22,090	23,456	10,259	49,318	12,189	-2,025	776	0.63	0.58
2009	BN	Dry	139	78,060	63,774	26,495	45,510	97,734	23,175	25,583	13,666	46,335	9,136	-466	-1,322	0.46	0.58
2010	BN	Dry	131	81,836	52,534	21,442	77,034	83,579	29,567	28,926	18,996	47,752	18,557	9,914	-4,445	0.53	0.54
2011	W	Wet	160	144,907	0	20,178	54,571	81,081	32,318	29,109	17,517	42,925	18,216	-13,480	11,968	0.88	0.49
2012	BN	Dry	123	146,272	0	21,606	68,621	92,620	25,622	25,900	16,336	48,489	14,240	12,423	870	0.87	0.55
2013	D	Dry	141	108,498	49,778	29,602	19,938	103,942	22,473	29,049	3,570	47,886	9,624	-15,729	7,002	0.58	0.55
2014	C	Dry	141	98,655	47,328	30,556	57,652	104,578	18,518	28,765	15,264	50,414	10,632	13,238	-7,217	0.56	0.59
Minimum			123	78,060	0	20,178	19,938	78,197	18,518	19,577	3,570	42,454	6,653	-15,729	-11,910	0.46	0.49
Maximum			166	146,272	63,774	47,615	81,043	106,140	33,500	29,109	28,328	54,566	23,856	13,238	11,968	0.88	0.63
Wet Year Average			151	122,588	0	30,909	63,981	80,796	30,714	24,728	19,022	45,887	19,213	-4,968	2,087	0.80	0.53
Dry Year Average			145	107,491	28,086	34,528	52,222	98,943	23,964	24,894	13,092	49,049	12,836	2,330	-2,782	0.63	0.58
Overall Average			147	111,805	20,061	33,494	55,582	93,758	25,893	24,847	14,786	48,146	14,658	245	-1,391	0.68	0.57

5.8.1. Distribution and Drainage System Water Balance

Inflows to the YCWA and member unit distribution and drainage systems include Yuba River diversions, return flows from BVID/Collins Lake[28], tributary inflows, precipitation, and tailwater. Outflows include deliveries to member units, spillage and tailwater outflows, seepage, evaporation, and riparian ET. These flow paths are quantified in Tables 5-11a and 5-11b for the Northside and Southside areas, respectively, and are discussed in this section. Also, performance indicators are described and discussed for each area.

Surface water diversions are reduced in groundwater substitution transfer years as compared to other years. Diversions are not necessarily reduced by the amount of groundwater pumped for transfer. Reductions in surface water inflows from the Yuba River and member unit deliveries in groundwater substitution transfer years reflect groundwater substitution but are offset to some extent by increased in irrigation demands resulting from reduced precipitation and increased evaporative demand.

Inflows

Over the 2001 to 2014 period, Northside area distribution and drainage system total inflows from the Yuba River ranged from approximately 125,000 af to 176,000 af per year with wet and dry year averages area 155,000 af and 151,000 af, respectively. The overall average for the fourteen year period is 152,000 af. Southside area distribution and drainage system total inflows from the Yuba River between 2001 and 2014 ranged from approximately 72,000 af to 142,000 af per year with wet and dry year averages of 117,000 af and 99,000 af, respectively. The overall average for the fourteen year period was approximately 104,000 af. As for the Northside area, surface water inflows from the Yuba River to the Southside area reflect the partially offsetting effects of increased irrigation demand in dry years and groundwater pumping in lieu of surface water use.

In addition to the Yuba River, sources of supply for YCWA and the member units include BVID return flows (Northside only), tributary inflows, groundwater pumping for substitution transfers (see Section 5.8.2); other private groundwater pumping (see Section 5.8.2), either where surface water is not available (e.g., portions of WWD), or to supplement surface supplies; tailwater recovery and reuse; and precipitation entering the distribution and drainage system directly or as runoff.

Return flows to the Northside area distribution and drainage system were estimated to be approximately 1,700 af per year. Minimum tributary inflows required to meet winter demands were estimated to range from approximately 0 to 12,000 af per year for the Northside area with an overall average of 5,000 af, a wet year average of 5,400 af, and a dry year average of 5,100 af. In the Southside area, minimum tributary inflows ranged from approximately 2,500 af to 15,000 af with an overall average of 8,000 af. Wet year and dry year average tributary inflow for the Southside is 5,700 af and 8,900 af, respectively.

Between 2001 and 2014, tailwater return flows to the distribution and drainage system in the Northside area varied from approximately 31,000 af to 47,000 af per year with an overall average of 37,000 af per year. Tailwater in wet years averaged approximately 36,000 acre-feet in wet years compared to 38,000 af in dry years. In the Southside area, tailwater return flows varied from approximately 20,000 af to 29,000 af per year with an overall average of 25,000 ac-ft per year. Tailwater was nearly the same in wet and dry years, at approximately about 25,000 af.

[28] Northside area only.

YCWA plans to continue to improve its boundary flow measurements in the future to better account for tributary inflows. Additional detail describing YCWA's Flow Measurement Improvement Plan is provided in Attachment E.

Precipitation entering the Northside area distribution and drainage system directly or as runoff from adjacent lands ranged from approximately 8,000 af to 44,000 af annually with an overall average of 27,000 af, a wet year average of 32,000 af, and a dry year average of 25,000 af. Precipitation entering the Southside area distribution and drainage system directly or as runoff from adjacent lands ranged from approximately 4,000 af to 29,000 af annually with an overall average of 15,000 af, a wet year average of 20,000 af, and a dry year average of 14,000 af.

Outflows

The primary outflows from the distribution and drainage system are the deliveries to member units. Additional outflows, which may be considered losses at the distribution and drainage system scale include spillage and tailwater outflows, seepage, evaporation, and riparian ET. The primary loss, spillage and tailwater outflow, is available for reuse by downgradient water users. Seepage from canals and drains provides beneficial recharge of the underlying aquifer. Of the distribution and drainage system losses, only evaporation and riparian ET are irrecoverable.

Over the 2001 to 2014 period, YCWA Northside member unit deliveries ranged from 132,000 af to 178,000 af for the calendar with a wet year average of 160,000 af and a dry year average of 156,000 af. The overall average for the fourteen year period was 157,000 af. In the Southside area, deliveries ranged from 78,000 af to 146,000 af with an overall average of 112,000 af, a wet year average of 123,000 af, and a dry year average of 107,000 af. As discussed previously, reduced deliveries resulting from in lieu use of groundwater during groundwater substitution transfer year, which tend to be dry years, are offset in part by increased crop irrigation demands resulting from decreased precipitation and increased evaporative demand.

Northside spillage and tailwater outflow varied from 37,000 af to 72,000 af between 2001 and 2014 with an overall average of 56,000 af per year, a wet year average of 60,000 af, and a dry year average of 54,000 af. Spillage and tailwater outflow in the Southside area varied from 18,000 af to 43,000 af with an overall average of 28,000 af per year, a wet year average of 32,000 af, and a dry year average of 26,000 af. Spillage and tailwater outflows tend to be less in dry years due to increased effort to prevent spillage and tailwater to conserve available surface water supplies.

Northside seepage was approximately 6,600 af per year for the fourteen-year period from 2001 to 2014 and varies little from year to year. Southside seepage was approximately 8,300 af per year and is also similar from year to year. Both estimates of seepage are based on a canal seepage coefficient of 0.06 feet per day calculated from NRCS soils data. This is a very low seepage rate compared to rates for agricultural canals and drains in other areas. This topic is discussed in Chapter 7 in the context of efficient water management practices.

Evaporation losses and riparian ET are relatively small and constant over time. Variations from year to year result primarily from differences in irrigation season length and evaporative demand (i.e., weather) over time. Between 2001 and 2014, evaporation losses were approximately 1,200 af in the Northside area and 1,600 af in the Southside area. Evaporation and riparian ET are estimated to be greater in the Southside area due to a greater length of the YCWA and member unit distribution and drainage system, as compared to the Northside.

Performance Indicators

The objective of YCWA and member unit operation of the distribution and drainage system is to meet irrigation demands. Comparing total deliveries to meet irrigation demand to Yuba River diversions provides a measure of the effectiveness of system operation to meet demands. A Delivery Fraction (DF), representing the ratio of deliveries to diversions may be calculated to provide an indicator of distribution and drainage system performance (Equation 5-3)[29].

Delivery Fraction = Deliveries to Member Units / Yuba River Diversions [5-3]

The DF reflects the impact of seepage and spillage that occurs in the delivery system prior to water delivery, the reuse of water supply, and the use of incidental water sources on the amount of water ultimately delivered to irrigation customers. For the Northside area, the DF ranged from 1.00 to 1.08 between 2001 and 2014 with an overall average of 1.03, a wet year average of 1.04, and a dry year average of 1.03. For the Southside area, the DF ranged from 1.02 to 1.14 with an overall average of 1.08, a wet year average of 1.05, and a dry year average of 1.09. DF values greater than 1.00 reflect the fact that YCWA and the member units utilize incidental sources of supply other than Yuba River diversions to meet irrigation demands including tailwater, tributary inflows, and precipitation.

Comparing total inflows to the YCWA and member unit distribution and drainage systems to total outflows to meet irrigation demands plus recoverable losses to seepage and spillage, a Water Management Fraction (WMF) may be calculated as an indicator of the amount of the total water supply not lost irrecoverably to evaporation or riparian ET (Equation 5-4).

Water Management Fraction =

(Deliveries to Member Units + Spillage and Tailwater Outflow + Seepage) / [5-4]

(Yuba River Diversions + Tributary Inflows[30] + Precipitation[31] + Tailwater)

Over the period from 2001 to 2014, the WMF was approximately 0.99 for the Northside area and 0.97 for the Southside area, indicating that essentially all available surface water supply is used to meet irrigation demands or is recoverable by downgradient surface water and groundwater users.

5.8.2. Farmed Lands Water Balance

Inflows to the member unit farmed lands include deliveries to member units[32], groundwater from private wells, and precipitation. Outflows include crop ET, tailwater, runoff of precipitation, and deep

[29] Although the surface water supply includes sources other than river diversions (e.g., precipitation inflows), the DF is calculated to include only diversions as this is the portion of surface water supply directly managed by YCWA and the MUs.

[30] In the Northside area, BVID/Collins Lake irrigation return flows are also included.

[31] Includes direct precipitation and runoff of precipitation entering the distribution and drainage system from adjacent lands).

percolation. These flow paths are quantified in Tables 5-12a and 5-12b for the Northside and Southside areas, respectively, and are discussed in this section. Also, performance indicators are described and discussed for each area.

Inflows

Over the 2001 to 2014 period, YCWA Northside member unit deliveries ranged from 132,000 af to 178,000 af for the calendar with a wet year average of 160,000 af and a dry year average of 156,000 af. The overall average for the fourteen year period was 157,000 af. In the Southside area, deliveries ranged from 78,000 af to 146,000 af with an overall average of 112,000 af, a wet year average of 123,000 af, and a dry year average of 107,000 af. As discussed previously, reduced deliveries resulting from in lieu use of groundwater during groundwater substitution transfer year, which tend to be dry years, are offset in part by increased crop irrigation demands resulting from decreased precipitation and increased evaporative demand.

Groundwater substitution in the Northside area ranged from 0 af to 47,000 af between 2001 and 2014 with an overall average of 14,000 af. Wet year and dry year average groundwater substitution pumping volumes were 0 af and 20,000 af, respectively. In the Southside area, groundwater substitution ranged from 0 af to 64,000 af between 2001 and 2014 with an overall average of 20,000 af. Wet year and dry year average groundwater substitution pumping volumes were 0 af and 28,000 af, respectively. As discussed previously in Section 5.8, groundwater substitution pumping and associated transfers in dry years supplement limited supplies in other areas to improve water supply reliability within the State as a whole.

Other private pumping where surface water is not available or to supplement surface water supplies was negligible in the Northside area for nine of the fourteen years evaluated, reflecting strong reliance on and access to Yuba River surface water supplies. Overall average private pumping in the Northside area was 1,600 af. Average wet and dry year pumping is 2,000 af and 6,000 af, respectively; suggesting growers rely more on groundwater during dry years than wet years. In the Southside area, private pumping other than for groundwater substitution is greater than for the Northside because the Wheatland Water District did not begin receiving surface water in substantial amounts until 2010 (Table 5-11b). Private pumping in the Southside area ranged from approximately 20,000 af to 48,000 af between 2001 and 2014 with an overall average of about 33,000 af. Pumping was similar in wet and dry years, averaging 31,000 af and 35,000 af, respectively.

The estimated contribution of precipitation to the YCWA member unit water supply, although small during the irrigation season, becomes significant when viewed on an annual basis. In the Northside area, precipitation ranged from 19,000 af to 75,000 af between 2001 and 2014, with an overall average of 52,000 af. The wet year average was 59,000 af, and the dry year average was 48,000 af. Precipitation volumes in the Southside area are similar ranging from 20,000 af to 81,000 af between 2001 and 2014, with an overall average of 56,000 af annually. The wet year average was 64,000 af, and the dry year average was 52,000 af. Much of the precipitation falling on farmed lands runs off into the distribution and drainage system and leaves the member unit service areas as spillage. The amount of precipitation

[32] As described previously, deliveries to member units include Yuba River diversions, as well as other inflows to the distribution and drainage system, including tributary inflows, tailwater, and precipitation.

stored in the root zone and available to support crop ET was described previously in Section 5.6.1 and is discussed with respect to the water balance below.

Outflows

The primary outflow from the farmed lands accounting centers is ET_{aw}. Northside ET_{aw} varied from 86,000 af to 113,000 af between 2001 and 2014 with an overall average of 101,000 af per year, a wet year average of 89,000 af, and a dry year average of 105,000 af. ET_{aw} in the Southside area varied from 78,000 af to 106,000 af with an overall average of 94,000 af per year, a wet year average of 81,000 af, and a dry year average of 99,000 af. ET_{aw} is less in wet years due to additional precipitation available to meet crop irrigation demands and reduced evaporative demand.

Northside ET_{pr} varied from 13,000 af to 23,000 af between 2001 and 2014 with an overall average of 18,000 af per year, a wet year average of 21,000 af, and a dry year average of 16,000 af. ET_{pr} in the Southside area varied from 19,000 af to 34,000 af with an overall average of 26,000 af per year, a wet year average of 31,000 af, and a dry year average of 24,000 af. ET_{pr} is greater in wet years due to additional precipitation available to meet crop irrigation demands and reduced evaporative demand. ETpr is greater in the Southside area as compared to the Northside due primarily to differences in cropping and total acreage.

Tailwater for the Northside area ranged from 31,000 af to 47,000 af between 2001 and 2014 with an overall average of 37,000 af per year, a wet year average of 36,000 af, and a dry year average of 38,000 af. In the Southside area, tailwater varied from 20,000 af to 29,000 af with an overall average of 25,000 af per year. Wet and dry year averages were also 25,000 af for the Southside area. As discussed in Section 5.8.1, For purposes of the water balance analysis, it was assumed that tributary inflows are negligible, unless required to meet irrigation demand.

Runoff of precipitation in the Northside varied from 8,000 af to 44,000 af between 2001 and 2014 with an overall average of 26,000 af per year, a wet year average of 32,000 af, and a dry year average of 24,000 af. Precipitation runoff in the Southside area varied from 4,000 af to 28,000 af with an overall average of 15,000 af per year, a wet year average of 19,000 af, and a dry year average of 13,000 af. Runoff is greater in wet years due to additional precipitation.

Deep percolation of applied water for the Northside area ranged from 37,000 af to 43,000 af between 2001 and 2014 with an overall average of 39,000 af per year, a wet year average of 38,000 af, and a dry year average of 40,000 af. In the Southside area, deep percolation of applied water varied from 42,000 af to 55,000 af with an overall average of 48,000 af per year. Wet and dry year averages were 46,000 af and 49,000 af, respectively, for the Southside area.

Northside deep percolation of precipitation varied from 4,000 af to 11,000 af between 2001 and 2014 with an overall average of 7,000 af per year, a wet year average of 9,000 af, and a dry year average of 6,000 af. Deep percolation of precipitation in the Southside area varied from 7,000 af to 24,000 af with an overall average of 15,000 af per year, a wet year average of 19,000 af, and a dry year average of 13,000 af. Deep percolation of precipitation is greater in wet years due to increased precipitation.

Losses from the farmed lands include tailwater (flowing into the distribution and drainage system) 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. See the discussion in the previous section for more information on tailwater inflows.

Performance Indicators

Comparing total surface water supply (other than precipitation falling on farmed lands) to total irrigation supply including groundwater pumping, a surface water supply fraction (SWSF) may be calculated as an indicator of the relative amount of the total irrigation supply derived from surface water (Equation 5-5).

Surface Water Supply Fraction =

Deliveries to Member Units / (Deliveries to Member Units + [5-4]

Groundwater Substitution Pumping + Other Private Pumping)

For the Northside area, the SWSF ranged from 0.75 to 1.00 between 2001 and 2014 with an overall average of 0.90, a wet year average of 0.99, and a dry year average of 0.86. For the Southside area, the SWSF ranged from 0.46 to 0.88 with an overall average of 0.68, a wet year average of 0.80, and a dry year average of 0.63. Greater SWSF values in wet years than dry years reflect relatively greater reliance on surface water supplies in wet years and relatively greater reliance on groundwater in lieu of surface water in dry years as part of groundwater substitution transfers and private pumping. The relatively greater average SWSF for the Northside area than the Southside area reflects the continued reliance on groundwater as a sole source of supply for some Southside areas, primarily within WWD.

Comparing crop ET_{aw} to total irrigation supplies, a crop consumptive use fraction (CCUF) may be calculated as an indicator of the relative amount of applied irrigation water consumed to grow the crop (Equation 5-5).

Crop Consumptive Use Fraction =

Crop ET of Applied Water / (Deliveries to Member Units + [5-4]

Groundwater Substitution Pumping + Other Private Pumping)

For the Northside area, the CCUF ranged from 0.53 to 0.63 between 2001 and 2014 with an overall average of 0.57, a wet year average of 0.55, and a dry year average of 0.58. For the Southside area, the CCUF ranged from 0.49 to 0.63 with an overall average of 0.57, a wet year average of 0.53, and a dry year average of 0.58. Similar CCUF values in wet and dry years indicate that farm irrigation practices are not greatly affected by wet vs. dry year hydrology or by substitution of groundwater for surface water during substitution transfer years. Relatively similar average CCUF values between the Northside and Southside areas suggest that farm irrigation practices do not differ greatly between the two areas.

5.9. WATER SUPPLY RELIABILITY (§10826.B(8))

YCWA member units require a reliable water supply to meet crop irrigation demands. Crop acreages and crop types do not vary substantially from year to year. The primary drivers of crop irrigation demand on an annual basis are precipitation and evaporative demand; however the effectiveness of precipitation to support the growth of rice, the area's primary crop, is limited due to rice being a ponded crop. YCWA and member unit surface water supplies are highly reliable as a result of the Yuba Accord and senior water rights. Deficiencies in surface water supplies are compensated for through conjunctive use of groundwater. The reliability of YCWA's water supplies is discussed in detail in Chapter 4.

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CHAPTER 6.0 - CLIMATE CHANGE (§10826.C)

6.1. INTRODUCTION

Climate change has the potential to directly impact the Agency's surface water supply and to indirectly impact groundwater supplies. The Agency is committed to adapting to climate change in a manner that protects the water resources for the maximum benefit of Yuba County while continuing to provide excellent service to the MUs and maintaining flood safety. This chapter includes a discussion of the potential effects of climate change on the Agency and its water supply, followed by a description of the resulting potential impacts on water supply, water quality, water demand, and flood protection. Finally, actions currently underway or that could be implemented to help mitigate future impacts are identified.

6.2. 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. YCWA is not located in the Sacramento-San Joaquin River Delta. As a result, this discussion of climate change focuses on climate change effects and impacts related to the Agency's water supply, water quality, water demand, and flood protection and does not discuss potential effects of rising sea level.

6.2.1. Sources of Information Describing Potential Climate Change Effects

Existing historical records and projections of future hydrology can be used to evaluate potential climate change effects. For this AWMP, historical full natural flow in Yuba River at Smartsville below Englebright Dam from 1901 to 2015 is evaluated. Unimpaired Yuba River flows were obtained from the California Data Exchange Center (CDEC).

To provide additional information describing potential future changes in the hydrology of the Yuba River watershed, projected future flows in the Feather River at Oroville are also presented as projections for the Yuba River are not available at this time. The Yuba River may experience similar relative effects of climate change based on the proximity of its watershed to the Feather River Watershed. Projected future flows were obtained from recent projections developed using Global Climate Models (GCMs) reported by USBR (USBR 2011).

Finally, results of 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) and irrigation water requirements.

6.2.2. Summary of Potential Climate Change Effects

<u>Changes in Timing of Runoff.</u> Some climate change effects are suggested by available data describing unimpaired River flows from 1900 to 2015 at the Yuba River at Smartsville, below Englebright Dam.

Over the last 100 years, April to July unimpaired runoff as a percentage of total water year flows shows a decreasing trend (Figure 6-1), suggesting that more runoff is occurring during the winter period and less during the irrigation season. This trend may continue over the next century.

Changes in Total Runoff. Total water year runoff may have also decreased during this period, as shown in Figure 6-2. The trend line suggests a decrease of approximately 300,000 af between 1900 and 2015, or about thirteen percent. Recent projections reported by USBR for the Feather River at Oroville suggest that total runoff could decrease over the next 100 years (USBR 2011), as well, as shown in Figure 6-3. The figure shows the 5th percentile, median, and 95th percentile annual Feather River runoff at Oroville for 2010 to 2100 based on 112 separate hydrologic projections. Over the next 100 years, the projections suggest an average decrease in total water year runoff for the Feather River of approximately seven percent.

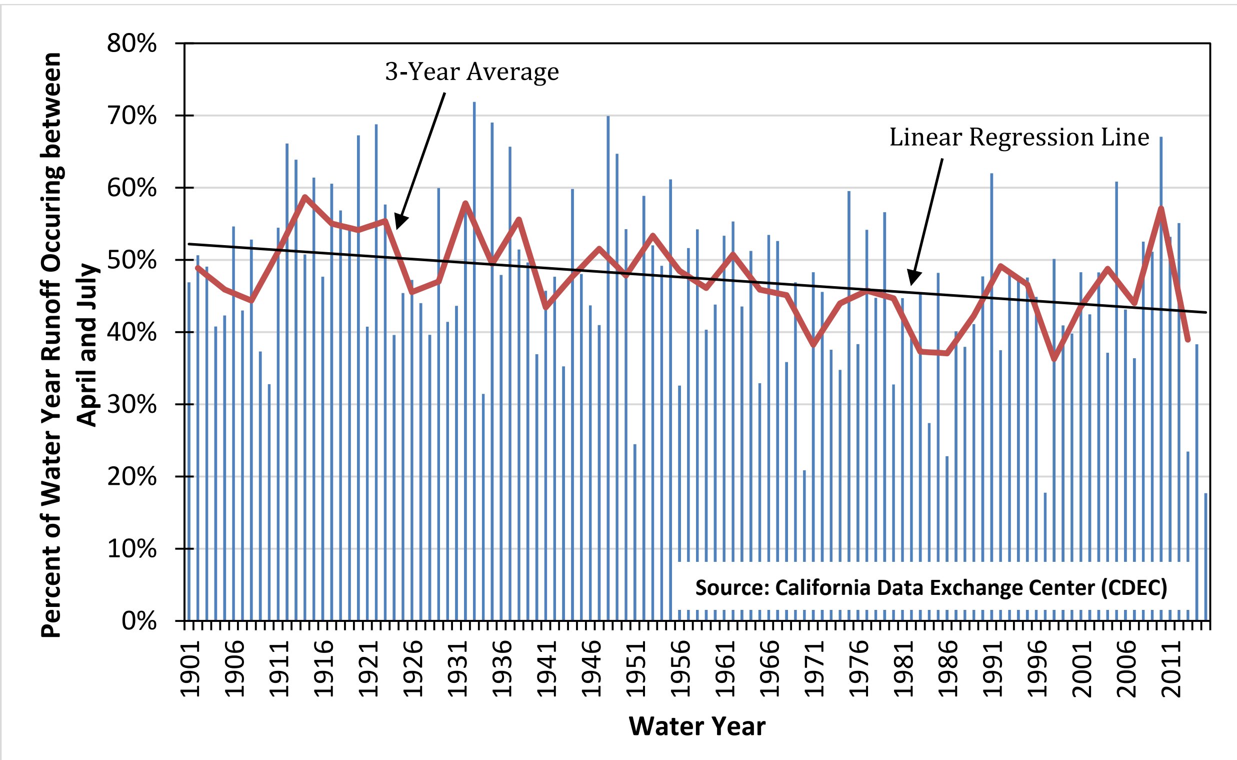

Figure 6-1. Annual April through July Unimpaired Runoff for Yuba River at Smartsville as Percentage of Total Water Year Runoff.

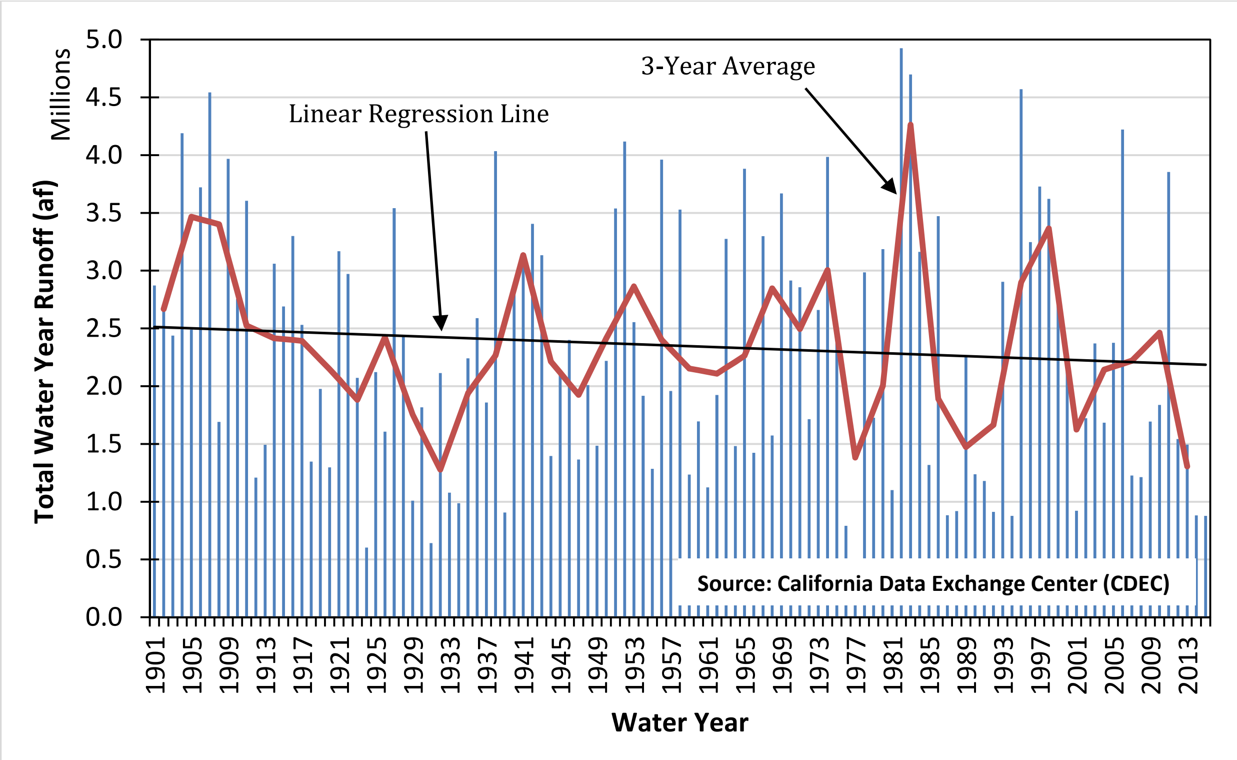

Figure 6-2. Total Water Year Runoff for Yuba River at Smartsville.

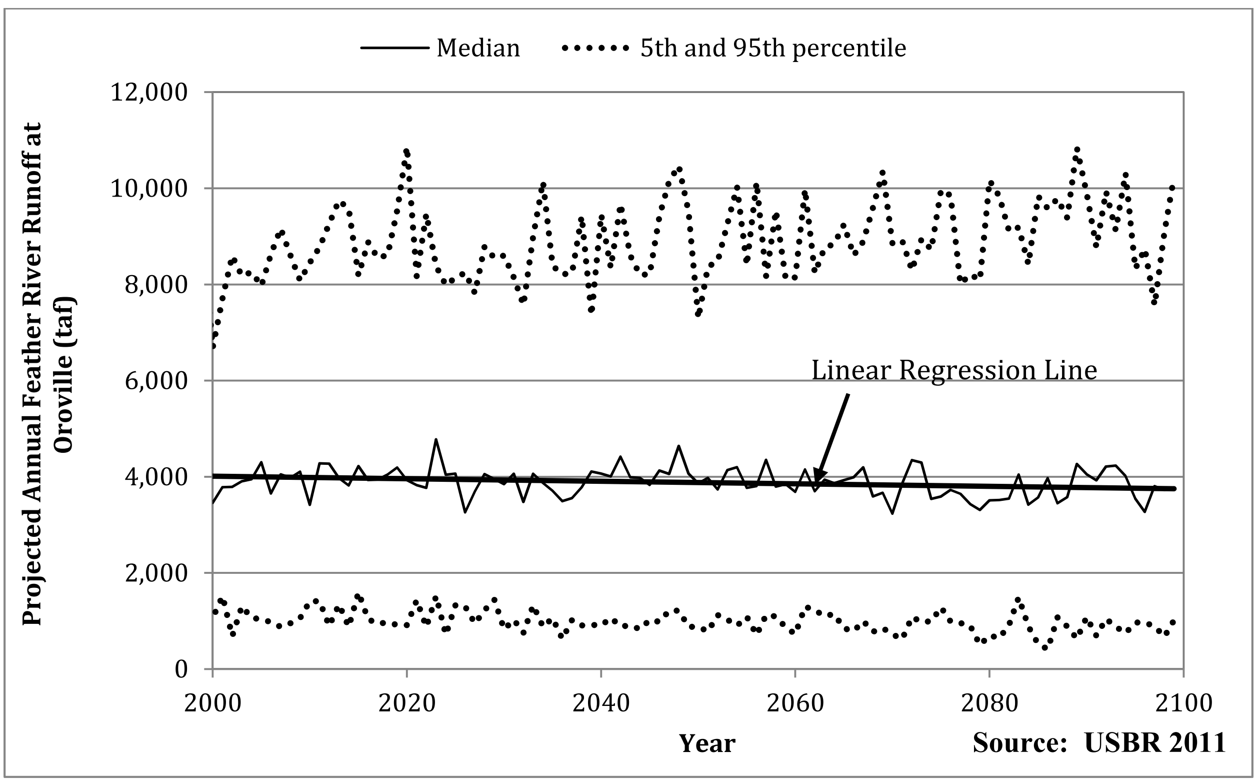

Figure 6-3. Annual Feather River Runoff at Oroville Based on 112 Hydrologic Projections.

<u>Changes in Crop Evapotranspiration.</u> Climate change has the potential to affect crop evapotranspiration and resulting irrigation water demands within the District. Changes in precipitation, temperature, and atmospheric CO_2 affect crop evapotranspiration (ET) and net irrigation water requirements (NIWR). Global climate models (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 in February 2015 (USBR 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. YCWA's service area falls within Planning Unit 507 E (PU507 E), which includes the North and South Yuba subbasins as well as areas east of the Feather River to Butte Creek and the Sutter Buttes. This section describes potential effects on crop ET for PU507E based on the 2015 study, while impacts on NIWR are described in Section 6.4, below.

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 FAO56 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 FAO-56 reference ET approach. The GCMs climatic projections were limited to daily maximum and minimum temperature and daily precipitation. 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-informed hybrid delta method. 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 effects and impacts, including the 2020's (2010-2039), 2050's (2040-2069) and 2080's (2070-2099).

Average air temperature in PU507is projected to increase for each of the five scenarios for each future period as shown in Figure 6-4. Projected temperature increases range from 1.3 to 2.6 deg. F during the 2020's period, 2.7 to 4.6 deg. F during the 2050's period, and 3.9 to 7.0 deg. F during the 2080's period.

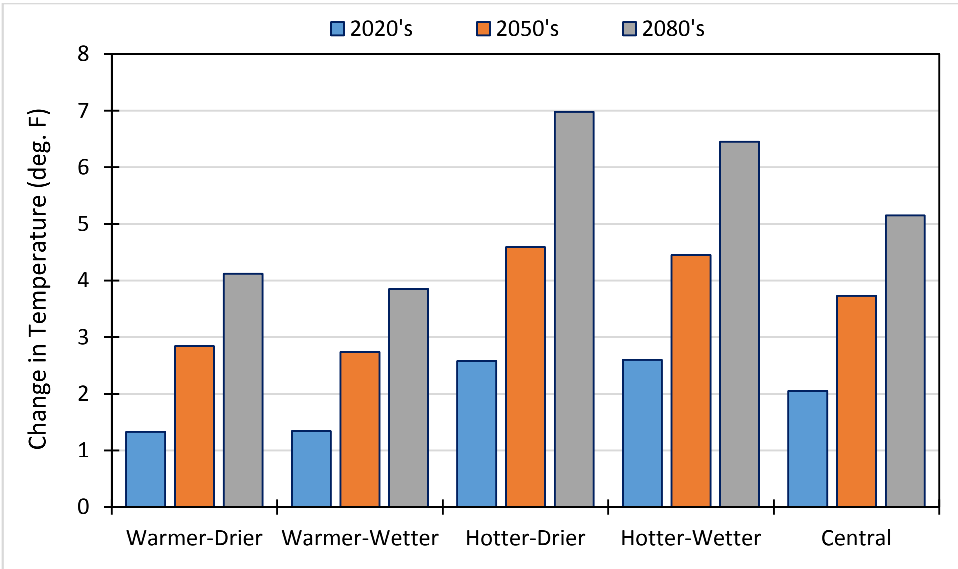

Figure 6-4. WWCRA Projected Temperature Change.

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 PU507 E are shown in Figure 6-5. Under wetter conditions increases in precipitation of 5.6 to 11.8 percent between the 2020's and the 2080's are predicted, while under drier conditions, decreases in precipitation of 7.1 to 14.9 percent between the 2020's and the 2080's are predicted. The central tendency results in a predicted slight decrease in precipitation of 0.5 to 1.7 percent between the 2020's and the 2080's.

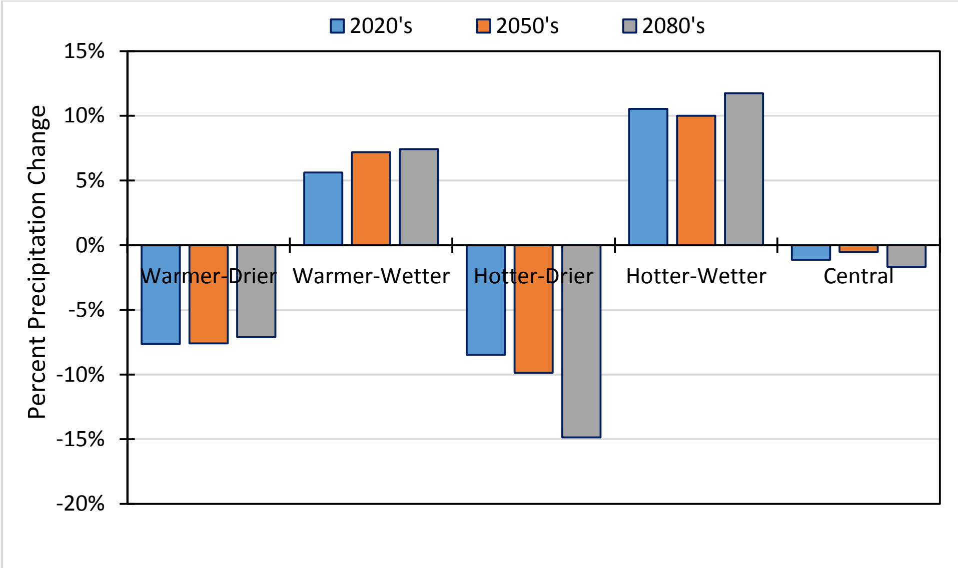

Figure 6-5. WWCRA Projected Precipitation Change.

From the projected temperature and precipitation results, WWCRA modelled projected reference ET and actual ET estimates. The results are shown below in Figures 6-6 and 6-7, respectively. Reference ET is expected to increase while actual ET depends on the weather scenario. Projected reference ET increases range from 1.8 to 3.6 percent during the 2020's period, 3.7 to 6.3 percent during the 2050's period, and 5.1 to 9.5 percent during the 2080's period. Projected actual ET changes range from 0 to 0.6 percent during the 2020's period, -0.5 to 0.7 percent during the 2050's period, and -1.6 to 0.4 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.

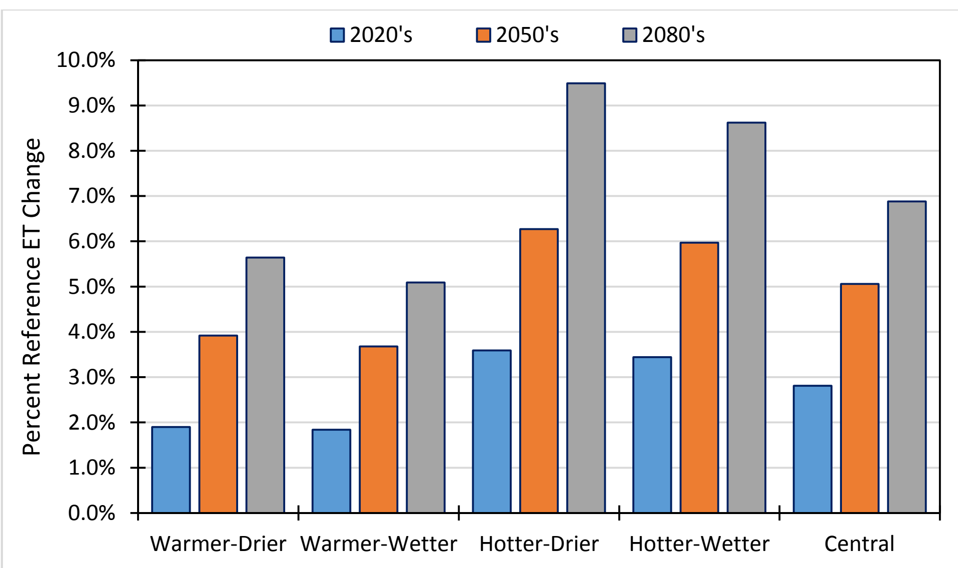

Figure 6-6. WWCRA Projected Reference ET Change.

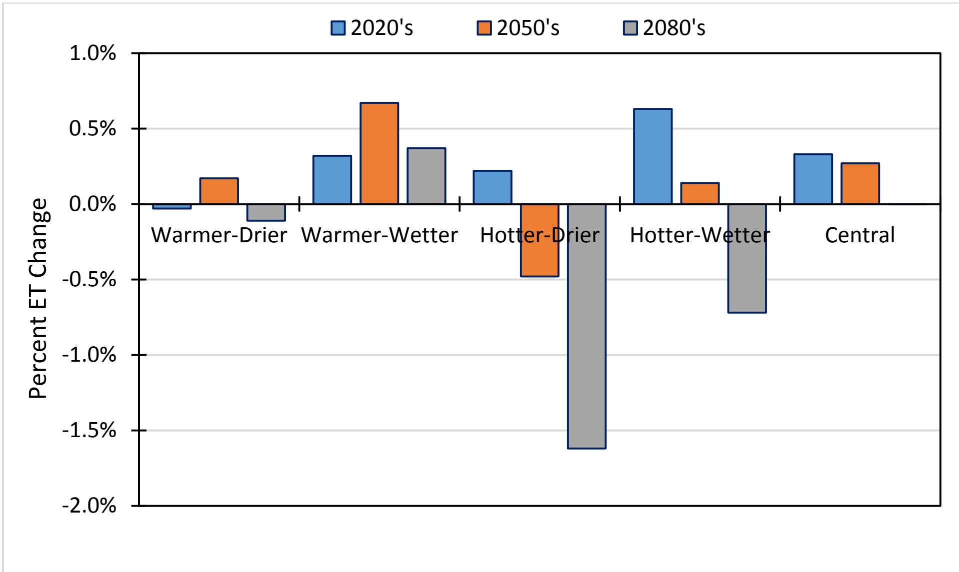

Figure 6-7. WWCRA Projected ET Change Assuming Non-Static Phenology.

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 expecting 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.

6.3. POTENTIAL CLIMATE CHANGE IMPACTS

6.3.1. Potential Impacts on Water Supply and Water 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. The Agency's flexibility in storing and delivering water is constrained by several factors including but not limited to runoff in the watershed, available storage in reservoirs, minimum instream flow requirements, operational requirements for flood control, and the Agency's power purchase agreement with PG&E. Additionally, reduced total inflows to Yuba River reservoirs in the future would increase the probability that total river supplies would be less than that required to meet agricultural, environmental, and other demands on the River.

Increased erosion and turbidity under climate change, if it occurred, would likely not significantly affect the water quality of the Yuba 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 Agency's MU service areas. Increased water temperature could result in additional challenges to the Agency and MUs in controlling aquatic plants in its 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 surface water for microirrigation of orchard crops.

6.3.2. Potential Impacts on Water Demand

The West-Wide Climate Risk Assessment, showed crop ET is expected to increase under most conditions, as discussed previously, due to effects of climate change, such as temperature increase and other climate factors (USBR 2015). Net irrigation water requirements (NIWR) are expected to increase for most but not all climate scenarios presented in the USBR report, shown in Figure 6-8. Changes in precipitation timing and amounts could result in greater or lesser 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 0.3 to 1.1 percent during the 2020's period, -0.4 to 1.1 percent during the 2050's period, and -1.9 to 0.6 percent during the 2080's period. Projected NIWR are based on non-static crop phenology for annual crops.

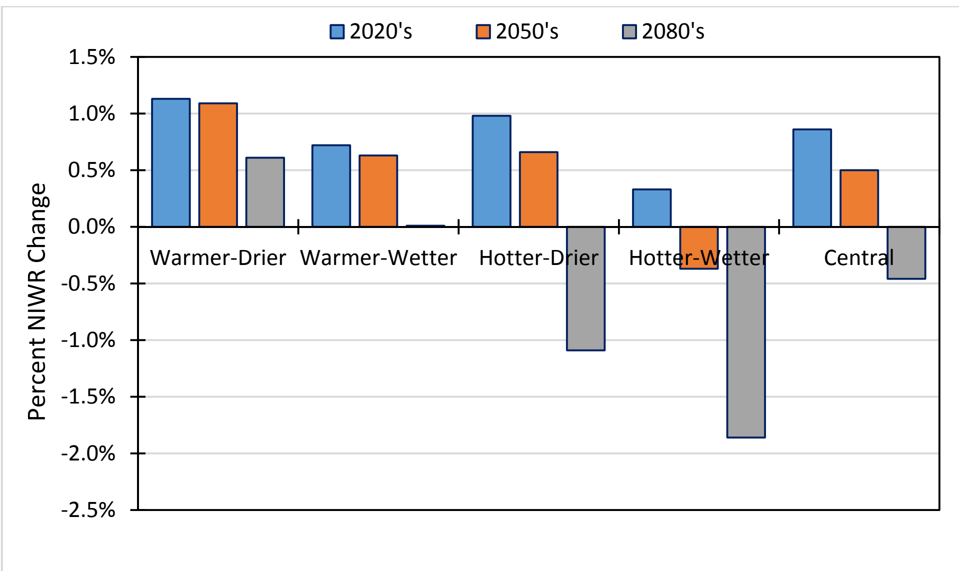

Figure 6-8. WWCRA Projected Net Irrigation Water Requirement Change Assuming Non-Static Phenology.

When interpreting results, several uncertainties must be accounted for. Estimating the effects of CO2 on irrigation demand requires the use of physiological crop growth models and was not included in the WWCRA. In general, increased atmospheric CO2 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).

6.3.3. Potential Flood Control Impacts

Limited information is currently available describing the likely impacts of climate change on flood risk. Models that predict the effects of climate change are generally not well suited to predict flooding at this time due to operating at monthly time steps and relatively coarse spatial scales. Potential increased winter inflows to Yuba River reservoirs resulting from climate change could result in increased flooding if reservoir capacities are not increased or flood control operations are not modified. Changes to flood control operations resulting in increased reserve capacity for runoff could result in less available water supply to meet dry season irrigation and environmental demands and could hinder YCWA's ability to transfer stored water.

6.4. STRATEGIES TO MITIGATE CLIMATE CHANGE IMPACTS

Although there is consensus that climate change is occurring, and the effects of climate change are being observed, the timing and magnitude of climate change impacts remains uncertain. The Agency will mitigate climate change impacts with this uncertainty in mind through an adaptive management approach in cooperation with other regional stakeholders, including the MUs, municipalities within the District, neighboring water management agencies, and USACE. Under adaptive management, key uncertainties will be identified and evaluated (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 actual impacts occur, the strategies will be prioritized, modified as needed, and implemented.

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 included as part of the California Water Plan 2009 and 2013 Updates (DWR 2010a and 2014) as well as strategies identified as part of the California Climate Adaptation Strategy (CNRA 2009). Many of these strategies applicable to agricultural water providers are already being implemented by YCWA in some form to meet local and regional water management objectives and will continue to serve the Agency well as climate change impacts occur.

Resource strategies that are being implemented or could be implemented by YCWA to adapt to climate change are summarized in Table 6-1

Table 6-1. Strategies to Mitigate Climate Change Impacts.

Source	Strategy	Status
California Water Plan (DWR 2010a and 2014)	Reduce water demand	The Agency is implementing its comprehensive water resources plan and all technically feasible, locally cost-effective EWMPs identified by SBx7-7 to achieve water use efficiency improvements in Agency operations and to encourage water management improvements by the member units.
	Improve operational efficiency and transfers	As described above and elsewhere in this AWMP, the Agency is implementing improvements to increase operational efficiency of its irrigation facilities. Additionally, the Agency actively transfers water through the Yuba River Accord and other agreements to satisfy environmental, urban, and other water needs.
	Increase water supply	YCWA and the MUs have increased available water supply through recycling and reuse of drainage water. In the future, YCWA will seek additional opportunities to increase available water supply, including consideration of opportunities to increase available groundwater supply and pumping capacity while sustainably managing the underlying groundwater basins as needed to compensate for reduced April through July runoff.
	Improve water quality	YCWA will continue to monitor groundwater quality and surface water quality as well as coordinate with the Yuba County Agricultural Commissioner's office regarding their participation in the Sacramento Valley Water Quality Coalition as part of the Irrigated Lands Regulatory Program.
	Practice resource stewardship	The Agency is an active steward of water in Yuba County as operator of the Yuba River Development Project, lead agency in the Yuba River Accord, and its intent to become a Groundwater Sustainability Agency. The MUs are active stewards of agricultural lands within their service areas through irrigation operations and resulting groundwater recharge. Additionally, YCWA and the MUs actively support protection of Yuba River fisheries through participation in the Accord and by sustaining riparian habitat coincident with their irrigation and drainage systems.
	Improve flood management	The need for flood control on the Yuba River was one of the primary reasons for the creation of the Yuba County Water Agency and the construction of New Bullards Bar Dam on the North Yuba River. The Agency operates the reservoir to maintain a portion New Bullards Bar's regulated capacity, up to 170 TAF, from September 15 through May 31 for flood control. If Yuba River runoff characteristics change substantially in the future, such that additional flood storage is needed to control flood risk, YCWA will work with USACE to modify flood control operations appropriately.
	Other strategies	Other strategies include crop idling, irrigated land retirement, and rainfed agriculture. Under severely reduced water supplies, the MUs could consider these strategies. Such actions are beyond the purview of YCWA, and 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 "Enhance and sustain ecosystems."
	Expand water storage and conjunctive management	Described above under "Increase water supply."
	Fix Delta water supply	Water transfers by YCWA have been used to help meet Delta water supply objectives and could continue in the future.
	Preserve, upgrade, and increase monitoring, data analysis, and management	YCWA has upgraded and increased monitoring, data analysis, and management through the Yuba River Accord, the GMP, FERC relicensing, and as part of ongoing operations. YCWA will continue to preserve, upgrade, and increase these efforts in the future.
	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 Agency are not anticipated, although the Agency could consider a role to help mitigate impacts to affected areas through water transfers or other means.

6.5. ADDITIONAL RESOURCES FOR WATER RESOURCES PLANNING FOR CLIMATE CHANGE

Much work has been done at State and regional levels to evaluate the effects and impacts of climate change and to develop strategies to support effective statewide, regional, and local water management in the future. The following resources provide additional information describing water resources planning for climate change:

- 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. (IPCC 2008)
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CHAPTER 7.0 - EFFICIENT WATER MANAGEMENT PRACTICES (§10826.E)

7.1. INTRODUCTION

This chapter describes the actions that YCWA has taken to efficiently manage available water supplies. These actions are described in the context of the Efficient Water Management Practices (EWMPs) established in the California Water Code §10608.48 (listed previously in Section 1.2). The Code lists two types of EWMPs: those that are mandatory (for all agricultural water suppliers subject to the Code) and those that must be implemented if found to be technically feasible and locally cost effective.

Two EWMPs mandatory for all water suppliers are described in the Code. These include 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. YCWA has implemented the delivery measurement accuracy in order to comply with the agricultural water delivery measurement regulation CCR 23 §597. YCWA has also implemented pricing based in part on the volume of water delivered through its charges for reimbursement of costs associated with operations and maintenance and monitoring of spillage and tailwater outflows to northside and southside member units.

YCWA has implemented all additional EWMPs that are technically feasible and locally cost effective. As a wholesaler of water, YCWA has a different perspective than irrigation retailers, in that it does not work directly with individual irrigators as customers, but rather with the member units. As a result, EWMPs related specifically to on-farm water management are generally beyond YCWA's purview and are therefore considered to be "technically infeasible" For YCWA to implement. One exception is that YCWA administers the District 10 well pump efficiency program, which provides financing for efficiency improvements to on-farm irrigation wells. The program is funded by the MUs, but administered by YCWA. EWMPs addressing on-farm water management are instead applicable to the member units, the Agency's customers. Table 7-1 describes each EWMP and summarizes YCWA's implementation status.

Table 7-1. Summary of EWMP Implementation Status.

Water Code Reference No.	EWMP Description	Implementation Status
Critical (Mandatory) EWMPs		
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 paragraph (2).	Implemented
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Implemented
Additional (Conditional) EWMPs		
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
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.	Implemented
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems.	Implemented
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.	Implemented
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.	Not Technically Feasible
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	Implemented
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems.	Implemented
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	Implemented

Water Code Reference No.	EWMP Description	Implementation Status
10608.48.c(9)	Automate canal control structures.	Implemented
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation.	Implemented
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implemented
10608.48.c(12)	Provide for the availability of water management services to water users.	Implemented
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.	Implemented
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implemented

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

YCWA has implemented improvements to more accurately measure the volume of water delivered to its customers, the MUs, according to the requirements of CCR 23 §597. Implementation includes preparation of a compliance certification document (Certification). The Certification is included as Attachment A to this AWMP and documents compliance of measurement devices with the regulation. As required by CCR 23 §597, the certification includes a description of water measurement best professional practices, including documentation of the conversion of water measurements to volume.

The Measurement Improvement Plan (MIP) prepared as part of YCWA's 2012 AWMP identified twelve customer delivery measurement sites that required accuracy certification to satisfy CCR 23 §597. Seven sites were determined to meet the accuracy requirements of the regulation at that time, with five sites requiring modifications to improve delivery measurement accuracy. Since that time, two sites were relocated (the Wheatland and South Yuba measurement sites), eliminating the need for two of the original five sites (the Beukleman and Rue Pump measurement sites). Thus, the actual corrective actions implemented to satisfy CCR 23 §597 are somewhat different from those described in the 2012 MIP. These actions are described in greater detail below and in Attachment A.

YCWA and others have completed the efforts to bring the remaining measurement sites into compliance. Additionally, the MIP also identified modernization improvements to be performed at each customer delivery measurement site in coordination with or following the compliance efforts. In addition to completing necessary measurement accuracy improvements, the Agency completed modernization improvements for all but one customer delivery measurement site in 2015. Table 7-2 summarizes improvements implemented to meet measurement accuracy requirements and to modernize and enhance measurement facilities. In addition to meeting measurement accuracy requirements, YCWA has elected to implement SCADA improvements at MU delivery measurement sites to provide real-time data access to YCWA staff and MUs. SCADA improvements include the development of a custom user interface for organizing and accessing the measurement data.

Table 7-2. Measurement and SCADA Improvements

Site Information			Measurement Improvements		Costs		
Original SiteID	Site Name	Member Unit(s)	Improvements for Compliance with CCR Sec. 597	Additional Modernization Improvements	YCWA Compliance Cost	YCWA Modernization Cost	YCWA Total Cost
Northside Service Area							
HLLWDS	Hallwood North	HIC	None Required. Existing measurement compliant.	SonTek IQ flow measurement device with solar power system and local flow display installed by HIC. Velocity-index rating performed over range of flows. Channel lining control section constructed by HIC. Communication hardware installed and integrated into SCADA system by YCWA providing real-time flow rate and water level.	$0	$12,385	$12,385
HLLWDN	Hallwood South	HIC	SonTek IQ flow measurement device with solar power system and local flow display installed by HIC. Velocity-index rating performed over range of flows.	Channel lining control section constructed by HIC. Communication hardware installed and integrated into SCADA system by YCWA providing real-time flow rate and water level.	$0	$12,385	$12,385

Site Information			Measurement Improvements		Costs		
Original SiteID	Site Name	Member Unit(s)	Improvements for Compliance with CCR Sec. 597	Additional Modernization Improvements	YCWA Compliance Cost	YCWA Modernization Cost	YCWA Total Cost
CRDRMZ	Cordua/Ramirez Canal Heading	RWD, CID	None Required. Existing measurement compliant.	SonTek SL3G flow measurement device with solar power system and local flow display installed by YCWA. Velocity-index rating performed over range of flows. Communication hardware installed and integrated into SCADA system by YCWA providing real-time flow rate and water level.	$37,091	$24,767	$61,858
RAMIRZ	Cordua/Ramirez Split	RWD	None Required. Existing measurement compliant.	Communication hardware installed and integrated into SCADA system by YCWA providing real-time flow rate.	$0	$24,767	$24,767
RMZD10	Ramirez D10	RWD	SonTek Pipe IQ flow measurement device with solar power system and local flow display installed by YCWA.	Communication hardware installed and integrated into SCADA system by YCWA providing real-time flow rate.	$33,764	$24,767	$58,531
NY0031	NY31 BVID Pump Canal Heading	BVID	None Required. Existing measurement compliant.	SonTek IQ flow measurement device installed by PG&E. Communication hardware installed and integrated into SCADA system by PG&E and YCWA providing real-time flow rate.	$0	$0	$0
Southside Service Area							

Site Information			Measurement Improvements		Costs		
Original SiteID	Site Name	Member Unit(s)	Improvements for Compliance with CCR Sec. 597	Additional Modernization Improvements	YCWA Compliance Cost	YCWA Modernization Cost	YCWA Total Cost
NY0033	NY33 Baker Gage	BWD, WWD, SYWD, DCMWC	None Required. Existing measurement compliant.	Velocity-index rating performed over range of flows. Communication hardware installed and integrated into SCADA system by PG&E providing real-time flow rate and water level.	$0	$0	$0
WHTP02	Wheatland Pump at Ostrom Road	WWD	Channel lining control section constructed by YCWA. SonTek SL3G flow measurement device with solar power system and local flow display installed by YCWA. Velocity-index rating performed over range of flows.	Communication hardware installed and integrated into SCADA system by YCWA providing real-time flow rate and water level	$80,677	$29,089	$109,766

Site Information			Measurement Improvements		Costs		
Original SiteID	**Site Name**	**Member Unit(s)**	**Improvements for Compliance with CCR Sec. 597**	**Additional Modernization Improvements**	**YCWA Compliance Cost**	**YCWA Modernization Cost**	**YCWA Total Cost**
SYWD01	South Yuba Meter 1	SYWD	Channel lining control section constructed by YCWA. SonTek SL3G flow measurement device with solar power system and local flow display installed by YCWA. Velocity-index rating performed over range of flows.	Communication hardware installed and integrated into SCADA system by YCWA providing real-time flow rate and water level	$51,306	$29,089	$80,395
DCMWC1	Dry Creek MWC Meter	DCMWC	SonTek Pipe IQ flow measurement device with solar power system and local flow display installed by YCWA.	Communication hardware installed and integrated into SCADA system by YCWA providing real-time flow rate	$30,779	$29,089	$59,868
				Totals	**$233,617**	**$186,338**	**$419,955**

Figure 7-1. South Yuba Meter 1 Measurement Site.

7.3. VOLUMETRIC PRICING (10608.48.B(2))

YCWA is currently implementing a pricing structure based in part on the volume delivered. MUs south of the Yuba River pay YCWA based on the actual volume of water delivered for reimbursement of operations and maintenance costs of YCWA and MU facilities and YCWA costs of monitoring spill and tailwater outflows in addition to their base and supplemental water charges under the delivery contracts. The provisions for these charges are described in the individual MU delivery contracts. Additionally, WWD and BWD are required per their contracts to reimburse for the operational costs of the Yuba Wheatland Canal pump stations, which are determined based on the volume of water delivered to each MU via the pumps.

MUs north of the Yuba River pay YCWA based on the actual volume of water delivered for reimbursement of YCWA costs of monitoring spill and tailwater outflows in addition to their base and supplemental water charges under the delivery contracts. Additional detail is provided in Section 3.8.3.

7.4. ADDITIONAL LOCALLY COST EFFECTIVE 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 existing water management practices, YCWA is currently implementing eleven of these measures at locally cost effective levels. The remaining three EWMPs are not technically feasible within YCWA.

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

This EWMP to facilitate alternative land use for lands with exceptionally high water duties or whose irrigation contributes to significant problems is not technically feasible for YCWA because lands with exceptionally high water duties or whose irrigation contributes to significant problems (required conditions for considering this EWMP) are not found within the MUs. Furthermore, YCWA's delivery contracts with the MUs prohibit wasteful use of water, preventing exceptional water duties or significant problems from occurring (see Section 3.9).

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

MUs south of the Yuba River are implementing this EWMP by capturing and reusing available recycled water for irrigation; however, note that this water is otherwise available for beneficial use by downstream water users. Sources of recycled water include:

- Beale Air Force Base – The wastewater treatment plant for the base is located approximately 0.4 miles east of the boundary of BWD. Discharge enters the Southside area via Hutchinson Creek where it is available for reuse. This source of recycled water may discontinue in the future as Beale evaluates options to transfer wastewater for treatment off-base.
- Olivehurst Public Utilities District – The wastewater treatment plant for Olivehurst is located approximately 0.5 miles west of the boundary of SYWD. Discharge enters the Southside area via a drain where it is available for reuse.

The Agency is willing to consider the use of additional recycled M&I water on a case-by-case basis. For example, the Agency would consider the use of recycled water to help local communities avoid or minimize expensive water treatment plant upgrades. Other potential sources of recycled water include:

- City of Wheatland – The wastewater treatment plant for Wheatland is located immediately east of DCMWC along the Bear River.
- City of Marysville – The wastewater treatment plant for Marysville is located approximately 2.3 miles southwest of HIC and is separated from HIC by the City of Marysville.
- Linda County Water District – The wastewater treatment plant for Linda is located approximately 2.2 miles west of BWD and is separated from BWD by the Yuba County Airport and the community of Olivehurst.

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

YCWA has implemented a well pump efficiency program in the District 10 area that facilitates capital improvements to on-farm irrigation systems. The District 10 area relies exclusively on groundwater for irrigation and is west of the north member units and east of the Feather River. All agricultural wells in District 10 are eligible. Funding is available for 100 percent of the cost of a pump efficiency test and 75 percent of any necessary repairs or enhancements. Eligible work may include lowering or repairing pump bowls, impellers, and well screen cleaning. Funding is provided by the MUs, and the program is administered by YCWA.

As a water wholesaler, YCWA does not have a role directly related to on-farm irrigation within the MU service areas. Irrigation service to individual irrigators is provided by the MUs. Thus, facilitation of on-farm capital improvements in these areas is beyond YCWA's purview. YCWA is willing to share pertinent data describing water use and other relevant information to support planning and financing of on-farm capital improvements by customers of the MUs, in coordination with the MUs.

Despite not having a direct role financing on-farm capital improvements within the MU service areas, YCWA has financed capital improvements by its customers, the MUs. Specifically, as part of its delivery contract with WWD, YCWA undertook the design, construction, and operation of the Yuba Wheatland Canal and related facilities. Funding for the project came in part from a Groundwater Storage Construction Grant Contract (Contract No. E90013) between YCWA and DWR.

Under its delivery agreement with YCWA, WWD must repay a portion of the project capital costs, including land acquisition costs, permitting and environmental review costs, engineering costs, and construction costs. YCWA has contributed a portion of the capital costs equal to half of the cost of the least costly option for construction of the facilities, plus one half of the estimated cost of operations and maintenance over the 30-year agreement based on six percent interest. Actual payments of this amount are made annually at an interest rate determined based on the actual rate of return on funds held by the Yuba County Treasurer for the prior year. For the first five years following the completion of Phase 1 of the project, WWD has the option of making interest only payments, with repayment of principal beginning in the sixth year. Once paid, the Agency will transfer ownership of portions of the distribution system within WWD to the District.

Additionally, as a condition of the delivery contract, WWD must repay a portion of the initial capital cost of the South Canal, of which a portion is used to convey water to the heading of the Yuba Wheatland Canal.

YCWA is willing to consider financing of other MU improvement projects that contribute to improved water management.

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

YCWA is implementing a pricing structure to incentivize the use of available surface water supplies from the Yuba River to provide beneficial groundwater recharge (Goal C), which supports conjunctive management of the North and South Yuba subbasins to the benefit of local water users and the State as a whole. The Yuba Accord further incentivizes groundwater production for instream benefits during dry years (Goal B) and allows for supplemental transfers, within the sustainable yield of the basin, to enlarge the State's water supply.

YCWA's implementation of a pricing structure based in part on the quantity of water delivered encourages more efficient water use at the member unit level to some extent, and may encourage more efficient water use at the farm level, depending upon the internal pricing structures of individual MUs (Goal A).

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

As explained in Chapter 5, an estimated seepage coefficient of 0.06 ft/day was developed for YCWA and MU canals and drains based on NRCS soils data. This estimate reflects the relatively low permeability of soils underlying the MU service areas and accounts for sealing of canals over time as a result of sedimentation. Based on a review of available literature, estimated seepage coefficients for concrete canal lining ranged from 0.03 ft/day to 0.56 ft/day with an average value of 0.21 ft/day[33]. Thus, it is anticipated that lining of YCWA and MU canals and drains would result in little, if any, seepage reduction. Additionally, any seepage that does occur in the MU service areas provides beneficial groundwater recharge of the underlying North Yuba and South Yuba groundwater subbasins, supporting YCWA's conjunctive management objectives. As a result, concrete lining or pipeline conversion of the YCWA and MU canals and drains is not technically feasible for seepage reduction.

At the head of the YCWA South Canal, water is diverted from the Yuba River into two ponds, Pond 17 and the Meadow Pond. These ponds, which lie within the Yuba Goldfields area on the south side of the River, intercept underflow from the Yuba River that is not directly diverted at Daguerre Point Dam. YCWA operates these reservoirs to provide regulating storage, allowing for flexible adjustments of system inflows by exercising available storage on a daily basis. As part of the EWMP for canal automation described in Section 7.4.9, YCWA has evaluated automation of these reservoirs to enhance operational flexibility and water service to the MUs while reducing losses to spillage and tailwater.

7.4.6. Increased Water Ordering and Delivery Flexibility (10608.48.c(6))

YCWA is currently maximizing the amount of flexibility in water ordering by, and delivery to, the MUs within operational limits. The primary constraints governing the flexibility of deliveries to MUs result from operational constraints on the Yuba River that are beyond YCWA's control, including institutional and regulatory constraints as well as travel time for reservoir releases to reach diversion points.

As described in Section 3.6.2, deliveries are made to MUs on a daily basis during the irrigation season. MUs call in orders to YCWA with 24 hours advance notice, and adjustments are made at the Narrows 2 powerhouse below Englebright Dam as needed to meet agricultural demands and maintain instream flows. This arrangement provides a great deal of flexibility to the MUs in ordering and receiving water. The YCWA project operators and ditch tenders track deliveries to individual MUs on a daily basis through a daily water report (See Figure 3-7 in Section 3.6.2).

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[33] Seepage rates for concrete lining estimated from the following sources:

1. Imperial Irrigation District tests in lined canals. Unpublished. (0.036 ft/day)
2. Bureau of Reclamation. 1994. Deschutes-Canal Lining Demonstration Project Construction Report. (0.07 ft/day)
3. Bureau of Reclamation Hydraulic Design Data. 1948. (0.33 ft/day)
4. Davis, A.P. and H.M. Wilson. 1919. Irrigation Engineering. John Wiley & Sons, Inc., p.235. (0.03 ft/day)
5. Haskell, W.C. and T.K. Gates. 1994. Magnitude and Variability of Canal Seepage Losses in USCID Newsletter, April-July 1994. (0.56 ft/day)
6. Leigh, E. and G. Fipps. Seepage Loss Test Results in Hidalgo County Irrigation District No. 2. Lower Rio Grande Valley, Texas. (0.18 ft/day)
   Worstell, R.V., 1976. Estimated Seepage Losses From Canal Systems. American Society of Civil Engineers, Journal of the Irrigation and Drainage Division. 102:1. Mar 1976. pp 137-147. (0.24 ft/day)

In the Southside area, YCWA's ditch tenders operate the South Yuba Canal and Yuba Wheatland Canal and deliver water to the MUs at individual delivery locations. Operation of MU facilities and deliveries to individual fields in the Southside area are performed by YCWA staff under the direction of the individual MUs. The staffing costs of serving the MUs are paid directly by the MUs to the Agency on the basis of the pro-rated quantity of water delivered to each MU each year. By providing Agency staff to work to operate the MU facilities and make deliveries to individual customers, the YCWA and MU facilities in the Southside area are operated with essentially seamless coordination between the wholesaler and irrigation retailers, resulting in greater levels of water ordering and delivery flexibility than would otherwise be achieved.

YCWA is currently incorporating all MU delivery sites into their SCADA system, providing real-time access to delivery data to YCWA and MU staff. These improvements will increases flexibility in water ordering by and delivery to the MUs. A summary of site improvements was provided previously in Table 7-2.

YCWA has evaluated automation of its Southside area facilities as part of the canal automation EWMP described in Section 7.4.9. Automation would serve to further increase flexibility in water ordering and delivery to the MUs while reducing losses to spillage and tailwater.

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

YCWA is implementing this EWMP through implementation of its comprehensive Measurement Improvement Plan (MIP), included as Attachment E of this AWMP. The MIP identifies measurement improvements for a combination of boundary inflow, boundary outflow, and internal existing or new measurement sites. These improvements are prioritized and will be implemented as funding becomes available, either through internal funding sources or through external sources, such as grants.

More frequent monitoring of key boundary outflow and internal operational sites as part of implementation of the MIP meets two key objectives of this EWMP: (1) providing improved monitoring of internal distribution and drainage system flows, canal spills, and boundary outflows to support spill reduction by YCWA and MU operators and (2) developing historical datasets of these flows to support evaluation of opportunities for future spill and tailwater recovery projects, including both operational and infrastructure improvements and to improve understanding of the water balance in the northside and southside service areas.

In addition to YCWA's spill and tailwater reduction and recovery efforts, the MUs practice extensive tailwater and spillage recovery and reuse within their service areas both north and south of the Yuba River. Within a given MU, spillage and tailwater entering the distribution and drainage system is actively reused to meet irrigation demands. Additionally, downgradient MUs actively utilize tailwater and spillage from upgradient MUs where possible to offset diversion demands. MU spillage and tailwater reuse is accomplished through a combination of gravity and pump flow.

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

YCWA is implementing this EWMP by conducting an effective, proactive program of conjunctive management of available surface water and groundwater supplies in order to meet the following water management objectives:

- Maintain local and Statewide water supply reliability
- Enhance fisheries habitat in the Yuba River
- Reduce energy requirements (through reduced pumping lift and overall pumping volume)

YCWA's conjunctive management strategy and programs are embodied in the Yuba Accord finalized in 2008 and through the Agency's 2010 Groundwater Management Plan. Under the Accord and other temporary transfers, MUs produce groundwater in lieu of surface water to meet irrigation demands in some years in order to increase available surface water supplies. Between 2001 and 2014, YCWA, in cooperation with the MUs, made more than 550,000 af available through groundwater substitution transfers to various parties.

YCWA's groundwater substitution program is supported by a proactive program to address potential impacts to groundwater wells from transfer pumping. Under the program, landowners who suspect that their well has been impacted by groundwater substitution pumping contact a representative from the nearest MU. The MU then works with the landowner to develop and implement a corrective action plan, as needed. All corrective actions are paid by the MU and implemented by the landowner.

In 2013, YCWA was awarded a grant under the Local Groundwater Management Assistance Act of 2000 to develop a groundwater flow model for the North Yuba and South Yuba subbasins in Yuba County. Development of the model began in late 2014 and is expected to be complete in 2016.

YCWA is actively implementing the Sustainable Groundwater Management Act of 2014 (SGMA) through formation of a Groundwater Sustainability Agency (GSA) for both the North Yuba Subbasin within Yuba County and the South Yuba Subbasin. YCWA additionally serves as the designated agency for the California Statewide Groundwater Elevation Monitoring (CASGEM) in Yuba County.

YCWA's conjunctive management activities are described in greater detail in Section 4.3.2 of this AWMP.

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

Automation of canal systems covers a broad range of applications, from remote monitoring of flows and water levels, to local automated control of individual structures (e.g. to hold flows or water levels at targeted values), to integrated control of multiple structures.

Currently, YCWA operates Yuba Wheatland Canal Pump Stations 1, 2, and 3. Each of these stations include variable frequency drive pumps that are operated in local automated control to maintain downstream water levels, essentially providing on-demand delivery to WWD. YCWA is currently investigating additional remote automation and control alternatives for the Wheatland Pump Stations.

Additionally, YCWA is implementing this EWMP through implementation of its MIP (Attachment E), which includes real time monitoring of MU delivery measurement sites and will ultimately include real time monitoring of key boundary inflow, boundary outflow, and internal operational sites to enhance operation of YCWA facilities to further increase delivery flexibility and steadiness, while reducing operational spillage.

YCWA has evaluated opportunities for more extensive automation, including automation of key YCWA facilities in the Southside area to route excess flows in the case of failure of the Yuba Wheatland Canal pump stations (Automation Alternative 1) and automation of YCWA diversions to the South Canal and operation of the Pond 17 and Meadow Pond regulating reservoirs to further enhance delivery flexibility and steadiness, while reducing operational spillage and tailwater (Automation Alternative 2). These automation alternatives are not locally cost effective at this time, but will be re-evaluated in the future and considered for implementation subject to additional refinement and the availability of funding through internal or external sources. Net benefit analyses for Automation Alternatives 1 and 2 are described in Attachment F.

7.4.10. Facilitate or Promote Customer Pump Testing and Evaluation (10608.48.c(10))

YCWA is implementing this EWMP by providing information on programs that provide these services. Currently, the Advanced Pumping Efficiency Program, funded by PG&E and administered by the Center for Irrigation Technology at California State University, Fresno provides these services to pumpers within the YCWA MU service areas. The program provides education and technical assistance, as well as funding for pump testing and incentive rebates for repair or replacement of pump bowls and impellers and other actions that improve pump efficiency.

YCWA has additionally implemented a well pump efficiency program in the District 10 area, which relies exclusively on groundwater for irrigation and is west of the north member units and east of the Feather River. All agricultural wells in District 10 are eligible. Funding is available for 100 percent of the cost of a pump efficiency test and 75 percent of any necessary repairs or enhancements. Eligible work may include lowering or repairing pump bowls, impellers, and well screen cleaning. Funding for the program is provided by the MUs, and administration is provided by YCWA.

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

YCWA is implementing this AWMP by assigning its Water Resources Manager with the responsibilities of Water Conservation Coordinator, including developing and implementing the AWMP, as well as coordinating various other water management activities with the MUs.

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

YCWA is implementing this EWMP by providing for the availability of various water management services to the MUs and District 10 groundwater pumpers. In particular, these include the following:

- Conducting semi-annual meetings with MUs and landowners to discuss water management information useful to MUs and irrigators, as well as other resources of interest to local agricultural producers.

- Implementation of the YCWA MIP, which will provide information describing real time flows and water levels at boundary inflow, boundary outflow, and internal operational sites. In particular, the availability of additional information describing outflows from MU services areas will enhance the water management capabilities of the MUs.
- Continued provision of experienced Agency staff for the operation of MU facilities in the Southside area to achieve seamless coordination between YCWA and MUs, resulting in greater levels of water ordering and delivery flexibility than would otherwise be achieved.
- Continued implementation of the District 10 well pump efficiency program.

In the future, YCWA will continue to evaluate opportunities to provide for the availability of additional water management services to the MUs and others as appropriate.

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

YCWA is implementing this EWMP through evaluation of policies of agencies that affect the Agency's ability to flexibly store and deliver water through its participation in the Lower Yuba River Accord and associated agreements, the FERC relicensing process, coordinated reservoir operations, and other initiatives, including flood protection operations. These agencies include the SWRCB, DWR, the Army Corps of Engineers, and others. YCWA will continue to evaluate such policies in the future and will seek changes to allow more flexible deliveries and storage.

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

YCWA owns and operates three pump stations to lift water in the Yuba Wheatland Canal for delivery to WWD. Yuba Wheatland Canal pump stations 1, 2, and 3 were completed in 2009. YCWA is implementing this EWMP by evaluating the efficiency of and maintaining the pumps as needed to ensure that pumping efficiency is maintained at cost-effective levels.

7.5. SUMMARY OF EWMP IMPLEMENTATION STATUS

As a wholesaler of water from the Yuba River for irrigation, YCWA is a leader in the management of surface water and groundwater supplies in Yuba County. This leadership, along with the contributions and cooperation of the MUs and various other stakeholders in the County and State as a whole, has led to the reversal of potentially serious overdraft conditions in the South Yuba Subbasin, improved water supply reliability locally and for the State, improved fishery conditions in the Yuba River, and an overall increase in water supply to meet agronomic, environmental, and other needs. For purposes of this AWMP, YCWA's water management actions have been organized and are reported with respect to the Efficient Water Management Practices (EWMPs) listed in CWC §10608.48. A summary of the implementation status of each listed EWMP is provided in Table 7-3.

Table 7-2. Summary of YCWA Implementation Status for EWMPs Listed Under CWC 10608.48.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
Critical (Mandatory) EWMPs				
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 paragraph (2).	Implemented	1. Prepared a certification of compliance for existing compliant customer delivery measurement sites (Attachment A). 2. Developed and implemented a corrective action plan for non-compliant and new sites to achieve compliance with CCR 23 §597 by December 31, 2015 (Attachment A)	1. Continue delivery measurement program (measurement and SCADA improvements are described in Attachment G).
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Implemented	1. Existing charges for operations and maintenance and spill and tailwater outflow monitoring to member units based on volume of water delivered.	1. Continue implementing pricing structure for reimbursement based in part on volume of water delivered.
Additional (Conditional) EWMPs				
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	Lands with exceptionally high water duties or whose irrigation contributes to significant problems are not found within the MU service areas. Furthermore, provisions of YCWA's delivery contracts with the MUs 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.	Implemented	1. Recycled M&I water from Beale Air Force Base and Olivehurst Public Utilities District is available for reuse in the southside service area. 2. Identified potential additional sources of recycled M&I water.	1. Facilitate continued existing use of recycled water. 2. Consider requests from all qualifying permitted dischargers for additional use of recycled water.
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems.	Implemented	1. The District 10 well pump efficiency program administered by YCWA provides financing of improvements to on-farm irrigation wells. 2. YCWA has financed capital improvements by its customers, the MUs, including the Yuba Wheatland Canal.	1. Continue administration of District 10 well pump efficiency program. 2. Consider financing of other MU improvement projects that contribute to improved water management.
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.	Implemented	1. Existing pricing structure promotes use of available surface water supplies to provide beneficial groundwater recharge (Goal C). 2. Yuba Accord promotes groundwater production during dry years (Goal B). 3. Pricing structure based in part on volume delivered encourages more efficient water use by MUs (Goal A).	1. Continue to promote use of surface water supplies for beneficial recharge. 2. Continue to promote groundwater production during dry years. 3. Continue pricing structure based in part on volume delivered to encourage more efficient water use by MUs.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
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.	Not Technically Feasible	Lining or pipeline conversion of existing canals and drains would result in little if any seepage reduction. Additionally, to the extent that lining or pipeline conversion would result in a limited reduction in seepage, beneficial recharge would be additionally reduced. Pond 17 and Meadow Pond downstream of the Yuba River diversion to the Southside area at Daguerre Point Dam are operated as regulating reservoirs. Automation of the ponds has been evaluated under the canal automation EWMP.	
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	Implemented	1. Currently maximizing flexibility within operational limits. Deliveries are made with 24 hours advance notice. 2. Providing Agency staff to work to the specification of MUs in Southside area to deliver water to MU customers, providing seamless coordination between operation of YCWA and MU facilities, enhancing flexibility. 3. Implementing a SCADA system to provide real-time delivery data to YCWA and MU staff, supporting increased flexibility in water ordering and delivery. 4. Evaluated automation of YCWA facilities to further increase flexibility to MUs under canal automation EWMP.	1. Continue deliveries with 24 hour advance notice. 2. Continue to provide Agency staff to the specification of MUs in Southside area to deliver water to MU customers. 3. Continue to maintain SCADA system and real-time data access. 4. Automate YCWA facilities as funding becomes available to further increase flexibility as described under canal automation EWMP.
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems.	Implemented	1. Implementing MIP to provide increased monitoring of key locations to support spill and tailwater reduction by YCWA and MU operators. 2. MUs practice extensive tailwater and spillage recovery and reuse.	1. Continue implementation of MIP, focused initially on securing funding for improvement/establishment of high priority sites.
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	Implemented	1. Conducting effective, proactive conjunctive management program to meet multiple objectives and address potential impacts. 2. Developing a groundwater flow model. 3. Actively involved in implementation of SGMA as a GSA. 4. Serves as the designated CASGEM reporting entity in Yuba County.	1. Continue conjunctive management and seek opportunities to enhance activities to increase local and statewide benefits. 2. Continue to implement SGMA as a GSA 3. Continue to serve as CASGEM agency
10608.48.c(9)	Automate canal control structures.	Implemented	1. Implementing MIP to provide increased monitoring of key locations to support enhanced operation of YCWA and MU facilities by Agency and MU operators. 2. Constructed Yuba Wheatland Canal pump stations operating in automatic downstream level control and currently investigating enhanced remote automation and control. 3. Evaluated opportunities for additional automation to be considered for implementation.	1. Continue implementation of MIP, focused initially on securing funding for high priority sites. 2. Continue automated operation of Yuba Wheatland Canal pump stations. 3. Implement additional automation at locally cost-effective levels.

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation.	Implemented	1. Provide information on available programs. 2. Employing a policy that encourages grower's to maximize pump efficiency by paying for groundwater substitutions on a volumetric basis. 3. Implementing District 10 well pump efficiency program to reimburse growers for pump improvements.	1. Continue to promote participation of MUs in available pump testing programs and employ current groundwater substitution payment policy. 2. Continue program to reimburse growers for pump improvements.
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implemented	1. Water Resources Manager serves as YCWA Water Conservation Coordinator.	1. Water Resources Manager will continue to serves as Water Conservation Coordinator.
10608.48.c(12)	Provide for the availability of water management services to water users.	Implemented	1. Conducting annual or semi-annual meetings with MUs to discuss water management. 2. Implementing MIP to provide improved monitoring of key locations to support enhanced operation of MU facilities. 3. Providing Agency staff for operation of MU facilities in Southside area. 4. Implementing District 10 well pump efficiency program to reimburse growers for pump improvements.	1. Continue to conduct meetings with MUs to discuss water management services. 2. Continue implementation of MIP, focused initially on securing funding for high priority sites. 3. Continue to provide Agency staff for operation of MU facilities. 4. Continue program to reimburse growers for pump improvements.
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.	Implemented	1. Evaluating policies of agencies that affect YCWA's ability to flexibly store and deliver water and seeking changes to increase flexibility.	1. Continue to evaluate policies of agencies that affect YCWA's ability to flexibly store and deliver water and seeking changes to increase flexibility.
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implemented	1. Evaluating pump efficiency and performing maintenance as needed.	1. Continue evaluating pump efficiency and performing maintenance as needed.

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7.6. 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 EWMPs that have been implemented by YCWA has been provided previously in Chapter 7. 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.

The value of evaluating water use efficiency (WUE) improvements (and EWMP implementation in general) from YCWA's perspective is to identify what the benefits of EWMP implementation are and to identify those additional actions that hold the potential to support and advance YCWA's water management objectives. YCWA's water management objectives include the long term reliability, quality, and affordability of local surface water and groundwater supplies; flood protection; fisheries enhancement; development and sale of hydroelectric power; and recreation. YCWA's water management activities are consistent with these objectives and have resulted in substantial local and statewide benefits. A key example of YCWA's stewardship of Yuba County's water resources is its leadership and in developing and implementing the Yuba Accord.

First and foremost among the issues that must be considered in any evaluation of the benefits of EWMP implementation and resulting WUE improvements is how water management actions affect the water balance (Davenport and Hagan, 1982; Keller, et al., 1996; Burt, et al., 2008; Clemmens, et al., 2008; Canessa, et al., 2011)[34]. Accordingly, any evaluation of EWMP implementation and WUE improvements for YCWA must consider how water balance changes relate to the Agency's water management objectives. 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. Reductions in these flows resulting from EWMP implementation could be considered WUE improvements at the farm, MU, or Agency scale, but have the consequential effect of diminishing

[34] Burt, C., Canessa, P., Schwankl, L. and D. Zoldoske. 2008. Agricultural Water Conservation and Efficiency in California - A Commentary. October 2008. 13 pp.

Canessa, P., S. Green and D. Zoldoske. 2011. Agricultural Water Use in California: A 2011 Update. Staff Report, Center for Irrigation Technology, California State University, Fresno. November 2011. 80 pp.

Clemmens, A.J., R.G. Allen, and C.M. Burt. 2008. Technical Concepts Related to Conservation of Irrigation and Rainwater in Agricultural Systems. Water Resources Research. Vol. 44. W00E03, doi:10.1029/ 2007WR006095.

Davenport, D.C. and R.M. Hagan. 1982. Agricultural Water Conservation in California, With Emphasis on the San Joaquin Valley. Department of Land, Air, and Water Resources. University of California at Davis. Davis, CA. October 1982.

Keller, A., J. Keller, and D. Seckler. 1996. Integrated Water Resource Systems: Theory And Policy Implications. IIMI Res. Rep. 3. International Irrigation Management Institute. Colombo, Sri Lanka.

recharge of the underlying groundwater system. Other flows that could be considered losses at the Agency, MU, or farm scale such as spillage and tailwater are also recoverable. For example, spillage from the YCWA and MU distribution and drainage systems is available for beneficial use by downgradient water users. The only distribution and drainage system or on-farm losses that are not recoverable within the YCWA MU service areas, the underlying groundwater basin, or the Sacramento River Basin as a whole are canal and reservoir water surface evaporation and evaporation from irrigation application. These components represent a small portion of YCWA's water supply (less than one percent as indicated in Table 5-13). An implication of this is that very little "new" water can be made available through water conservation in YCWA's member unit service areas to increase the State's overall water supply.

An essential first step in evaluating EWMP implementation and water use efficiency improvements is a comprehensive, quantitative, multi-year water balance (see Chapter 5). The quantitative understanding of the water balance flow paths enables identification of targeted flow paths for 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 relatively small changes in flow paths resulting from many water management improvements (relative to day to day and year to year variation in water diversions and use) coupled with inaccuracies inherent in even the best water measurement greatly complicate the evaluation of water balance impacts. The implications of recoverable and irrecoverable losses at varying scales complicate the evaluation of WUE improvements, and consequential, potentially unintended effects must be considered.

As part of assembling this AWMP, YCWA has identified the targeted flow paths associated with implementation of each EWMP, the water management benefits of each EWMP and the potential consequential effects of implementation. A brief discussion of the benefits associated with implementation of each EWMP is provided, along with a brief discussion of consequential effects that must be considered. A summary of targeted flow paths, beneficial impacts, and consequential effects associated with implementation of each EWMP by YCWA is provided in Table 7-4.

Table 7-4. Summary of WUE Improvements by EWMP.

Water Code Reference No.	EWMP	Implementation Status	Targeted Flow Path(s)	Benefits	Consequential Effects	Comments (See End of Table)
10608.48.b (1)	Measure the volume of water delivered to customers with sufficient accuracy.	Implemented	None	Not Applicable	Not Applicable	1
10608.48.b (2)	Adopt a pricing structure based at least in part on quantity delivered.	Implemented	MU Deliveries, Spillage, Tailwater, Diversions, Groundwater Pumping, Drainage Outflows	Volumetric pricing could create a modest incentive to reduce MU deliveries, primarily through reduced spillage and tailwater. In aggregate, reduced deliveries result in decreased required diversions and pumping and corresponding reductions in drainage outflows. Available water not diverted or pumped could provide increased storage or be available for transfer. Additionally, water quality benefits may occur through reduced tailwater outflow.	Volumetric pricing of MU deliveries could result in reduced deep percolation in non-rice areas if MUs likewise implement volumetric pricing, resulting in reduced beneficial recharge of the underlying groundwater system. Reduced drainage outflows from spillage and tailwater result in reduced water available for beneficial use by downgradient water users.	2
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	Not Applicable	Not Applicable	3
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.	Implemented	Diversions, Groundwater Pumping, MU Deliveries	Recycled water use by YCWA and the MUs provides a limited reduction in required surface water and groundwater supplies. Available water not diverted or pumped could provide increased storage or be available for transfer.	Recycled water is of diminished quality as compared to surface water and groundwater supplies.	
10608.48.c (3)	Facilitate financing of capital improvements for on-farm irrigation systems.	Implemented	Not Applicable	Improved pumping efficiency in the District 10 area results in decreased energy demand and pumping costs for customers. There are no direct benefits to YCWA.	Not Significant	2
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.	Implemented	Varies	Provision of surface water at lower rates than the cost of groundwater pumping incentivizes goal C, providing beneficial groundwater recharge. Participation in groundwater substitution transfers incentivizes goal B, increase conjunctive use of groundwater to improve local and State water supply reliability.	Potential consequential effects of implementing a volumetric pricing structure, potentially promoting goal A, are the same as described for the volumetric pricing EWMP (10608.48.b(2)).	2
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.	Not Technically Feasible	Not Applicable	Not Applicable	Not Applicable	2

Water Code Reference No.	EWMP	Implementation Status	Targeted Flow Path(s)	Benefits	Consequential Effects	Comments (See End of Table)
10608.48.c (6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	Implemented	Diversions, Groundwater Pumping, Spillage, MU and Farm Deliveries Tailwater, Deep Percolation of Applied Water, Drainage Outflows	Highly flexible ordering and delivery practices result in reduced losses to spillage by MUs, tailwater, and deep percolation for non-rice crops, resulting in decreased required diversions and pumping. Available water not diverted or pumped could provide increased storage or be available for transfer. Additionally, water quality benefits may occur through reduced tailwater and deep percolation.	Reduced deep percolation in non-rice areas results in reduced beneficial recharge of the underlying groundwater system. Reduced drainage outflows result in reduced water available for beneficial use by downgradient water users.	2
10608.48.c (7)	Construct and operate supplier spill and tailwater recovery systems.	Implemented	Diversions, Groundwater Pumping, Tailwater, Spillage, Drainage Outflows	Reductions in spillage and tailwater production result in decreased required diversions and pumping. Available water not diverted or pumped could provide increased storage or be available for transfer. Additionally, water quality benefits may occur through reduced tailwater outflow.	Reduced drainage outflows result in reduced water available for beneficial use by downgradient water users.	
10608.48.c (8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	Implemented	Diversions, Groundwater Pumping	Conjunctive management provides multiple benefits: 1. Maintain local and statewide water supply reliability 2. Enhance fisheries 3. Reduced energy requirements	Not Significant	2
10608.48.c (9)	Automate canal control structures.	Implemented	Diversions, Groundwater Pumping, Spillage, MU and Farm Deliveries, Tailwater, Deep Percolation of Applied Water, Drainage Outflows	Automation improves delivery steadiness and flexibility, allowing for reduced losses at the MU and farm scale, while also reducing spillage losses at the Agency scale. These reductions allow for reductions in required diversions and pumping. Available water not diverted or pumped could provide increased storage or be available for transfer. Additionally, water quality benefits may occur through reduced tailwater outflow.	Reduced deep percolation in non-rice areas results in reduced beneficial recharge of the underlying groundwater system. Reduced drainage outflows result in reduced water available for beneficial use by downgradient water users.	2
10608.48.c (10)	Facilitate or promote customer pump testing and evaluation.	Implemented	None	Improved pumping efficiency by YCWA's customers results in decreased energy demand and pumping costs for customers. There are no direct benefits to YCWA.	Not Significant	
10608.48.c (11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implemented	Varies	See Comment	See Comment	4
10608.48.c (12)	Provide for the availability of water management services to water users.	Implemented	MU and Farm Deliveries, Tailwater, Deep Percolation of Applied Water, Diversions, Groundwater Pumping Drainage Outflows	Water management support by YCWA allows for reduced losses to spillage at the MU scale and reduced losses to tailwater and deep percolation (non-rice crops only) at the farm scale. These reductions allow for reductions in required diversions and pumping. Available water not diverted or pumped could provide increased storage or be available for transfer. Additionally, water quality benefits may occur through reduced tailwater outflow.	Reduced deep percolation in non-rice areas results in reduced beneficial recharge of the underlying groundwater system. Reduced drainage outflows result in reduced water available for beneficial use by downgradient water users.	2

Water Code Reference No.	EWMP	Implementation Status	Targeted Flow Path(s)	Benefits	Consequential Effects	Comments (See End of Table)
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.	Implemented	Diversions, Groundwater Pumping, Spillage, MU and Farm Deliveries Tailwater, Deep Percolation of Applied Water, Drainage Outflows	Increased flexibility and storage in the Agency's surface water supply could allow for increased water available for transfer or to meet local demand. Improvements in system operation to increase flexibility could result in reductions in losses to spillage, tailwater, and deep percolation (non-rice crops only), resulting in decreased required diversions and pumping. Available water not diverted or pumped could provide increased storage or be available for transfer. Additionally, water quality benefits may occur through reduced tailwater and deep percolation.	Reduced deep percolation in non-rice areas results in reduced beneficial recharge of the underlying groundwater system. Reduced drainage outflows result in reduced water available for beneficial use by downgradient water users.	2
10608.48.c (14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implemented	None	Improved pumping efficiency of YCWA's pumps results in decreased energy demand and reduced pumping costs and increases pump reliability.	Not Significant	

Notes:

1. Although delivery measurement does not directly affect any flow paths, it will support improvement of the overall water balance in the future.
2. YCWA works to balance tradeoffs between incentivizing water conservation and maintaining long-term surface water and groundwater reliability for the region.
3. Such lands do not exist in YCWA. As a result, it is not technically feasible to implement this EWMP.
4. Implementation of the AWMP by YCWA's Water Resources Manager and other staff is the mechanism by which all EWMPs are implemented and targeted benefits are realized.

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WUE definitions vary. For purposes of evaluating WUE improvements associated with EWMP implementation by YCWA, specific WUE improvement categories or objectives, as described by CALFED and DWR (CALFED 2006[35], DWR 2012[36]), have been identified that correspond to each EWMP. Potential WUE improvements include reduction of irrecoverable losses, increased local supply, increased local flexibility, increased in-stream flow, improved water quality, and improved energy efficiency. Definitions for each of the WUE improvement categories have been developed and are provided in Table 7-5. Note that the WUE improvement categories are not mutually exclusive in many cases. For example, reductions in irrecoverable losses could be used to increase local supply. The applicability of each EWMP to each WUE improvement category based on YCWA's water management activities has been identified and is presented in Table 7-6.

Table 7-5. WUE Improvement Categories.

Water Use Efficiency Improvement Category	Definition
Reduce Irrecoverable Losses	Reduce losses that cannot be recovered and used by the water supplier or downgradient users (e.g. evaporation and flows to salt sinks).
Increase Local Supply	Reduce losses and/or increase storage locally to increase supply available to meet demands, including both near-term (within an irrigation season) and long-term (over more than one year).
Increase Local Flexibility	Improve the supplier's ability to divert, pump, convey, control, and deliver available water supplies to meet customer demands.
Increase In-Stream Flow	Increase flow in natural waterways to benefit fisheries or meet other environmental objectives.
Improve Water Quality	Increase the quality of targeted water bodies (i.e. streams, lakes, or aquifers).
Improve Energy Efficiency	Increase the efficiency of water supplier or customer pumps.

In order to more explicitly report an estimate of WUE improvements that have occurred since the last AWMP and an estimate of WUE improvements expected to occur five and ten years in the future, YCWA has estimated the qualitative magnitude (expressed as None, Limited, Modest, or Substantial in order of increasing relative magnitude) for the targeted flow paths associated with each EWMP relative to the applicable WUE improvement categories identified in Table 7-6. Past WUE improvements are estimated relative to no historical implementation. WUE improvements relative to the time of the last plan are based on YCWA's 2012 AWMP. 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 7-7.

YCWA will continue to seek out and implement water management actions that meet its overall water management objectives and result in WUE improvements. YCWA staff regularly attend water

[35] CALFED Bay Delta Program. 2006. Water Use Efficiency Comprehensive Evaluation. Final Report. CALFED Bay-Delta Program Water Use Efficiency Element. August 2006.
[36] California Department of Water Resources. 2012. 2012 Agricultural Water Use Efficiency Draft Proposal Solicitation. Powerpoint Presentation. September 20, 2012.

management conferences and evaluate technological advances in the context of YCWA's water management objectives and regional setting. The continuing review of water management within YCWA, coupled with exploration of innovative opportunities to improve water management will result in future management improvements by the Agency and additional WUE improvements.

Table 7-6. Applicability of EWMPs to WUE Improvement Categories.

Water Code Reference No.	EWMP	Implementation Status	Water Use Efficiency Improvement Category					
			Reduce Irrecoverable Losses	Increase Local Supply	Increase Local Flexibility	Increase In-Stream Flow	Improve Water Quality	Improve Energy Efficiency
10608.48.b (1)	Measure the volume of water delivered to customers with sufficient accuracy	Implemented	No Direct WUE Improvements					
10608.48.b (2)	Adopt a pricing structure based at least in part on quantity delivered	Implemented		✓		✓	✓	
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 YCWA					
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.	Implemented		✓		✓		
10608.48.c (3)	Facilitate financing of capital improvements for on-farm irrigation systems	Implemented		✓				✓
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.	Implemented		✓		✓	✓	
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	Not Technically Feasible	Not Applicable to YCWA					
10608.48.c (6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Implemented		✓	✓	✓	✓	
10608.48.c (7)	Construct and operate supplier spill and tailwater recovery systems	Implemented		✓		✓	✓	
10608.48.c (8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Implemented		✓				
10608.48.c (9)	Automate canal control structures	Implemented		✓	✓	✓	✓	
10608.48.c (10)	Facilitate or promote customer pump testing and evaluation	Implemented						✓
10608.48.c (11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implemented	The activities of the Water Conservation Coordinator and other YCWA staff to achieve WUE improvements through implementation of the AWMP are described individually by EWMP.					
10608.48.c (12)	Provide for the availability of water management services to water users.	Implemented		✓	✓	✓	✓	✓
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.	Implemented		✓	✓	✓	✓	
10608.48.c (14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implemented						✓

Table 7-7. 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	Implemented	No Direct WUE Improvements			
10608.48.b (2)	Adopt a pricing structure based at least in part on quantity delivered	Implemented	Modest	Modest	None to Limited, Depending on Structure and Changes to MU Pricing Structures	
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 YCWA			
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.	Implemented	Limited	None	None to Limited, Depending on Opportunities	
10608.48.c (3)	Facilitate financing of capital improvements for on-farm irrigation systems	Implemented	Modest	Modest	Modest	
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.	Implemented	Substantial (Goals B & C)	Modest (Goal A)	None	
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	Not Technically Feasible	Not Applicable to YCWA			
10608.48.c (6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits	Implemented	Substantial	Modest	None to Modest, Depending on Funding	
10608.48.c (7)	Construct and operate supplier spill and tailwater recovery systems	Implemented	Substantial	Limited	None to Modest, Depending on Funding	
10608.48.c (8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Implemented	Substantial	Substantial	Modest	
10608.48.c (9)	Automate canal control structures	Implemented	Substantial	Limited	None to Modest, Depending on Funding	
10608.48.c (10)	Facilitate or promote customer pump testing and evaluation	Implemented	None	Modest	Limited	Limited
10608.48.c (11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Implemented	The activities of the Water Conservation Coordinator and other YCWA 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.	Implemented	Modest	Modest	Limited	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.	Implemented	Substantial	Limited	None to Modest, Depending on Outcomes	
10608.48.c (14)	Evaluate and improve the efficiencies of the supplier's pumps.	Implemented	None[6]	Limited	None to Limited, Depending on Opportunities	

1. As noted herein and throughout this analysis, reductions in losses that result in WUE improvements at the farm, MU, or Agency scale do not result in WUE improvements at the Sacramento River Basin scale, except in the case of evaporation reduction. All losses to seepage, spillage, tailwater, and deep percolation are recoverable within the YCWA MU service areas or by downgradient water users.

2. 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.

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.

6. The Agency's Yuba Wheatland Canal pump stations were completed in 2009 and evaluated at that time, though efficiency improvements have not been warranted.