YUBA COUNTY WATER AGENCY

Agricultural Water Management Plan

DECEMBER 2012

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). 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).

To develop and adopt this Plan by the December 31, 2012 deadline, the Agency initiated preparations in late 2010, developed a project schedule and engaged technical consultants to assist with preparing the Plan. Working backwards from the December 31 deadline, the District scheduled Plan adoption by the Board of Directors at its second meeting in November (November 27). This was the latest schedule possible that would allow time to revise the Plan, if needed, in response to public comment. To allow approximately one month for public review of the Plan prior to the public hearing and adoption of the Plan in late November, the final draft of the Plan had to be complete by late October. To ensure the draft final Plan was complete by mid-October, all Plan chapters were substantially complete by the middle of September. In contrast to this schedule, the draft revised California Department of Water Resources (DWR) Guidebook to Assist Agricultural Water Suppliers to Prepare a 2012 Agricultural Water Management Plan (Guidebook) was not released until September 10, 2012 with the final version scheduled for release sometime in October. Thus, the Guidebook was not available as a reference for preparation of this 2012 Plan. The main resources used to develop this 2012 Plan were the CWC itself, the relevant sections of the CCR, and the January 12, 2012 version of the Guidebook. The final revised Guidebook will be referenced during preparation of the 2015 Plan.

A cross-reference identifying the location(s) in the AWMP within which each of the applicable requirements of SBx7-7 and the corresponding sections of the CWC is addressed is provided on the following page. 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

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

Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
Chapter 4. Agricultural Water Suppliers				
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

Division	Subdivision	Paragraph	Code Language	Applicable AWMP Section(s)
Chapter 3. Agricultural Water Management Plans				
Article 1. General Provisions				
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

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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**

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Table of Contents

Introduction....1
Conjunctive Management....1
Implementation of Efficient Water Management Practices....2
Conclusion....2
Chapter 1.0 INTRODUCTION....1-1
Chapter 2.0 PLAN PREPARATION....2-1
2.1. Regulatory Compliance....2-1
2.2. Public Participation....2-1
2.3. Regional Coordination....2-2
Chapter 3.0 BACKGROUND AND DESCRIPTION OF SERVICE AREA....3-1
3.1 Background and History....3-1
3.1.1 Agency Formation and History....3-1
3.1.2 Organization....3-7
3.1.3 Distribution System....3-8
3.1.4 Member Units....3-8
3.1.5 Lower Yuba River Accord....3-8
3.1.6 FERC Relicensing....3-10
3.1.7 Water Rights and Operational Considerations....3-11
3.2 Size of Service Area (§10826.A(1))....3-12
3.2.1 Wholesaler Perspective....3-12
3.2.2 Description of Member Units....3-12
3.3 Location of Service Area And Water Management Facilities (§10826.A(2))....3-16
3.3.1 Wholesaler Perspective....3-16
3.3.2 YCWA Irrigation Facilities....3-16
3.3.3 Water Ordering and Delivery Procedures....3-21
3.4 Terrain and Soils (§10826.A(3))....3-21
3.5 Climate (§10826.A(4))....3-27
3.6 Operating Rules and Regulations (§10826.A(5))....3-28
3.6.1 Wholesaler Perspective....3-28
3.6.2 General Description of Operations....3-28
3.7 Water Delivery Measurements and Calculations (§10826.A(6))....3-30

3.8 Water Rate Schedules and Billing (§10826.A(7)) 3-31
3.8.1 Wholesaler Perspective 3-31
3.8.2 Summary of Rate Structures and Water Rates by Member Unit 3-31
3.8.3 Compliance with California Water Code 10608.48 3-32
3.9 Water Shortage Allocation Policies (§10826.A(8)) 3-35
3.9.1 Lower Yuba River Accord and Member Unit Delivery Contracts 3-35
3.9.2 Policies Addressing Wasteful Use 3-36
Chapter 4.0 INVENTORY OF WATER SUPPLIES 4-1
4.1 Introduction 4-1
4.2. Surface Water Supply (§10826.b(1)) 4-1
4.3. Groundwater Supply (§10826.b(2)) 4-1
4.3.1. Overview 4-1
4.3.2. Conjunctive Management 4-5
4.3.3. Groundwater Management Planning 4-10
4.4. Other Water Supplies (§10826.b(3)) 4-16
4.5. Water Quality Monitoring Practices (§10826.b(4)) 4-16
4.5.1. Surface Water 4-16
4.5.2. Groundwater 4-17
Chapter 5.0 WATER BALANCE 5-1
5.1. Introduction 5-1
5.2. Water Balance Overview 5-1
5.3. Water Balance Areas 5-4
5.3.1. Northside Water Balance Area Description 5-4
5.3.2. Southside Water Balance Area Description 5-5
5.4. Flow Path Estimation and Uncertainty 5-5
5.5. Hydrologic Year Types 5-13
5.6. Water Uses (§10826.b(5)) 5-15
5.6.1. Agricultural 5-15
5.6.2. Environmental 5-24
5.6.3. Recreational 5-25
5.6.4. Municipal and Industrial 5-25
5.6.5 Groundwater Recharge 5-25
5.6.6. Transfers and Exchanges 5-31
5.6.7. Other Water Uses 5-33
5.7. Drainage (§10826.b(6)) 5-33

5.7.1. Tailwater 5-33
5.7.2. Boundary Outflows 5-36
5.8. Water Accounting (Summary of Water Balance Results) (§10826.b(7)) 5-38
5.8.1. Distribution and Drainage System Water Balance 5-49
5.8.2. Farmed Lands Water Balance 5-52
5.9. Water Supply Reliability (§10826.b(8)) 5-55
Chapter 6.0 CLIMATE CHANGE (§10826.c) 6-1
6.1. Introduction 6-1
6.2. Potential Climate Change Effects 6-1
6.3. Potential Climate Change Impacts 6-4
6.3.1. Potential Impacts on Water Supply and Water Quality 6-4
6.3.2. Potential Impacts on Water Demand 6-5
6.3.3. Potential Flood Control Impacts 6-5
6.4. Strategies to Mitigate Climate Change Impacts 6-5
6.5. Additional Resources for Water Resources Planning for Climate Change 6-7
Chapter 7.0 EFFICIENT WATER MANAGEMENT PRACTICES (§10826.e) 7-1
7.1. Introduction 7-1
7.2. Delivery Measurement Accuracy (10608.48.B(1)) 7-4
7.3. Volumetric Pricing (10608.48.B(2)) 7-4
7.4. Additional Locally Cost Effective EWMPS 7-4
7.4.1. Alternative Land Use (10608.48.c(1)) 7-4
7.4.2. Recycled Water Use (10608.48.c(2)) 7-5
7.4.3. Capital Improvements for On-Farm Irrigation Systems (10608.48.c(3)) 7-5
7.4.4. Incentive Pricing Structures (10608.48.c(4)) 7-6
7.4.5. Lining or Piping of Distribution System and Construction of Regulating Reservoirs (10608.48.c(5)) 7-6
7.4.6. Increased Water Ordering and Delivery Flexibility (10608.48.c(6)) 7-7
7.4.7. Supplier Spill and Tailwater Recovery Systems (10608.48.c(7)) 7-7
7.4.8. Increase Planned Conjunctive Use (10608.48.c(8)) 7-8
7.4.9. Automate Canal Control Structures (10608.48.c(9)) 7-8
7.4.10. Facilitate or Promote Customer Pump Testing and Evaluation (10608.48.c(10)) 7-9
7.4.11. Designate Water Conservation Coordinator (10608.48.c(11)) 7-9
7.4.12. Provide for Availability of Water Management Services (10608.48.c(12)) 7-9
7.4.13. Evaluate Supplier Policies to Allow More Flexible Deliveries and Storage (10608.48.c(13)) 7-10
7.4.14. Evaluate and Improve Efficiencies of Supplier's Pumps (10608.48.c(14)) 7-10

7.5. Summary of EWMP Implementation Status 7-10
7.6. Evaluation of Water Use Efficiency Improvements 7-15

List of Tables

Table 3-1. YCWA Historical Water Transfers, 1987 Through 2010 3-6
Table 3-2. North Member Unit Land Use and Cropping, 2005 3-14
Table 3-3. South Member Unit Land Use and Cropping, 2005. 3-16
Table 3-4. YCWA Irrigation Facilities 3-17
Table 3-5. Characteristics of Dominant Soils in MU Service Areas 3-22
Table 3-6. Mean Daily Weather Parameters by Month at Nicolaus CIMIS Station and Yuba County Airport NWS Station (January 2001 through December 2010) 3-28
Table 3-7. Member Unit Water Rights and Base and Supplemental Yuba Project Contract Volumes 3-32
Table 3-8. Member Unit Operations and Maintenance Charges for 2010 3-32
Table 5-1a. Northside YCWA Water Balance Flow Paths, Supporting Data, and Estimated Uncertainty 5-9
Table 5-1b. Southside YCWA Water Balance Flow Paths, Supporting Data, and Estimated Uncertainty 5-11
Table 5-2. 2001 to 2010 Yuba River Index, Water Year Precipitation and Irrigation Season ET_o, and Hydrologic Year Type 5-14
Table 5-3. YCWA Crop Acreages, 2001 to 2010 5-18
Table 5-4. Verification of SEBAL-Based Crop Coefficients for YCWA MU Service Areas 5-20
Table 5-5. Average Acreages and Annual Evapotranspiration Rates for YCWA Crops 5-23
Table 5-6a. YCWA Northside Total Groundwater Recharge, 2001 to 2010 5-26
Table 5-6b. YCWA Southside Total Groundwater Recharge, 2001 to 2010 5-27
Table 5-7a. YCWA Northside Net Groundwater Recharge, 2001 to 2010 5-29
Table 5-7b. YCWA Southside Net Groundwater Recharge, 2001 to 2010 5-30
Table 5-8. YCWA and Member Unit Water Transfer Volumes by Transfer Category, 2001 to 2010 5-32
Table 5-9a. YCWA Northside Tailwater, 2001 to 2010 5-34
Table 5-9b. YCWA Southside Tailwater, 2001 to 2010 5-35
Table 5-10a. YCWA Northside Boundary Outflows, 2001 to 2010 5-37
Table 5-10b. YCWA Southside Boundary Outflows, 2001 to 2011. 5-38
Table 5-11a. YCWA Northside Distribution and Drainage System Annual Water Balance Results, 2001 to 2010 5-41
Table 5-11b. YCWA Southside Distribution and Drainage System Annual Water Balance Results, 2001 to 2010 5-43
Table 5-12a. YCWA Northside Member Unit Laterals and Farmed Lands Annual Water Balance Results, 2001 to 2010 5-45
Table 5-12b. YCWA Southside Member Unit Laterals and Farmed Lands Annual Water Balance Results, 2001 to 2010 5-47
Table 6-1. Strategies to Mitigate Climate Change Impacts 6-6

Table 7-1. Summary of EWMP Implementation Status 7-2
Table 7-2. Summary of YCWA Implementation Status for EWMPs Listed Under CWC 10608.48 7-11
Table 7-3. Summary of WUE Improvements by EWMP 7-17
Table 7-4. WUE Improvement Categories 7-19
Table 7-5. Applicability of EWMPs to WUE Improvement Categories 7-21
Table 7-6. Evaluation of Relative Magnitude of Past and Future WUE Improvements by EWMP 7-25

List of Figures

Figure 3-1. New Bullards Bar Dam 3-2
Figure 3-2. New Colgate Powerhouse 3-3
Figure 3-3. Hydrograph Showing Historical Groundwater Elevations for a Typical South Yuba Subbasin Well 3-4
Figure 3-4. YCWA Organizational Chart 3-7
Figure 3-5. YCWA Facilities, Member Units, and Hydrography. 3-19
Figure 3-6. YCWA Soil Map Units 3-23
Figure 3-7. YCWA Soil Depth to Restrictive Layer 3-25
Figure 3-8. YCWA Daily Water Report for June 22, 2012 3-30
Figure 4-1. North and South Yuba Groundwater Subbasins 4-2
Figure 4-2. Spring 2010 Groundwater Elevations in North and South Yuba Basins 4-4
Figure 4-3. Accord Monthly Minimum Instream Flows at Marysville and Smartsville by Flow Schedule Year Type 4-6
Figure 4-4. Organization of Groundwater Management Plan Elements 4-11
Figure 4-5. Yuba Groundwater Basin Wells Monitored by YCWA and DWR for Elevation 4-13
Figure 4-6. Yuba Groundwater Basin Wells Monitored for Water Quality 4-14
Figure 4-7. Yuba Basin Subsidence Monitoring Network 4-15
Figure 5-1a. Northside Water Balance Structure. 5-2
Figure 5-1b. Southside Water Balance Structure. 5-3
Figure 5-2a. YCWA Northside Water Balance Area, Inflows, and Outflows 5-6
Figure 5-2b. Northside Water Balance 5-7
Figure 5-3. Rice near Marysville in August 5-15
Figure 5-4a. Northside Land Uses, 2001 to 2010 5-19
Figure 5-4b. Southside Land Uses, 2001 to 2010 5-19
Figure 5-5a. YCWA Northside Spatially Distributed Seasonal Actual ET from SEBAL, 2001 Irrigation Season 5-21
Figure 5-5b. YCWA Southside Spatially Distributed Seasonal Actual ET from SEBAL, 2001 Irrigation Season 5-22
Figure 5-6. Estimated Average Monthly Tailwater Production as Percentage of Annual Total, 2001 to 2010 5-36
Figure 6-1. Annual April through July Unimpaired Runoff for Yuba River at Smartsville as Percentage of Total Water Year Runoff 6-2
Figure 6-2. Total Water Year Runoff for Yuba River at Smartsville 6-3

Figure 6-3. Annual Feather River Runoff at Oroville Based on 112 Hydrologic Projections 6-3
Figure 6-4. Sensitivity of Reference Evapotranspiration to Hypothetical Changes in Climate 6-4

Attachments

A. Agricultural Water Measurement Compliance Documentation

B. Public Coordination

1. Notification of Intent to Prepare AWMP
2. Affidavit of Publication for Notice of Availability of Draft AWMP for Public Review and Hearing
3. Amended Notice and Agenda for Special Meeting of YCWA Board of Directors, December 20, 2012
4. Public Hearing Outreach Materials
5. Resolution No. 2012-15 Adopting 2012 AWMP

C. YCWA Groundwater Management Plan

D. Yuba County Integrated Regional Water Management Plan

E. YCWA Measurement Improvement Plan

F. Net Benefit Analysis for Canal Automation Alternatives

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
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
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
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

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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). 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 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. 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)
- The YCWA Groundwater Management Plan (2010)

Development of the AWMP represents a substantial effort by YCWA to evaluate its water management, including the development of detailed water balances spanning the period from 2001 to 2010 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.

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 for transfer.

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

Development of this AWMP 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).	Being Implemented	• Prepared a certification of compliance for existing compliant customer delivery measurement sites (Attachment A). • Developed a corrective action plan for non-compliant and new sites to achieve compliance with CCR 23 §597 by December 31, 2015 (Attachment A)	• Implement corrective action plan described in Attachment A by December 31, 2015.
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Being Implemented	• Existing operations and maintenance charges to southside member units based on volume of water delivered. • Identified examples of operations and maintenance charges that could be included in northside member unit delivery contracts. • Developed Agency objectives to be considered when evaluating alternative pricing structures. • Developed conceptual alternative pricing structure to satisfy Agency objectives. • Initiated discussion with MUs regarding requirement for pricing structure based in part on volume delivered.	• Continue implementing pricing structure for reimbursement of operations and maintenance costs based on volume of water delivered. • Continue discussions with MUs to modify existing pricing structures, as needed. • If necessary and mutually agreeable, amend MU delivery contracts to modify pricing, or modify contracts accordingly upon expiration.
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.	Being Implemented	• Reusing recycled M&I water from Beale Air Force Base and Olivehurst Public Utilities District. • Identified potential additional sources of recycled M&I water.	• Continue existing use of recycled water. • 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.	Not Technically Feasible	Financing of on-farm capital improvements is beyond YCWA's purview as a wholesaler; however, YCWA has financed capital improvements by its customers, the MUs.	
10608.48.c(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Being Implemented	• Existing pricing structure promotes use of available surface water supplies to provide beneficial groundwater recharge (Goal C). • Yuba Accord promotes groundwater production during dry years (Goal B). • Implementing pricing structure that will encourage more efficient water use by MUs.	• Continue to promote use of surface water supplies for beneficial recharge. • Continue to promote groundwater production during dry years. • Implement pricing structure based in part on volume delivered to encourage more efficient water use by MUs.
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.	

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

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	Being Implemented	• Currently maximizing flexibility within operational limits. Deliveries are made with 24 hours advance notice. • Providing Agency staff to work under direction of MUs in Southside area to deliver water to MU customers, providing seamless coordination between operation of YCWA and MU facilities, enhancing flexibility. • Evaluated automation of YCWA facilities to further increase flexibility to MUs under canal automation EWMP.	• Continue deliveries with 24 hour advance notice. • Continue to provide Agency staff to work under direction of MUs in Southside area to deliver water to MU customers. • 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.	Being Implemented	• Implementing MIP to provide continuous monitoring of key locations to support spill and tailwater reduction by YCWA and MU operators. • MUs practice extensive tailwater and spillage recovery and reuse.	• Continue implementation of MIP, focused initially on securing funding for improvement/establishment of high priority sites. • Make monitoring data available to MUs as it becomes available.
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	Being Implemented	• Conducting effective, proactive conjunctive management program to meet multiple objectives.	• Continue conjunctive management and seek opportunities to enhance activities to increase local and statewide benefits.
10608.48.c(9)	Automate canal control structures.	Being Implemented	• Implementing MIP to provide continuous monitoring of key locations to support enhanced operation of YCWA and MU facilities by Agency and MU operators. • Constructed Yuba Wheatland Canal pump stations operating in automatic downstream level control. • Evaluated opportunities for additional automation to be considered for implementation.	• Continue implementation of MIP, focused initially on securing funding for improvement/establishment of high priority sites. • Make monitoring data available to MUs as it becomes available. • Continue automated operation of Yuba Wheatland Canal pump stations. • Implement additional automation at locally cost-effective levels.
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation.	Being Implemented	• Providing link on Agency web site to Advanced Pumping Efficiency Program funded by PG&E.	• Continue to promote participation of MUs in available pump testing programs.
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Being Implemented	• Water Resources Manager serves as YCWA Water Conservation Coordinator.	• Water Resources Manager will continue to serve as Water Conservation Coordinator.
10608.48.c(12)	Provide for the availability of water management services to water users.	Being Implemented	• Providing links to water management services on Agency web site. • Implementing MIP to provide continuous monitoring of key locations to support enhanced operation of MU facilities. • Providing Agency staff for operation of MU facilities in Southside area.	• Continue to provide web links to water management services. • Continue implementation of MIP, focused initially on securing funding for improvement/establishment of high priority sites. • Continue to provide Agency staff for operation of MU facilities.
10608.48.c(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Being Implemented	• Evaluating policies of agencies that affect YCWA's ability to flexibly store and deliver water and seeking changes to increase flexibility.	• 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.	Being Implemented	• Periodic evaluation of pump efficiency and maintenance as needed to improve pump efficiency.	• Continue periodic evaluation of pump efficiency and maintenance as needed to improve pump efficiency.

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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). 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).

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 ten-year period from 2001 to 2010 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).

YCWA has not previously prepared an AWMP.

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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 and the CWC. 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 5, 2012;
- Publication in the Marysville Appeal Democrat on December 5, 2012 and December 17, 2012 of the time and place of a hearing to review the draft Plan;
- Posting of the draft Plan on the District's web page on December 5, 2012, including instructions for reviewers to submit comments;
- Posting of the draft AWMP for public review on December 5, 2012;
- Review of the publicly noticed presentation of the draft Plan at a special meeting of the Board of Directors on December 20, 2012;
- Adoption of the final AWMP at a special meeting of the Board of Directors on December 20, 2012; and
- Provision of copies of the adopted AWMP to the following parties by January 19, 2013:
    - 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 August 22, 2012.

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 …."
>
> "The Agency shall have the power to develop hydroelectric power to the extent that such power can be developed in connection with the construction and operation of its projects …."

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.

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.

Figure 3-1. New Bullards Bar Dam

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.

Figure 3-2. New Colgate Powerhouse

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.

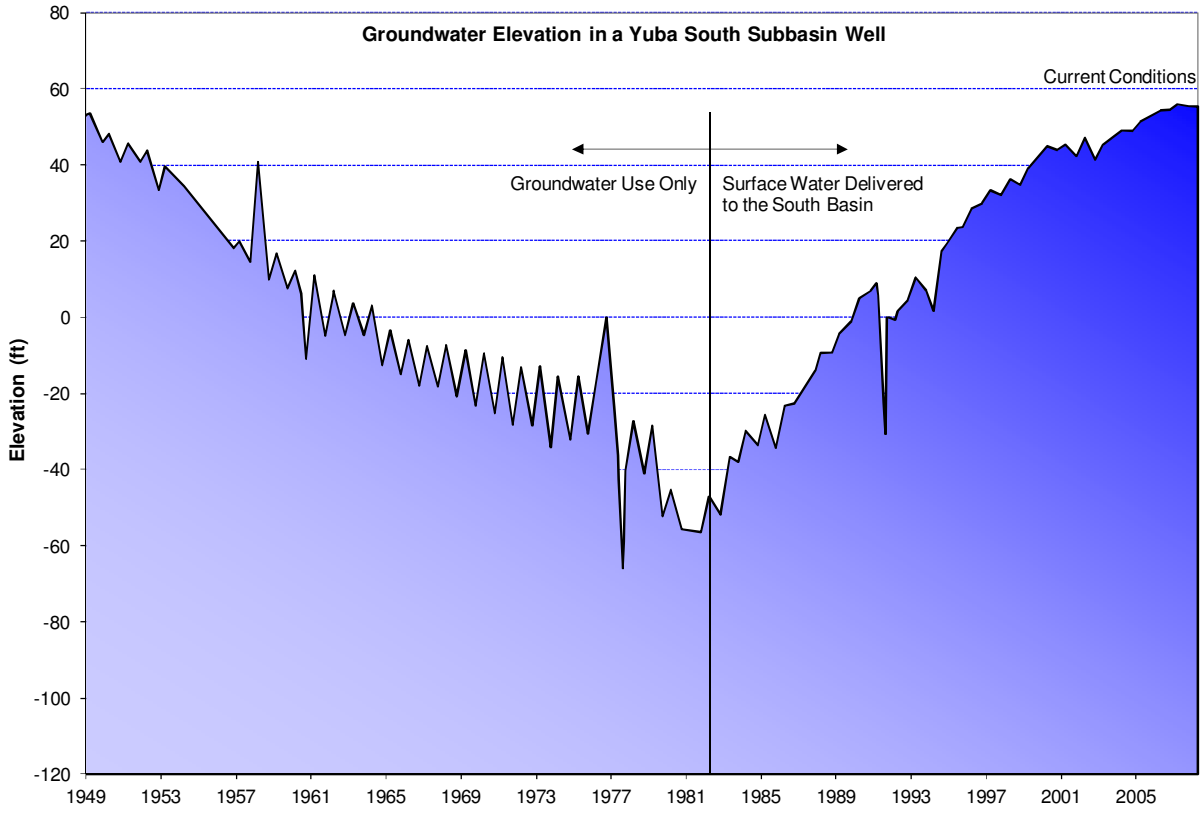
Over the following 34 years, contracts were entered into by the Agency to provide wholesale water supplies for agricultural use to irrigation and water districts north and south of the River in Yuba County. Today, YCWA provides water to 8 member units (MUs) representing 79,590 gross acres[1]. The newest 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

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

- Dry Creek Mutual Water Company (DCMWC) – 1996
- Wheatland Water District (WWD) – 2004

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.



Source: Grinnell, S. 2011. Personal Communication

Figure 3-3. Hydrograph Showing Historical Groundwater Elevations for a Typical South Yuba Subbasin Well

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.

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 enhancement and protection of regional and statewide water supplies. Between 1987 and 2010, YCWA provided water through 33 individual surface water and groundwater

substitution transfers representing more than 2 million acre-feet. These transfers are summarized in Table 3-1, excerpted from the Agency's 2010 GMP.

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 2010

Year	Sacramento Valley Index[i] Water-Year Type	Buyer	Stored-Water Transfer (acre-feet)	Groundwater Substitution Transfer (acre-feet)
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 Utility District	60,000a	
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
Total			1,636,076	431,259

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, 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 includes 60 TAF of stored water for the Environmental Water Account
[h] The 2007 transfer was under Yuba Accord Pilot Program. It also included 60 TAF of transfer 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.
Key:
AF = Acre-feet EWA = Environmental Water Account

Source: YCWA GMP WRP

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 human resources, finance, special projects, water resources, power systems, and business services 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.

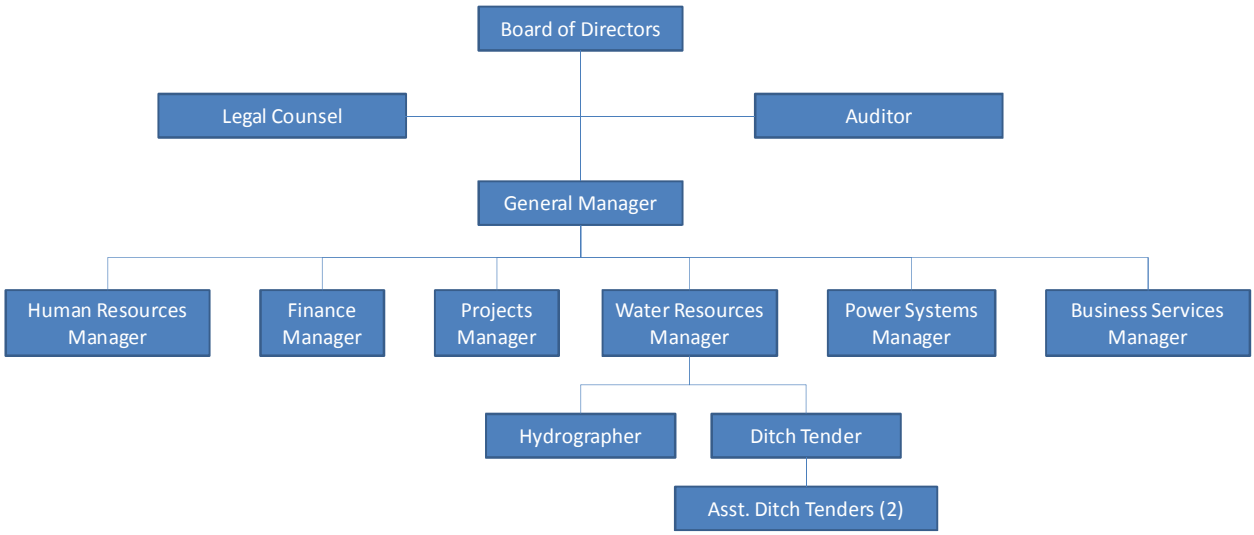


Figure 3-4. YCWA Organizational Chart

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 development of ratings for canal sections to support accurate flow measurement, monitoring of deliveries to member units north of the Yuba River, 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. 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 service areas are:

- North of Yuba River
  - Browns Valley Irrigation District (7,062 acres[2])
  - 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. 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.

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

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)**[3] – 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.
- **Amendments to 1966 Power Purchase Contract between YCWA and PG&E (January 2008)** – Specifies changes to the operation of New Bullard's Bar Reservoir

[3] 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.

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 the relicensing process in 2008, and it is currently 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[4]. ILP provides a more efficient and timely licensing process than other licensing processes. Pre-Application Activities can be divided into the following five phases:

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

- **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. Studies by YCWA began in May 2011 and are expected to be completed in February 2014.
- **DLA/PLP** – Filing of Draft License Application (DLA) or Preliminary Licensing Proposal (PLP) by YCWA. It is anticipated YCWA will file its DLA or PLP no later than December 2013.

Following filing of the DLA or PLP, YCWA will file a Final License Application (FLA) no later than April 30, 2014, which will initiate 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 will also prepare 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 service areas are:

- North of Yuba River
  - Browns Valley Irrigation District (7,062 acres[5])
  - 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.

3.2.2.1 North Member Units

Browns Valley Irrigation District. 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 Sierra foothills and Sacramento Valley, with approximately 7,100 acres

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

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

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

Source: DWR land use survey information for Yuba County from 2005. (www.water.ca.gov/landwateruse/lusrvymain.cfm)
Key:
BVID = Browns Valley Irrigation District
CID = Cordua Irrigation District
HIC = Hallwood Irrigation Company
RWD = Ramirez Water District
YCWA =Yuba County Water Agency

3.2.2.2 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).

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[6].

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

Key:
BWD = Brophy Water District
DCMWC = Dry Creek Mutual Water Company
SYWD = South Yuba Water District
WWD = Wheatland Water District
YCWA = Yuba County Water Agency

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.

[6] 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

Key:
cfs = cubic feet per second
YCWA = Yuba County Water Agency

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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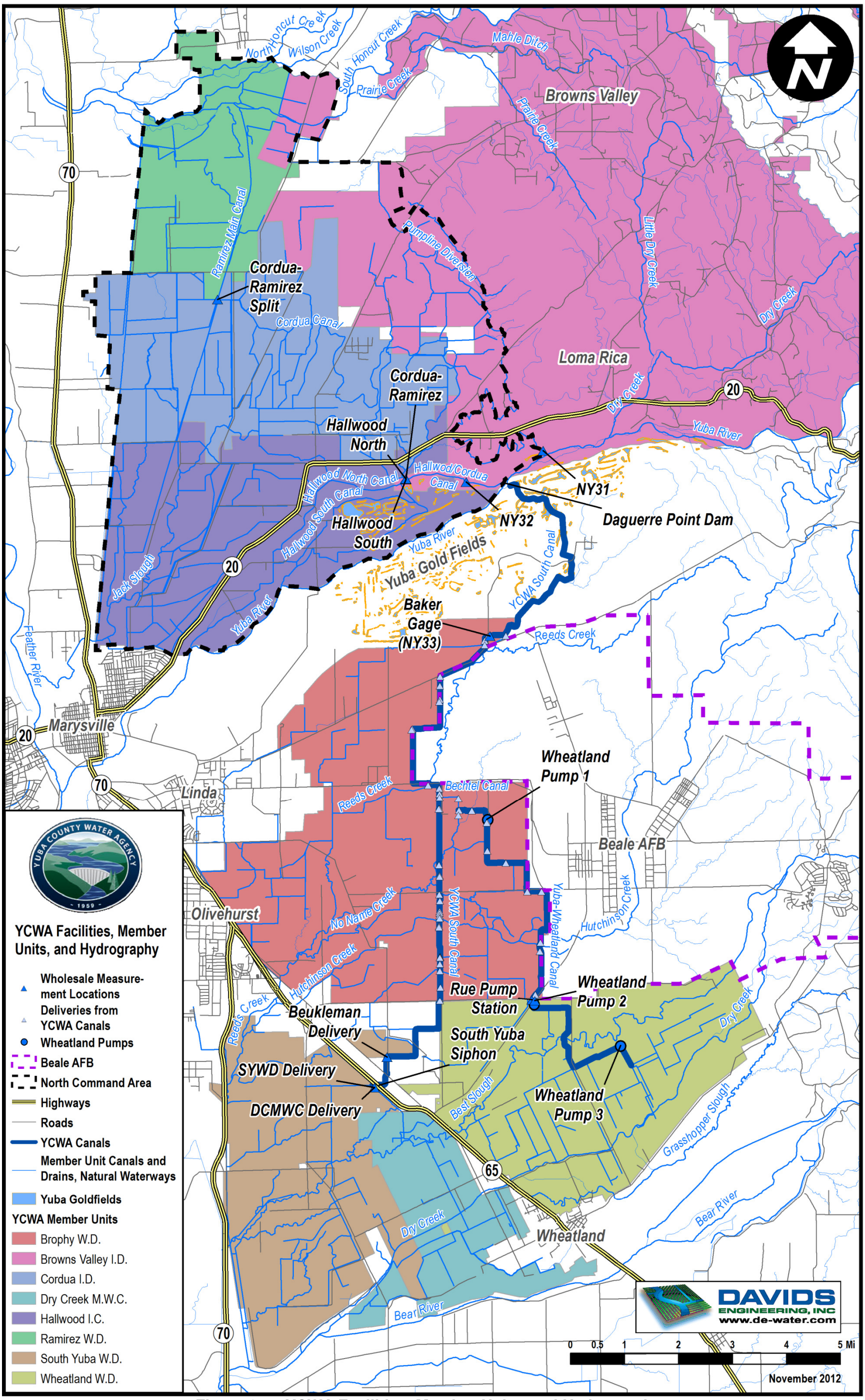

Figure 3-5. YCWA Facilities, Member Units, and Hydrography.

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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 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 percent of area), Redding Gravelly Loam (9 percent of area), Conejo Loam (8 percent of area), and Hollenbeck silty clay loam (4 percent 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

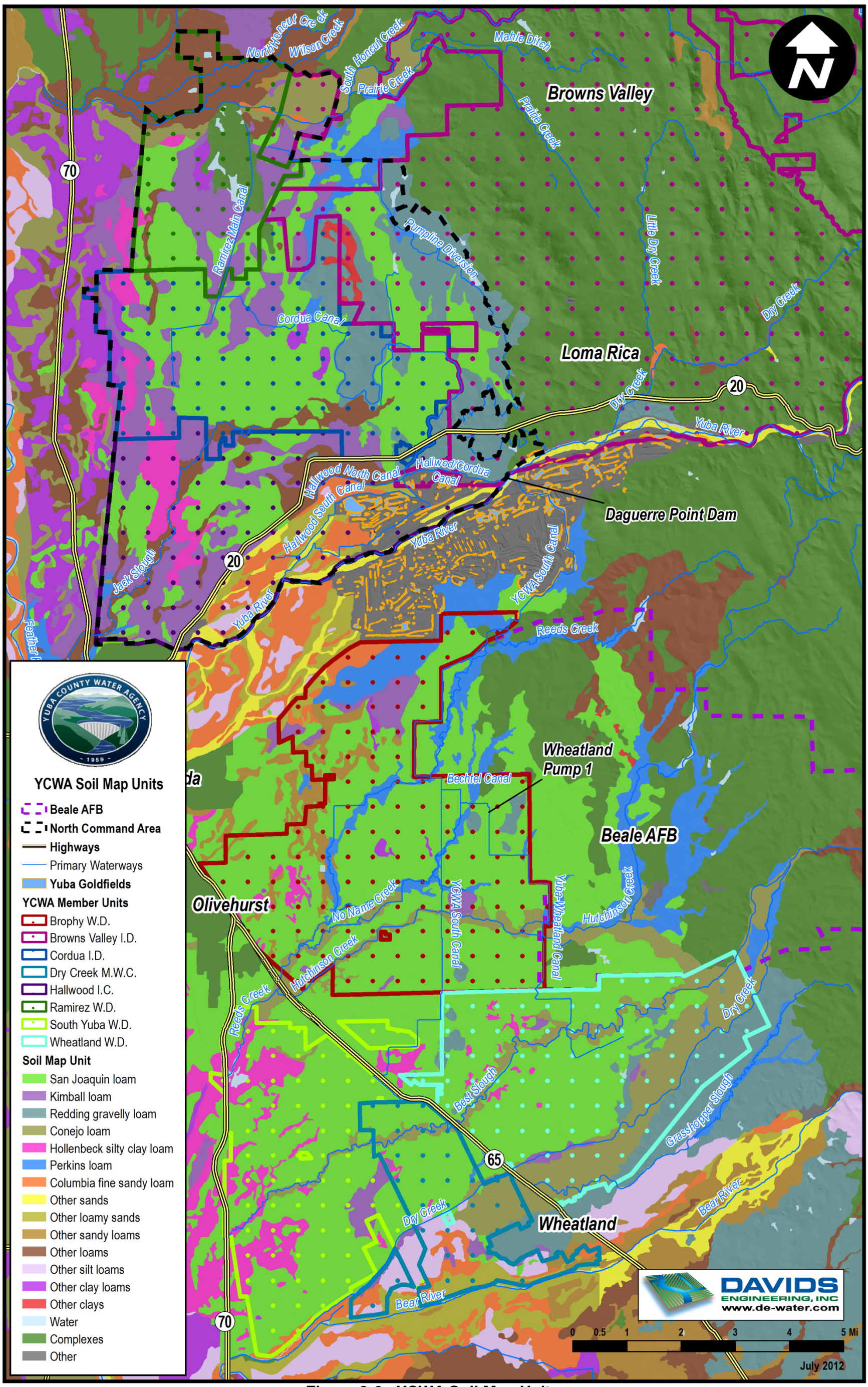

Figure 3-6. YCWA Soil Map Units

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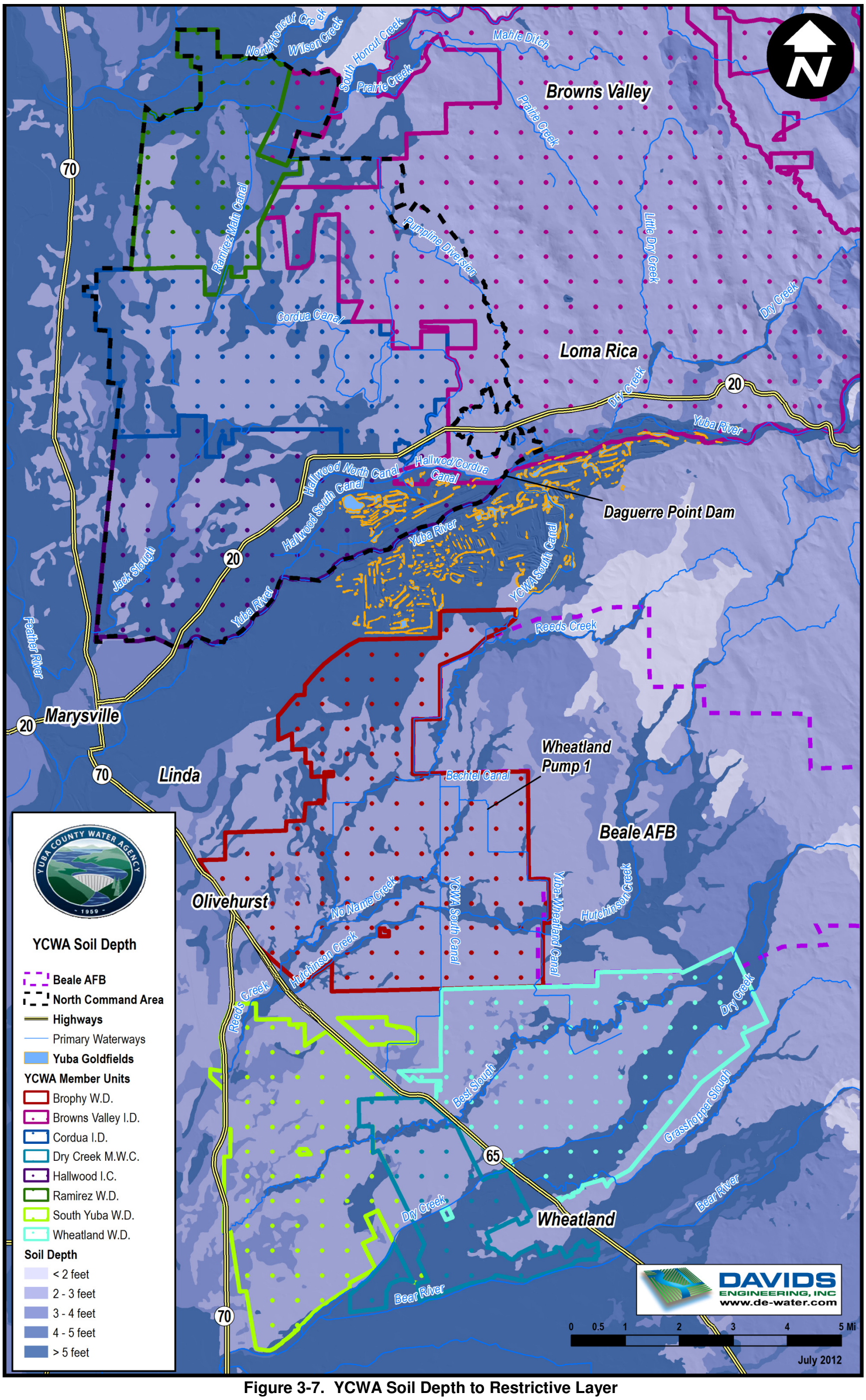

Figure 3-7. YCWA Soil Depth to Restrictive Layer

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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).[7]

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 percent, which is indicative of an irrigated area, and exceeds 95 percent between November and March. Minimum relative humidity ranges between approximately 31 percent during the summer and roughly 70 percent 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.

[7] 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).

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:[8]

- 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, the 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.

[8] 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):	18
Generation (MWH)				**PGE Entitlement:**	n/
Colgate 24 Hr:	2791	Colgate Mo to Date:	77664	Colgate Yr to Date:	49
Narr 2 24 Hr:	386	Narr 2 Mo to Date:	8098	Narr 2 Yr to Date:	77
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:	31
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 AWMP, YCWA has prepared a comprehensive Measurement Improvement Plan (MIP), included as Attachment E. The MIP describes existing measurement of MU deliveries, boundary inflows, boundary outflows, and internal flows and water levels at key operational sites. As part of the AWMP, the MIP serves the following functions:

- Documentation of existing water measurement by YCWA
- 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 is implementing 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 includes 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.

Of twelve sites that have been or will be used to measure deliveries to the eight MUs, seven existing sites were determined to be compliant with the measurement accuracy standard and are described in Attachment A.[9] Corrective actions for the remaining five sites are described in the MIP.

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. To some extent the terms of these agreements vary. 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.

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 $1.93 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.

[9] Two new measurement sites will be established as part of corrective actions to ensure that measurements to MUs comply with the accuracy standards of the Regulation.

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 south of the Yuba River are required to reimburse YCWA for the operations and maintenance of YCWA and MU facilities south of the River. 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. Operations and maintenance charges for 2010 are summarized in Table 3-8.

Table 3-8. Member Unit Operations and Maintenance Charges for 2010

Member Unit	Percent Share of O&M Costs
Brophy Water District	54%
South Yuba Water District	24%
Dry Creek Mutual Water Company	8%
Wheatland Water District	14%
TOTALS	100%

Key:
O&M = operations and maintenance

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 currently measures deliveries to individual MUs, but was unable to evaluate whether existing practices comply with new regulatory requirements specifying the level of accuracy required until the regulation was adopted by the State. Measurement accuracy requirements are defined in CCR 23 §597, which was approved by the State and put into effect on July 11, 2012. YCWA is implementing improvements to existing customer delivery measurements to comply with CCR 23 §597, as described in Attachment E of this AWMP.

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 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.

On December 20, 2012, YCWA adopted a resolution to adopt the Agency's 2012 AWMP and continue the process to comply with CWC 10608.48. Continued implementation of volumetric pricing will include consideration of extending operations and maintenance costs to serve the north MUs through modification of their delivery contracts. Examples of operations and maintenance costs incurred by the Agency to serve the MUs north of the Yuba River could include reimbursement for the cost to monitor flows by the YCWA hydrographer and installation and maintenance of delivery measurement devices.

Due to the provisions of YCWA's existing delivery contracts with the MUs, it is anticipated that 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 to be considered when designing an alternative volumetric pricing structure. The 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. The pricing objectives will help facilitate future 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.

3.8.3.1 Volumetric Pricing Objectives

Beyond the need to comply with new 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 its volumetric rate structure:

- **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.

3.8.3.2 Conceptual Volumetric Rate Structure to Satisfy Objectives

The main 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 areas-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 fully satisfy the requirements of SBx7-7 by pricing water at least in part based on the volume delivered for all Member Units.

The Agency could develop a simple rate and revenue model to evaluate potential rate structures. Such a rate structure could:

- Comply with SBx7-7 by charging the MUs based at least in part on the quantity of water used.
- Maintain relatively stable revenues for the Agency by having a large fixed cost component.
- Maintain revenue neutrality relative to historical water charges and costs for each MU.
- Avoid unintended hydrologic consequences such as reducing beneficial recharge.
- Maintain equitability by using uniform volume rates for all MUs.
- Retain the existing distinction between base and supplemental project supplies and the same quantities of each in each MU agreement.

3.9 WATER SHORTAGE ALLOCATION POLICIES (§10826.A(8))

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 goal is to develop a water shortage allocation policy, despite the high reliability of YCWA surface and groundwater supplies. Currently, agreement and contract provisions exist 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. These provisions are described in greater detail in Section 4.3.2, as part of the discussion of YCWA's conjunctive management program.

Additionally, provisions for the allocation of limited Project surface water supplies are included in the delivery contracts with each MU. These provisions 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 percent of the 50-year average, 100 percent of the settlement is available, and

  - When the forecast is less than 40 percent, 80 percent of the settlement is available.
- BVID Pre-1914 Water Rights Settlement
  - 100 percent of the settlement is available in all years.[10]
- 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 percent of the 50-year average, 100 percent of the base supply is available,
    - When the forecast is less than or equal to 85 percent and greater than 50 percent 85 percent of the base supply is available,
    - When the forecast is less than or equal to 50 percent and greater than or equal to 40 percent, 70 percent of the base supply is available,
    - When the forecast is less than 40 percent, 50 percent of the base supply is available,
  - Supplemental Supply
    - 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.

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

[10] 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 less than 47.2 cfs, as dictated by BVID's Pre-1914 water rights, the District must reduce its Pumpline diversion amount accordingly.

from its operations and those of the MUs. Moving forward, YCWA will expand 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.

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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.

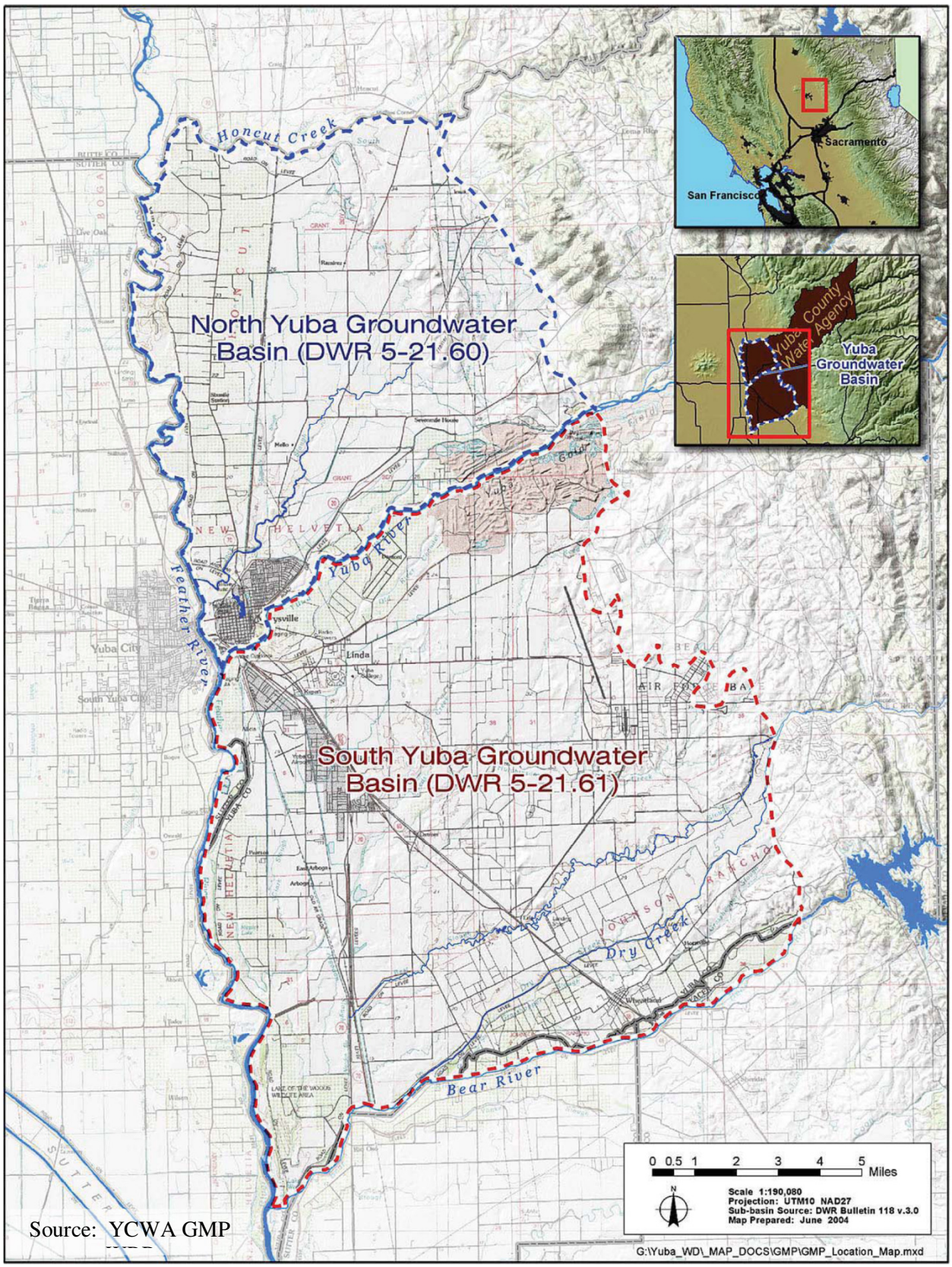
Historical diversions of surface water by YCWA are described in detail in Chapter 5, which discusses the water balance for the north and south service areas.

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. As 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.



Source: YCWA GMP

Figure 4-1. North and South Yuba Groundwater Subbasins

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.

4.1.1.1 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.

4.1.1.2 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). 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.

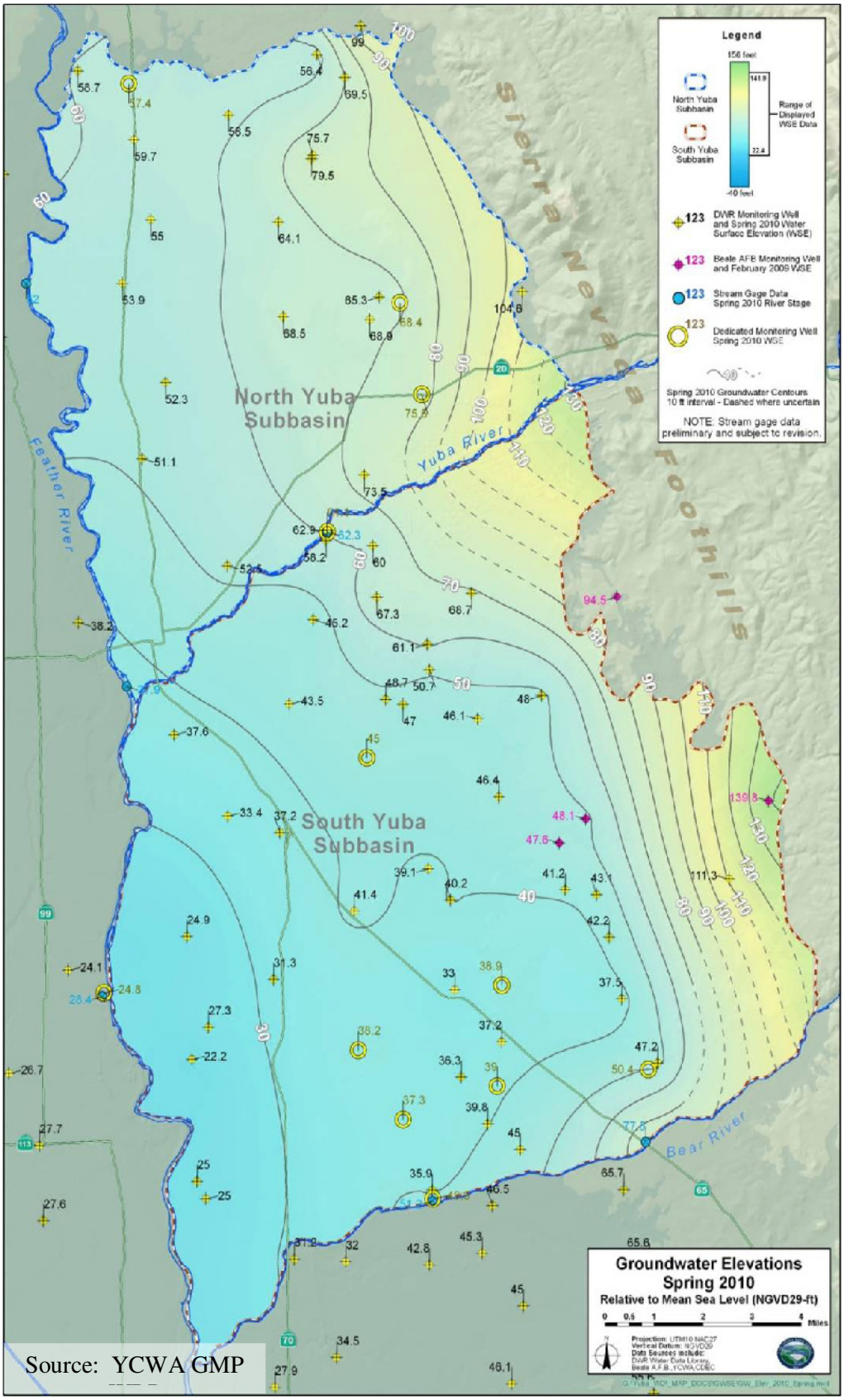


Figure 4-2. Spring 2010 Groundwater Elevations in North and South Yuba Basins

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.

4.1.1.3 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

<u>Fisheries Agreement</u>

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 (October 1 to September 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	398722
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[11] 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

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

subsequent years such that the total amount provided for the eight year period from 2008 to 2015 is 480,000 acre-feet.

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

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.

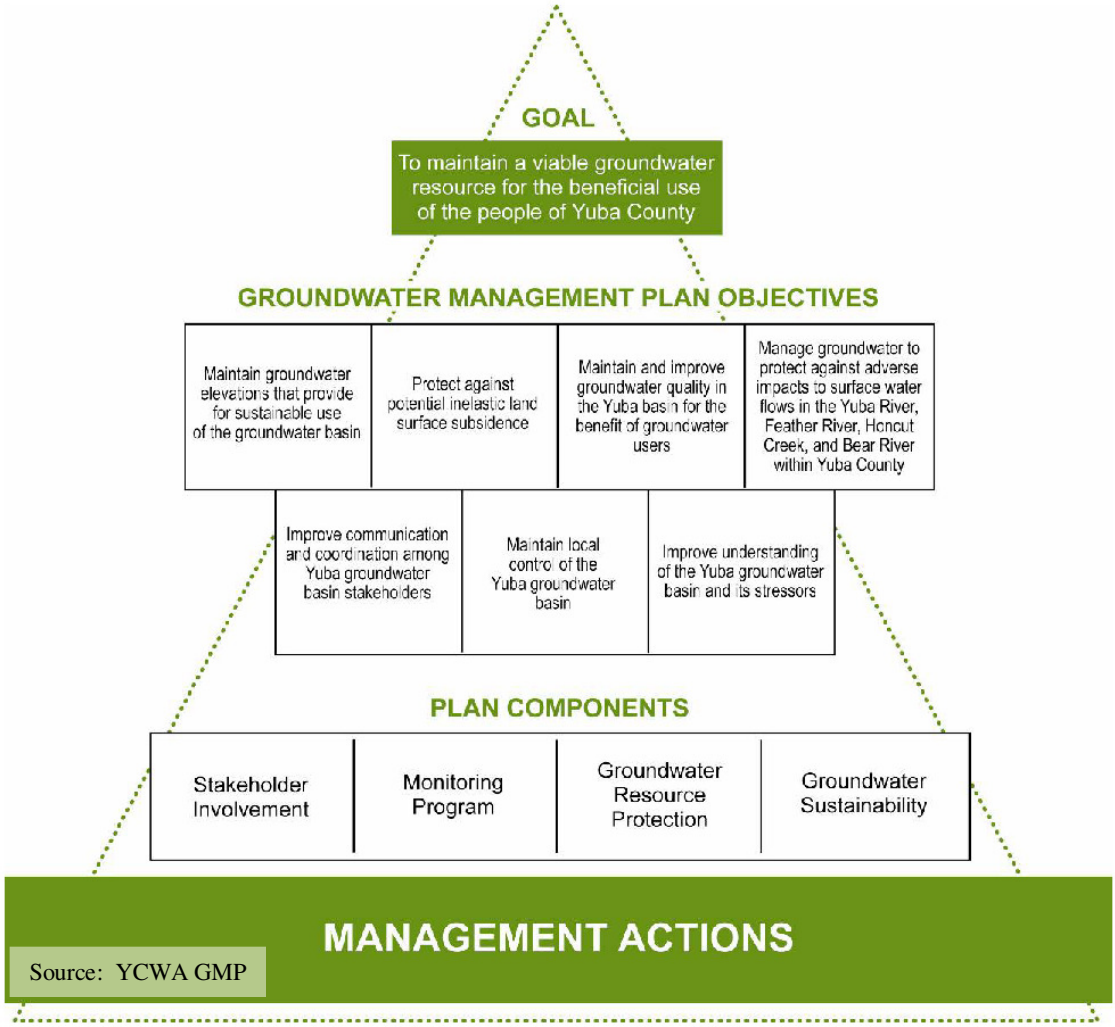
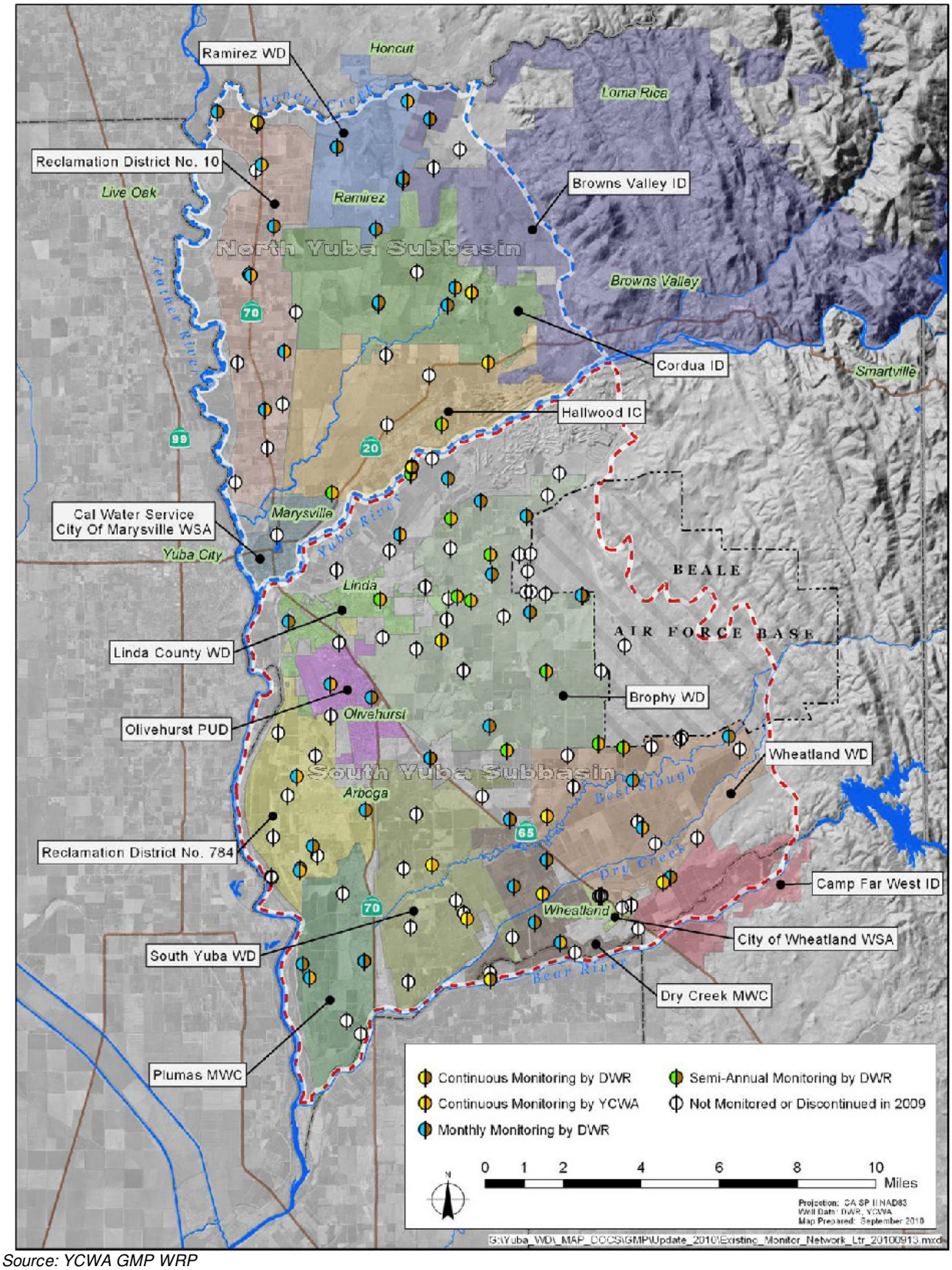


Figure 4-4. Organization of Groundwater Management Plan Elements

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.



Source: YCWA GMP WRP

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

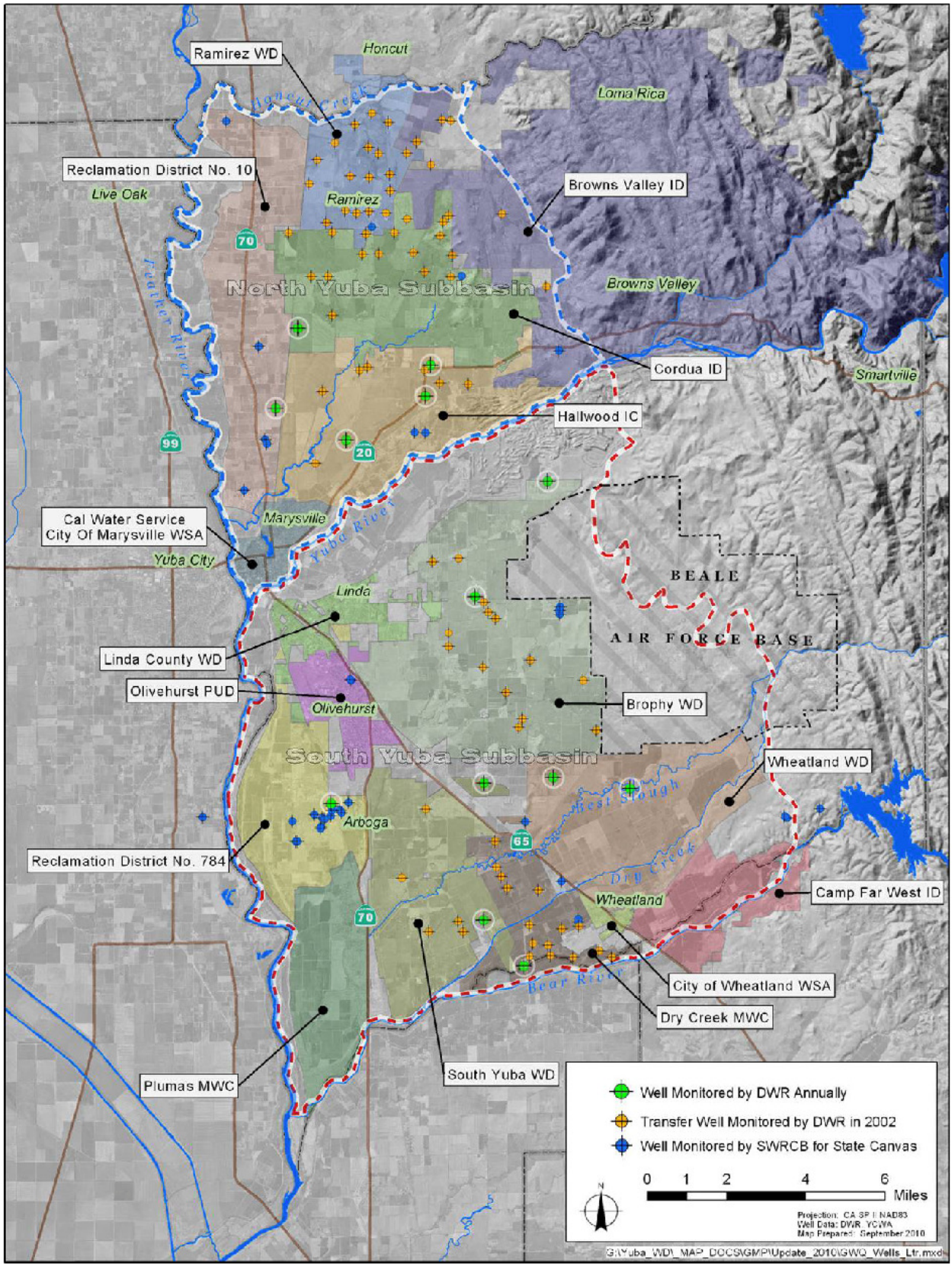


Figure 4-6. Yuba Groundwater Basin Wells Monitored for Water Quality

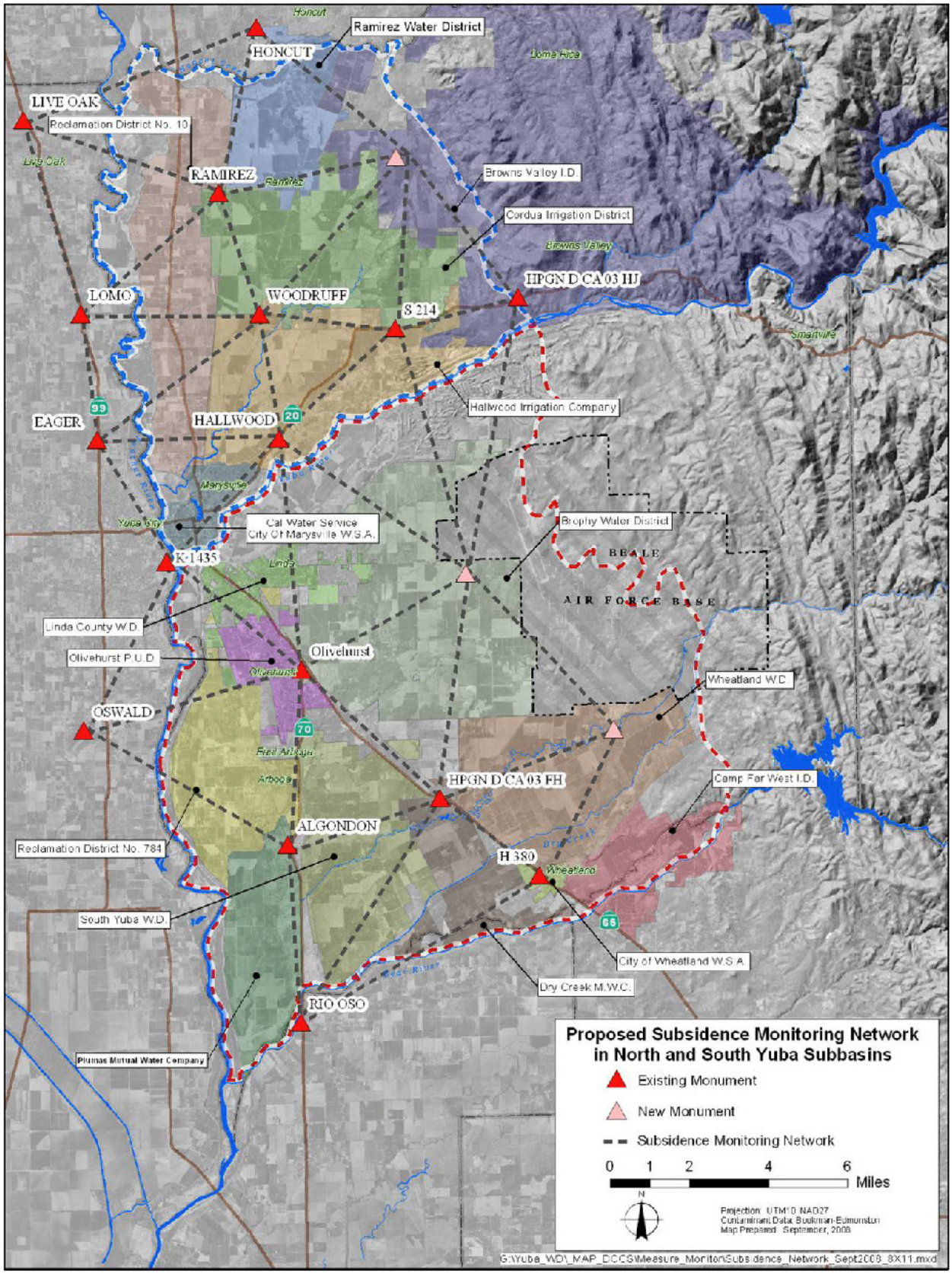


Figure 4-7. Yuba Basin Subsidence Monitoring Network

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.

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.

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.[12]

- 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."[13]
- 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.

[12] 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.

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

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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 2010 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.

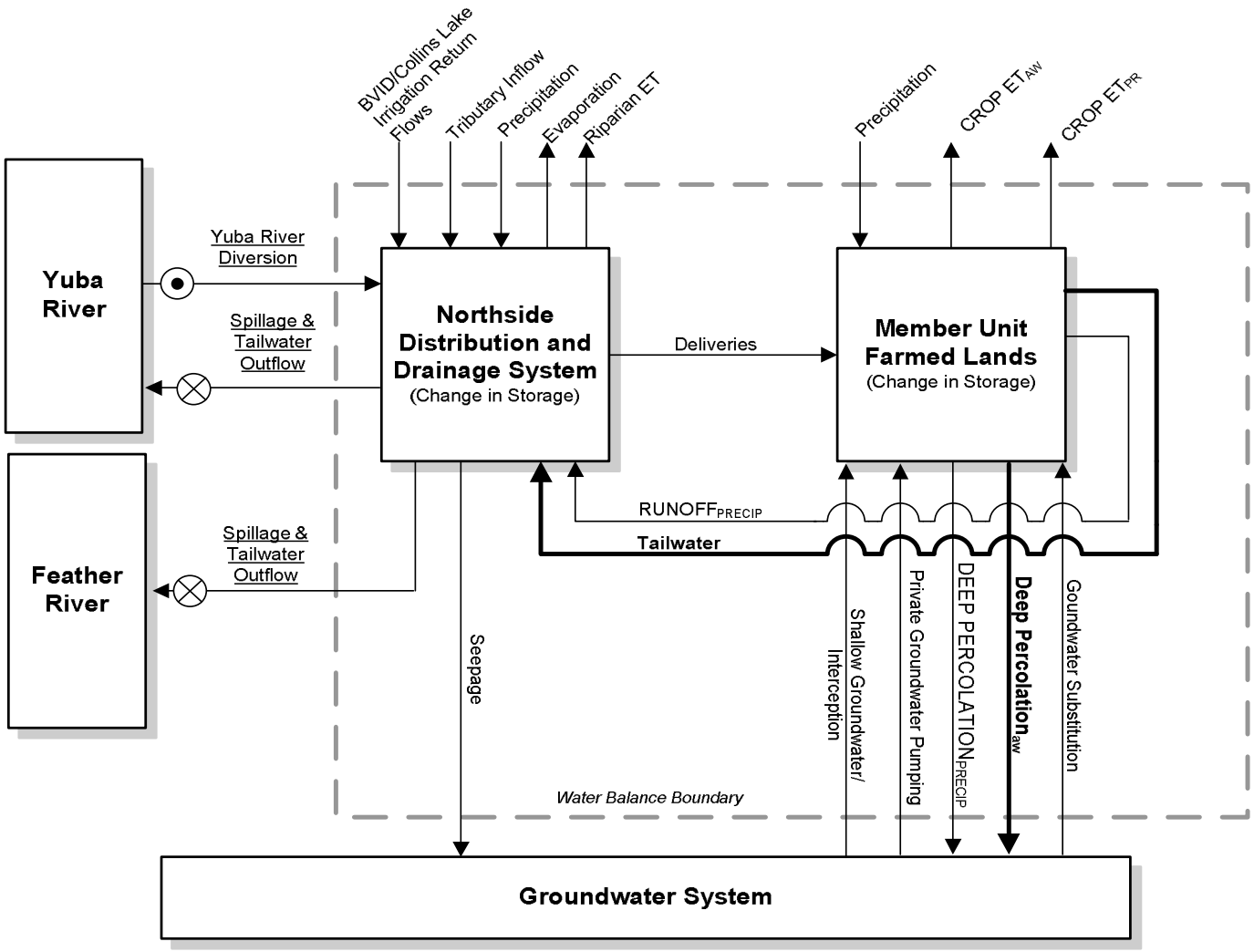
5.2. WATER BALANCE OVERVIEW

The YCWA water balance includes separate accounting centers for the distribution and drainage system[14] 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. A schematic 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 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 identical to the Northside (described above), except that it does not have a flow path for drainwater intercepted from upslope irrigation in BVID.

[14] 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).



= Full Record	Underlined = Flow Paths Based on YCWA Data
= Partial Record	Capitalized = Flow Paths are IDC Root Zone Calculation Results
	Bold = Flow Paths are Closure Terms
	BVID = Browns Valley Irrigation District

Figure 5-1a. Northside Water Balance Structure.

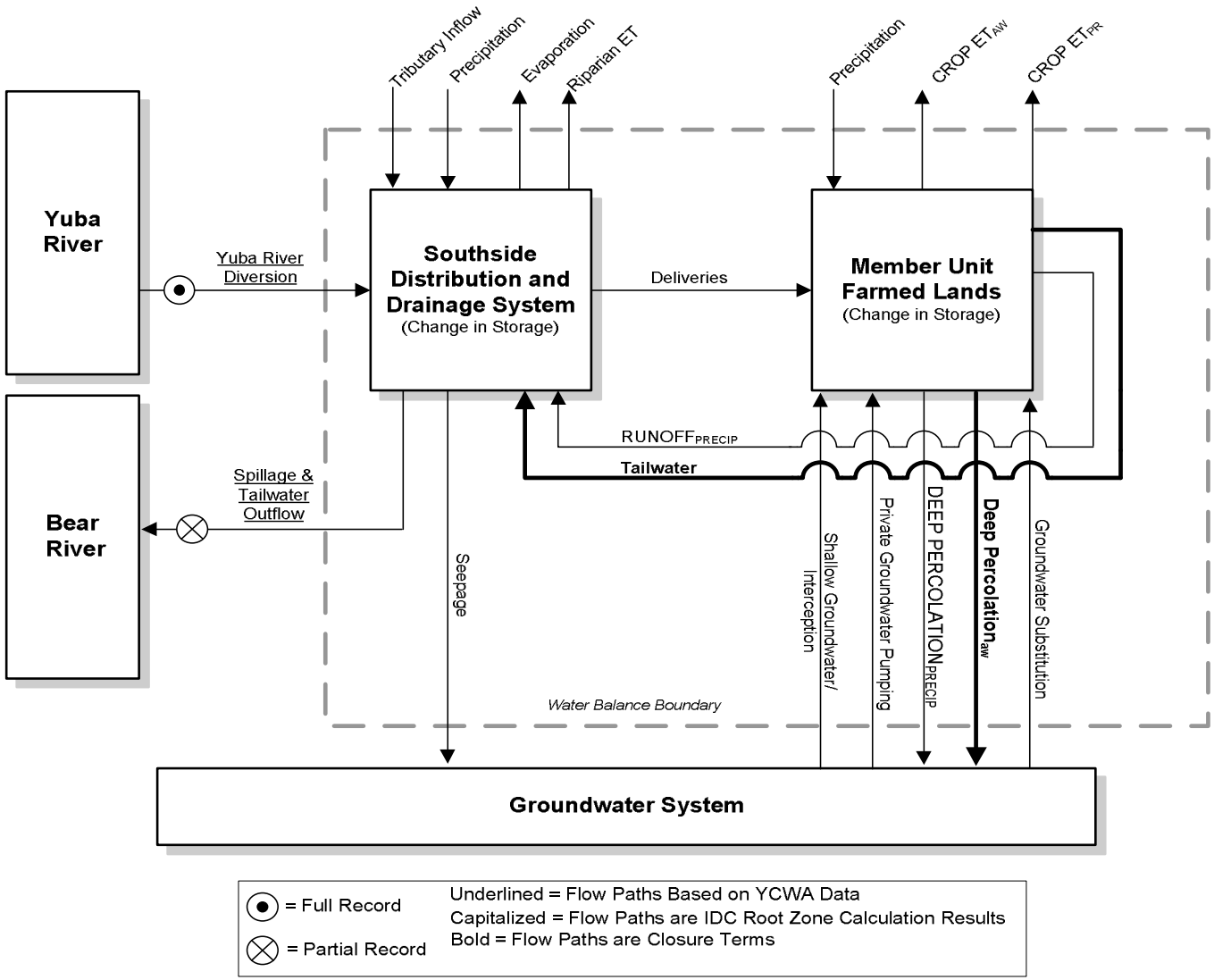


Figure 5-1b. Southside Water Balance Structure.

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).

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

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

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}.

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.

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, tailwater volumes were calculated as the closure term. Tailwater was selected because tailwater represents the largest, flow path with no available measurements. The deliveries to member units are recorded by YCWA. Limited spot measurements of spillage and tailwater outflows were available for estimating this flow path. For the member unit farmed lands accounting center, deep percolation of applied water was calculated as the closure term. Deep percolation of applied water was selected because it is a relatively large flow path and nearly impossible to estimate otherwise.

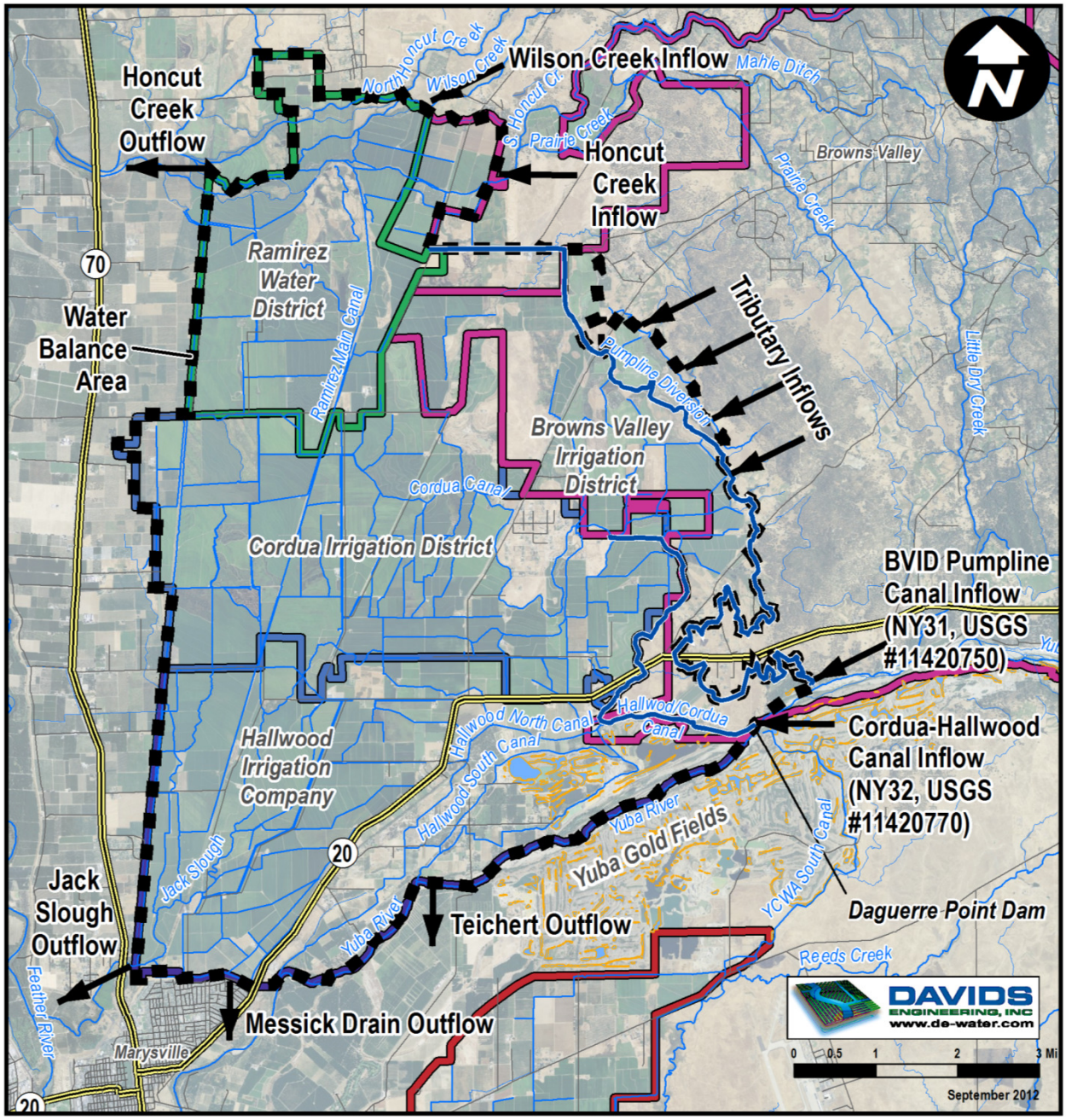


Figure 5-2a. YCWA Northside Water Balance Area, Inflows, and Outflows

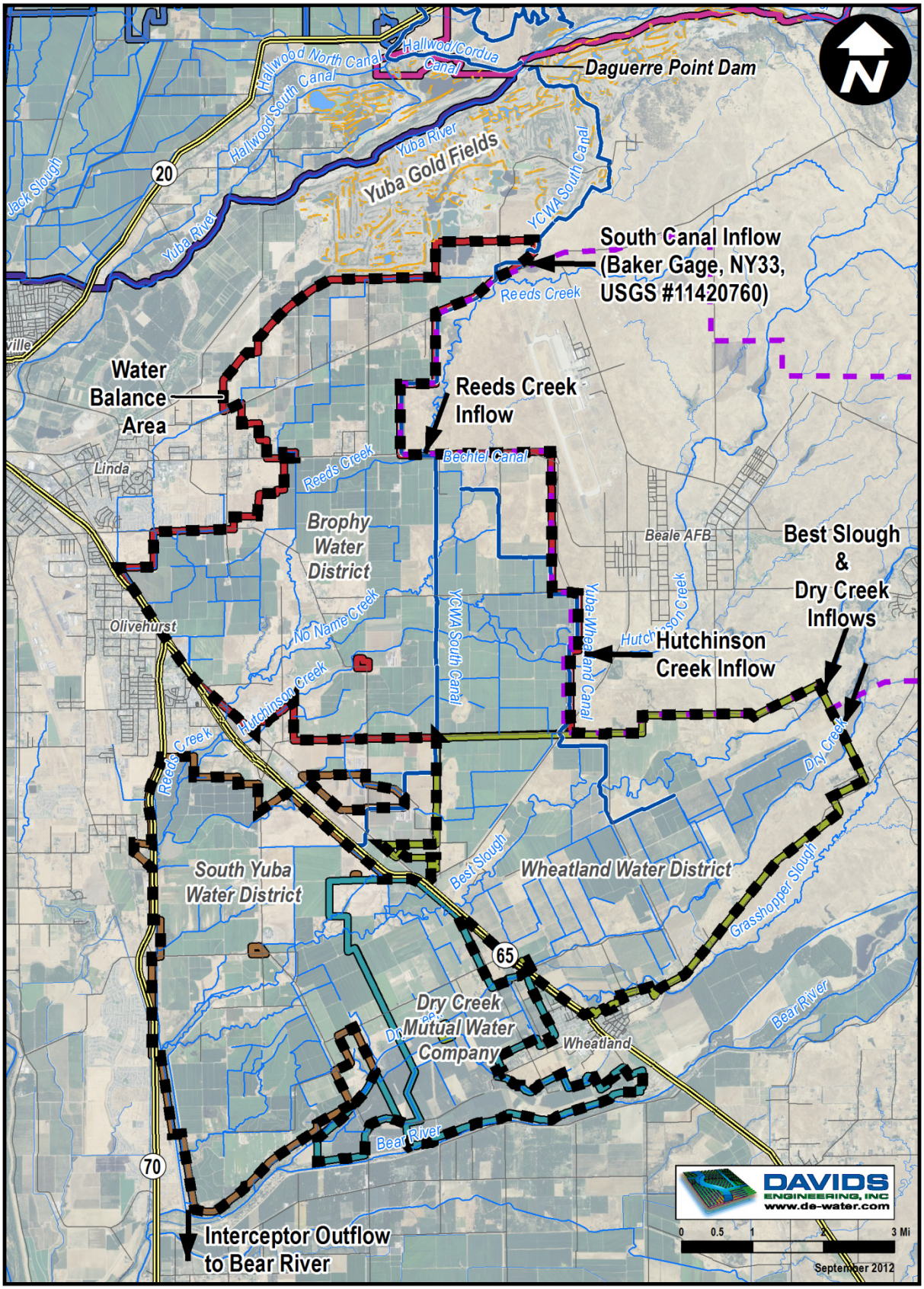


Figure 5-2b. Northside Water Balance

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, an estimated percent uncertainty (approximately equivalent to a 95 percent 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)[15]. 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 2010 water balance results), and the estimated uncertainty, expressed as a percent. As indicated, estimated uncertainties vary by flow path from 5 percent to 100 percent of the estimated value, with uncertainties generally being less for measured flow paths and greater for calculated flow paths. The estimated uncertainty of each closure term, calculated based on the concept of propagation of random errors as described above, is also shown for each closure term.

The estimated uncertainty in tailwater inflows to the distribution and drainage systems is 81 percent and 88 percent in the Northside and Southside areas, respectively. This uncertainty is relatively large due to the combination of the relatively small uncertainty in deliveries, which represent the largest flow path in the distribution system balance and the relatively large uncertainty in the spillage and tailwater outflows from the distribution and drainage system, the third largest flow path. The estimated uncertainty in deep percolation of applied water is over 85% and 70% in the Northside and Southside areas, respectively. This relatively large percent uncertainty reflects that fact that deep percolation of applied water is a relatively small flow path as compared to deliveries and crop evapotranspiration of applied water. As a result, a relatively small percent uncertainty in the larger flow paths results in a relatively large uncertainty in the smaller, closure term. Despite appreciable uncertainty in some flow path quantities, the water balance provides useful insights into YCWA's water management. In the future YCWA will work to improve the estimation of the various flow paths to increase the certainty of the water balance results.

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

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

Account-ing 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	5,400	50%
		BVID/Collins Lake Irrigation Return Flows[16]	Calculation	Area draining to BVID canal and estimated tailwater from this area	1,700	50%
		Tailwater	**Closure (Distribution and Drainage System)**	**Difference of total outflows and measured/estimated inflows for Distribution and Drainage System accounting center**	**37,000**	**81%**
		Runoff of Precipitation	Calculation	Integrated Water Flow Model Demand Calculator (IDC) root zone simulation analysis, CIMIS precipitation data, NRCS curve number method	20,000	25%
		Precipitation	Calculation	Quality-controlled precipitation from Yuba County Airport NWS station, estimated canal surface area	500	20%
	Outflows	Deliveries	Measurement/ Calculation	YCWA recorded deliveries	162,000	15%
		Riparian ET	Calculation	CIMIS reference ET, estimated crop coefficient based on SEBAL 2001 analysis, estimated riparian area	1,800	35%
		Seepage	Calculation	NRCS soils data, estimated wetted area, estimated wetted duration	5,800	35%
		Spillage and Tailwater Outflows	Calculation	YCWA spot flow measurements	46,000	50%
		Evaporation	Calculation	CIMIS reference ET, estimated evaporation coefficient, estimated wetted surface area	1,200	20%
Member Unit Farmed Lands	Inflows	Deliveries	Measurement/ Calculation	YCWA recorded deliveries	162,000	15%
		Private Groundwater Pumping	Calculation	Assumed to be negligible. Minor pumping estimated in some years based on unmet demands	1,600	35%
		Groundwater Substitution	Measurement	Flow meter records from groundwater wells included in program	15,700	5%
		Shallow Groundwater Interception	Calculation	Estimated as zero	0	100%
		Precipitation	Calculation	Quality-controlled precipitation from Yuba County Airport NWS station, MU cropped area	54,000	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	96,000	15%
		Tailwater	**Closure (Distribution and Drainage System)**	**Difference of total outflows and measured/ estimated inflows for Distribution and Drainage System accounting center**	**37,000**	**81%**
		Deep Percolation of Applied Water	**Closure (Member Unit Farmed Lands)**	**Difference of total inflows and measured/estimated outflows for Farmed Lands accounting center applied water balance**	**45,000**	**85%**
		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	16,000	15%
		Deep Percolation of Precipitation	Calculation	IDC analysis, NRCS soils characteristics, CIMIS precipitation data	17,000	35%
		Runoff of Precipitation	Calculation	IDC analysis, CIMIS precipitation data, NRCS curve number method	20,000	35%
		Change in Storage of Precipitation	Calculation	IDC analysis, CIMIS precipitation data, NRCS curve number method	300	35%

Key:
AF = acre-feet
BVID = Browns Valley Irrigation District
CIMIS = California Irrigation Management Information System
DWR = California Department of Water Resources
ET = evapotranspiration
ETpr = evapotranspiration of precipitation
IDC = Integrated Water Flow Model Demand Calculation
MU = Member Unit
NRCS = Natural Resources Conservation Service
SEBAL = Surface Energy Balance Algorithm for Land
USGS = U.S. Geological Survey
YCWA = Yuba County Water Agency

[16] May include deliberate deliveries by BVID, at times.

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

Account-ing 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 NY33 (Baker Gage)	99,000	5%
		Tributary Inflow	Calculation	Minimum tributary inflows needed to meet crop demands estimated based on Crop ET of applied water, described below	4,400	50%
		Tailwater	**Closure (Distribution and Drainage System)**	**Difference of total outflows and measured/ estimated inflows for Distribution and Drainage System accounting center**	**20,000**	**88%**
		Runoff of Precipitation	Calculation	Integrated Water Flow Model Demand Calculator (IDC) root zone simulation analysis, CIMIS precipitation data, NRCS curve number method	17,000	25%
		Precipitation	Calculation	Quality-controlled precipitation from Yuba County Airport NWS station, estimated canal surface area	700	20%
	Outflows	Deliveries	Measurement/ Calculation	YCWA recorded deliveries	106,000	15%
		Riparian ET	Calculation	CIMIS reference ET, estimated crop coefficient based on SEBAL 2001 analysis, estimated riparian area	2,300	35%
		Seepage	Calculation	NRCS soils data, estimated wetted area, estimated wetted duration	7,500	35%
		Spillage and Tailwater Outflows	Calculation	YCWA spot flow measurements	24,000	50%
		Evaporation	Calculation	CIMIS reference ET, estimated evaporation coefficient, estimated wetted surface area	1,500	20%
Member Unit Farmed Lands	Inflows	Deliveries	Measurement/ Calculation	YCWA recorded deliveries	106,000	15%
		Private Groundwater Pumping	Calculation	Estimated groundwater only area (Wheatland Water District), estimated ETaw and Crop Consumptive Use Fraction	31,000	35%
		Groundwater Substitution	Measurement	Flow meter records from groundwater wells included in program	18,000	5%
		Shallow Groundwater Interception	Calculation	Estimated as zero	0	100%
		Precipitation	Calculation	Quality-controlled precipitation from Yuba County Airport NWS station, MU cropped area	58,000	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	15%
		Tailwater	**Closure (Distribution and Drainage System)**	**Difference of total outflows and measured/ estimated inflows for Distribution and Drainage System accounting center**	**20,000**	**88%**
		Deep Percolation of Applied Water	**Closure (Member Unit Farmed Lands)**	**Difference of total inflows and measured/estimated outflows for Farmed Lands accounting center applied water balance**	**42,000**	**70%**
		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	21,000	15%
		Deep Percolation of Precipitation	Calculation	IDC analysis, NRCS soils characteristics, CIMIS precipitation data	20,000	35%
		Runoff of Precipitation	Calculation	IDC analysis, CIMIS precipitation data, NRCS curve number method	17,000	35%
		Change in Storage of Precipitation	Calculation	IDC analysis, CIMIS precipitation data, NRCS curve number method	200	35%

Key:
AF = acre-feet
BVID = Browns Valley Irrigation District
CIMIS = California Irrigation Management Information System
DWR = California Department of Water Resources
ET = evapotranspiration
ETpr = evapotranspiration of precipitation
IDC = Integrated Water Flow Model Demand Calculation
MU = Member Unit
NRCS = Natural Resources Conservation Service
SEBAL = Surface Energy Balance Algorithm for Land
USGS = U.S. Geological Survey
YCWA = Yuba County Water Agency

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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 is essential to evaluate and plan for "…planned conjunctive use of surface water and groundwater…", an EWMP discussed in Section 7.4. To support review and interpretation of water uses and overall water balance results over time, Yuba River Index (YRI), total calendar year precipitation[17], 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 the 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 2010 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 2010 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

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

For purposes of review of the 2001 to 2010 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 2010 Yuba River Index, Water Year Precipitation and Irrigation Season ET_o, and Hydrologic Year Type

Year	Irrigation Start	Yuba River Index	Precipitation, in[1]	ET_o, in[2]	Hydrologic Year Type
2001	April 12	C	24.2	58.5	Dry
2002	April 16	C	18.0	51.9	Dry
2003	May 11	AN	20.1	49.1	Wet
2004	Apr 8	BN	21.0	50.8	Dry
2005	April 21	AN	29.2	47.3	Wet
2006	May 2	W	23.3	50.9	Wet
2007	April 5	D	12.8	54.7	Dry
2008	Mar 31	C	15.3	54.4	Dry
2009	April 6	BN	16.4	51.3	Dry
2010	April 30	BN	27.8	48.7	Dry
		Minimum	12.8	47.3	
		Maximum	29.2	58.5	
		Wet Year Average	24.2	49.1	
		Dry Year Average	19.4	52.2	
		Overall Average	20.8	51.8	

Notes:
[1] Yuba County Airport NWS weather station.
[2] Nicolaus CIMIS station.
Key:
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
ETo = reference evapotranspiration
W = Wet

Based on the analysis of the YRI, water-year precipitation,[18] and ET_o, three years between 2001 and 2010 were assigned to wet year types, and seven years were assigned to dry year types. During the wet years of 2003, 2005, and 2006, average precipitation was nearly five inches more than the average during the dry years. Calendar year ET_o for the wet years averaged approximately 49 inches, three 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

[18] 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.

crop irrigation 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 additional years with full and 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.

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 2010 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 changed little over time.

Figure 5-3. Rice near Marysville in August

Between 2001 and 2010, 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 1,138 acres of fallow or idle lands (629 and 509 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 21,862 acres (about 70 percent of farmed area) in the Northside area and 16,618 acres (about 50 percent of farmed area) in the Southside area. Pasture was grown on an average of 1,577 acres and 5,197 acres on the North and 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 2,511 acres or 8 percent of the total cropped area in the Northside area and 7,659 acres or 23 percent 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.[19] 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 2010 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 extended periods with no rain during the off season, water is sometimes diverted by YCWA 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 2001 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-Colusa Irrigation District (GCID), which lies approximately 30 miles to the west. Spatially distributed cropping data from 2001 obtained from GCID 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 2001 SEBAL dataset for most land use types due to lack of spatial cropping data for 2001; however, crop coefficients specific to YCWA were developed for native vegetation, riparian vegetation, wetlands, and ponds based on the assumption that those areas have not changed land uses substantially over the period of analysis.

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[20]) for the member unit service areas in 2001 was calculated based on quality-controlled ET_o data from the Nicolaus CIMIS station and the crop coefficients to estimate total actual ET for the growing season. The results of this calculation were compared to the total April through September ET_a from the 2001 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 less than one percent greater and three percent greater than the SEBAL ET_a in the Northside and Southside areas, respectively. The spatial distribution of the total April through 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

[19] 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.

[20] Note that actual ET, or ET_a, is equivalent to crop ET, or ET_c, for purposes of this AWMP.

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 2010

Crops	Crop Acreage by Year										Average
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Northside											
Rice	22,050	21,837	21,895	21,579	21,293	21,564	21,952	21,631	22,333	22,487	21,862
Pasture	1,593	1,594	1,593	1,584	1,575	1,578	1,579	1,587	1,553	1,531	1,577
Walnuts	1,066	1,175	1,154	1,120	1,105	1,178	1,209	1,177	1,190	1,272	1,165
Prunes	1,573	1,547	1,524	1,441	1,449	1,255	1,249	1,159	1,132	1,126	1,346
Other (Grain, Olives, Melons, Corn)	381	335	335	321	269	299	299	386	296	343	326
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
Idle	241	416	403	859	1,215	1,029	616	965	400	146	629
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
Total Area	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
Southside											
Rice	16,565	16,391	16,456	16,380	16,348	16,501	16,764	16,379	17,247	17,146	16,618
Pasture	5,191	5,189	5,193	5,216	5,243	5,235	5,230	5,210	5,203	5,063	5,197
Walnuts	3,941	4,341	4,272	4,187	4,176	4,440	4,546	4,387	4,524	4,778	4,359
Prunes	3,816	3,749	3,700	3,533	3,594	3,102	3,081	2,833	2,824	2,772	3,300
Grain	1,809	1,524	1,499	1,437	1,108	1,297	1,292	1,828	1,286	1,531	1,461
Other (Corn, Olives, Melon)	234	221	307	303	287	336	335	334	338	340	303
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
Idle	192	332	322	693	991	837	500	777	328	118	509
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
Total Area	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

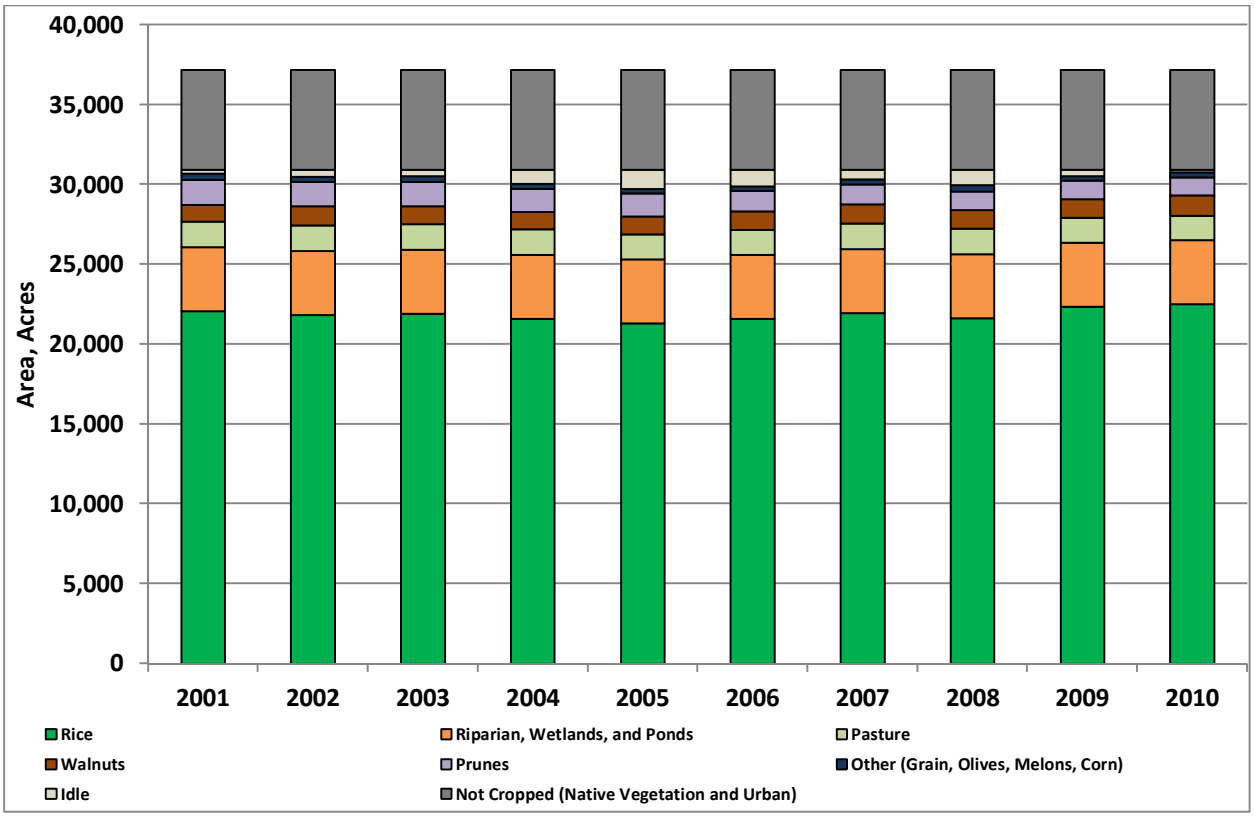

Figure 5-4a. Northside Land Uses, 2001 to 2010

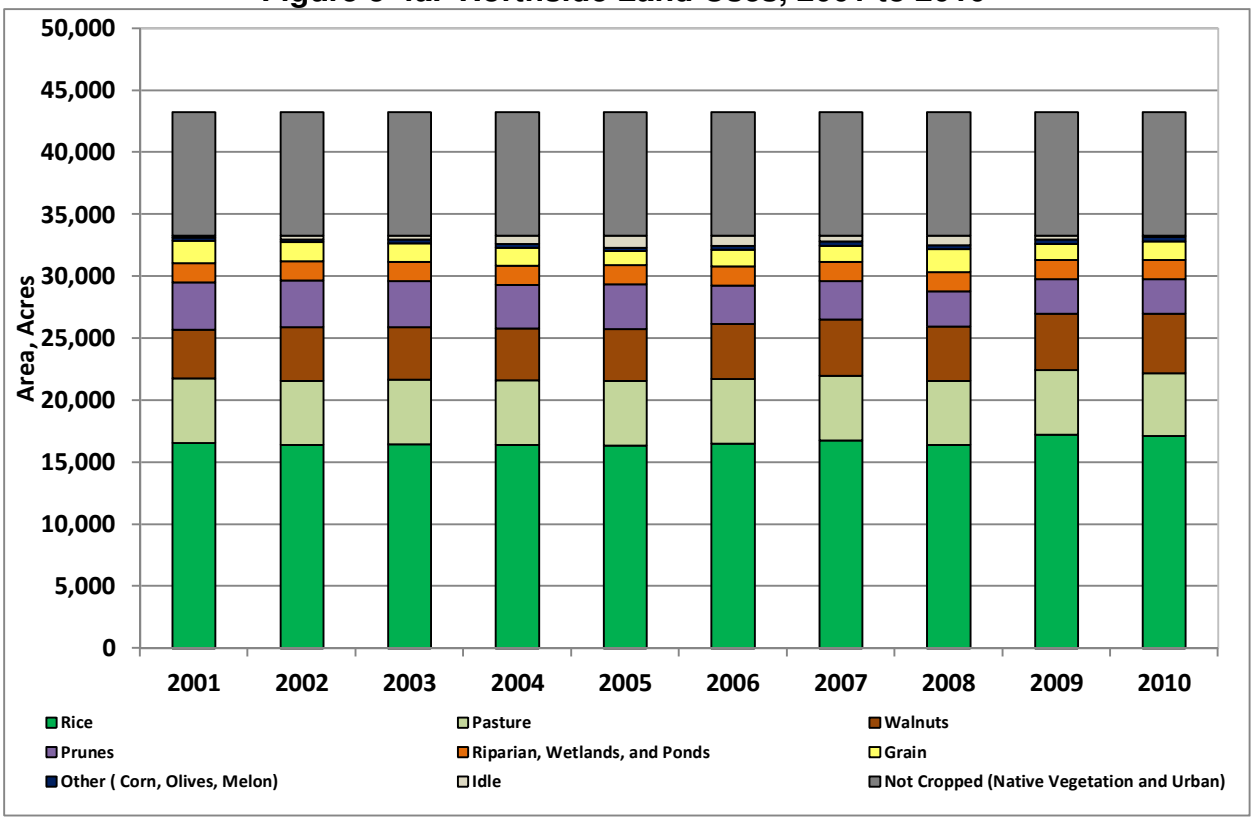

Figure 5-4b. Southside Land Uses, 2001 to 2010

Table 5-4. Verification of SEBAL-Based Crop Coefficients for YCWA MU Service Areas

Area	Irrigation-Season Crop ET_a (AF)		Percent Difference
	CIMIS ET_o and SEBAL Crop Coefficient ET	SEBAL Crop ET_a	
North	97,559	97,235	0%
South	98,147	95,183	3%
Total	195,706	192,418	2%

Key:
CIMIS = California Irrigation Management Information System
ET_o = reference evapotranspiration
MU = Member Unit
SEBAL = Surface Energy Balance Algorithm for Land
YCWA = Yuba County Water Agency

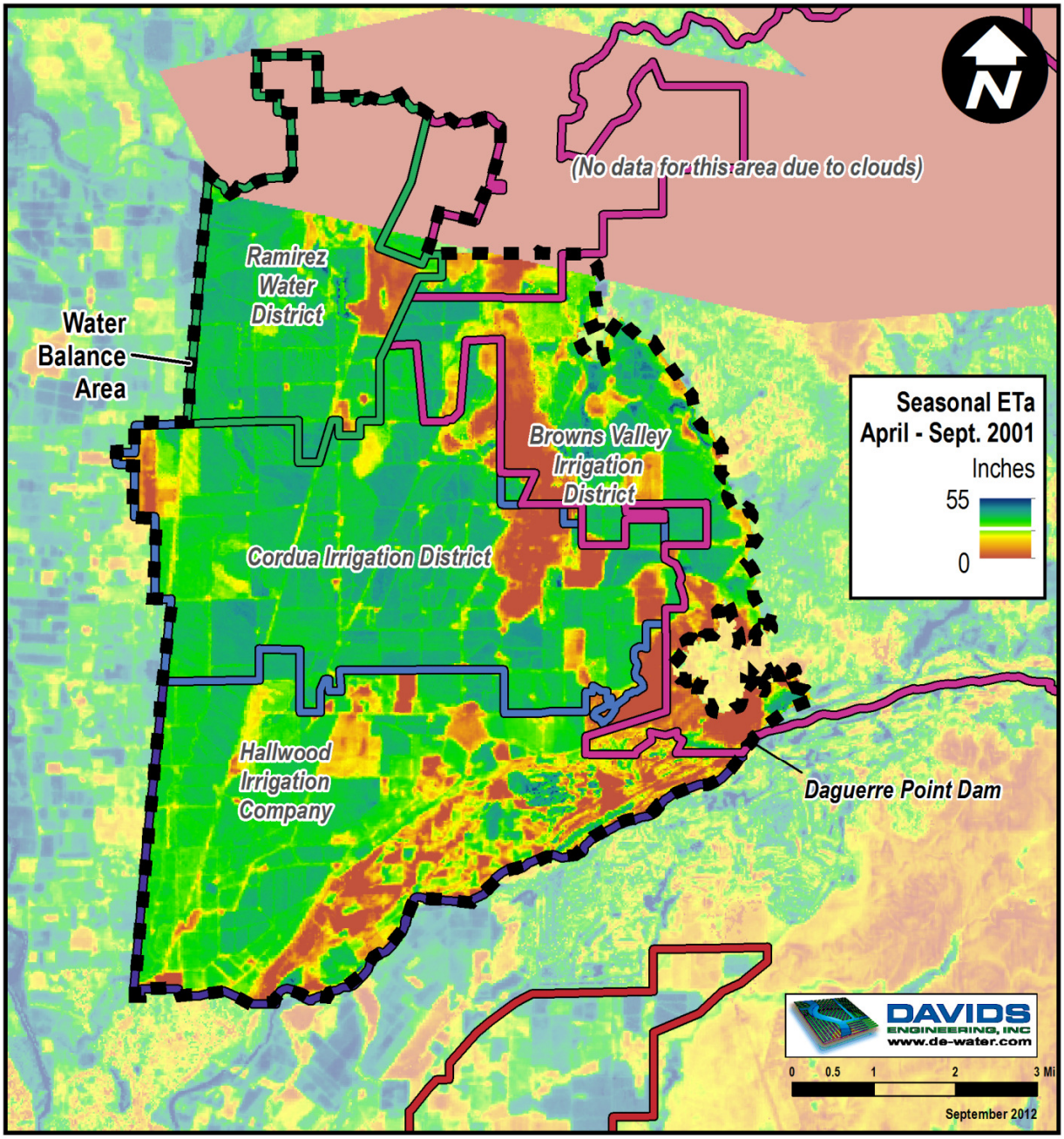

Figure 5-5a. YCWA Northside Spatially Distributed Seasonal Actual ET from SEBAL, 2001 Irrigation Season

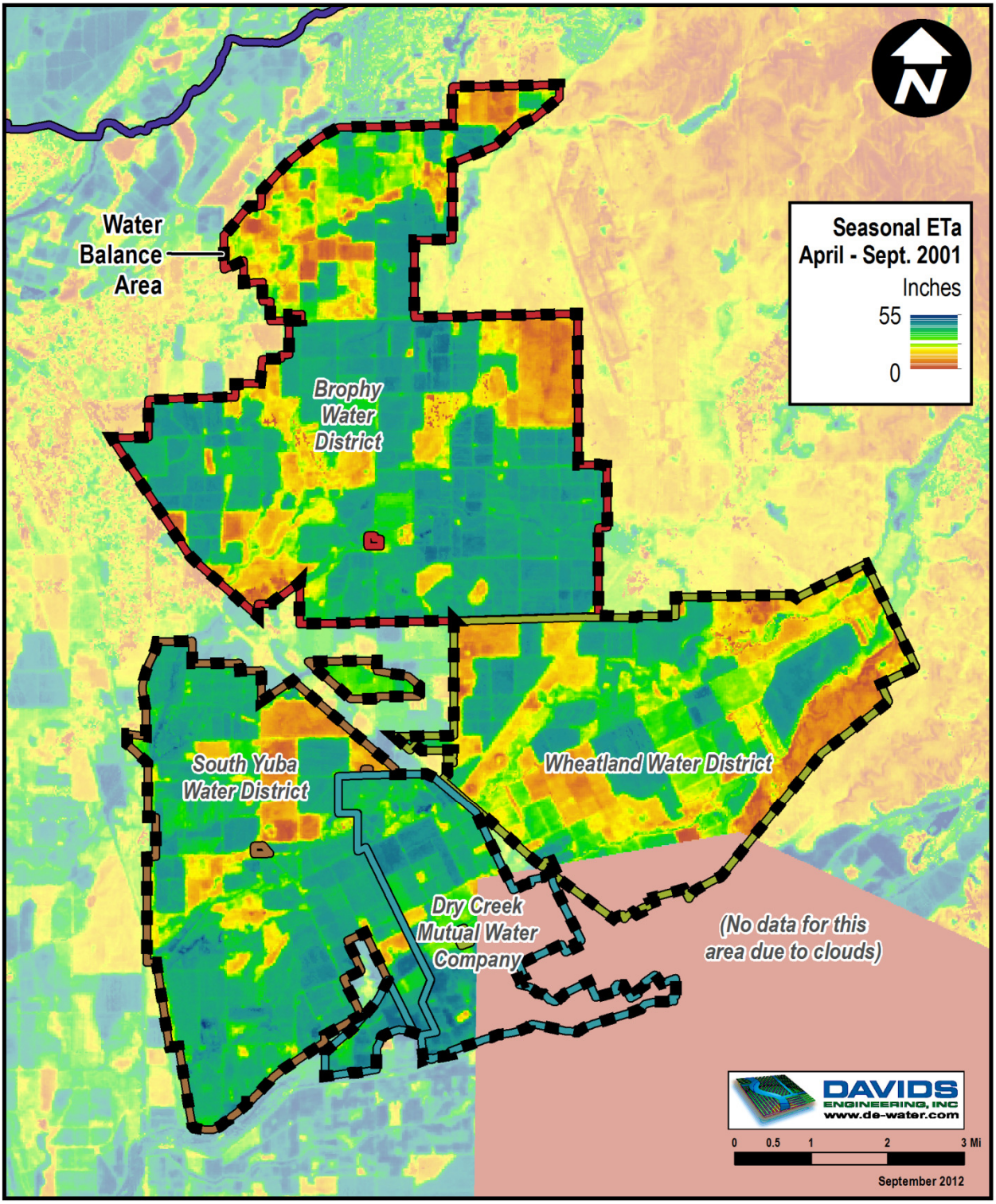

Figure 5-5b. YCWA Southside Spatially Distributed Seasonal Actual ET from SEBAL, 2001 Irrigation Season

The consumptive use of water by crops in YCWA member unit service areas ranges from approximately 22 inches of total crop ET for grain to approximately 44 inches for wetlands (Table 5-5).[21] ET_{aw} ranges from approximately 22 inches to 46 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 46 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. Riparian areas and wetlands ET ranged between 42 and 45 inches with 30 and 33 inches derived from irrigation water, respectively. Surprisingly, the ET for ponds on the Southside is shown to be about seven 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 (inches)		
		ETpr	ETaw	ETc
Corn	272	7.8	24.1	31.9
Grain	1,701	6.6	15.5	22.1
Idle	1,118	5.5	0.0	5.5
Melons	40	8.1	22.3	30.4
Native Vegetation	12,843	9.3	17.6	26.9
Olives	90	11.1	27.5	38.5
Pasture	6,769	10.8	29.4	40.2
Pond (North)	803	11.6	31.7	43.2
Pond (South)	330	11.2	24.9	36.1
Prunes	4,583	10.8	23.8	34.6
Rice	38,534	4.1	41.6	45.7
Riparian	1,896	11.6	30.5	42.1
Urban	3,373	8.0	16.6	24.6
Walnuts	5,547	11.5	29.2	40.7
Wetlands	2,528	11.8	32.6	44.5
Totals	80,426	7.2	31.9	39.1

Key:
ETaw = evapotranspiration of applied water
ETc = crop evapotranspiration
ETpr = evapotranspiration from precipitation
YCWA = Yuba County Water Agency

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

[21] 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.

support crop growth and offset crop irrigation requirements. For the 2001 to 2010 period, Northside wet year ET_c averaged approximately 41.9 inches while dry year ET_c averaged 45.6 inches. Wet year ET_{aw} averaged 35.2 inches while dry year ET_{aw} averaged 40.0 inches. Similarly, Southside wet year ET_c averaged approximately 40.0 inches while dry year ET_c averaged 43.4 inches. Wet year ET_{aw} averaged 32.2 inches while dry year ET_{aw} averaged 36.8 inches.

On the Northside, total irrigation season crop ET varied between approximately 102,400 AF and 126,200 AF during the 2001 to 2010 period, with an average annual volume of 113,900 AF. On average, approximately 96,400 AF of ET were derived from applied irrigation water (86 percent of total ET), and 16,200 AF of ET were derived from precipitation (14 percent of total ET).

On the Southside, total irrigation season crop ET varied between approximately 106,700 AF and 130,200 AF during the 2001 to 2010 period, with an average annual volume of 118,200 AF. On average, approximately 94,100 ac-ft were derived from applied irrigation water (82 percent of total ET), and 21,200 AF were derived from precipitation (18 percent of total ET).

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 low 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 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.

Annual volumes of crop ET are provided in Section 5.8.

5.6.2. ENVIRONMENTAL

As noted previously, the Yuba River Accord provides required instream flows for fisheries. During a typical year, about 72 percent of the Yuba River total runoff volume remains in the stream and discharges to the Feather River. Approximately 4 percent 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 percent of the total runoff volume is exported from the Yuba Basin by others (17 percent) or diverted by other water rights holders within the basin (7 percent).

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 was calculated as the closure term of the farmed lands water balance accounting center. Seepage and deep percolation volumes for the 2001 to 2010 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 2010

Year	Yuba River Index	Hydrologic Year Type	Canal and Drain Seepage (AF)	Deep Percolation of Precipi-tation (AF)	Deep Percolation of Applied Water (AF)	Total Recharge	
						(AF)	(AF/ac)
2001	C	Dry	6,087	28,439	58,254	92,780	3.0
2002	C	Dry	6,012	15,759	53,495	75,266	2.4
2003	AN	Wet	5,789	16,810	44,194	66,793	2.2
2004	BN	Dry	6,288	15,362	46,799	68,449	2.2
2005	AN	Wet	5,642	18,213	33,104	56,960	1.8
2006	W	Wet	5,955	24,564	37,306	67,824	2.2
2007	D	Dry	4,585	8,759	28,281	41,624	1.3
2008	C	Dry	6,123	14,677	50,577	71,377	2.3
2009	BN	Dry	5,928	11,540	50,508	67,976	2.2
2010	BN	Dry	5,742	19,124	50,939	75,805	2.5
Minimum			4,585	8,759	28,281	41,624	1.3
Maximum			6,288	28,439	58,254	92,780	3.0
Wet Year Average			5,795	19,862	38,201	63,859	2.1
Dry Year Average			5,824	16,237	48,408	70,468	2.3
Overall Average			5,815	17,325	45,346	68,485	2.2

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
YCWA = Yuba County Water Agency

Table 5-6b. YCWA Southside Total Groundwater Recharge, 2001 to 2010

Year	Yuba River Index	Hydro-logic Year Type	Canal and Drain Seepage (AF)	Deep Percolation of Precipi-tation (AF)	Deep Percolation of Applied Water (AF)	Total Recharge	
						(AF)	(AF/ac)
2001	C	Dry	7,832	30,744	31,572	70,148	2.1
2002	C	Dry	7,192	17,914	35,771	60,877	1.8
2003	AN	Wet	7,076	18,796	39,914	65,786	2.0
2004	BN	Dry	7,973	17,841	33,185	58,999	1.8
2005	AN	Wet	7,367	21,374	43,492	72,233	2.2
2006	W	Wet	8,563	28,497	42,746	79,806	2.4
2007	D	Dry	7,172	9,807	36,896	53,875	1.6
2008	C	Dry	7,477	15,745	38,604	61,826	1.9
2009	BN	Dry	6,864	13,011	53,865	73,740	2.2
2010	BN	Dry	7,043	21,488	59,792	88,324	2.7
Minimum			6,864	9,807	31,572	53,875	1.6
Maximum			8,563	30,744	59,792	88,324	2.7
Wet Year Average			7,669	22,889	42,051	72,609	2.2
Dry Year Average			7,365	18,079	41,384	66,827	2.0
Overall Average			7,456	19,522	41,584	68,562	2.1

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
YCWA = Yuba County Water Agency

Total recharge between 2001 and 2010 on the Northside ranged from approximately 42,000 AF to 93,000 AF per year, or from 1.3 AF to 3.0 AF per acre per year. The overall average total deep percolation for the 2001 to 2010 period is 68,000 AF per year (2.2 AF/ac), with approximately 8 percent of recharge originating from canal seepage, 25 percent of recharge originating from deep percolation of precipitation, and 66 percent of recharge originating from deep percolation of applied water. Wet year average total recharge is approximately 64,000 AF (2.1 AF/ac), and dry year average total recharge is 70,000 AF (2.3 AF/ac). Dry years average about 7,000 AF more total recharge than wet years due to increased deep percolation of applied water as compared to wet years, which is greater than the decrease in deep percolation of precipitation between wet and dry years.

On the Southside, total recharge between 2001 and 2010 ranged from approximately 54,000 AF to 88,000 AF per year, or from 1.6 AF to 2.7 AF per acre per year. The overall average total deep percolation for the 2001 to 2010 period is 69,000 AF per year (2.1 AF/ac), with approximately 11 percent of recharge originating from canal seepage, 28 percent of recharge originating from deep percolation of precipitation, and 61 percent of recharge originating from deep percolation of applied water. Wet year average total recharge is approximately 73,000 AF (2.2 AF/ac), and dry year average total recharge is 67,000 AF (2.0 AF/ac). Dry years average

about 6,000 AF less total recharge than wet years due to decreased deep percolation of applied water and decreased deep percolation of precipitation as compared to wet years.

Total recharge 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 seepage in the distribution and drainage systems occurs. 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. This is true on the Northside; however, on the Southside the deep percolation of applied water on average is about the same in dry and wet years. This may be due to differences in main canal and MU operations between the Northside and Southside areas. Differences in cropping between the areas may also result in differences in total recharge in wet and dry years.

Groundwater recharge net of groundwater pumping[22] 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 2010 on the Northside ranged from approximately 30,000 AF to 68,000 AF per year, or from 1.0 AF to 2.2 AF per acre per year. The overall average net deep percolation for the 2001 to 2010 period is 51,000 AF per year (1.7 AF/ac). Wet year average net recharge is approximately 62,000 AF (2.0 AF/ac), and dry year average net recharge is 46,000 AF (1.5 AF/ac). Wet years average about 6,000 AF more net recharge than dry years due to increased groundwater pumping as compared to wet years and decreased deep percolation of precipitation, which when combined are greater than the decrease in deep percolation of applied water between wet and dry years on the Northside.

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

Table 5-7a. YCWA Northside Net Groundwater Recharge, 2001 to 2010

Year	Yuba River Index	Hydrologic Year Type	Total Recharge (AF)	Groundwater Pumping (AF)	Net Recharge	
					(AF)	(AF/ac)
2001	C	Dry	92,780	46,528	46,252	1.5
2002	C	Dry	75,266	31,150	44,116	1.4
2003	AN	Wet	66,793	0	66,793	2.2
2004	BN	Dry	68,449	0	68,449	2.2
2005	AN	Wet	56,960	4,471	52,489	1.7
2006	W	Wet	67,824	0	67,824	2.2
2007	D	Dry	41,624	11,921	29,704	1.0
2008	C	Dry	71,377	27,636	43,741	1.4
2009	BN	Dry	67,976	35,901	32,075	1.0
2010	BN	Dry	75,805	15,627	60,178	1.9
Minimum			41,624	0	29,704	1.0
Maximum			92,780	46,528	68,449	2.2
Wet Year Average			63,859	1,490	62,369	2.0
Dry Year Average			70,468	24,109	46,359	1.5
Overall Average			68,485	17,323	51,162	1.7

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
YCWA = Yuba County Water Agency

Table 5-7b. YCWA Southside Net Groundwater Recharge, 2001 to 2010

Year	Yuba River Index	Hydrologic Year Type	Total Recharge (AF)	Groundwater Pumping (AF)	Net Recharge	
					(AF)	(af/ac)
2001	C	Dry	70,148	53,272	16,877	0.5
2002	C	Dry	60,877	60,050	827	0.0
2003	AN	Wet	65,786	32,986	32,800	1.0
2004	BN	Dry	58,999	34,115	24,884	0.7
2005	AN	Wet	72,233	32,986	39,247	1.2
2006	W	Wet	79,806	32,986	46,820	1.4
2007	D	Dry	53,875	34,115	19,760	0.6
2008	C	Dry	61,826	56,466	5,360	0.2
2009	BN	Dry	73,740	86,269	-12,529	-0.4
2010	BN	Dry	88,324	73,976	14,348	0.4
Minimum			53,875	32,986	-12,529	-0.4
Maximum			88,324	86,269	46,820	1.4
Wet Year Average			72,609	32,986	39,622	1.2
Dry Year Average			66,827	56,895	9,932	0.3
Overall Average			68,562	49,722	18,839	0.6

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
YCWA = Yuba County Water Agency

Net recharge between 2001 and 2010 on the Southside was substantially less than on the Northside, ranging from a net depletion of approximately 13,000 AF (0.4 AF/ac) in 2008 to net recharge of 47,000 AF (1.4 AF/ac) in 2006. The overall average net deep percolation for the 2001 to 2010 period is 50,000 AF per year (0.6 AF/ac). Wet year average net recharge is approximately 40,000 AF (1.2 AF/ac), and dry year average net recharge is 10,000 AF (0.3 AF/ac). Wet years average about 30,000 AF more net recharge than dry years due to increased groundwater pumping and decreased deep percolation of applied water and precipitation as compared to wet years.

Net groundwater recharge tends to be less in dry years due to increased groundwater pumping, decreased deep percolation of precipitation, and potentially due to decreased deep percolation of applied water. On the Northside, net wet year recharge averages approximately 62,000 AF, while net dry year recharge averages approximately 46,000 AF. Net wet year recharge on the Southside averages approximately 40,000 AF, while net dry year recharge averages approximately 10,000 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 decades. Between 2001 and 2010, YCWA participated in seventeen transfers, five 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 1.15 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 115,000 AF, ranging from 9,000 AF to 191,000 AF over the ten year period. Wet year transfer volumes averaged 47,000 AF, while dry year transfer volumes averaged 144,000 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 2010

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
TOTAL			793,768	320,386	38,000	1,152,154
Minimum			6,086	0	0	9,186
Maximum			117,212	88,900	11,400	191,400
Wet Year Average			45,362	0	2,067	47,429
Dry Year Average			93,955	45,769	4,543	144,267
Overall Average			79,377	32,039	3,800	115,215

Note:
[1] Other includes transfers by individual member units, which may be based on stored water or groundwater substitution.
Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
YCWA = Yuba County Water Agency

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 use pumps located along these laterals/drains that are operated during the irrigation season to capture and reuse tailwater. The distribution and drainage system 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 2010 are summarized in Tables 5-9a and 5-9b.

Table 5-9a. YCWA Northside Tailwater, 2001 to 2010

Year	Yuba River Index	Hydrologic Year Type	Tailwater (AF)
2001	C	Dry	37,260
2002	C	Dry	40,865
2003	AN	Wet	41,900
2004	BN	Dry	35,724
2005	AN	Wet	37,144
2006	W	Wet	49,095
2007	D	Dry	36,938
2008	C	Dry	33,175
2009	BN	Dry	32,391
2010	BN	Dry	29,245
Minimum			29,245
Maximum			49,095
Wet Year Average			42,713
Dry Year Average			35,085
Overall Average			37,374

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
YCWA = Yuba County Water Agency

Tailwater entering the distribution and drainage system between 2001 and 2010 in the Northside area ranged from approximately 29,000 AF to 49,000 AF per year. The overall average tailwater for the 2001 to 2010 period was 37,000 AF per year. Wet year average tailwater was approximately 43,000 AF, and dry year average tailwater was approximately 35,000 AF.

Table 5-9b. YCWA Southside Tailwater, 2001 to 2010

Year	Yuba River Index	Hydrologic Year Type	Tailwater (AF)
2001	C	Dry	21,757
2002	C	Dry	19,729
2003	AN	Wet	19,915
2004	BN	Dry	21,716
2005	AN	Wet	17,755
2006	W	Wet	22,201
2007	D	Dry	21,473
2008	C	Dry	22,264
2009	BN	Dry	19,093
2010	BN	Dry	17,000
Minimum			17,000
Maximum			22,264
Wet Year Average			19,957
Dry Year Average			20,433
Overall Average			20,290

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
YCWA = Yuba County Water Agency

Tailwater entering the distribution and drainage system between 2001 and 2010 in the Southside area ranged from approximately 17,000 AF to 22,000 AF per year. The overall average tailwater for the 2001 to 2010 period was 20,000 AF per year. Wet year and dry year average tailwater were essentially the same as the overall average of 20,000 AF.

The greater variability of and higher tailwater volumes in the Northside area may result in part from the assumption that tributary inflows during the irrigation season are negligible unless required to meet irrigation demand. To the extent that substantial unaccounted tributary inflows do occur during the irrigation season, these inflows are included in the water balance closure term, tailwater.

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 August, when more tailwater is produced on the Northside, relative to the annual total for the area. This may be due to rice making up a greater portion of the total cropped area on the Northside than the Southside, reflecting drain down of rice prior to harvest.

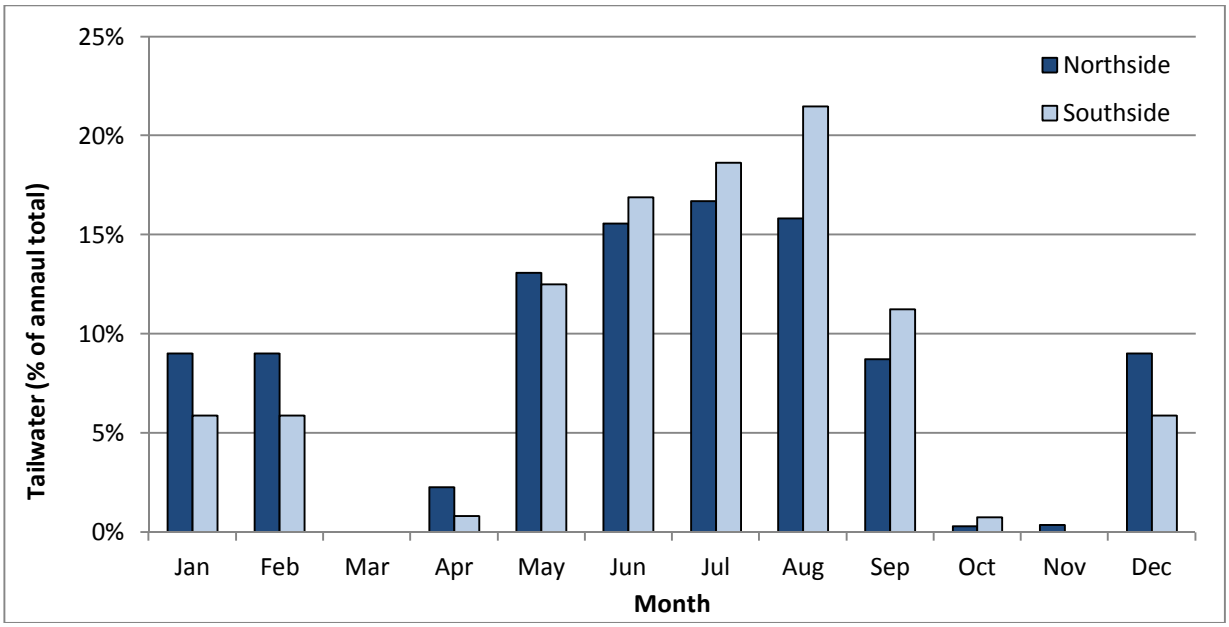

Figure 5-6. Estimated Average Monthly Tailwater Production as Percentage of Annual Total, 2001 to 2010

5.7.2. BOUNDARY OUTFLOWS

Estimated total boundary outflows[23] from YCWA for 2001 to 2010 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 2010 in the Northside area ranged from approximately 34,000 AF to 61,000 AF per year. The overall average boundary outflow for the 2001 to 2010 period was 46,000 AF per year. Wet year average boundary outflows were approximately 54,000 AF, and dry year average boundary outflows were approximately 43,000 AF. Wet years averaged about 11,000 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 2010 in the Southside area ranged from approximately 15,000 AF to 35,000 AF per year. The overall average boundary outflow for the 2001 to 2010 period was 24,000 AF per year. Wet year average boundary outflows were approximately 28,000 AF, and dry year average boundary outflows were approximately 22,000 AF. Wet years averaged about 6,000 AF more boundary outflow than dry years primarily due to increased runoff of precipitation.

[23] Surface water boundary outflows quantified as part of this AWMP include operational spillage, tailwater, and natural streamflow, to the extent that it occurs during the irrigation season. 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. YCWA plans to improve boundary inflow and outflow measurements in the future to allow for quantification of these flows for inclusion in the water balance.

Table 5-10a. YCWA Northside Boundary Outflows, 2001 to 2010

Year	Yuba River Index	Hydrologic Year Type	Spillage and Tailwater Boundary Outflow (AF)
2001	C	Dry	51,244
2002	C	Dry	48,486
2003	AN	Wet	46,790
2004	BN	Dry	47,806
2005	AN	Wet	60,801
2006	W	Wet	53,599
2007	D	Dry	33,597
2008	C	Dry	38,375
2009	BN	Dry	35,891
2010	BN	Dry	45,624
Minimum			33,597
Maximum			60,801
Wet Year Average			53,730
Dry Year Average			43,003
Overall Average			46,221

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
YCWA = Yuba County Water Agency

Table 5-10b. YCWA Southside Boundary Outflows, 2001 to 2011.

Year	Yuba River Index	Hydrologic Year Type	Spillage and Tailwater Boundary Outflow (AF)
2001	C	Dry	28,055
2002	C	Dry	22,127
2003	AN	Wet	20,427
2004	BN	Dry	27,449
2005	AN	Wet	34,805
2006	W	Wet	28,819
2007	D	Dry	15,680
2008	C	Dry	21,618
2009	BN	Dry	15,312
2010	BN	Dry	23,753
Minimum			15,312
Maximum			34,805
Wet Year Average			28,017
Dry Year Average			21,999
Overall Average			23,805

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
YCWA = Yuba County Water Agency

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 2010 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 2010 for the farmed lands accounting center for the Northside and Southside areas are provided in Tables and 5-12a and 5-12b, respectively.

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Table 5-11a. YCWA Northside Distribution and Drainage System Annual Water Balance Results, 2001 to 2010

Year	Yuba River Index	Hydrologic Year Type	Number of Days	Inflows (AF)						Outflows (AF)					Performance Indicators	
				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	1,674	1,377	610	23,733	37,260	153,651	51,244	6,087	1,302	2,046	1.03	0.98
2002	C	Dry	147	159,084	1,700	3,152	455	16,865	40,865	164,477	48,486	6,012	1,221	1,924	1.03	0.99
2003	AN	Wet	129	158,873	1,700	9,143	507	17,505	41,900	174,253	46,790	5,789	1,073	1,723	1.10	0.99
2004	BN	Dry	152	176,150	1,700	2,351	531	22,690	35,724	181,952	47,806	6,288	1,224	1,875	1.03	0.99
2005	AN	Wet	141	141,438	1,700	6,535	737	33,107	37,144	151,587	60,801	5,642	1,002	1,629	1.07	0.99
2006	W	Wet	134	157,133	1,700	10,403	588	20,748	49,095	177,097	53,599	5,955	1,158	1,858	1.13	0.99
2007	D	Dry	155	138,688	1,700	3,654	324	8,383	36,938	148,670	33,597	4,585	1,099	1,736	1.07	0.99
2008	C	Dry	159	160,844	1,700	2,353	387	13,591	33,175	164,362	38,375	6,123	1,258	1,932	1.02	0.98
2009	D	Dry	149	139,953	1,700	2,265	414	14,796	32,391	146,765	35,891	5,928	1,145	1,790	1.05	0.98
2010	BN	Dry	130	138,357	1,700	12,340	701	26,700	29,245	154,904	45,624	5,742	1,064	1,710	1.12	0.99
Minimum			129	138,357	1,674	1,377	324	8,383	29,245	146,765	33,597	4,585	1,002	1,629	1.02	0.98
Maximum			160	176,150	1,700	12,340	737	33,107	49,095	181,952	60,801	6,288	1,302	2,046	1.13	0.99
Wet Year Average			135	152,481	1,700	8,694	611	23,787	42,713	167,646	53,730	5,795	1,078	1,737	1.10	0.99
Dry Year Average			150	151,822	1,696	3,927	489	18,108	35,085	159,255	43,003	5,824	1,188	1,859	1.05	0.99
Overall Average			146	152,020	1,697	5,357	525	19,812	37,374	161,772	46,221	5,815	1,155	1,822	1.07	0.99

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
BVID = Browns Valley Irrigation District
C = Critical
D = Dry
ET = evapotranspiration
YCWA = Yuba County Water Agency

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Table 5-11b. YCWA Southside Distribution and Drainage System Annual Water Balance Results, 2001 to 2010

Year	Yuba River Index	Hydrologic Year Type	Number of Days	Inflows (AF)					Outflows (AF)					Performance Indicators	
				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	1,001	767	19,788	21,757	100,967	28,055	7,832	1,636	2,578	1.03	0.97
2002	C	Dry	145	88,238	4,457	572	14,089	19,729	93,905	22,127	7,192	1,636	2,368	1.06	0.97
2003	AN	Wet	131	102,516	6,465	637	14,213	19,915	112,714	20,427	7,076	1,636	2,172	1.10	0.98
2004	BN	Dry	154	113,797	2,393	668	18,865	21,716	118,104	27,449	7,973	1,636	2,379	1.04	0.98
2005	AN	Wet	153	104,392	5,008	927	29,320	17,755	111,839	34,805	7,367	1,636	2,090	1.07	0.98
2006	W	Wet	158	118,151	2,631	739	17,823	22,201	120,010	28,819	8,563	1,636	2,547	1.02	0.97
2007	D	Dry	165	116,559	5,861	407	6,897	21,473	124,404	15,680	7,172	1,636	2,402	1.07	0.97
2008	C	Dry	166	100,028	5,165	486	11,466	22,264	106,369	21,618	7,477	1,636	2,395	1.06	0.97
2009	D	Dry	139	72,361	5,378	521	12,483	19,093	84,186	15,312	6,864	1,636	2,120	1.16	0.97
2010	BN	Dry	131	77,732	6,069	881	22,674	17,000	90,246	23,753	7,043	1,636	2,048	1.16	0.97
Minimum			131	72,361	1,001	407	6,897	17,000	84,186	15,312	6,864	1,636	2,048	1.02	0.97
Maximum			166	118,151	6,465	927	29,320	22,264	124,404	34,805	8,563	1,636	2,578	1.16	0.98
Wet Year Average			147	108,353	4,701	768	20,452	19,957	114,854	28,017	7,669	1,636	2,269	1.06	0.98
Dry Year Average			150	95,210	4,332	615	15,180	20,433	102,597	21,999	7,365	1,636	2,327	1.08	0.97
Overall Average			149	99,153	4,443	661	16,762	20,290	106,275	23,805	7,456	1,636	2,310	1.08	0.97

Key:
ac = acre
AF = acre-feet
AN = Above Normal
BN = Below Normal
C = Critical
D = Dry
ET = evapotranspiration
YCWA = Yuba County Water Agency

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Table 5-12a. YCWA Northside Member Unit Laterals and Farmed Lands Annual Water Balance Results, 2001 to 2010

Year	Yuba River Index	Hydro-logic Year Type	Number of Days	Inflows (AF)				Outflows (AF)						Change in Storage (AF)		Performance Indicators	
				Deliveries to Member Units	Ground-water Substitution	Private Ground-water	Precip-itation	Crop ETaw	Crop ETpr	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	153,651	46,528	0	62,232	104,666	20,315	37,260	23,733	58,254	28,439	-10,254	0	0.77	0.52
2002	C	Dry	147	164,477	31,150	0	46,431	101,267	16,447	40,865	16,865	53,495	15,759	-2,641	0	0.84	0.52
2003	AN	Wet	129	174,253	0	0	51,714	88,159	17,183	41,900	17,505	44,194	16,810	216	0	1.00	0.51
2004	BN	Dry	152	181,952	0	0	54,196	99,429	14,249	35,724	22,690	46,799	15,362	1,895	0	1.00	0.55
2005	AN	Wet	141	151,587	0	4,471	75,217	85,810	15,827	37,144	33,107	33,104	18,213	8,069	0	0.97	0.55
2006	W	Wet	134	177,097	0	0	59,964	90,696	22,109	49,095	20,748	37,306	24,564	-7,456	0	1.00	0.51
2007	D	Dry	155	148,670	0	11,921	33,038	100,261	12,016	36,938	8,383	28,281	8,759	3,880	-4,889	0.93	0.62
2008	C	Dry	159	164,362	27,636	0	39,462	103,357	13,309	33,175	13,591	50,577	14,677	-2,115	4,889	0.86	0.54
2009	D	Dry	149	146,765	35,901	0	42,244	99,767	12,886	32,391	14,796	50,508	11,540	3,022	0	0.80	0.55
2010	BN	Dry	130	154,904	15,627	0	71,506	90,347	17,751	29,245	26,700	50,939	19,124	7,931	0	0.91	0.53
Minimum			129	146,765	0	0	33,038	85,810	12,016	29,245	8,383	28,281	8,759	-10,254	-4,889	0.77	0.51
Maximum			160	181,952	46,528	11,921	75,217	104,666	22,109	49,095	33,107	58,254	28,439	8,069	4,889	1.00	0.62
Wet Year Average			135	167,646	0	1,490	62,299	88,222	18,373	42,713	23,787	38,201	19,862	276	0	0.99	0.52
Dry Year Average			150	159,255	22,406	1,703	49,873	99,871	15,282	35,085	18,108	48,408	16,237	245	0	0.87	0.55
Overall Average			146	161,772	15,684	1,639	53,600	96,376	16,209	37,374	19,812	45,346	17,325	255	0	0.91	0.54

Key:
ac = acre
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BN = Below Normal
C = Critical
D = Dry
ETaw = evapotranspiration of applied water
ETpr = evapotranspiration of precipitation
YCWA = Yuba County Water Agency

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Table 5-12b. YCWA Southside Member Unit Laterals and Farmed Lands Annual Water Balance Results, 2001 to 2010

Year	Yuba River Index	Hydro-logic Year Type	Number of Days	Inflows (AF)				Outflows (AF)						Change in Storage (AF)		Performance Indicators	
				Deliveries to Member Units	Ground-water Substitution	Private Ground-water	Precip-itation	Crop ETaw	Crop ETpr	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	100,967	19,157	34,115	67,044	100,910	26,288	21,757	19,788	31,572	30,744	-9,777	0	0.65	0.65
2002	C	Dry	145	93,905	25,935	34,115	49,979	98,455	21,615	19,729	14,089	35,771	17,914	-3,640	0	0.61	0.64
2003	AN	Wet	131	112,714	0	32,986	55,700	85,871	22,321	19,915	14,213	39,914	18,796	371	0	0.77	0.59
2004	BN	Dry	154	118,104	0	34,115	58,386	97,318	19,227	21,716	18,865	33,185	17,841	2,452	0	0.78	0.64
2005	AN	Wet	153	111,839	0	32,986	81,031	83,578	21,407	17,755	29,320	43,492	21,374	8,930	0	0.77	0.58
2006	W	Wet	158	120,010	0	32,986	64,589	88,049	27,866	22,201	17,823	42,746	28,497	-9,596	0	0.78	0.58
2007	D	Dry	165	124,404	0	34,115	35,581	100,149	15,943	21,473	6,897	36,896	9,807	2,934	0	0.78	0.63
2008	C	Dry	166	106,369	22,351	34,115	42,513	101,967	16,929	22,264	11,466	38,604	15,745	-1,627	0	0.65	0.63
2009	D	Dry	139	84,186	63,774	22,495	45,510	97,497	17,184	19,093	12,483	53,865	13,011	2,832	0	0.49	0.57
2010	BN	Dry	131	90,246	52,534	21,442	77,034	87,429	23,353	17,000	22,674	59,792	21,488	9,519	0	0.55	0.53
Minimum			131	84,186	0	21,442	35,581	83,578	15,943	17,000	6,897	31,572	9,807	-9,777	0	0.49	0.53
Maximum			166	124,404	63,774	34,115	81,031	101,967	27,866	22,264	29,320	59,792	30,744	9,519	0	0.78	0.65
Wet Year Average			147	114,854	0	32,986	67,107	85,833	23,865	19,957	20,452	42,051	22,889	-99	0	0.78	0.58
Dry Year Average			150	102,597	26,250	30,644	53,721	97,675	20,077	20,433	15,180	41,384	18,079	385	0	0.65	0.61
Overall Average			149	106,275	18,375	31,347	57,737	94,122	21,213	20,290	16,762	41,584	19,522	240	0	0.69	0.60

Key:
ac = acre
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YCWA = Yuba County Water Agency

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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[24], 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.

5.1.1.1 Inflows

Over the 2001 to 2010 period, Northside area distribution and drainage system total inflows from the Yuba River ranged from approximately 138,000 AF to 176,000 AF per year with wet and dry year averages nearly the same at just over and just under 152,000 acre-feet, respectively. The overall average for the ten year period was also 152,000 acre-feet. Southside area distribution and drainage system total inflows from the Yuba River between 2001 and 2010 ranged from approximately 72,000 AF to 118,000 AF per year with wet and dry year averages of 108,000 AF and 95,000 AF, respectively. The overall average for the ten year period was approximately 99,000 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 1,000 to 12,000 AF per year for the Northside area with an overall average of 5,000 AF, a wet year average of 9,000 AF, and a dry year average of 4,000 AF. In the Southside area, minimum tributary inflows ranged from approximately 1,000 AF to 6,000 AF with an overall average of 4,000 AF. Wet year and dry year averages were similar to the overall average in the Southside area.

Between 2001 and 2010, tailwater return flows to the distribution and drainage system in the Northside area varied from approximately 29,000 AF to 49,000 AF per year with an overall average of 37,000 AF per year. Tailwater in wet years averaged approximately 43,000 acre-feet in wet years compared to 35,000 AF in dry years. In the Southside area, tailwater return flows

[24] Northside area only.

varied from approximately 17,000 AF to 22,000 AF per year with an overall average of 20,000 ac-ft per year. Tailwater was nearly the same in wet and dry years, at approximately about 20,000 AF.

Because tailwater is a closure term of the water balance, calculated tailwater volumes for the Northside area are likely influenced by the presence of tributary inflows not currently accounted for. For purposes of the water balance analysis, it was assumed that tributary inflows are negligible, unless required to meet irrigation demand. To the extent that tributary inflows do occur, these are represented in the calculation of tailwater production. In the Southside area, potential overestimation of tailwater production due to unaccounted tributary inflows is less likely to occur due to less tributary inflow occurring.

YCWA plans 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 9,000 AF to 34,000 AF annually with an overall average of 20,000 AF, a wet year average of 24,000 AF, and a dry year average of 19,000 AF. Precipitation entering the Southside area distribution and drainage system directly or as runoff from adjacent lands ranged from approximately 7,000 AF to 30,000 AF annually with an overall average of 17,000 AF, a wet year average of 21,000 AF, and a dry year average of 16,000 AF.

5.1.1.2 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 2010 period, YCWA Northside member unit deliveries ranged from 147,000 AF to 182,000 AF for the calendar with a wet year average of 168,000 AF and a dry year average of 159,000 AF. The overall average for the ten year period was 162,000 AF. In the Southside area, deliveries ranged from 84,000 AF to 124,000 AF with an overall average of 106,000 AF, a wet year average of 115,000 AF, and a dry year average of 103,000 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 34,000 AF to 61,000 AF between 2001 and 2010 with an overall average of 46,000 AF per year, a wet year average of 54,000 AF, and a dry year average of 43,000 AF. Spillage and tailwater outflow in the Southside area varied from 15,000 AF to 35,000 AF with an overall average of 24,000 AF per year, a wet year average of 28,000 AF, and a dry year average of 22,000 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 5,800 AF per year for the ten-year period from 2001 to 2010 and varies little from year to year. Southside seepage was approximately 7,500 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 2010, 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.

5.1.1.3 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).[25]

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 1.02 to 1.13 between 2001 and 2010 with an overall average of 1.07, a wet year average of 1.10, and a dry year average of 1.05. For the Southside area, the DF ranged from 1.02 to 1.16 with an overall average of 1.08, a wet year average of 1.06, and a dry year average of 1.08. 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[26] + Precipitation[27] + Tailwater)

[25] 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.
[26] In the Northside area, BVID/Collins Lake irrigation return flows are also included.
[27] Includes direct precipitation and runoff of precipitation entering the distribution and drainage system from adjacent lands).

Over the period from 2001 to 2010, 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,[28] groundwater from private wells, and precipitation. Outflows include crop ET, tailwater, runoff of precipitation, and deep 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.

5.1.1.4 Inflows

Over the 2001 to 2010 period, YCWA Northside member unit deliveries ranged from 147,000 AF to 182,000 AF for the calendar with a wet year average of 168,000 AF and a dry year average of 159,000 AF. The overall average for the ten year period was 162,000 AF. In the Southside area, deliveries ranged from 84,000 AF to 124,000 AF with an overall average of 106,000 AF, a wet year average of 115,000 AF, and a dry year average of 103,000 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 2010 with an overall average of 16,000 AF. Wet year and dry year average groundwater substitution pumping volumes were 0 AF and 22,000 AF, respectively. In the Southside area, groundwater substitution ranged from 0 AF to 64,000 AF between 2001 and 2010 with an overall average of 18,000 AF (Table 5-11b). Wet year and dry year average groundwater substitution pumping volumes were 0 A Fand 26,000 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 eight of the ten years evaluated, reflecting strong reliance on and access to Yuba River surface water supplies. In 2005 and 2007, it is estimated that 4,000 AF and 12,000 AF, respectively, were pumped to supplement surface water supplies. Overall average private pumping in the Northside area was 1,600 AF and was similar in wet and dry 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 21,000 AF to 34,000 AF between 2001 and 2010 with an overall average of about 31,000 AF. Pumping was similar in wet and dry years, averaging 33,000 AF and 31,000 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

[28] 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.

Northside area, precipitation ranged from 33,000 AF to 75,000 AF between 2001 and 2010, with an overall average of 54,000 AF. The wet year average was 62,000 AF, and the dry year average was 50,000 AF. Precipitation volumes in the Southside area are similar ranging from 36,000 AF to 81,000 AF between 2001 and 2010, with an overall average of 57,700 AF annually. The wet year average was 67,000 AF, and the dry year average was 54,000 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 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.

5.1.1.5 Outflows

The primary outflow from the farmed lands accounting centers is ET_{aw}. Northside ET_{aw} varied from 86,000 AF to 105,000 AF between 2001 and 2010 with an overall average of 96,000 AF per year, a wet year average of 88,000 AF, and a dry year average of 100,000 AF. ET_{aw} in the Southside area varied from 84,000 AF to 102,000 AF with an overall average of 94,000 AF per year, a wet year average of 86,000 AF, and a dry year average of 98,000 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 12,000 AF to 22,000 AF between 2001 and 2010 with an overall average of 16,000AFper year, a wet year average of 18,000 AF, and a dry year average of 15,000 AF. ET_{pr} in the Southside area varied from 16,000 AF to 28,000 AF with an overall average of 21,000 AF per year, a wet year average of 24,000 AF, and a dry year average of 20,000 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 29,000 AF to 49,000 AF between 2001 and 2010 with an overall average of 37,000 AF per year, a wet year average of 43,000 AF, and a dry year average of 35,000 AF. In the Southside area, tailwater varied from 17,000 AF to 22,000 AF with an overall average of 20,000 AF per year. Wet and dry year averages were also 20,000 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. To the extent that tributary inflows do occur, particularly in the Northside area, these are represented in the calculation of tailwater production.

Runoff of precipitation varied from 8,000 AF to 33,000 AF between 2001 and 2010 with an overall average of 20,000 AF per year, a wet year average of 24,000 AF, and a dry year average of 18,000 AF. Precipitation runoff in the Southside area varied from 7,000 AF to 29,000 AF with an overall average of 17,000 AF per year, a wet year average of 20,000 AF, and a dry year average of 15,000 AF. Runoff is greater in wet years due to additional precipitation.

Deep percolation of applied water for the Northside area ranged from 28,000 AF to 58,000 AF between 2001 and 2010 with an overall average of 45,000 AF per year, a wet year average of 38,000 AF, and a dry year average of 48,000 AF. In the Southside area, deep percolation of applied water varied from 32,000 AF to 60,000 AF with an overall average of 42,000 AF per year. Wet and dry year averages were 42,000 AF and 41,000 AF, respectively, for the Southside area.

Northside deep percolation of precipitation varied from 9,000 AF to 28,000 AF between 2001 and 2010 with an overall average of 17,000 AF per year, a wet year average of 20,000 AF, and a dry year average of 16,000 AF. Deep percolation of precipitation in the Southside area varied from 10,000 AF to 31,000 AF with an overall average of 20,000 AF per year, a wet year average of 23,000 AF, and a dry year average of 18,000 AF. Deep percolation of precipitation is greater in wet years due to increased precipitation.

5.1.1.6 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 0.77 to 1.00 between 2001 and 2010 with an overall average of 0.91, a wet year average of 0.99, and a dry year average of 0.87. For the Southside area, the SWSF ranged from 0.49 to 0.78 with an overall average of 0.69, a wet year average of 0.78, and a dry year average of 0.65. 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. 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 0.51 to 0.62 between 2001 and 2010 with an overall average of 0.54, a wet year average of 0.52, and a dry year average of 0.55. For the Southside area, the CCUF ranged from 0.53 to 0.65 with an overall average of 0.60, a wet year average of 0.58, and a dry year average of 0.61. 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.

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.

Deep percolation of applied water losses varied from 28,000 AF to 58,000 AF between 2001 and 2010 with an average of 45,000 AF per year on the Southside. Deep percolation losses were about 10,000 AF similar, less on average, in wet years. Deep percolation of applied water losses on the Southside varied from 32,000 AF to 60,000 AF between 2001 and 2010 with an average of 43,000 AF per year on the Southside. Deep percolation losses were about the same in wet and dry years. Annual fluctuations in deep percolation estimates result from differences in rainfall patterns and resulting applied water demands, as well as from uncertainty in the flow paths used to calculate the deep percolation amount. Due to the relatively large uncertainty in the deep percolation of applied water estimate, it is difficult to identify clear trends resulting from changes in hydrology or other factors over time. Moving forward, it is anticipated that the confidence with which deep percolation of applied water can be estimated will improve as measurement accuracy improves.

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

YCWA member units require a firm 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.

Some climate change impacts are suggested by available data describing unimpaired River flows from 1900 to 2011 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.

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 200,000 AF between 1900 and 2010, or about eight 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. Similar projections for the Yuba River are not available at this time, but the Feather River will likely experience similar effects of climate change based on the proximity of its watershed to the Yuba River watershed. Over the next 100 years, the projections suggest an average decrease in total water year runoff of approximately seven percent.

In addition to the shift of runoff from the spring to the winter period, temperatures in California have increased by approximately 1°F over the last century. All else equal, increased temperature will lead to increased crop evapotranspiration. These increases may be offset to some extent by reduced transpiration due to increased atmospheric carbon dioxide concentrations and changes in other factors that drive crop water demands, such as humidity, incoming solar radiation, and wind. An example of the potential increase in evaporative demand if temperature increases and other factors remain unchanged is shown in Figure 6-4. The figure was developed based on an

analysis of monthly mean climate data from Davis, California assuming an increase in air temperature of 3°F, an increase in air temperature and dew point temperature of 3°F, and finally an increase in air temperature and dew point temperature coupled with an increase in canopy resistance.

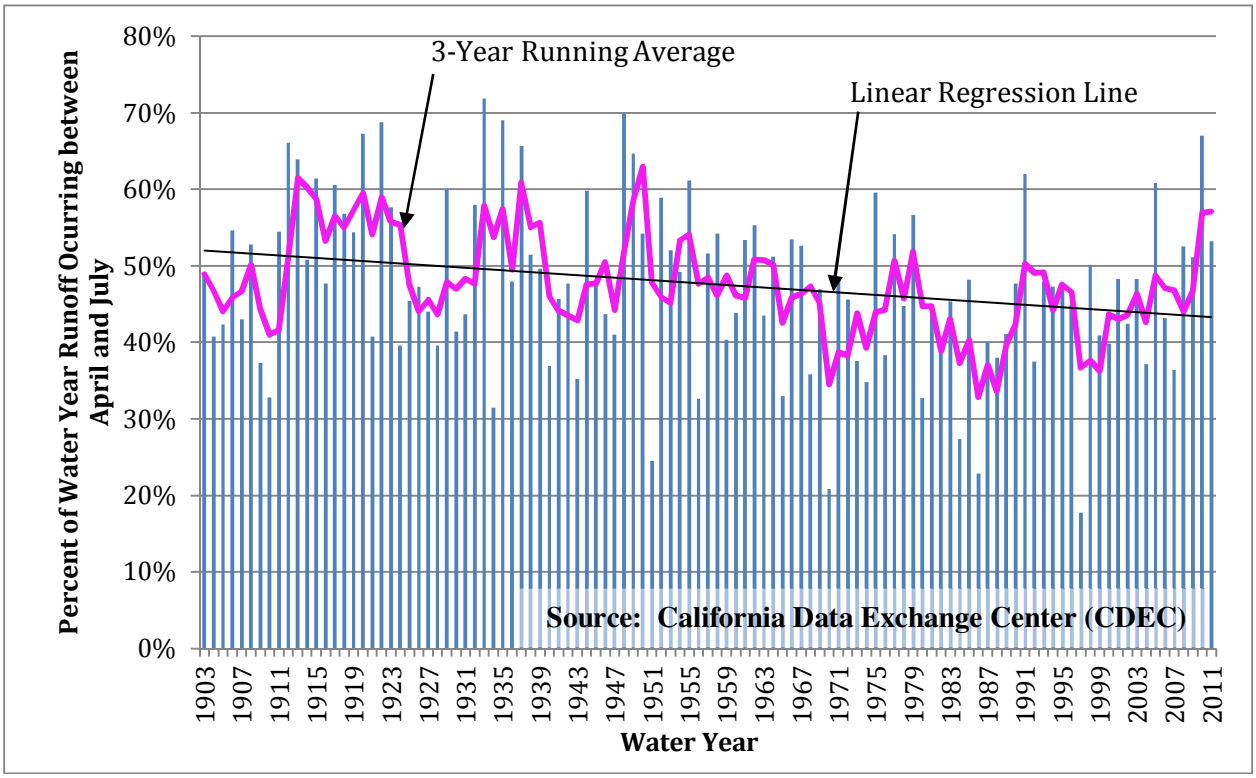

Figure 6-1. Annual April through July Unimpaired Runoff for Yuba River at Smartsville as Percentage of Total Water Year Runoff

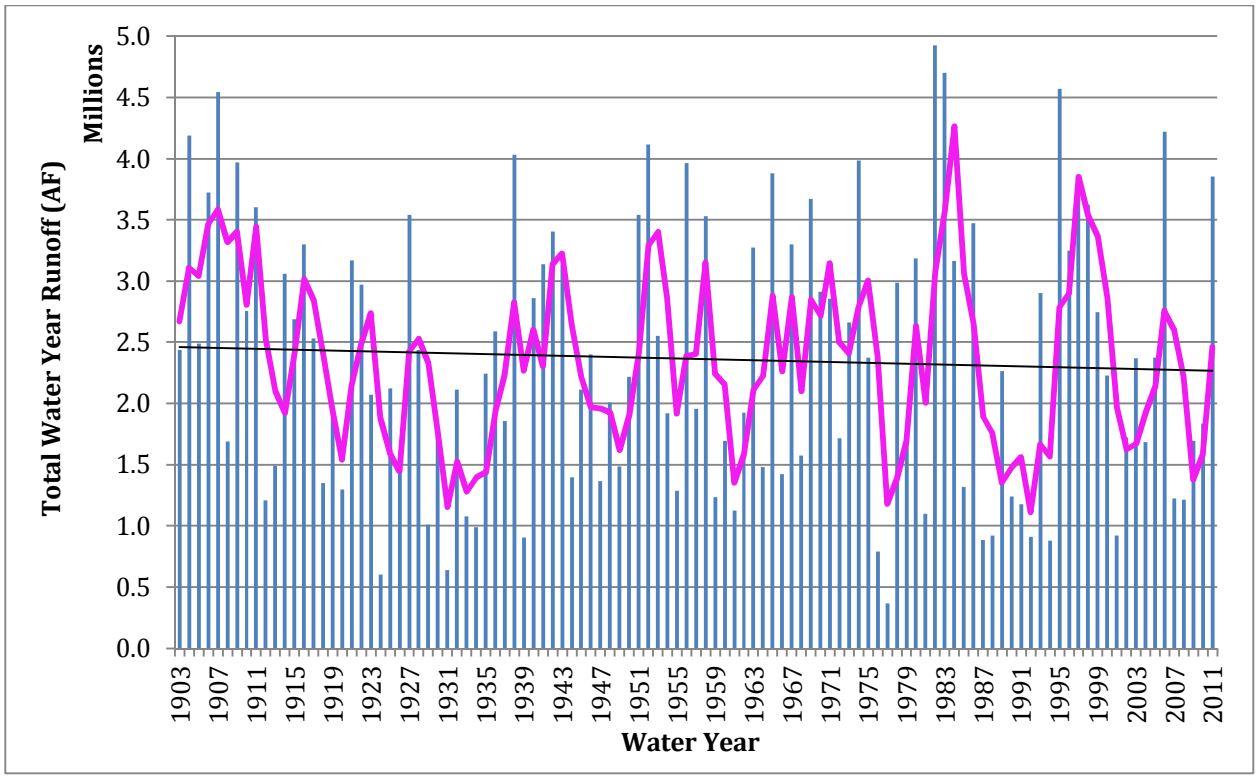

Figure 6-2. Total Water Year Runoff for Yuba River at Smartsville

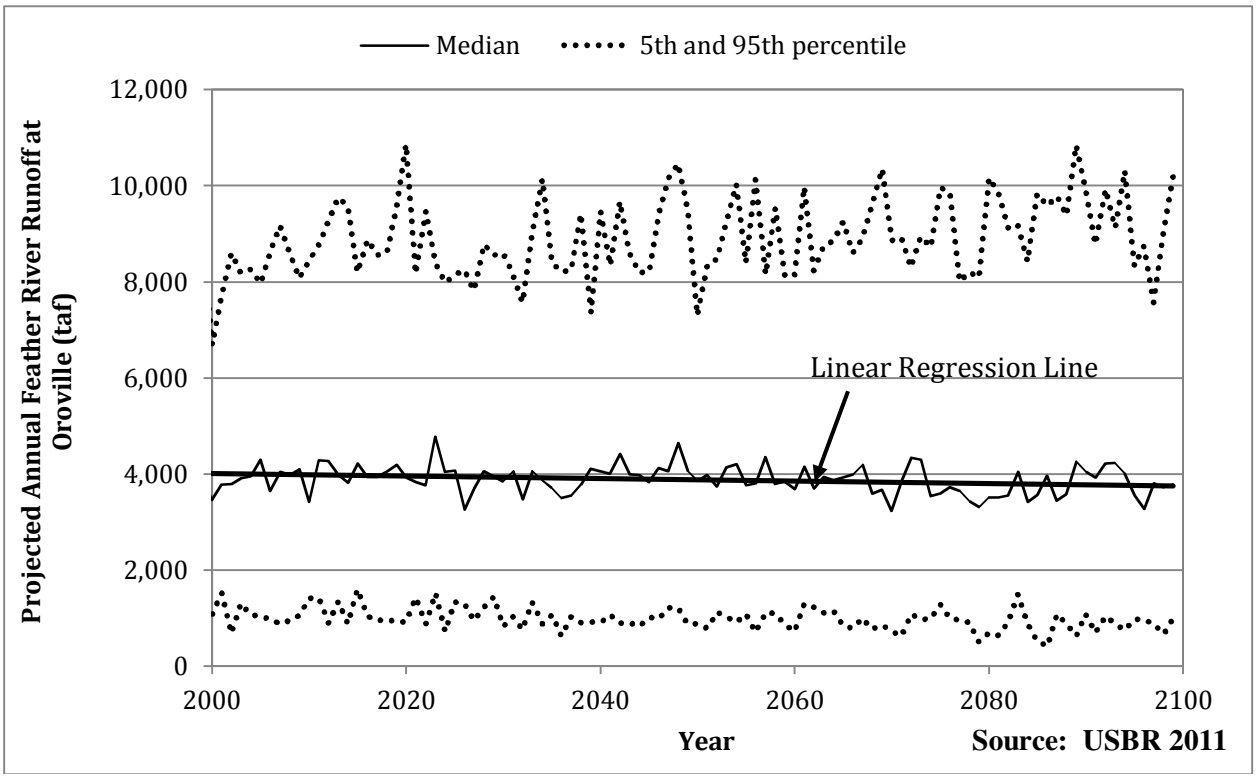

Figure 6-3. Annual Feather River Runoff at Oroville Based on 112 Hydrologic Projections

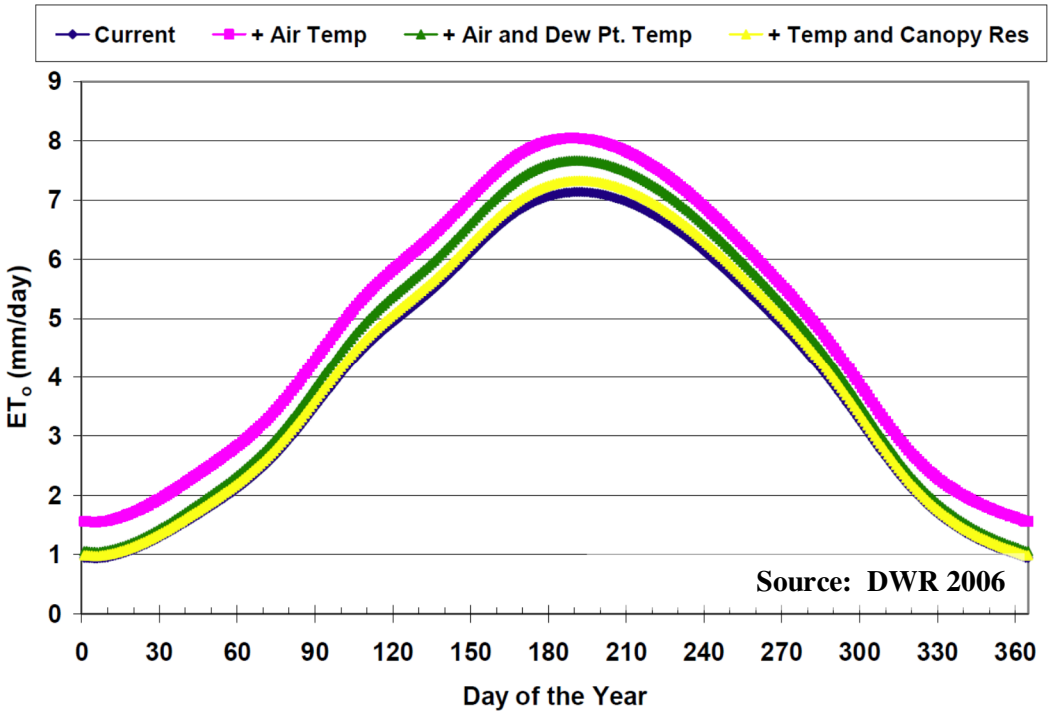

Figure 6-4. Sensitivity of Reference Evapotranspiration to Hypothetical Changes in Climate

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 has 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. 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

Increased temperature and changes to other climate factors could result in increased crop water demands, as discussed previously. Additionally, changes in precipitation timing and amounts could result in greater irrigation requirements to meet ET demands. Changes in the timing of crop planting, development, and harvest could also result in changes to the timing of irrigation demands during the year.

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 not well suited to predict flooding 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 (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 Update (DWR 2010a) 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 2009)	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 as well as municipal and industrial water discharged to the from sources including Beale Air Force Base, the City of Wheatland, and OPUD. 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 within the long term sustainable yield of the basin to compensate for reduced April through July runoff.
	Improve water quality	The 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 and lead agency in the Yuba River Accord. 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 and 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.

Table 6-1. Strategies to Mitigate Climate Change Impacts (contd.)

Source	Strategy	Status
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 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.

Key:
AWMP = Agricultural Water Management Plan
CNRA = California Natural Resources Agency
DWR = California Department of Water Resources
EWMP = Efficient Water Management Practice
FERC = Federal Energy Regulatory Commission
GMP = Groundwater Management Plan
MU = Member Unit
OPUD = Olivehurst Public Utilities District
TAF = thousand acre-feet
USACE = U.S. Army Corps of Engineers
YCWA = Yuba County Water Agency

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 manage available water resources effectively under climate change. 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)
- Managing An Uncertain Future: Climate Change Adaptation Strategies for California's Water. California Department of Water Resources Report. October 2008. (DWR 2008)

- 2009 California Climate Change Adaptation Strategy. California Natural Resources Agency Report to the Governor. December 2009. (CNRA 2009)
- Climate Change and Water Resources Management: A Federal Perspective. U.S. Geological Survey. (USGS 2009)
- Managing an Uncertain Future. California Water Plan Update 2009. Volume 1, Chapter 5. March 2010. (DWR 2010a)
- Climate Change Characterization and Analysis in California Water Resources Planning Studies. California Department of Water Resources Final Report. December 2010. (DWR 2010b)
- Climate Change Handbook for Regional Water Planning. Prepared for U.S. Environmental Protection Agency and California Department of Water Resources by CDM. November 2011. (CDM 2011)
- Climate Action Plan—Phase 1: Greenhouse Gas Emissions Reduction Plan. California Department of Water Resources. May 2012. (DWR 2012)
- Climate Change and Integrated Regional Water Management in California: A Preliminary Assessment of Regional Perspectives. Department of Environmental Science, Policy and Management. University of California at Berkeley. June 2012. (UCB 2012)

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

7.1. INTRODUCTION

This chapter describes the actions that YCWA has taken and is planning to take to accomplish improved and more efficient water management. These actions are organized with respect to the Efficient Water Management Practices (EWMP) described in 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 are must be implemented if found to be technically feasible and locally cost effective.

Two EWMPs mandatory for all water suppliers are included 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 is actively implementing the delivery measurement accuracy EWMP and in Attachment A has included a plan to comply with the agricultural water delivery measurement regulation CCR 23 §597. YCWA also is currently implementing pricing based in part on the volume of water delivered through its charges for reimbursement of operations and maintenance costs to southside member units. YCWA will evaluate extending this pricing to the northside member units, by beginning discussions with the MUs to amend existing delivery contracts or to incorporate volumetric pricing into new delivery contracts once the existing contracts expire or sooner, if possible. This plan was described previously in Section 3.8.

YCWA has been implementing and plans to continue implementing 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 beyond YCWA's purview and are therefore considered to be "technically infeasible" For YCWA to implement. 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).	Being Implemented
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Being 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.	Being Implemented
10608.48.c(3)	Facilitate financing of capital improvements for on-farm irrigation systems.	Not Technically Feasible
10608.48.c(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Being Implemented
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.	Being Implemented
10608.48.c(7)	Construct and operate supplier spill and tailwater recovery systems.	Being Implemented
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	Being Implemented
10608.48.c(9)	Automate canal control structures.	Being Implemented
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation.	Being Implemented

Table 7-1. Summary of EWMP Implementation Status (contd.)

Water Code Reference No.	EWMP Description	Implementation Status
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Being Implemented
10608.48.c(12)	Provide for the availability of water management services to water users.	Being 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.	Being Implemented
10608.48.c(14)	Evaluate and improve the efficiencies of the supplier's pumps.	Being Implemented

Key:
EWMP = Efficient Water Management Practice

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

YCWA is implementing improvements in measurement of 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.

Of twelve sites that have been or will be used to measure deliveries to the eight MUs, seven existing sites were determined to be compliant with the measurement accuracy standard and are described in Attachment A. Corrective actions for the remaining five sites, including establishment of two new sites, are described in Attachment A.

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 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.

On December 20, 2012, YCWA adopted a resolution to adopt the Agency's 2012 AWMP and continue the process to comply with CWC 10608.48. Continued implementation of volumetric pricing will include consideration of extending operations and maintenance costs to serve the north MUs through modification of their delivery contracts. Examples of operations and maintenance costs incurred by the Agency to serve the MUs north of the Yuba River could include reimbursement for the cost to monitor flows by the YCWA hydrographer and installation and maintenance of delivery measurement devices. Alternatively, YCWA has identified objectives to be considered when designing an alternative pricing structure and has developed a conceptual rate structure to satisfy those objectives. 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))

YCWA and the MUs 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 utilized for irrigation 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.
- **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))

As a water wholesaler, YCWA does not have a role directly related to on-farm irrigation. Irrigation service to individual irrigators is provided by the MUs. Thus, facilitation of on-farm capital improvements is beyond YCWA's purview and is not technically feasible for the Agency. 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, 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.

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[29]. Thus, it is anticipated that lining of YCWA and MU canals and drains would result in little, if any, seepage reduction. Additionally, seepage 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,

[29] 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)

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).

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 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.

Continuous monitoring of key boundary outflow and internal operational sites as part of implementation of the MIP will meet two key objectives of this EWMP: (1) provide real time monitoring of internal distribution and drainage system flows, canal spills, and boundary outflows to support spill reduction by YCWA and MU operators and (2) develop historical datasets of these flows to support evaluation of opportunities for future spill and tailwater recovery projects, including both operational and infrastructure improvements.

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 2010, YCWA, in cooperation with the MUs, made more than 320,000 AF available through groundwater substitution transfers to various parties. 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.

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

Third, 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 links on its website to 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.

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. In particular, these include the following:

- Links on YCWA web site to sources of water management information useful to MUs and irrigators, as well as other resources of interest to local agricultural producers:
  - California Irrigation Management Information System (www.cimis.water.ca.gov)
  - Advanced Pumping Efficiency Program (www.pumpefficiency.org)
  - Irrigation & Training Research Center (www.itrc.org)
  - UC Davis Biometeorology Program—Irrigation Scheduling (biomet.ucdavis.edu/irrigation-scheduling.html)
- 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.

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

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, and other initiatives. 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 stations1, 2, and 3 were completed in 2009. YCWA is implementing this EWMP by periodically evaluating the efficiency of the pumps 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 7-2.

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).	Being Implemented	• Prepared a certification of compliance for existing compliant customer delivery measurement sites (Attachment A). • Developed a corrective action plan for non-compliant and new sites to achieve compliance with CCR 23 §597 by December 31, 2015 (Attachment A)	• Implement corrective action plan described in Attachment A by December 31, 2015.
10608.48.b(2)	Adopt a pricing structure for water customers based at least in part on quantity delivered.	Being Implemented	• Existing operations and maintenance charges to southside member units based on volume of water delivered. • Identified examples of operations and maintenance charges that could be included in northside member unit delivery contracts. • Developed Agency objectives to be considered when evaluating alternative pricing structures. • Developed conceptual alternative pricing structure to satisfy Agency objectives. • Initiated discussion with MUs regarding requirement for pricing structure based in part on volume delivered.	• Continue implementing pricing structure for reimbursement of operations and maintenance costs based on volume of water delivered. • Continue discussions with MUs to modify existing pricing structures, as needed. • If necessary and mutually agreeable, amend MU delivery contracts to modify pricing, or modify contracts accordingly upon expiration.
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.	Being Implemented	• Reusing recycled M&I water from Beale Air Force Base and Olivehurst Public Utilities District. • Identified potential additional sources of recycled M&I water.	• Continue existing use of recycled water. • 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.	Not Technically Feasible	Financing of on-farm capital improvements is beyond YCWA's purview as a wholesaler; however, YCWA has financed capital improvements by its customers, the MUs.	
10608.48.c(4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Being Implemented	• Existing pricing structure promotes use of available surface water supplies to provide beneficial groundwater recharge (Goal C). • Yuba Accord promotes groundwater production during dry years (Goal B). • Implementing pricing structure that will encourage more efficient water use by MUs.	• Continue to promote use of surface water supplies for beneficial recharge. • Continue to promote groundwater production during dry years. • Implement pricing structure based in part on volume delivered to encourage more efficient water use by MUs.
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.	

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

Water Code Reference No.	EWMP	Implementation Status	Implemented Activities	Planned Activities
10608.48.c(6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	Being Implemented	• Currently maximizing flexibility within operational limits. Deliveries are made with 24 hours advance notice. • 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. • Evaluated automation of YCWA facilities to further increase flexibility to MUs under canal automation EWMP.	• Continue deliveries with 24 hour advance notice. • Continue to provide Agency staff to the specification of MUs in Southside area to deliver water to MU customers. • 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.	Being Implemented	• Implementing MIP to provide continuous monitoring of key locations to support spill and tailwater reduction by YCWA and MU operators. • MUs practice extensive tailwater and spillage recovery and reuse.	• Continue implementation of MIP, focused initially on securing funding for improvement/establishment of high priority sites. • Make monitoring data available to MUs as it becomes available.
10608.48.c(8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	Being Implemented	• Conducting effective, proactive conjunctive management program to meet multiple objectives.	• Continue conjunctive management and seek opportunities to enhance activities to increase local and statewide benefits.
10608.48.c(9)	Automate canal control structures.	Being Implemented	• Implementing MIP to provide continuous monitoring of key locations to support enhanced operation of YCWA and MU facilities by Agency and MU operators. • Constructed Yuba Wheatland Canal pump stations operating in automatic downstream level control. • Evaluated opportunities for additional automation to be considered for implementation.	• Continue implementation of MIP, focused initially on securing funding for improvement/establishment of high priority sites. • Make monitoring data available to MUs as it becomes available. • Continue automated operation of Yuba Wheatland Canal pump stations. • Implement additional automation at locally cost-effective levels.
10608.48.c(10)	Facilitate or promote customer pump testing and evaluation.	Being Implemented	• Providing link on Agency web site to Advanced Pumping Efficiency Program funded by PG&E.	• Continue to promote participation of MUs in available pump testing programs.
10608.48.c(11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Being Implemented	• Water Resources Manager serves as YCWA Water Conservation Coordinator.	• 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.	Being Implemented	• Providing links to water management services on Agency web site. • Implementing MIP to provide continuous monitoring of key locations to support enhanced operation of MU facilities. • Providing Agency staff for operation of MU facilities in Southside area.	• Continue to provide web links to water management services. • Continue implementation of MIP, focused initially on securing funding for improvement/establishment of high priority sites. • Continue to provide Agency staff for operation of MU facilities.
10608.48.c(13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Being Implemented	• Evaluating policies of agencies that affect YCWA's ability to flexibly store and deliver water and seeking changes to increase flexibility.	• 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.	Being Implemented	• Periodic evaluation of pump efficiency and maintenance as needed to improve pump efficiency.	• Continue periodic evaluation of pump efficiency and maintenance as needed to improve pump efficiency.

Key:
CCR = California Code of Regulations
EWMP = Efficient Water Management Practice
MIP = Measurement Improvement Plan
MU = Member Unit
PG&E = Pacific Gas and Electric Company
YCWA = Yuba County Water Agency

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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)[30]. 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 recharge of the underlying groundwater system. Other flows that could be considered losses at the Agency, MU, or farm

[30] 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.

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 7-3.

Table 7-3. 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.	Being Implemented	None	Not Applicable	Not Applicable	1
10608.48.b (2)	Adopt a pricing structure based at least in part on quantity delivered.	Being 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.	Being 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.	Not Technically Feasible	Not Applicable	Not Applicable	Not Applicable	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.	Being 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
10608.48.c (6)	Increase flexibility in water ordering by, and delivery to, water customers within operational limits.	Being 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.	Being 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.	

Water Code Reference No.	EWMP	Implementation Status	Targeted Flow Path(s)	Benefits	Consequential Effects	Comments (See End of Table)
10608.48.c (8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area.	Being Implemented	Diversions, Groundwater Pumping	Conjunctive management provides multiple benefits: Maintain local and statewide water supply reliability Enhance fisheries Reduced energy requirements	Not Significant	2
10608.48.c (9)	Automate canal control structures.	Being 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.	Being Implemented	None	Improved pumping efficiency by YCWA's customers does not affect the 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.	Being Implemented	Varies	See Comment	See Comment	4
10608.48.c (12)	Provide for the availability of water management services to water users.	Being 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
10608.48.c (13)	Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage.	Being Implemented	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.	Being 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.
Key:
EWMP = Efficient Water Management Practice
MU = Member Unit
YCWA = Yuba County Water Agency

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[31], DWR 2012[32]), 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 7-4. 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 7-5.

Table 7-4. 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.

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

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Table 7-5. 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	Being Implemented	No Direct WUE Improvements					
10608.48.b (2)	Adopt a pricing structure based at least in part on quantity delivered	Being 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.	Being Implemented		✓		✓		
10608.48.c (3)	Facilitate financing of capital improvements for on-farm irrigation systems	Not Technically Feasible	Not Applicable to YCWA					
10608.48.c (4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Being Implemented		✓		✓	✓	
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	Being Implemented		✓	✓	✓	✓	
10608.48.c (7)	Construct and operate supplier spill and tailwater recovery systems	Being Implemented		✓		✓	✓	
10608.48.c (8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Being Implemented		✓				
10608.48.c (9)	Automate canal control structures	Being Implemented		✓	✓	✓	✓	
10608.48.c (10)	Facilitate or promote customer pump testing and evaluation	Being Implemented						✓
10608.48.c (11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Being Implemented	The activities of the Water Conservation Coordinator and other 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.	Being 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.	Being Implemented		✓	✓	✓	✓	
10608.48.c (14)	Evaluate and improve the efficiencies of the supplier's pumps.	Being Implemented						✓

Key:
AWMP = Agricultural Water Management Plan
EWMP = Efficient Water Management Practice
WUE = Water Use Efficiency
YCWA = Yuba County Water Agency

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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 7-5. Past WUE improvements are estimated relative to no historical implementation. WUE improvements relative to the time of the last plan are not applicable as YCWA has not previously prepared an AWMP. Future WUE improvements are estimated for five years in the future (2017) relative to 2012 and for ten years in the future (2022) relative to 2012. The result of this evaluation is provided in Table 7-6.

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 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.

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Table 7-6. Evaluation of Relative Magnitude of Past and Future WUE Improvements by EWMP

Water Code Reference No.	EWMP	Implementation Status	Marginal WUE Improvements[1,2]			
			Past		Future	
			Relative to No Historical Implementation[3]	Since Last AWMP[4]	5 Years in Future[5]	10 Years in Future[5]
10608.48.b (1)	Measure the volume of water delivered to customers with sufficient accuracy	Being Implemented	No Direct WUE Improvements			
10608.48.b (2)	Adopt a pricing structure based at least in part on quantity delivered	Being Implemented	None	Not Applicable	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.	Being Implemented	Limited	Not Applicable	None to Limited, Depending on Opportunities	
10608.48.c (3)	Facilitate financing of capital improvements for on-farm irrigation systems	Being Implemented	Not Applicable to YCWA			
10608.48.c (4)	Implement an incentive pricing structure that promotes one or more of the following goals: (A) More efficient water use at farm level, (B) Conjunctive use of groundwater, (C) Appropriate increase of groundwater recharge, (D) Reduction in problem drainage, (E) Improved management of environmental resources, (F) Effective management of all water sources throughout the year by adjusting seasonal pricing structures based on current conditions.	Being Implemented	Substantial (Goals B & C)	Not Applicable	None to Limited (Goal A), Depending on Structure and Changes to MU Pricing Structures	
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	Being Implemented	Substantial	Not Applicable	None to Modest, Depending on Funding	
10608.48.c (7)	Construct and operate supplier spill and tailwater recovery systems	Being Implemented	Substantial	Not Applicable	None to Modest, Depending on Funding	
10608.48.c (8)	Increase planned conjunctive use of surface water and groundwater within the supplier service area	Being Implemented	Substantial	Not Applicable	Modest	
10608.48.c (9)	Automate canal control structures	Being Implemented	Substantial	Not Applicable	None to Modest, Depending on Funding	
10608.48.c (10)	Facilitate or promote customer pump testing and evaluation	Being Implemented	None[6]	Not Applicable	Limited	Limited
10608.48.c (11)	Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress report.	Being Implemented	The activities of the Water Conservation Coordinator and other 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.	Being Implemented	Modest	Not Applicable	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.	Being Implemented	Substantial	Not Applicable	None to Modest, Depending on Outcomes	
10608.48.c (14)	Evaluate and improve the efficiencies of the supplier's pumps.	Being Implemented	None[7]	Not Applicable	None to Limited, Depending on Opportunities	

Note:
[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. Not applicable, as YCWA has not previously prepared an AWMP.
[5] WUE Improvements expected in 2017 (five years in the future) and 2022 (ten years in the future), relative to level of implementation in recent years.
[6] A link on the YCWA website has been added as part of YCWA's review of its water management over the course of preparing its 1012 AWMP and was not provided historically.
[7] The Agency's Yuba Wheatland Canal pump stations were completed in 2009 and evaluated at that time, though efficiency improvements have not been warranted.

Key:
AWMP = Agricultural Water Management Plan
EWMP = Efficient Water Management Practice
WUE = Water Use Efficiency
YCWA = Yuba County Water Agency

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Yuba County Water Agency
2012 Agricultural Water Management Plan
Attachment A:
Agricultural Water Measurement Compliance Documentation

Prepared By

DAVIDS ENGINEERING, INC
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December 2012

ATTACHMENT A: AGRICULTURAL WATER MEASUREMENT COMPLIANCE DOCUMENTATION

Contents

ATTACHMENT A: Introduction....A-5
Compliance Requirements....A-5
Measurement Accuracy....A-5
Accuracy Certification....A-5
Measurement Practices....A-6
Field-Testing Results and Device Certification....A-10
Overview....A-10
Field-Test Results....A-10
NY31....A-12
Hallwood South....A-15
Hallwood North....A-17
Cordua-Ramirez Heading....A-20
Cordua-Ramirez Split....A-23
NY33....A-26
Rue Pump Station....A-29
South Yuba WD Heading....A-31
Dry Creek MWC Heading....A-35
Measurement by Difference Accuracy Analysis....A-38
Cordua Irrigation District....A-40
Brophy Water District....A-40
South Yuba Water District....A-41
Required Reporting (CCR 23 §597(e)(2))....A-41
Best Professional Practices....A-41
Collection of Measurement Data....A-41
Frequency of Measurements....A-41
Method for Determining Irrigated Acres....A-41
Quality Control and Quality Assurance Parameters....A-41
Conversion of Measured Values to Water Volume (CCR 23 §597(e)(3))....A-42
Corrective Action Plan for Non-Compliant Devices (CCR 23 §597(e)(4))....A-42
Corrective Actions Needed to Achieve Compliance....A-42

Hallwood South (Improvements to Existing Site) A-42
Ramirez D-10 Delivery (Improvements to Existing Site) A-42
Wheatland Canal at Beale Road (Establishment of New Site) A-43
Beukleman Delivery (Establishment of New Site) A-43
South Yuba WD Heading (Improvements to Existing Site) A-43
Schedule A-43
Budget and Finance Plan A-43

List of Tables

Table A-1. Twelve Agency Measurement Sites and Site Measurement Methods 6
Table A-2. Member Unit Water Delivery Quantification Equations and Methodologies 7
Table A-3. Field-Testing Results Summary..... 11
Table A-4. NY31 Field-Testing Summary 12
Table A-5. Hallwood South Field-Testing Summary..... 15
Table A-6. Hallwood North Field-Testing Summary..... 17
Table A-7. Cordua-Ramirez Heading Field-Testing Summary 20
Table A-8. Cordua-Ramirez Split Field-Testing Summary 23
Table A-9. NY33 Field-Testing Summary 26
Table A-10. Rue Pump Station Field-Testing Summary 29
Table A-11. Rue Pump Station Measurement Summary..... 31
Table A-12. South Yuba WD Heading Field-Testing Summary 32
Table A-13. Dry Creek MWC Heading Field-Testing Summary 35
Table A-14. Measurement by Difference Accuracy Analysis Summary..... 40

List of Figures

Figure A-1. Northside Measurement Sites 8
Figure A-2. Southside Measurement Sites 9
Figure A-3. NY31 Measurement Location 13
Figure A-4. NY31 Measurement Summary 14
Figure A-5. Hallwood South Measurement Location 16
Figure A-6. Hallwood South Measurement Summary 16
Figure A-7. Hallwood North Measurement Location 18
Figure A-8. Hallwood North Measurement Summary 19
Figure A-9. Cordua-Ramirez Heading Measurement Location 21
Figure A-10. Cordua-Ramirez Heading Measurement Summary 22
Figure A-11. Cordua-Ramirez Split Measurement Location 24
Figure A-12. Cordua-Ramirez Split Measurement Summary 25
Figure A-13. NY33 Measurement Location 27
Figure A-14. NY33 Measurement Summary 28
Figure A-15. Rue Pump Station Measurement Location 30
Figure A-16. South Yuba WD Heading Measurement Location 33
Figure A-17. South Yuba WD Heading Measurement Summary 34
Figure A-18. Dry Creek MWC Heading Measurement Location 36
Figure A-19. Dry Creek MWC Heading Measurement Summary 37

ATTACHMENT A: INTRODUCTION

Pursuant to the Water Conservation Act of 2009, California Water Code (CWC) §10608.48(b) requires that on or before July 31, 2012 agricultural water suppliers shall measure the volume of water delivered to customers with sufficient accuracy to:

- Adopt a pricing structure for water customers based at least in part on quantity delivered
- Submit an annual report to the Department of Water Resources that summarizes aggregated farm-gate water delivery data on a monthly or bi-monthly basis

Under the authority provided for in CWC §10608.48(b), the California Department of Water Resources adopted the regulations summarized below pertaining to Agricultural Water Measurement, which became effective on July 11, 2012. Those regulations are contained in the California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (CCR 23 §597 or Regulation) and apply unconditionally to agricultural suppliers serving more than 25,000 acres and to suppliers serving between 10,000 acres and 25,000 acres if funding is provided. The permanent regulation was approved by the Office of Administrative Law on July 11, 2012.

The Regulation requires measurement at individual customer delivery points or, provided specific conditions exist, at points serving multiple customers

Yuba County Water Agency (YCWA or Agency) provides wholesale agricultural water delivery to eight customers whose aggregate service exceeds 25,000 acres and is therefore subject to the Regulation.

COMPLIANCE REQUIREMENTS

MEASUREMENT ACCURACY

According to CCR 23 §597, specific accuracy thresholds apply to different measurement devices. Existing measurement devices shall be certified to be accurate to within ±12 percent by volume and new or replacement measurement devices shall be certified to be accurate to within:

- ±5 percent by volume in the laboratory if using a laboratory certification; or
- ±10 percent by volume in the field if using a non-laboratory certification

In order to comply with CCR 23 §597, YCWA intends to use its existing customer delivery measurement devices (sites) to the maximum extent possible, but is establishing new measurement sites at some locations and replacing measurement devices at other locations. As a result, the ±12 percent by volume accuracy standard applies to existing devices, and the ±10 percent by volume accuracy standard applies to new and replacement measurement devices to be installed as part of YCWA's corrective action plan, described in Section 6 of this document. YCWA intends to use a non-laboratory certification involving field testing of new and replacement devices.

ACCURACY CERTIFICATION

Existing measurement devices shall be initially certified by trained individuals and documented in a report certified by an engineer by either:

- Field-testing of a random and statistically representative sample of existing devices or

- Field-inspections and analysis completed for every device.

YCWA elected to take a field testing certification approach; however, because there are only 10 existing customer delivery measurement sites, field tests were conducted at all sites rather that at a random sample of sites. Field-testing measurements were performed between July 11 and July 17, 2012 by a two person crew trained in the use of state-of-the-art current metering devices including a SonTek RiverSurveyor M9 Acoustic Doppler Current Profiler (ADCP) and a SonTek FlowTracker Acoustic Doppler Velocimeter (ADV). Best professional practices were used for all field-testing measurements. The field testing results are reported in Section 4.

MEASUREMENT PRACTICES

YCWA is a wholesale agricultural water supplier that provides water to eight individual Member Units (MU) within the Agency service area. The MUs are regarded as the Agency's customers for purposes of complying with the CCR 23 §597. The volumes of water delivered by the Agency to the MUs are measured at 12 flow measurement sites, including 10 existing sites and 2 new sites. Table A-1 summarizes the measurement method employed at each of the 12 measurement sites.

Table A-1. Twelve Agency Measurement Sites and Site Measurement Methods

SiteID	Site Name	Existing/New	Measurement Method
NY0031	NY31	Existing	Rated section. Stage-discharge relationship created and maintained by PG&E
HLLWDS	Hallwood South	Existing	Rated section. Stage-discharge relationship created by Surface Water Data Inc.
HLLWDN	Hallwood North	Existing	Rated section. Stage-discharge relationship created by Surface Water Data Inc.
CRDRMZ	Cordua-Ramirez Heading	Existing	Modified 20' wide Parshall Flume
RAMIRZ	Cordua-Ramirez Split	Existing	SonTek Argonaut SW mounted in pipeline
RMZD10	Ramirez D-10 Delivery	Existing	Open flow propeller meter
NY0033	NY33	Existing	SonTek Argonaut SW installed in concrete lined canal section
RUEPMP	Rue Pump Station	Existing	McCrometer propeller meters
WHTP02	Wheatland Canal at Beale Road	New	SonTek IQ in pipeline
BUKLMN	Beukleman Delivery	New	SonTek IQ in pipeline
SYWD01	South Yuba WD Heading	Existing	SonTek IQ in pipeline
DCMWC1	Dry Creek MWC Heading	Existing	Open flow propeller meter

The quantities of water delivered to five of the MUs are measured directly (at either single or multiple sites). For the remaining three MUs, the quantities of water delivered are determined by difference calculations using certain measured quantities. Table A-2 summarizes the equations used to quantify water deliveries to each MU (each six digit name represents one of the 12 measurement sites) along with the quantification methodology.

Table A-2. Member Unit Water Delivery Quantification Equations and Methodologies

Member Unit	Equation for Quantifying Water Deliveries using Measured Values	Quantification Methodology
Browns Valley Irrigation District (BVID)	BVID = NY0031	Measured at one site
Ramirez Water District (RWD)	RWD = RAMIRZ + RMZD10	Measured at two sites
Cordua Irrigation District (CID)	CID = CRDRMZ - RAMIRZ - RMZD10	Calculated by difference involving 3 measured sites
Hallwood Irrigation Company (HIC)	HIC = HLLWDN + HLLWDS	Measured at two sites
Brophy Water District (BWD)	BWD = NY0033 - WHTP02 - RUEPMP - BUKLMN - SYWD01	Calculated by difference involving 5 measured sites
Wheatland Water District (WWD)	WWD = WHTP02 + RUEPMP	Measured at two sites
Dry Creek Mutual Water Company (DCMWC)	DCMWC = DCMWC1	Measured at one site
South Yuba Water District (SYWD)	SYWD = SYWD01 + BUKLMN - DCMWC1	Measured at one site plus calculated by difference at two sites

Six of the measurement sites are on the north side of the Yuba River (Northside) and six of the measurement sites are on the south side of the Yuba River (Southside) as shown in Figures A-1 and A-2, respectively.

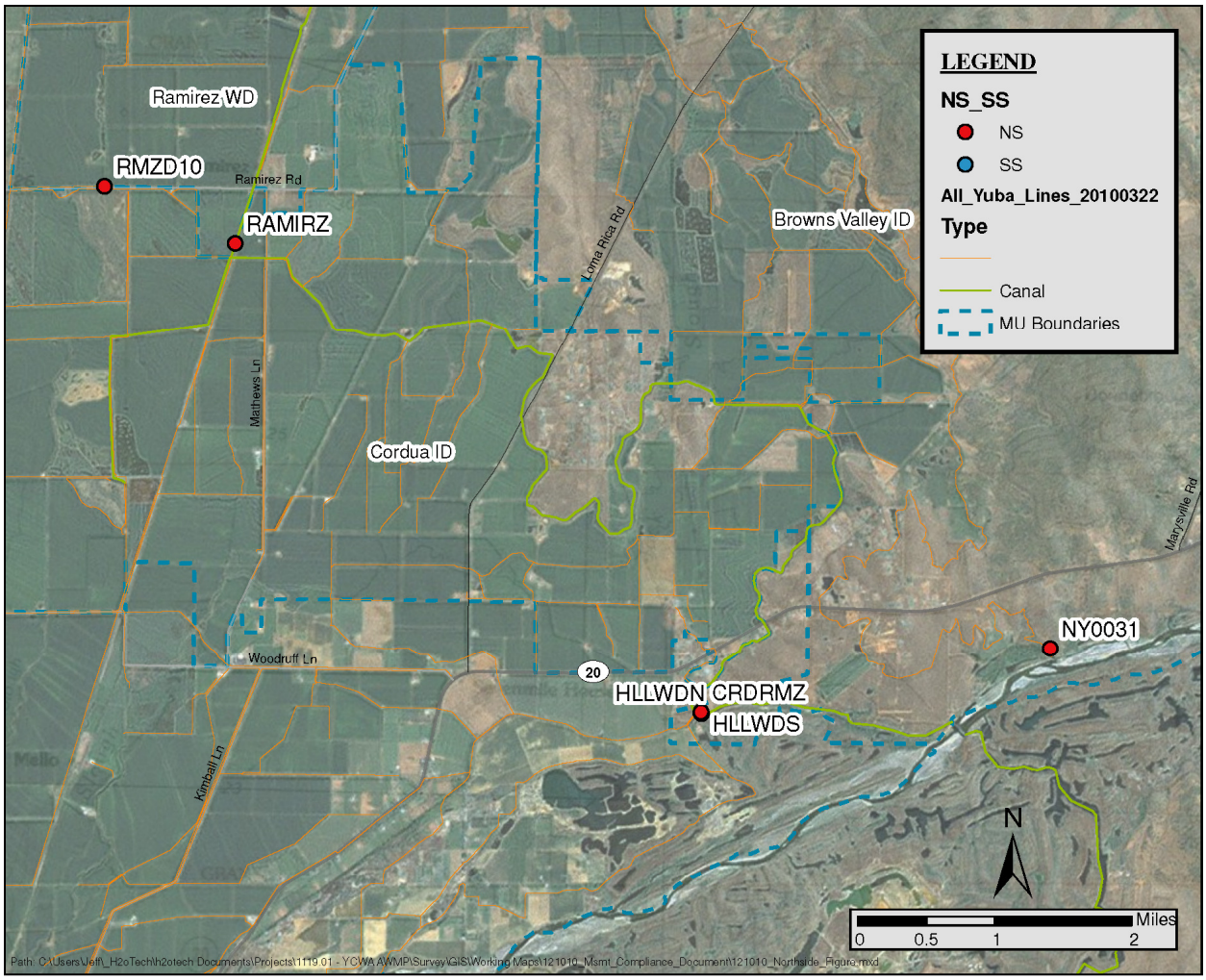

Figure A-1. Northside Measurement Sites

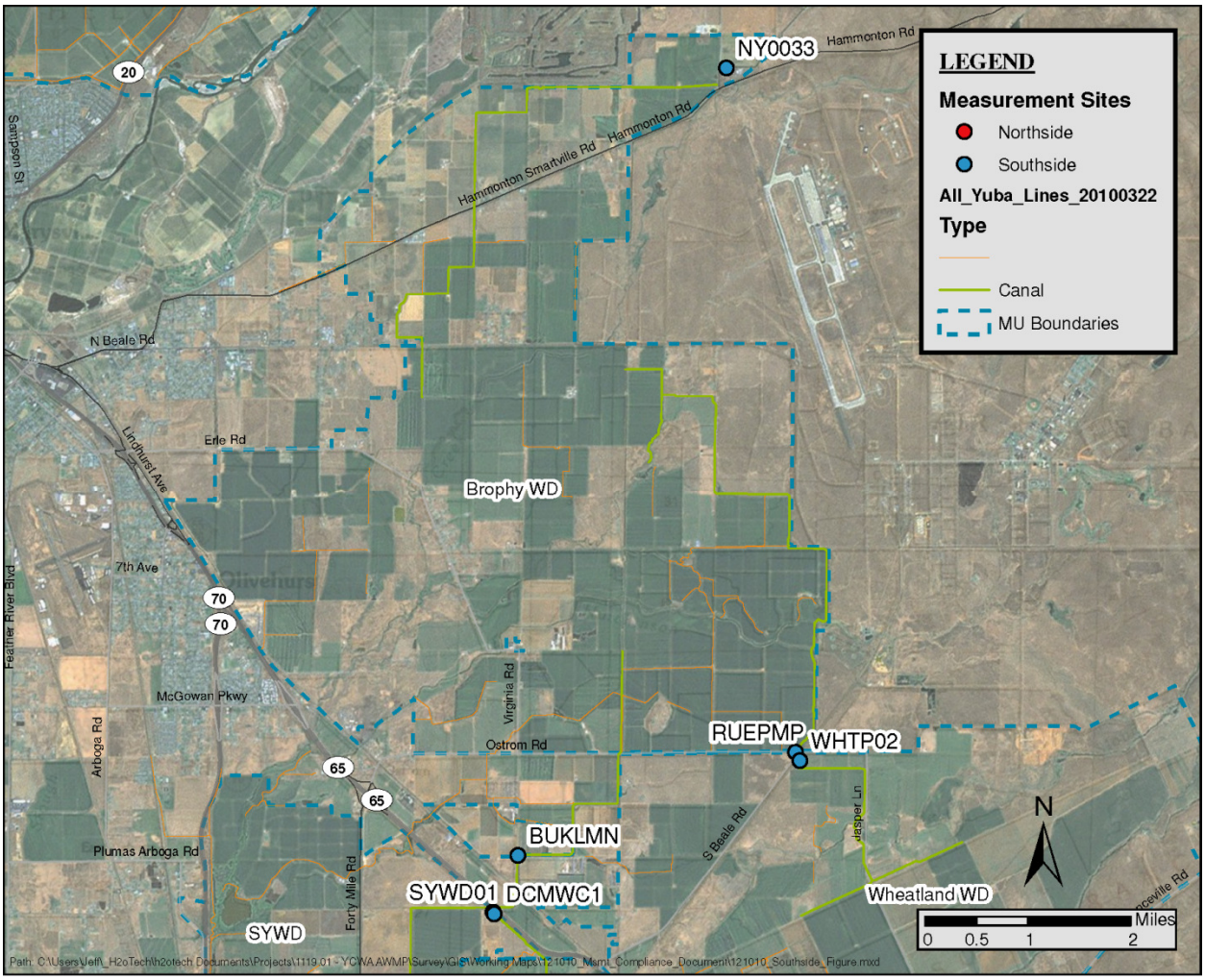

Figure A-2. Southside Measurement Sites

FIELD-TESTING RESULTS AND DEVICE CERTIFICATION

OVERVIEW

The Regulation states that field-testing should be performed on a sample of 10 percent of the existing devices for each device type, with a minimum of 5 and a maximum of 100 individual devices (recommended). Alternatively, a supplier may develop its own sampling plan using accepted statistical methodology. Because there are only 10 existing measurement sites involved with quantifying customer deliveries and because several different types of measurement devices are used, the Agency elected to field test all 10 sites.

The equation defining 'Accuracy' from CCR 23 §597.2(a)(1) was used for volumetric accuracy calculations based on the field tests (Equations A-1a and A-1b).

$$Accuracy = 100 * \frac{measured\ value - actual\ value}{actual\ value} \qquad \text{[A-1a]}$$

$$Volumetric\ Accuracy\ (VA_{SiteX}) = 100 * \frac{measured\ volume_{SiteX} - actual\ volume_{SiteX}}{actual\ volume_{SiteX}} \qquad \text{[A-1b]}$$

If an existing device measured flow rate, then the accuracy in flow rate was determined by Equation A-2.

$$Flow\ Rate\ Accuracy\ (FRA_{SiteX}) = 100 * \frac{measured\ flow_{SiteX} - actual\ flow_{SiteX}}{actual\ flow_{SiteX}} \qquad \text{[A-2]}$$

If a device either (1) provides a continuous record (e.g. stage-discharge site with continuous water level measurement) or (2) totalizes volume (e.g. propeller meter with totalizer), conversion flow rate to volume introduces no error, so instantaneous flow rate accuracy and volumetric accuracy are the same. All 12 of the Agency's customer delivery measurement sites do, or (once constructed) will fall in this category (Equation A-3).

$$VA_{SiteX} = FRA_{SiteX} = 100 * \frac{measured\ flow_{SiteX} - actual\ flow_{SiteX}}{actual\ flow_{SiteX}} \qquad \text{[A-3]}$$

FIELD-TEST RESULTS

Table A-3 provides a summary of the field-testing results. Among the 10 existing measurement sites, nine were actually tested and one was not tested because it was determined before testing that corrective actions were needed there. Among the nine sites that were tested, seven sites had flow rate, and therefore volumetric, accuracies of within ±12 percent accuracy standard applicable to existing devices. Two sites had accuracies that were outside the ±12 percent accuracy standard and will require corrective actions to achieve the standard. Once corrective actions have been implemented on these two sites, additional field tests will be performed to determine that their accuracy is within the standard. Additionally, field tests will be performed at the two new sites once they are established to determine that their accuracy is within the ±10 percent standard applicable to new devices.

Supporting information for each of nine sites for which field tests were performed is provided in the following subsections. The supporting information includes a summary of the field test results and a summary of the actual flow rate measurement. A photograph of the site is also provided.

Table A-3. Field-Testing Results Summary

SiteID	Site Name	Existing/New	Member Unit(s) for which Measurement Site is Used to Quantify Delivered Water Volume	Date Field-Testing was Performed	Field-Testing (Actual) Flow Rate (cfs)	Site Indicated (Measured) Flow Rate (cfs)	Calculated Accuracy Using Equation from Regulation	Accuracy Assessment (Pass/Fail) Relative to ±12% Accuracy Standard
NY0031	NY31	Existing	BVID	7/17/12 2:25 PM	60.6	63.3	4.5%	Pass
HLLWDS	Hallwood South	Existing	HIC	7/16/12 12:29 PM	38.1	50.2	31.7%	Fail
HLLWDN	Hallwood North	Existing	HIC	7/16/12 12:13 PM	150.0	154.0	2.6%	Pass
CRDRMZ	Cordua-Ramirez Heading	Existing	CID, RWD	7/16/12 4:23 PM	211.1	218.0	3.3%	Pass
RAMIRZ	Cordua-Ramirez Split	Existing	CID, RWD	7/16/12 4:23 PM	71.3	67.9	-4.7%	Pass
RMZD10	Ramirez D-10 Delivery	Existing	RWD	8/23/12 10:30 AM	Field test to be conducted after site improvements are implemented			
NY0033	NY33	Existing	BWD	7/11/12 8:54 AM	494.8	496.1	0.3%	Pass
RUEPMP	Rue Pump Station	Existing	WWD, BWD	7/11/12 12:37 PM	23.6	22.2	-6.0%	Pass
WHTP02	Wheatland Canal at Beale Road	New	WWD, BWD	7/11/12 11:20 AM	Field test to be conducted after site is established			
BUKLMN	Beukleman Delivery	New	SYWD, BWD	7/12/12 8:39 AM	Field test to be conducted after site is established			
SYWD01	South Yuba WD Heading	Existing	SYWD, BWD	7/11/12 3:31 PM	91.1	60.0	-34.1%	Fail
DCMWC1	Dry Creek MWC Heading	Existing	DCMWC, BWD	7/11/12 2:17 PM	40.8	39.3	-3.8%	Pass

NY31

Field-Test Results Summary

Table A-4 summarizes the field-test measurement (measurement) at NY31. The measurement was performed with a SonTek RiverSurveyor M9 ADCP. Existing flow measurement site flow rate was obtained from PG&E and the continuous record was average for the duration of the field-test measurement. Figure A-3 shows the existing measurement site. The accuracy of NY31 was determined to be 4.5 percent, which is within ±12 percent.

Table A-4. NY31 Field-Testing Summary

Site ID	NY0031
Site Name	NY31
Associated MUs[1]	BVID
Date CCR 23 §597 Field-Testing of Existing Site Performed	7/17/12 2:25 PM
Verification Measurement Method	RiverSurveyor M9 ADCP
Field-Testing Flow Rate (cfs)	60.6
Existing Measurement Site Flow Rate (cfs)	63.3
Accuracy Between Field-Testing and Existing Site	4.5%
Accuracy Requirement Pass/Fail	Pass

Note:
[1] Associated MUs refers to all the MUs that utilize the measurement site for volumetric delivery calculations.
Key:
ADCP = Acoustic Doppler Current Profiler
BVID = Browns Valley Irrigation District
CCR = California Code of Regulations
cfs = cubic feet per second
MU = Member Unit

Figure A-3. NY31 Measurement Location

Measurement Summary

Discharge Measurement Summary

Date Measured: Tuesday, July 17, 2012

Site Information

Site Name	NY0031
Station Number	001
Location	001

Measurement Information

Party	MT_TO
Boat/Motor	H20Tech
Meas. Number	001

System Information

System Type	RS-M9
Serial Number	334
Firmware Version	2.00
Software Version	3.01

System Setup

Transducer Depth (ft)	0.22
Salinity (ppt)	0.0
Magnetic Declination (deg)	14.4

Units

Distance	ft
Velocity	ft/s
Area	ft2
Discharge	cfs
Temperature	degF

Discharge Calculation Settings

Track Reference	GPS-GGA	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (ft)	15.77
Area (ft2)	42.3
Mean Speed (ft/s)	1.434
Total Q (cfs)	60.564

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
2	L	2:12:39 PM	0:07:13	67.3	30.73	13.28	15.98	42.4	0.071	1.398	0.46	0.93	8.76	39.27	9.80	59.229	--	66.3
3	R	2:20:05 PM	0:04:21	66.0	21.08	13.24	15.94	43.8	0.081	1.401	0.00	0.86	9.51	40.23	10.74	61.335	--	65.6
4	L	2:24:39 PM	0:06:10	64.8	28.52	13.01	15.71	41.5	0.077	1.480	0.54	1.01	10.03	39.00	10.83	61.414	--	63.5
5	R	2:31:13 PM	0:06:15	63.9	28.04	12.77	15.47	41.4	0.075	1.456	0.54	0.81	9.66	38.51	10.76	60.280	--	63.9
			Mean	65.5	27.09	13.07	15.77	42.3	0.076	1.434	0.38	0.90	9.49	39.25	10.53	60.564	0.000	64.8
			Std Dev	1.3	3.62	0.20	0.20	1.0	0.004	0.035	0.22	0.07	0.46	0.62	0.43	0.891	0.000	1.2
			COV	0.0	0.134	0.016	0.013	0.023	0.047	0.025	0.583	0.082	0.049	0.016	0.040	0.015	0.000	0.018

Exposure Time: 0:23:59

Tr2=20120717141239r.rivr; Tr3=20120717142004r.rivr; Tr4=20120717142438r.rivr; Tr5=20120717143112r.rivr;

Comments

Tr2=20120717141239r.rivr - 200' d/s of discharge; Tr3=20120717142004r.rivr - 200' d/s of discharge;
Tr4=20120717142438r.rivr - 200' d/s of discharge; Tr5=20120717143112r.rivr - 200' d/s of discharge;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M1.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.01

Figure A-4. NY31 Measurement Summary

HALLWOOD SOUTH

Field-Test Results Summary

Table A-5 summarizes the field-test measurement (measurement) at Hallwood South. The measurement was performed with a SonTek FlowTracker ADV. Existing flow measurement site flow rate was obtained from stage measurements converted to flow using an established stage-discharge curve, where water levels were obtained throughout the verification measurement and then averaged. Figure A-5 shows the existing measurement site. The accuracy of Hallwood South was determined to be 31.7 percent, which is outside of ±12 percent. Corrective action plans for this flow measurement site are presented in Section 6.1.1.

Table A-5. Hallwood South Field-Testing Summary

Site ID	HLLWDS
Site Name	Hallwood South
Associated MUs	HIC
Date CCR 23 §597 Field-Testing of Existing Site Performed	7/16/12 12:29 PM
Verification Measurement Method	FlowTracker ADV
Field-Testing Flow Rate (cfs)	38.1
Existing Measurement Site Flow Rate (cfs)	50.2
Accuracy Between Field-Testing and Existing Site	31.7%
Accuracy Requirement Pass/Fail	Fail

Key:
ADV = Acoustic Doppler Velocimeter
CCR = California Code of Regulations
cfs = cubic feet per second
HIC = Hallwood Irrigation Company
MU = Member Unit

Figure A-5. Hallwood South Measurement Location

Measurement Summary

Discharge Measurement Summary

Date Generated: Mon Jul 23 2012

File Information

File Name	HLLWDS.001.WAD
Start Date and Time	2012/07/16 11:45:07

Site Details

Site Name	HLLWDS
Operator(s)	TJO

System Information

Sensor Type	FlowTracker
Serial #	P2281
CPU Firmware Version	3.7
Software Ver	2.30
Mounting Correction	0.0%

Units	**(English Units)**
Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.1%	0.4%
Velocity	0.3%	0.8%
Width	0.1%	0.1%
Method	0.9%	-
# Stations	1.7%	-
Overall	**2.2%**	**1.3%**

Summary

Averaging Int.	40	# Stations	30
Start Edge	REW	Total Width	14.920
Mean SNR	16.1 dB	Total Area	19.112
Mean Temp	57.67 °F	Mean Depth	1.281
Disch. Equation	Mid-Section	Mean Velocity	1.9950
		Total Discharge	**38.1273**

Figure A-6. Hallwood South Measurement Summary

HALLWOOD NORTH

Field-Test Results Summary

Table A-6 summarizes the field-test measurement (measurement) at Hallwood North. The measurement was performed with a SonTek RiverSurveyor M9 ADCP. Existing flow measurement site flow rate was obtained from stage measurements converted to flow using an established stage-discharge curve, where water levels were obtained throughout the verification measurement and then averaged. Figure A-7 shows the existing measurement site. The accuracy of Hallwood North was determined to be 2.6 percent, which is within ±12 percent.

Table A-6. Hallwood North Field-Testing Summary

Site ID	HLLWDN
Site Name	Hallwood North
Associated MUs	HIC
Date CCR 23 §597 Field-Testing of Existing Site Performed	7/16/12 12:13 PM
Verification Measurement Method	RiverSurveyor M9 ADCP
Field-Testing Flow Rate (cfs)	150.0
Existing Measurement Site Flow Rate (cfs)	154.0
Accuracy Between Field-Testing and Existing Site	2.6%
Accuracy Requirement Pass/Fail	Pass

Key:
ADCP = Acoustic Doppler Current Profiler
CCR = California Code of Regulations
cfs = cubic feet per second
HIC = Hallwood Irrigation Company
MU = Member Unit

Figure A-7. Hallwood North Measurement Location

Measurement Summary

Discharge Measurement Summary

Date Measured: Monday, July 16, 2012

Site Information

Site Name	HLLWDN
Station Number	1
Location	YCWA

Measurement Information

Party	MT_TO
Boat/Motor	H2oTech Hydroboard
Meas. Number	1

System Information

System Type	RS-M9
Serial Number	334
Firmware Version	2.00
Software Version	3.00

System Setup

Transducer Depth (ft)	0.22
Salinity (ppt)	0.0
Magnetic Declination (deg)	14.4

Units

Distance	ft
Velocity	ft/s
Area	ft2
Discharge	cfs
Temperature	degF

Discharge Calculation Settings

Track Reference	GPS-GGA	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (ft)	22.05
Area (ft2)	64.6
Mean Speed (ft/s)	2.324
Total Q (cfs)	150.047

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	R	11:58:08 AM	0:08:14	63.4	55.72	18.81	22.11	65.1	0.113	2.293	1.15	1.22	29.50	93.45	24.05	149.362	--	62.6
2	L	12:06:38 PM	0:08:31	62.0	48.86	18.42	21.72	63.7	0.096	2.348	1.07	0.95	28.95	94.04	24.59	149.589	--	62.9
3	R	12:15:24 PM	0:07:26	61.2	47.77	18.92	22.22	64.2	0.107	2.295	0.98	1.03	29.25	93.87	22.31	147.441	--	63.7
4	L	12:23:06 PM	0:06:13	60.8	44.70	18.83	22.13	65.2	0.120	2.359	0.92	1.08	30.28	96.81	24.70	153.796	--	62.9
			Mean	61.8	49.26	18.75	22.05	64.6	0.109	2.324	1.03	1.07	29.50	94.54	23.91	150.047	0.000	63.0
			Std Dev	1.0	4.03	0.19	0.19	0.6	0.009	0.030	0.09	0.10	0.49	1.33	0.96	2.320	0.000	0.4
			COV	0.0	0.082	0.010	0.009	0.010	0.081	0.013	0.083	0.091	0.017	0.014	0.040	0.015	0.000	0.006

Exposure Time: 0:30:24

Tr1=20120716115806r.rivr; Tr2=20120716120637r.rivr; Tr3=20120716121522r.rivr; Tr4=20120716122304r.rivr;

Comments

Tr1=20120716115806r.rivr - ; Tr2=20120716120637r.rivr - ; Tr3=20120716121522r.rivr - ; Tr4=20120716122304r.rivr - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M3.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.00

Figure A-8. Hallwood North Measurement Summary

CORDUA-RAMIREZ HEADING

Field-Test Results Summary

Table A-7 summarizes the field-test measurement (measurement) at the Cordua-Ramirez Heading. The measurement was performed with a SonTek RiverSurveyor M9 ADCP. Existing flow measurement site flow rate was obtained from stage measurements converted to flow using an established stage-discharge curve, where water levels were obtained throughout the verification measurement and then averaged. Figure A-9 shows the existing measurement site. The accuracy of the Cordua-Ramirez Heading was determined to be 3.3 percent, which is within ±12 percent.

Table A-7. Cordua-Ramirez Heading Field-Testing Summary

Site ID	CRDRMZ
Site Name	Cordua-Ramirez Heading
Associated MUs	CID, RWD
Date CCR 23 §597 Field-Testing of Existing Site Performed	7/16/12 4:23 PM
Verification Measurement Method	RiverSurveyor M9 ADCP
Field-Testing Flow Rate (cfs)	211.1
Existing Measurement Site Flow Rate (cfs)	218.0
Accuracy Between Field-Testing and Existing Site	3.3%
Accuracy Requirement Pass/Fail	Pass

Key:
ADCP = Acoustic Doppler Current Profiler
CCR = California Code of Regulations
cfs = cubic feet per second
CID = Cordua Irrigation District
RWD = Ramirez Water District
MU = Member Unit

Figure A-9. Cordua-Ramirez Heading Measurement Location

Measurement Summary

Discharge Measurement Summary

Date Measured: Monday, July 16, 2012

Site Information

Site Name	CRDRMZ
Station Number	1
Location	YCWA

Measurement Information

Party	MT TO
Boat/Motor	H2oTech Hydroboard
Meas. Number	1

System Information

System Type	RS-M9
Serial Number	334
Firmware Version	2.00
Software Version	3.00

System Setup

Transducer Depth (ft)	0.22
Salinity (ppt)	0.0
Magnetic Declination (deg)	14.4

Units

Distance	ft
Velocity	ft/s
Area	ft2
Discharge	cfs
Temperature	degF

Discharge Calculation Settings

Track Reference	GPS-GGA	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (ft)	36.77
Area (ft2)	158.6
Mean Speed (ft/s)	1.331
Total Q (cfs)	211.141

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	L	1:40:03 PM	0:11:59	65.5	109.56	33.99	37.49	159.9	0.152	1.380	0.39	0.96	29.50	157.99	31.75	220.594	--	71.6
2	R	1:52:23 PM	0:09:52	63.9	104.29	33.37	36.87	160.5	0.176	1.247	0.41	0.78	26.27	143.08	29.68	200.216	--	71.5
3	L	2:02:36 PM	0:07:31	63.1	72.15	33.39	36.89	159.7	0.160	1.392	0.44	0.73	30.26	159.10	31.80	222.341	--	71.6
4	R	2:10:30 PM	0:08:36	62.6	97.71	33.21	36.71	159.7	0.189	1.339	0.49	1.13	28.30	153.13	30.85	213.905	--	71.6
5	L	2:19:24 PM	0:08:05	62.4	82.41	32.54	36.04	154.4	0.170	1.335	0.38	1.24	27.49	147.76	29.31	206.174	--	71.7
6	R	2:27:52 PM	0:08:51	62.3	77.95	33.12	36.62	157.7	0.147	1.292	0.44	0.93	27.22	145.31	29.71	203.617	--	71.4
			Mean	63.3	90.68	33.27	36.77	158.6	0.166	1.331	0.43	0.96	28.17	151.06	30.52	211.141	0.000	71.5
			Std Dev	1.1	13.93	0.43	0.43	2.1	0.014	0.050	0.03	0.18	1.36	6.12	1.01	8.397	0.000	0.1
			COV	0.0	0.154	0.013	0.012	0.013	0.087	0.037	0.082	0.186	0.048	0.041	0.033	0.040	0.000	0.001

Exposure Time: 0:54:54

Tr1=20120716134003r.rivr; Tr2=20120716135222r.rivr; Tr3=20120716140235r.rivr; Tr4=20120716141030r.rivr; Tr5=20120716141924r.rivr; Tr6=20120716142752r.rivr;

Comments

Tr1=20120716134003r.rivr - ; Tr2=20120716135222r.rivr - ; Tr3=20120716140235r.rivr - ; Tr4=20120716141030r.rivr - ; Tr5=20120716141924r.rivr - ; Tr6=20120716142752r.rivr - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M2.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.00

Figure A-10. Cordua-Ramirez Heading Measurement Summary

CORDUA-RAMIREZ SPLIT

Field-Test Results Summary

Table A-8 summarizes the field-test measurement (measurement) at the Cordua-Ramirez split. The measurement was performed with a SonTek RiverSurveyor M9 ADCP. Existing flow measurement site flow rate was obtained from a deployed SonTek Argonaut SW meter and the continuous record was averaged for the duration of the field-test measurement. Figure A-11 shows the existing measurement site. The accuracy of the Cordua-Ramirez Heading was determined to be -4.7 percent, which is within ±12 percent.

Table A-8. Cordua-Ramirez Split Field-Testing Summary

Site ID	RAMIRZ
Site Name	Cordua-Ramirez Split
Associated MUs	CID, RWD
Date CCR 23 §597 Field-Testing of Existing Site Performed	7/16/12 4:23 PM
Verification Measurement Method	RiverSurveyor M9 ADCP
Field-Testing Flow Rate (cfs)	71.3
Existing Measurement Site Flow Rate (cfs)	67.9
Accuracy Between Field-Testing and Existing Site	-4.7%
Accuracy Requirement Pass/Fail	Pass

Key:
ADCP = Acoustic Doppler Current Profiler
CCR = California Code of Regulations
cfs = cubic feet per second
CID = Cordua Irrigation District
RWD = Ramirez Water District
MU = Member Unit

Figure A-11. Cordua-Ramirez Split Measurement Location

Measurement Summary

Discharge Measurement Summary

Date Measured: Monday, July 16, 2012

Site Information

Site Name	RAMIRZ
Station Number	1
Location	YCWA

Measurement Information

Party	MT_TO
Boat/Motor	H2oTech Hydroboard
Meas. Number	1

System Information

System Type	RS-M9
Serial Number	334
Firmware Version	2.00
Software Version	3.00

System Setup

Transducer Depth (ft)	0.22
Salinity (ppt)	0.0
Magnetic Declination (deg)	14.4

Units

Distance	ft
Velocity	ft/s
Area	ft2
Discharge	cfs
Temperature	degF

Discharge Calculation Settings

Track Reference	GPS-GGA	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (ft)	25.26
Area (ft2)	85.6
Mean Speed (ft/s)	0.832
Total Q (cfs)	71.280

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	R	3:57:16 PM	0:09:24	67.7	51.31	21.15	24.95	83.3	0.091	0.805	0.50	0.08	7.93	47.32	11.17	67.014	--	70.6
2	L	4:06:56 PM	0:08:22	66.6	48.14	21.55	25.35	86.6	0.096	0.863	0.51	0.19	8.97	54.33	10.77	74.772	--	72.7
3	R	4:16:00 PM	0:09:25	65.8	53.43	21.60	25.40	83.6	0.095	0.824	0.37	-0.03	9.08	48.17	11.33	68.927	--	69.8
4	L	4:25:37 PM	0:06:26	65.6	42.68	21.05	24.85	86.4	0.111	0.834	0.40	0.01	8.82	51.48	11.41	72.111	--	71.4
5	R	4:32:46 PM	0:07:53	65.3	47.46	21.76	25.56	86.6	0.100	0.840	0.50	-0.07	9.18	51.14	11.98	72.728	--	70.2
6	L	4:41:17 PM	0:07:28	65.2	48.13	21.62	25.42	87.3	0.107	0.827	0.60	0.08	8.94	51.33	11.16	72.126	--	71.2
			Mean	66.0	48.53	21.46	25.26	85.6	0.100	0.832	0.48	0.04	8.82	50.63	11.30	71.280	0.000	71.0
			Std Dev	0.9	3.35	0.26	0.26	1.6	0.007	0.018	0.08	0.09	0.41	2.31	0.36	2.564	0.000	0.9
			COV	0.0	0.069	0.012	0.010	0.018	0.070	0.021	0.161	1.943	0.047	0.046	0.032	0.036	0.000	0.013

Exposure Time: 0:48:58

Tr1=20120716155716r.rivr; Tr2=20120716160656r.rivr; Tr3=20120716161559r.rivr; Tr4=20120716162537r.rivr; Tr5=20120716163246r.rivr; Tr6=20120716164116r.rivr;

Comments

Tr1=20120716155716r.rivr - ; Tr2=20120716160656r.rivr - ; Tr3=20120716161559r.rivr - ; Tr4=20120716162537r.rivr - ; Tr5=20120716163246r.rivr - ; Tr6=20120716164116r.rivr - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M2.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.00

Figure A-12. Cordua-Ramirez Split Measurement Summary

NY33

Field-Test Results Summary

Table A-9 summarizes the field-test measurement (measurement) at NY33. The measurement was performed with a SonTek RiverSurveyor M9 ADCP. Existing flow measurement site flow rate was obtained from a deployed SonTek Argonaut SW meter and the continuous record was averaged for the duration of the field-test measurement. Figure A-13 shows the existing measurement site. The accuracy of NY33 was determined to be 0.3 percent, which is within ±12 percent.

Table A-9. NY33 Field-Testing Summary

Site ID	NY0033
Site Name	NY33
Associated MUs	BWD
Date CCR 23 §597 Field-Testing of Existing Site Performed	7/11/12 8:54 AM
Verification Measurement Method	RiverSurveyor M9 ADCP
Field-Testing Flow Rate (cfs)	494.8
Existing Measurement Site Flow Rate (cfs)	496.1
Accuracy Between Field-Testing and Existing Site	0.3%
Accuracy Requirement Pass/Fail	Pass

Key:
ADCP = Acoustic Doppler Current Profiler
CCR = California Code of Regulations
cfs = cubic feet per second
BWD = Brophy Water District
MU = Member Unit

Figure A-13. NY33 Measurement Location

Measurement Summary

Discharge Measurement Summary

Date Measured: Wednesday, July 11, 2012

Site Information

Site Name	NY0033
Station Number	1
Location	YCWA

Measurement Information

Party	TO_MT
Boat/Motor	H2oTech Hydroboard
Meas. Number	1

System Information

System Type	RS-M9
Serial Number	334
Firmware Version	2.00
Software Version	3.00

System Setup

Transducer Depth (ft)	0.22
Salinity (ppt)	0.0
Magnetic Declination (deg)	14.4

Units

Distance	ft
Velocity	ft/s
Area	ft2
Discharge	cfs
Temperature	degF

Discharge Calculation Settings

Track Reference	Bottom-Track	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (ft)	43.12
Area (ft2)	207.6
Mean Speed (ft/s)	2.383
Total Q (cfs)	494.787

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	R	8:36:23 AM	0:10:23	68.2	74.93	40.46	44.26	210.6	0.120	2.411	0.91	0.96	66.28	369.31	70.24	507.699	--	72.7
2	L	8:48:26 AM	0:06:26	67.0	57.92	38.57	42.37	206.3	0.150	2.362	1.05	1.10	63.29	354.60	67.21	487.254	--	72.8
3	R	8:58:57 AM	0:06:24	66.0	56.87	38.71	42.51	203.0	0.148	2.401	1.10	1.02	63.54	352.82	68.88	487.356	--	72.4
4	L	9:06:31 AM	0:06:42	65.6	59.16	39.55	43.35	210.6	0.147	2.359	1.22	1.16	65.08	359.66	69.72	496.838	--	72.4
			Mean	66.7	62.22	39.32	43.12	207.6	0.141	2.383	1.07	1.06	64.54	359.10	69.01	494.787	0.000	72.6
			Std Dev	1.0	7.38	0.76	0.76	3.2	0.012	0.023	0.11	0.08	1.21	6.41	1.15	8.410	0.000	0.2
			COV	0.0	0.119	0.019	0.018	0.015	0.087	0.010	0.104	0.074	0.019	0.018	0.017	0.017	0.000	0.003

Exposure Time: 0:29:55

Tr1=20120711083622r.rivr; Tr2=20120711084825r.rivr; Tr3=20120711085856r.rivr; Tr4=20120711090631r.rivr;

Comments

Tr1=20120711083622r.rivr - ; Tr2=20120711084825r.rivr - ; Tr3=20120711085856r.rivr - ; Tr4=20120711090631r.rivr - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M3.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.00

Figure A-14. NY33 Measurement Summary

RUE PUMP STATION

Field-Test Results Summary

Table A-10 summarizes the field-test measurement at the Rue Pump Station. The measurement was performed with an Endress and Hauser ProSonics 92T Transit time pipe meter. Existing flow measurement site flow rate was obtained from a deployed McCrometer Propeller Meter and averaged during the course of the verification measurement. Figure A-15 shows the existing measurement site. The accuracy of the Rue Pump Station was determined to be -6.0 percent, which is within ±12 percent.

Table A-10. Rue Pump Station Field-Testing Summary

Site ID	RUEPMP
Site Name	Rue Pump Station
Associated MUs	WWD, BWD
Date CCR 23 §597 Field-Testing of Existing Site Performed	7/11/12 12:37 PM
Verification Measurement Method	Endress and Hauser ProSonics 92T Transit Meter
Field-Testing Flow Rate (cfs)	23.6
Existing Measurement Site Flow Rate (cfs)	22.2
Accuracy Between Field-Testing and Existing Site	-6.0%
Accuracy Requirement Pass/Fail	Pass

Key:
CCR = California Code of Regulations
cfs = cubic feet per second
BWD = Brophy Water District
MU = Member Unit
WWD = Wheatland Water District

Figure A-15. Rue Pump Station Measurement Location

Measurement Summary

The ProSonics Transit Time Pipe Meter does not provide a direct summary report of the measurement data collected. Table A-11 is a post processed summary providing relevant discharge data.

Table A-11. Rue Pump Station Measurement Summary

Site ID	RUEPMP
Start Datetime	7/11/12 12:34 PM
End Datetime	7/11/12 12:40 PM
Duration (minutes)	6
Sampling Interval (sec)	8
Number of Samples	46
Average Flow (cfs)	23.6
Standard Deviation (cfs)	0.43

Key:
cfs = cubic feet per second

SOUTH YUBA WD HEADING

Field-Test Results Summary

Table A-12 summarizes the field-test measurement (measurement) at the South Yuba WD Heading. The measurement was performed with a SonTek RiverSurveyor M9 ADCP. Existing flow measurement site flow rate was obtained from a deployed McCrometer Propeller Meter and averaged during the course of the verification measurement. Figure A-16 shows the existing measurement site. The accuracy of the South Yuba WD Heading was determined to be -34.1 percent, which is outside of ±12 percent. Corrective action plans for this flow measurement site are presented in Section 6.1.5. The new measurement site at the South Yuba WD heading is assumed to be five percent accurate by flow and volume for the purposes of the Member Unit volumetric accuracy analysis in Section 4.3.

Table A-12. South Yuba WD Heading Field-Testing Summary

Site ID	SYWD01
Site Name	South Yuba WD Heading
Associated MUs	SYWD, BWD
Date CCR 23 §597 Field-Testing of Existing Site Performed	7/11/12 3:31 PM
Verification Measurement Method	RiverSurveyor M9 ADCP
Field-Testing Flow Rate (cfs)	91.1
Existing Measurement Site Flow Rate (cfs)	60.0
Accuracy Between Field-Testing and Existing Site	-34.1%
Accuracy Requirement Pass/Fail	Fail

Key:
ADCP = Acoustic Doppler Current Profiler
BWD = Brophy Water District
CCR = California Code of Regulations
cfs = cubic feet per second
MU = Member Unit
SYWD = South Yuba Water District
WD = Water District

Figure A-16. South Yuba WD Heading Measurement Location

Measurement Summary

Discharge Measurement Summary

Date Measured: Wednesday, July 11, 2012

Site Information

Site Name	SYWD01
Station Number	1
Location	YCWA

Measurement Information

Party	MT_TO
Boat/Motor	H2oTech Hydroboard
Meas. Number	1

System Information

System Type	RS-M9
Serial Number	334
Firmware Version	2.00
Software Version	3.00

System Setup

Transducer Depth (ft)	0.22
Salinity (ppt)	0.0
Magnetic Declination (deg)	14.4

Units

Distance	ft
Velocity	ft/s
Area	ft2
Discharge	cfs
Temperature	degF

Discharge Calculation Settings

Track Reference	GPS-GGA	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (ft)	31.13
Area (ft2)	123.7
Mean Speed (ft/s)	0.737
Total Q (cfs)	91.100

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	R	3:14:55 PM	0:11:25	75.1	39.28	24.02	30.62	124.8	0.057	0.734	2.12	0.41	10.67	62.10	16.28	91.578	--	67.8
2	L	3:26:38 PM	0:07:31	73.6	32.28	24.43	31.03	120.7	0.072	0.746	1.98	0.45	10.94	61.76	15.00	90.123	--	68.5
3	R	3:34:20 PM	0:06:54	72.8	35.41	24.68	31.28	124.5	0.086	0.728	2.04	0.31	10.84	60.94	16.45	90.596	--	67.3
4	L	3:41:36 PM	0:07:24	72.2	31.00	24.99	31.59	124.7	0.070	0.739	2.01	0.35	11.24	62.85	15.65	92.102	--	68.2
			Mean	73.4	34.49	24.53	31.13	123.7	0.071	0.737	2.04	0.38	10.92	61.91	15.85	91.100	0.000	68.0
			Std Dev	1.1	3.20	0.36	0.36	1.7	0.010	0.007	0.05	0.05	0.21	0.69	0.57	0.781	0.000	0.5
			COV	0.0	0.093	0.015	0.011	0.014	0.141	0.009	0.026	0.135	0.019	0.011	0.036	0.009	0.000	0.007

Exposure Time: 0:33:14

Tr1=20120711151454r.rivr; Tr2=20120711152636r.rivr; Tr3=20120711153419r.rivr; Tr4=20120711154134r.rivr;

Comments

Tr1=20120711151454r.rivr - ; Tr2=20120711152636r.rivr - ; Tr3=20120711153419r.rivr - ; Tr4=20120711154134r.rivr - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M3.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.00

Figure A-17. South Yuba WD Heading Measurement Summary

DRY CREEK MWC HEADING

Field-Test Results Summary

Table A-13 summarizes the field-test measurement (measurement) at the Dry Creek MWC Heading. The measurement was performed with a SonTek RiverSurveyor M9 ADCP. Existing flow measurement site flow rate was obtained from a deployed McCrometer Propeller Meter and averaged during the course of the verification measurement. Figure A-18 shows the existing measurement site. The accuracy of the Dry Creek MWC Heading was determined to be -3.8 percent, which is within ±12 percent.

Table A-13. Dry Creek MWC Heading Field-Testing Summary

Site ID	DCMWC1
Site Name	Dry Creek MWC Heading
Associated MUs	DCMWC, BWD
Date CCR 23 §597 Field-Testing of Existing Site Performed	7/11/12 2:17 PM
Verification Measurement Method	RiverSurveyor M9 ADCP
Field-Testing Flow Rate (cfs)	40.8
Existing Measurement Site Flow Rate (cfs)	39.3
Accuracy Between Field-Testing and Existing Site	-3.8%
Accuracy Requirement Pass/Fail	Pass

Key:
ADCP = Acoustic Doppler Current Profiler
BWD = Brophy Water District
CCR = California Code of Regulations
cfs = cubic feet per second
DCMWC = Dry Creek Municipal Water Company
MU = Member Unit
MWC = Municipal Water Company

Figure A-18. Dry Creek MWC Heading Measurement Location

Measurement Summary

Discharge Measurement Summary

Date Measured: Wednesday, July 11, 2012

Site Information

Site Name	DCMWC1
Station Number	001
Location	001

Measurement Information

Party	MT-TO
Boat/Motor	H20Tech
Meas. Number	001

System Information

System Type	RS-M9
Serial Number	334
Firmware Version	2.00
Software Version	3.00

System Setup

Transducer Depth (ft)	0.22
Salinity (ppt)	0.0
Magnetic Declination (deg)	14.4

Units

Distance	ft
Velocity	ft/s
Area	ft2
Discharge	cfs
Temperature	degF

Discharge Calculation Settings

Track Reference	GPS-GGA	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (ft)	43.26
Area (ft2)	232.9
Mean Speed (ft/s)	0.175
Total Q (cfs)	40.811

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	L	2:01:41 PM	0:07:23	75.6	43.93	36.41	44.11	234.4	0.099	0.192	0.31	0.35	4.55	32.64	7.22	45.073	--	72.4
2	R	2:09:16 PM	0:06:17	74.3	40.33	35.93	43.13	234.8	0.107	0.168	0.30	0.16	3.98	29.20	5.89	39.517	--	73.9
3	L	2:16:38 PM	0:06:47	73.1	41.23	36.14	43.34	233.4	0.101	0.194	0.26	0.30	4.60	32.86	7.31	45.335	--	72.5
4	R	2:24:02 PM	0:06:49	72.4	41.10	35.28	42.68	231.9	0.100	0.161	0.33	0.29	3.75	27.49	5.58	37.447	--	73.4
5	L	2:31:29 PM	0:06:20	72.1	40.79	35.71	43.11	229.3	0.107	0.174	0.41	0.31	4.01	28.82	6.40	39.945	--	72.2
6	R	2:38:07 PM	0:05:56	71.8	40.05	35.80	43.20	233.7	0.112	0.161	0.29	0.18	3.78	27.67	5.63	37.547	--	73.7
			Mean	73.2	41.24	35.88	43.26	232.9	0.105	0.175	0.32	0.26	4.11	29.78	6.34	40.811	0.000	73.0
			Std Dev	1.3	1.27	0.35	0.43	1.9	0.005	0.014	0.05	0.07	0.34	2.18	0.71	3.241	0.000	0.7
			COV	0.0	0.031	0.010	0.010	0.008	0.045	0.077	0.146	0.267	0.083	0.073	0.112	0.079	0.000	0.009

Exposure Time: 0:39:32

Tr1=20120711140141r.rivr; Tr2=20120711140916r.rivr; Tr3=20120711141638r.rivr; Tr4=20120711142401r.rivr; Tr5=20120711143128r.rivr; Tr6=20120711143807r.rivr;

Comments

Tr1=20120711140141r.rivr - ; Tr2=20120711140916r.rivr - ; Tr3=20120711141638r.rivr - ; Tr4=20120711142401r.rivr - ; Tr5=20120711143128r.rivr - ; Tr6=20120711143807r.rivr - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M1.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.00

Figure A-19. Dry Creek MWC Heading Measurement Summary

MEASUREMENT BY DIFFERENCE ACCURACY ANALYSIS

As previously noted, the volumes of water delivered to three of the Agency's eight MUs (customers) are computed by difference using measured values. The three MUs are Cordua Irrigation District, Brophy Water District, and South Yuba Water District. Because this quantification methodology is not addressed directly by the Regulation, an analysis of error in the calculated values was performed to demonstrate that the accuracy of the computed volumes also falls within the ±10% accuracy standard (the more stringent of the two standards applicable to YCWA devices).

Equation A-4 used for calculating the quantity of water delivered to these MUs has the general form

- $V_{MU_X} = V_{Site\ 1} \pm \cdots \pm V_{Site\ N}$ [A-4]

Where:

- V_{MU_X}: Volume Delivered to MU_X
- $V_{Site\ N}$: Volume measured by site N
- N: Number of measurements sites used in computation (ranges from 1 to 5 sites)

The absolute accuracy in the volume delivered (units of volume) to MU_X is given by Equation A-5:

$$\sigma_{V_{MU_X}} = \pm\sqrt{\left(\frac{\partial V_{MU_X}}{\partial V_{Site1}} * \sigma_{V_{Site1}}\right)^2 + \cdots + \left(\frac{\partial V_{MU_X}}{\partial V_{SiteN}} * \sigma_{V_{SiteN}}\right)^2} \qquad \text{[A-5]}$$

Solving for the partial derivatives:

$$\frac{\partial V_{MU_X}}{\partial V_{Site1}} = 1 \ and \ \frac{\partial V_{MU_X}}{\partial V_{SiteN}} = 1$$

Therefore (Equation A-6):

$$\sigma_{V_{MU_X}} = \pm\sqrt{\left(\sigma_{V_{Site1}}\right)^2 + \cdots + \left(\sigma_{V_{SiteN}}\right)^2} \qquad \text{[A-6]}$$

The relative accuracy in the volume delivered (units of percent) to MU_X is equal to the absolute accuracy in the volume delivered divided by the actual volume delivered (Equation A-7):

- $U_{V_{MU_X}} = \frac{\sigma_{V_{MU_X}}}{V_{MU_X}}$ [A-7]

Therefore:

- $U_{V_{MU_X}} = \pm\frac{\sqrt{\left(\sigma_{V_{Site1}}\right)^2 + \cdots + \left(\sigma_{V_{SiteN}}\right)^2}}{V_{MU_X}}$ [A-8]

As previously discussed, if a device either (1) provides a continuous record (e.g. stage-discharge site with continuous water level measurement) or (2) totalizes volume (e.g. propeller meter with totalizer), the conversion from flow rate to volume does not add significant error. Therefore, in these cases, flow rate accuracy and volumetric accuracy are essentially the same (Equation A-9):

- $$U_{V_{MU_X}} = U_{Q_{MU_X}} = \pm \frac{\sqrt{\left(\sigma_{Q_{Site1}}\right)^2 + \cdots + \left(\sigma_{Q_{SiteN}}\right)^2}}{Q_{MU_X}} \qquad \text{[A-9]}$$

The absolute accuracies in the numerator are the product of the accuracies of each of the sites and the actual flow. The absolute accuracy can also be calculated as the difference between the measured flow (i.e. of the device) and the actual flow (i.e. of the verification). Combining the equations presented above, the volumetric accuracy (in percent) for the three member units whose deliveries are quantified by difference calculations was computed with the following equation (Equation A-10):

$$MU_{\ X}VA = \pm \frac{\sqrt{\left(U_{Q_{Site1}} * Q_{Site1}\right)^2 + \cdots + \left(U_{Q_{SiteN}} * Q_{SiteN}\right)^2}}{Q_{MU_X}} \qquad \text{[A-10]}$$

Where:

- $MU_{\ X}VA$: Volumetric Accuracy in Deliveries to MU_X
- $U_{Q_{Site1}}$: Flow rate Accuracy of measurement site 1
- Q_{Site1}: Flow rate of measurement site 1
- N: Number of measurements sites used in computation (ranges from 1 to 5 sites)
- Q_{MU_X}: Flow rate for the MU (using equations presented in summary Table A-14 below)

For the three wholesale by difference MUs, Table A-14 provides the (1) volumetric quantification equations, (2) quantification methodology, and (3) the resulting volumetric accuracy. Note that in the quantification equation for each member unit, one or more of the sites that have not yet been field tested are used; therefore, the accuracy associated with those sites is not yet known. For those sites, an accuracy of ±5% was assumed for purposes of computing the overall accuracy in the calculated deliveries to each the three members units. For all three, subject to the assumption noted above, the error in the calculated volumes is less than the ±10% accuracy standard. These calculations will be revised based on actual field test results, once the tests has been completed.

Table A-14. Measurement by Difference Accuracy Analysis Summary

Member Unit	Equation for Quantifying Water Deliveries using Measured Values	Quantification Methodology	Volumetric Accuracy
Cordua Irrigation District (CID)	CID = CRDRMZ - RAMIRZ - RMZD10	Calculated by difference involving 3 measured sites	7.1%
Brophy Water District (BWD)	BWD = NY0033 - WHTP02 - RUEPMP - BUKLMN - SYWD01	Calculated by difference involving 5 measured sites	2.0%
South Yuba Water District (SYWD)	SYWD = SYWD01 + BUKLMN - DCMV	Measured at one site plus calculated by difference at two sites	9.2%

Note: device accuracy for RMXD10, WHTP02 and BUKLMN assumed to be ±5% for purposes of calculating volume accuracy indicated in table.

The following subsections detail the calculation of the volumetric accuracy for each of the three subject member units.

CORDUA IRRIGATION DISTRICT

Cordua Irrigation District (CID) deliveries are measured by difference involving CRDRMZ, RAMIRZ and RMZD10 (Equation A-11):

$$V_{CID} = CRDRMZ - RAMIRZ - RMZD10 \qquad \text{[A-11]}$$

Volumetric accuracy for CID is given by Equation A-12:

$$MU_{CID}VA = \pm\frac{\sqrt{\left(U_{Q_{CRDRMZ}} * Q_{CRDRMZ}\right)^2 + \left(U_{QRAMIRZ} * Q_{RAMIRZ}\right)^2 + \left(U_{QRMZD10} * Q_{RMZD10}\right)^2}}{Q_{CID}}$$

$$MU_{CID}VA = \pm\frac{\sqrt{(3.3 * 211.1)^2 + (-4.7 * 71.3)^2 + (5.0 * 30)^2}}{109.86}$$

•

$$MU_{CID}\,VA = \pm\frac{7.80}{109.86} \quad \underline{\text{or}} \quad \boxed{MU_{CID}\,VA = 0.071\ or\ 7.1\%} \qquad \text{[A-12]}$$

BROPHY WATER DISTRICT

Brophy Water District (BWD) deliveries are measured by difference involving NY0033, WHTP02, RUEPMP, BUKLMN, and SYWD01 (Equation A-13):

$$V_{BWD} = \text{NY0033} - \text{WHTP02} - \text{RUEPMP} - \text{BUKLMN} - \text{SYWD01} \qquad \text{[A-13]}$$

Volumetric accuracy for BWD is given by Equation A-14:

$$MU_{BWD}VA = \pm\frac{\sqrt{\left(U_{QNY0033}*Q_{NY0033}\right)^2+\left(U_{QWHTP02}*Q_{WHTP02}\right)^2+\left(U_{QRUEPMP}*Q_{RUEPMP}\right)^2+\left(U_{QBUKLMN}*Q_{BUKLMN}\right)^2+\left(U_{QSYWD01}*Q_{SYWD01}\right)^2}}{Q_{BWD}}$$

$$MU_{BWD}VA = \pm\frac{\sqrt{(1.1*494.79)^2+(5.0*54.7)^2+(-6.0*23.62)^2+(5.0*2.21)^2+(5.0*91.1)^2}}{282.35}$$

$$MU_{BWD}\,VA = \pm\frac{5.72}{282.35} \quad \underline{\text{or}} \quad \boxed{MU_{BWD}\,VA = 0.020\ or\ 2.0\%} \qquad \text{[A-14]}$$

SOUTH YUBA WATER DISTRICT

South Yuba Water District (SYWD) deliveries are measured by difference involving WHTP02, BUKLMN and RUEPMP (Equation A-15).

- $V_{SYWD} = \text{SYWD01} + \text{BUKLMN} - \text{DCMWC1}$ [A-15]

Volumetric accuracy for SYWD is given by Equation A-16:

$$MU_{SYWD}VA = \pm\frac{\sqrt{\left(U_{QSYWD01} * Q_{SYWD01}\right)^2 + \left(U_{QBUKLMN} * Q_{BUKLMN}\right)^2 + \left(U_{QDCMWC1} * Q_{DCMWC1}\right)^2}}{Q_{SYWD}}$$

$$MU_{SYWD}VA = \pm\frac{\sqrt{(5.0*91.1)^2+(5.0*2.21)^2+(-3.8*91.1)^2}}{52.49}$$

$$MU_{SYWD}\,VA = \pm\frac{4.82}{52.49} \quad \underline{\text{or}} \quad \boxed{MU_{SYWD}\,VA = 0.092\ or\ 9.2\%} \quad \text{[A-16]}$$

REQUIRED REPORTING (CCR 23 §597(E)(2))

BEST PROFESSIONAL PRACTICES

COLLECTION OF MEASUREMENT DATA

The Agency's 12 customer delivery measurement sites presently are or will be equipped with continuously recording devices (e.g. acoustic Doppler devices or pressure transducers) to store measurement data on a datalogger. Data will be manually downloaded monthly or more frequently as needed to provide information on a timely basis.

FREQUENCY OF MEASUREMENTS

The continuously recording devices at each site will be configured to record measurements every 15 minutes.

METHOD FOR DETERMINING IRRIGATED ACRES

The Agency is not employing the option of measuring at points upstream of multiple customers and then apportioning water among customers based on acreage (and other) parameters. Thus this practice of determining irrigated acreage is not applicable for purposes of complying with the Regulation.

QUALITY CONTROL AND QUALITY ASSURANCE PARAMETERS

The following subsections describe periodic maintenance tasks that presently are or will be performed at each of the three different types of measurement sites for the purpose of quality control and quality assurance to ensure that each site remains in compliance.

Rated Section (i.e., Stage-Discharge Curve)

The following actions will be performed to keep the accuracy of the stage-discharge curve measurement stations to that observed:

- Periodic discharge measurements to check/refine stage-discharge curve
- Periodic elevation survey of water level measurement device (e.g. pressure transducer or float and pully etc.)
- Maintenance of channel cross section (e.g. weed and sediment removal as necessary)

Propeller Meter

The following actions will be performed to keep the accuracy of the propeller meter measurement stations to that observed:

- Periodic maintenance checks on propeller meter to ensure that the propeller spins freely
- Maintenance of pipe cross section (e.g. weed and sediment removal as necessary)

Acoustic Doppler

The following actions will be performed to maintain the accuracy of the acoustic Doppler measurement sites to that observed:

- Periodic discharge measurements to check/refine Acoustic meter calibration
- Maintenance of channel cross section (e.g. weed and sediment removal as necessary)

CONVERSION OF MEASURED VALUES TO WATER VOLUME (CCR 23 §597(E)(3))

All 12 of the Agency's measurement sites will have a continuous record of date/time stamped flow rates. Volume will be calculated from flow rate with the following equation (as suggested in CCR 23 §597(e)(3)(A)) (Equation A-17):

$$Volume = flow\ rate * duration\ of\ delivery \qquad \text{[A-17]}$$

CORRECTIVE ACTION PLAN FOR NON-COMPLIANT DEVICES (CCR 23 §597(E)(4))

Results from the field-testing presented in Section 4 indicated that two of the nine existing measurement sites require improvements to achieve compliance (HLLWDS and SYWD01). Additionally, three sites are new and need to be established (RMZD10, WHTP02 and BUKLMN). These corrective actions are described for each site in the following sections.

CORRECTIVE ACTIONS NEEDED TO ACHIEVE COMPLIANCE

HALLWOOD SOUTH (IMPROVEMENTS TO EXISTING SITE)

Install SonTek IQ acoustic Doppler meter in stable cross section of existing channel. Perform velocity-index rating over range of flows to calibrate the sensor. Install digital flow display for local monitoring and facilitate downloading of data. Install solar power system to power the acoustic Doppler meter and the flow display. The estimated cost to complete the corrective action and achieve compliance is $25,950.

RAMIREZ D-10 DELIVERY (IMPROVEMENTS TO EXISTING SITE)

Install SonTek IQ acoustic Doppler meter in downstream end of existing delivery pipeline. Install digital flow display for local monitoring and facilitate downloading of data. Install solar

power system to power the meter and the flow display. The estimated cost to complete the corrective action and achieve compliance is $22,330.

WHEATLAND CANAL AT BEALE ROAD (ESTABLISHMENT OF NEW SITE)

Install SonTek IQ acoustic Doppler meter in downstream end of South Beale Road siphon approximately 500' upstream of Yuba Wheatland Canal Pump Station #2. Perform velocity-index rating over range of flows to calibrate the sensor. Install digital flow display for local monitoring and facilitate downloading of data. Install solar power system to power the meter and the flow display. The estimated cost to complete the corrective action and achieve compliance is $32,820.

BEUKLEMAN DELIVERY (ESTABLISHMENT OF NEW SITE)

Replace non-functioning propeller meter that exists at site with new McCrometer propeller meter with instantaneous readout of flow rate and cumulative volume. The estimated cost to complete the corrective action and achieve compliance is $4,240.

SOUTH YUBA WD HEADING (IMPROVEMENTS TO EXISTING SITE)

Install SonTek IQ acoustic Doppler meter in siphon under Hwy 70 and perform velocity-index rating over range of flows to calibrate the sensor. Install digital flow display for local monitoring and facilitate downloading of data. Install solar power system to power the meter and the flow display. The estimated cost to complete the corrective action and achieve compliance is $32,820.

SCHEDULE

The corrective actions detailed in Section 6.1 will be completed by December of 2015.

BUDGET AND FINANCE PLAN

The estimated budget for performing the corrective actions outlined in Section 6.1 is $118,130. The improvements will be financed from the Agency's general fund.

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Yuba County Water Agency
2012 Agricultural Water Management Plan
Attachment B:
Public Coordination

Prepared By

DAVIDS ENGINEERING, INC
www.de-water.com

December 2012

Flood Control • Water Supply • Fishery Enhancement • Recreation • Hydro Electric Generation

December 5, 2012

The City of Marysville
Post Office Box 150
Marysville, CA 95901

RE: Notice of Intent to Prepare 2012 Agricultural Water Management Plan

To whom it may concern:

Yuba County Water Agency (YCWA) is in the process of a preparing a 2012 Agricultural Water Management Plan (AWMP) in accordance with Senate Bill x7-7 (SBx7-7), also known as the Water Conservation Act of 2009, which modifies Division 6 of the California Water Code, adding Part 2.55 (commencing with §10608) and replacing Part 2.8 (commencing with §10800).

The public review draft of the AWMP will be available for inspection from December 5 through December 19, 2012. Copies of the draft plan will be available at the YCWA office (1220 F Street, Marysville, CA 95901) and on the Agency's website (www.ycwa.com).

The Agency will conduct a public hearing on the AWMP on December 20, 2012 at 8:30 a.m. at the Yuba County Government Center, Board Chambers, 915 8th Street, Marysville, CA after which the Agency may adopt the plan. Public notices of the hearing will be advertized in the Marysville Appeal Democrat prior to the hearing date.

For further information, please contact me at (530) 741-6278, ext. 117 or smatyac@ycwa.com.

Sincerely,

Scott Matyac
Water Resources Manager

1220 F Street • Marysville, CA 95901-4740 • 530.741.6278 • *Fax:* 530.741.6541
www.ycwa.com

Flood Control • Water Supply • Fishery Enhancement • Recreation • Hydro Electric Generation

December 5, 2012

The City of Wheatland
313 Main Street
Wheatland, CA 95692

RE: Notice of Intent to Prepare 2012 Agricultural Water Management Plan

To whom it may concern:

Yuba County Water Agency (YCWA) is in the process of a preparing a 2012 Agricultural Water Management Plan (AWMP) in accordance with Senate Bill x7-7 (SBx7-7), also known as the Water Conservation Act of 2009, which modifies Division 6 of the California Water Code, adding Part 2.55 (commencing with §10608) and replacing Part 2.8 (commencing with §10800).

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Water Resources Manager

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www.ycwa.com

Flood Control • Water Supply • Fishery Enhancement • Recreation • Hydro Electric Generation

December 5, 2012

Yuba County
Community Development
915 8th Street, S-123
Marysville, CA 95901

RE: Notice of Intent to Prepare 2012 Agricultural Water Management Plan

To whom it may concern:

Yuba County Water Agency (YCWA) is in the process of a preparing a 2012 Agricultural Water Management Plan (AWMP) in accordance with Senate Bill x7-7 (SBx7-7), also known as the Water Conservation Act of 2009, which modifies Division 6 of the California Water Code, adding Part 2.55 (commencing with §10608) and replacing Part 2.8 (commencing with §10800).

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For further information, please contact me at (530) 741-6278, ext. 117 or smatyac@ycwa.com.

Sincerely,

Scott Matyac

Scott Matyac
Water Resources Manager

1220 F Street • Marysville, CA 95901-4740 • 530.741.6278 • *Fax:* 530.741.6541
www.ycwa.com

APPEAL-DEMOCRAT

1530 Ellis Lake Drive, Marysville, CA 95901
(530) 749-4700

Affidavit of Publication

(2015.5 C.C.P)

STATE OF CALIFORNIA,

Counties of Yuba and Sutter

Yuba County Water Agency

Notice of Public Hearing

I am not a party to, nor interested in the above entitled matter. I am the principal clerk of the printer and publisher of THE APPEAL-DEMOCRAT, a newspaper of general circulation, printed & published in the City of Marysville, County of Yuba, to which Newspaper has been adjudged a newspaper of general circulation by The Superior Court of the County of Yuba, State of California under the date of November 9, 1951, No. 11481, and County of Sutter to which Newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of Sutter, State of California under the date of May 17, 1999, Case No. CV PT99-0819 that the notice of which the annexed is a printed copy (set in type not smaller than nonpareil), has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

December 5, 17, 2012

I declare under penalty of perjury
that the foregoing is true and correct.
Executed at Marysville, California

Date: December 17, 2012

Nancy Brown
(Signature)

This space is for the County Clerk's filing stamp.

RECEIVED
DEC 19 2012
YUBA CO WATER AGENCY

Notice of Public Hearing
Yuba County Water Agency

Yuba County Water Agency (YCWA) is in the process of a preparing a 2012 Agricultural Water Management Plan (AWMP) in accordance with Senate Bill x7-7 (SBx7-7), also known as the Water Conservation Act of 2009, which modifies Division 6 of the California Water Code, adding Part 2.55 (commencing with §10608) and replacing Part 2.8 (commencing with §10800). The Agency will conduct a public hearing on the AWMP on December 20, 2012 after which the Agency may take action to adopt the plan. Interested parties are encouraged to attend the public hearing. **The public hearing will be held on December 20, 2012 at 8:30 a.m. at the Yuba County Government Center, Board Chambers, 915 8th Street, Marysville, CA 95901.**

The public review draft of the AWMP will be available for inspection from December 5 through December 19, 2012 at the YCWA office (1220 F Street, Marysville, CA 95901) and on the Agency's website (www.ycwa.com). For further information, please contact Scott Matyac, YCWA Water Resources Manager at (530) 741-6278, ext. 117 (smatyac@ycwa.com).

Signed:
Jeanene Upton
Assistant Board Secretary

December 5 & 17, 2012 Ad #00147793

AMENDED NOTICE

Yuba County Water Agency

Special Meeting – Board of Directors

Thursday, December 20, 2012

8:30 A.M.

Yuba County Government Center

915 8th Street, Marysville, CA 95901

AGENDA ITEMS

1. Roll Call

2. Opportunity for Public Comments on any items of interest that are within the jurisdiction of the Agency Board. However, no action may be taken on items which do not appear on the posted agenda. **(The public may address the Board on each agenda item during the Board's consideration of the item.)**

3. Consent Items
   a. Approval of Minutes: November 27, 2012
   b. Approval of General Fund Claims
   c. Approval of Operation and Maintenance Fund Claims
   d. Approval of GF Hydro Claims
   e. Monthly Financials for November 2012

4. Public Hearing – Consider adopting a 2012 Agricultural Water Management Plan in accordance with Senate Bill x7-7, also known as the Water Conservation Act of 2009.

5. Consider adopting Resolution No. 2012-15 Adopting a 2012 Agricultural Water Management Plan.

6. Consider approval of the Memorandum of Understanding between Yuba County Water Agency and I.B.E.W. Local 1245 effective December 20, 2012 through June 30, 2015.

7. Consider approval of Longevity Pay Policy retroactively to May 22, 2007.

8. Consider adopting Resolution No. 2012-16 Documenting Benefit Policy of Non-Represented Employees.

9. Consider adopting Resolution No. 2012-17 Adopting a Cafeteria plan for Active Employees and a Health Reimbursement Arrangement for Retirees.

10. Consider adopting Resolution No. 2012-18 Authorizing Finance Manager and General Manager to open a new checking account with Rabo Bank and issue HRA checks.

11. Consider approval of Fiscal Year 2012-2013 Final Budgets for General Fund and GF Hydro Fund and related 2013 Salary Schedules.

12. Manager's Report concerning status of Agency Facilities and Operations. Additionally, current event topics may be reported.

13. Directors Comments and Reports

14. Closed session conference with legal counsel – anticipated litigation under Government Code section 54956.9(c) – one potential case involving the Yuba River Development Project relicensing proceeding.

15. Adjourn

In compliance with the Americans with Disabilities Act, if you have a disability and you need a disability-related modification or accommodation to participate in this meeting, then please contact Jeanene Upton at 530-741-6278 or fax 530-741-6541. Requests must be made as early as possible, and at least one-full business day before the start of the meeting.

12/20/2012

YUBA COUNTY WATER AGENCY
1959
Yuba County Water Agency
Agricultural Water Management Plan
Public Hearing
December 20, 2012
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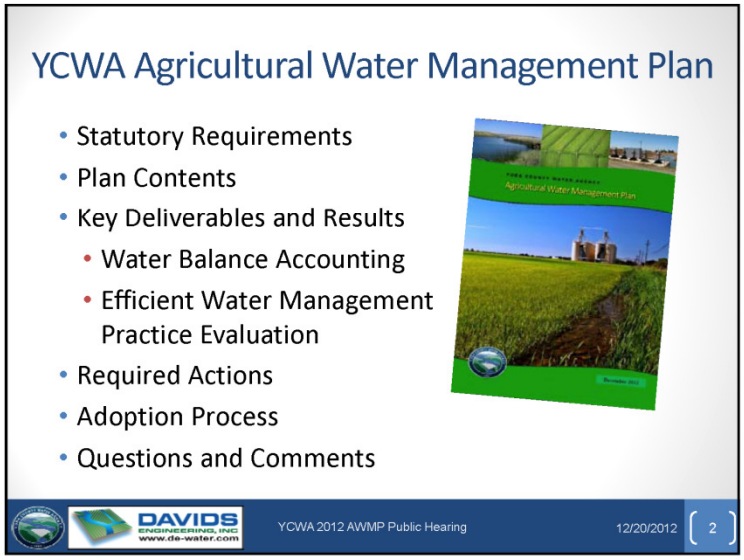
www.de-water.com
YCWA 2012 AWMP Public Hearing
12/20/2012
1


YCWA Agricultural Water Management Plan
Statutory Requirements
Plan Contents
Key Deliverables and Results
Water Balance Accounting
Efficient Water Management Practice Evaluation
Required Actions
Adoption Process
Questions and Comments
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YCWA 2012 AWMP Public Hearing
12/20/2012
2

1

12/20/2012

Senate Bill x7-7
Water Conservation Act of 2009

- Enacted in 2009
- Mandatory process for suppliers over 25,000 acres
- Requires preparation and adoption of AWMP
- Includes new delivery measurement and volumetric pricing requirements

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Senate Bill x7-7
Water Conservation Act of 2009

- Adoption and Update Deadlines
  - Prepare and adopt by Dec. 31, 2012
  - Update by Dec. 31, 2015 and every 5 years thereafter
- Non-Compliance Results in Ineligibility for State Water Grants and Loans

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2

12/20/2012

AWMP Preparation and Contents

Required Elements	Status
• Prepare Water Balance	✓
• Implement Critical (Mandatory) EWMPs	Ongoing
• Delivery measurement with "sufficient accuracy"	
• Volumetric pricing	
• Evaluate Additional (Conditional) EWMPs	✓
• Implement if technically feasible and cost-effective	

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AWMP Preparation and Contents (cont.)

Required Elements	Status
• Prepare Plan	✓
• Plan Preparation	
• Agency Description	
• Water Supply Inventory	
• Water Balance	
• Climate Change Evaluation	
• Description of EWMP Implementation Status	
• Evaluation of Water Use Efficiency Improvements	
• Involve the Public	Ongoing

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3

12/20/2012

AWMP Results

Water Balance

What is a Water Balance?

- Complete accounting of all water flowing into and out of the service area over a specified period (months or years)
- Basic accounting principle:
  Inflow – Outflow ± Change in Storage = 0
- Same as a checking account:
  Deposits – Withdrawals ± Change in Balance = 0

4

12/20/2012

Water Balance Benefits

- Assess water measurement and data management practices
- Assess water supply adequacy and conservation opportunities
- Provide insights into local water management
  - Support review of Agency operational practices and policies
- Better understand relationship between surface water and underlying groundwater system

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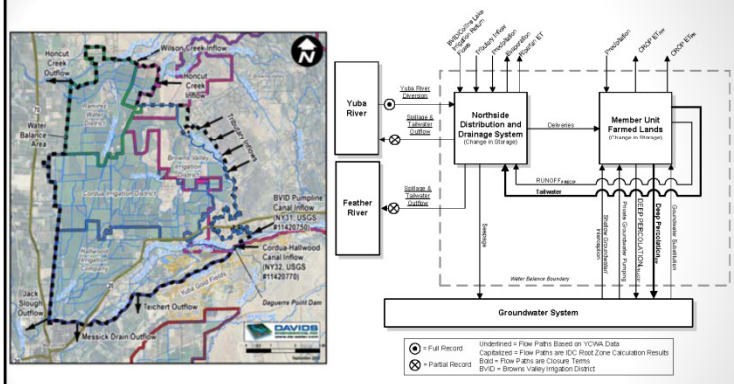
YCWA Water Balance Structure (North)



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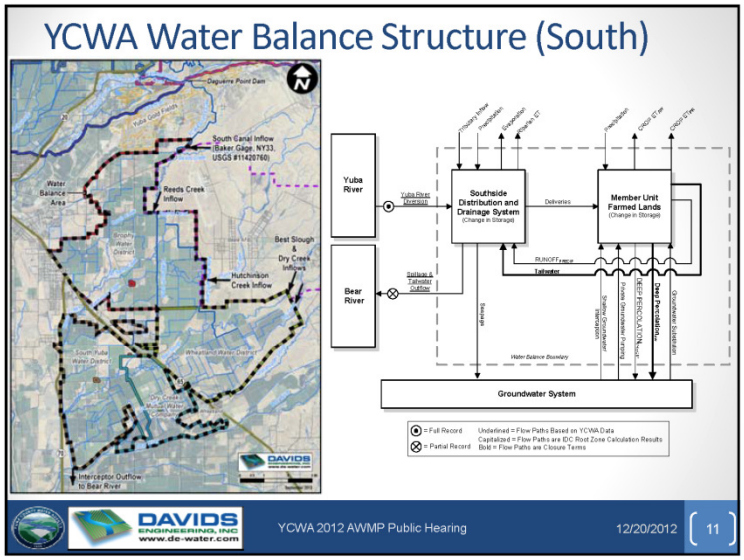
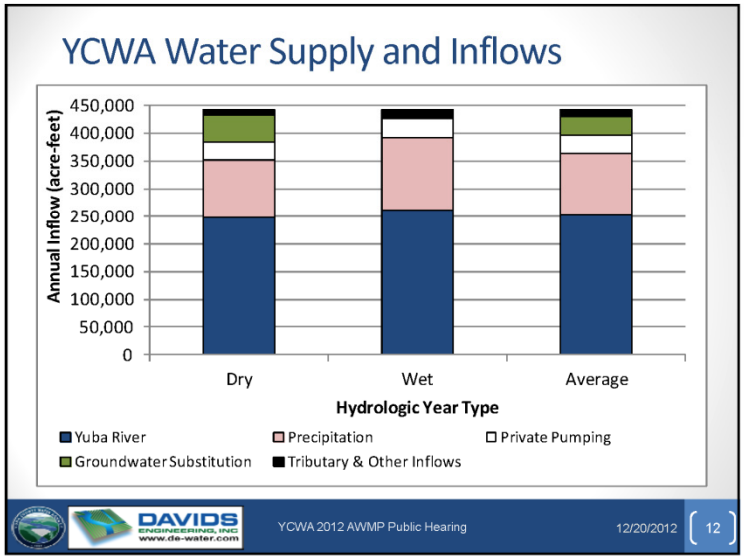
5

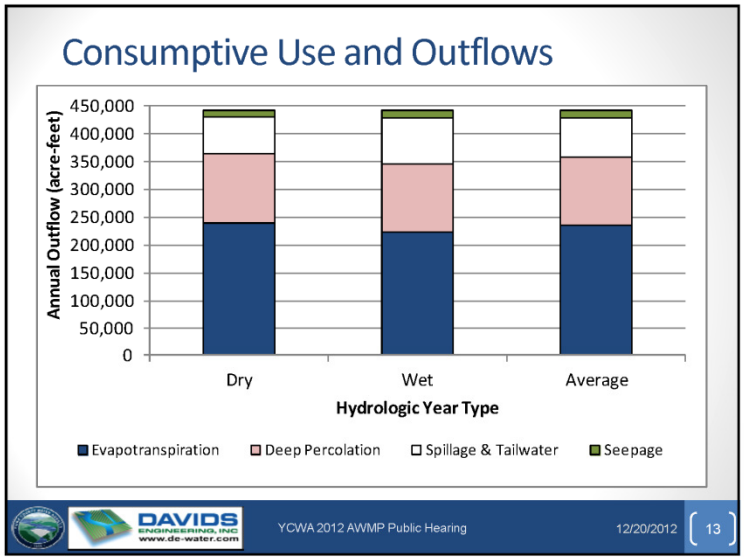
12/20/2012


YCWA Water Balance Structure (South)
Yuba River
Bear River
Southside Distribution and Drainage System
(Change in Storage)
Member Unit Farmed Lands
(Change in Storage)
Deliveries
Groundwater System
Water Balance Boundary
= Full Record
= Partial Record
Undefined = Flow Paths Based on YCWA Data
Capitalized = Flow Paths are IDC Root Zone Calculation Results
Bold = Flow Paths are Closure Terms
YCWA 2012 AWMP Public Hearing
12/20/2012
11


YCWA Water Supply and Inflows
Annual Inflow (acre-feet)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Dry
Wet
Average
Hydrologic Year Type
Yuba River
Precipitation
Private Pumping
Groundwater Substitution
Tributary & Other Inflows
YCWA 2012 AWMP Public Hearing
12/20/2012
12

6

12/20/2012


Consumptive Use and Outflows
Annual Outflow (acre-feet)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Dry
Wet
Average
Hydrologic Year Type
Evapotranspiration
Deep Percolation
Spillage & Tailwater
Seepage
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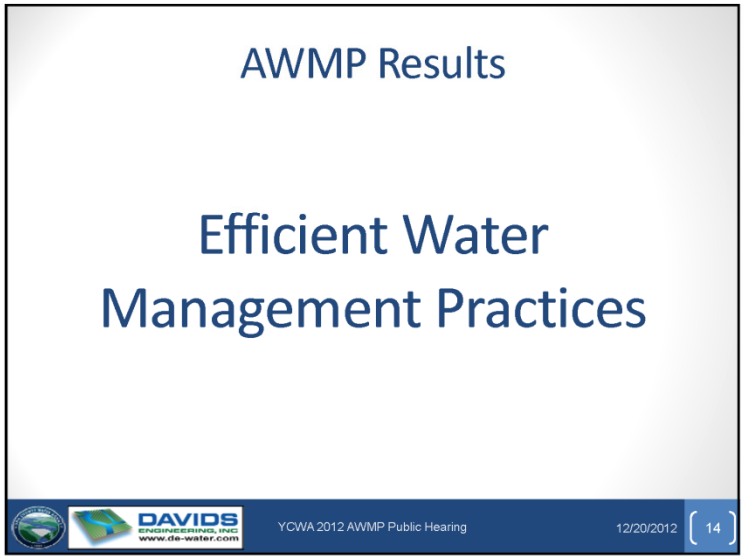
12/20/2012
13


AWMP Results
Efficient Water Management Practices
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12/20/2012
14

7

12/20/2012

Efficient Water Management Practices

- SBx7-7 requires suppliers to evaluate & implement two types of EWMPs
  - 2 Critical (Mandatory) EWMPs [§10608.48(b)]
    - Delivery Measurement
    - Volumetric Pricing
  - 14 Additional (Conditional) EWMPs [§10608.48(c)]

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Critical (Mandatory) EWMPs

1. Delivery Measurement
   - Evaluation of existing measurement and options
   - Development of wholesale by difference approach
   - Implementing plan for "corrective action" by Dec. 31, 2015
2. Volumetric Pricing
   - Reimbursement of O&M by South Member Units based on volume delivered meets requirement
   - Consider negotiating reimbursement by North Member Units for metering and hydrographic services
   - Consider development and implementation of revenue-neutral volumetric pricing structure

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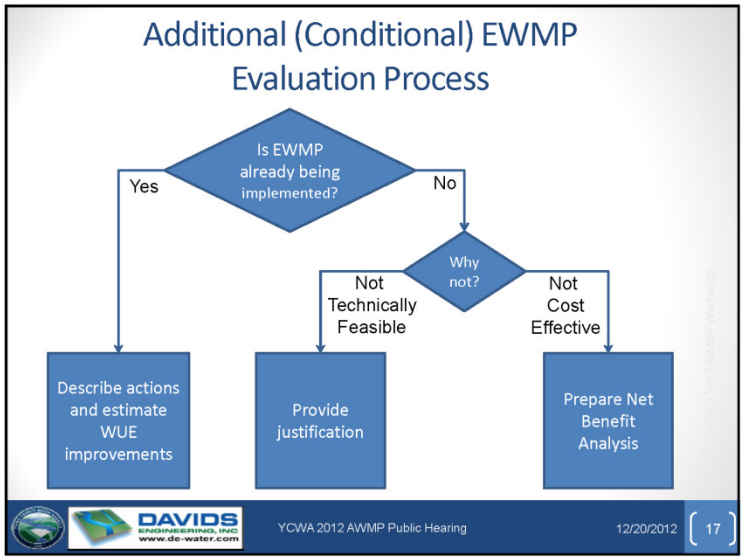
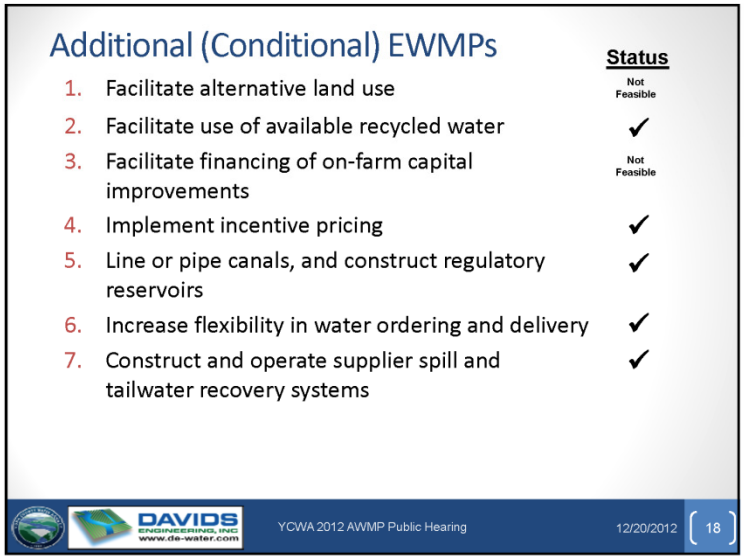
8

12/20/2012


Additional (Conditional) EWMP Evaluation Process
Is EWMP already being implemented?
Yes
No
Why not?
Not Technically Feasible
Not Cost Effective
Describe actions and estimate WUE improvements
Provide justification
Prepare Net Benefit Analysis
YCWA 2012 AWMP Public Hearing
12/20/2012
17


Additional (Conditional) EWMPs
Status
1. Facilitate alternative land use
Not Feasible
2. Facilitate use of available recycled water
✓
3. Facilitate financing of on-farm capital improvements
Not Feasible
4. Implement incentive pricing
✓
5. Line or pipe canals, and construct regulatory reservoirs
✓
6. Increase flexibility in water ordering and delivery
✓
7. Construct and operate supplier spill and tailwater recovery systems
✓
YCWA 2012 AWMP Public Hearing
12/20/2012
18

9

12/20/2012

Additional (Conditional) EWMPs, cont.

	Status
8. Increase planned conjunctive use of surface water and groundwater	✓
9. Automate canal control structures	✓
10. Facilitate or promote customer pump testing and evaluation	✓
11. Designate Water Conservation Coordinator	✓
12. Provide for the availability of water management services to customers	✓
13. Evaluate supplier's policies	✓
14. Improve supplier's pumping efficiency	✓

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Required Actions and Adoption

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10

12/20/2012

Required Actions

- Adopt 2012 Agricultural Water Management Plan
- Implement delivery measurement improvements to comply with Senate Bill x7-7 accuracy requirements by December 31, 2015
- Consider amendments to water service agreements to fully comply with volumetric pricing requirement of Senate Bill x7-7

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2012 AWMP Adoption Process

- Notice and Hold public hearing
- Adopt at Board meeting, subject to any revisions
- Make final adopted plan available **(within 30 days of adoption)**
  - File with Department of Water Resources
  - Post on Internet
  - Place at local libraries
  - Send to other local entities

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11

12/20/2012

Questions and Comments

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12

RESOLUTION NO. 2012-15

**A RESOLUTION OF THE BOARD OF DIRECTORS
OF THE YUBA COUNTY WATER AGENCY
ADOPTING A 2012 AGRICULTURAL WATER MANAGEMENT PLAN**

WHEREAS, the California Legislature enacted Senate Bill x7-7, the Water Conservation Act of 2009, which modifies Division 6 of the California Water Code, adding Part 2.55 (commencing with §10608) and replacing Part 2.8 (commencing with §10800); and

WHEREAS, agricultural water suppliers providing water to 25,000 or more acres are required to prepare and adopt an Agricultural Water Management Plan as set forth in the California Water Code and the California Code of Regulations on or before December 31, 2012, after public review and hearing; and

WHEREAS, the Plan shall be updated by December 31, 2015 and on or before December 31 every five years thereafter; and

WHEREAS, the Agency has prepared a Plan which satisfies the California Water Code and the California Code of Regulations; and

WHEREAS, the Agency has properly noticed the opportunity for public review and the time and place for a public hearing on the Plan which was held by the Agency's Board of Directors on December 20, 2012; and

NOW, THEREFORE BE IT RESOLVED, by the Board of Directors of the Yuba County Water Agency as follows:

(1) The 2012 Agricultural Water Management Plan is hereby adopted and ordered filed with the Agency;

(2) The Clerk of the Board of Directors is hereby authorized and directed to file the Plan with the California Department of Water Resources and other specified entities and post the Plan on the Agency's website within 30 days of adoption in accordance with the California Water Code;

(3) The General Manager, or his designee, is hereby authorized and directed to implement the Agricultural Water Management Plan.

PASSED AND ADOPTED by the Board of Directors of the Yuba County Water Agency on this 20th day of December 2012 by the following vote:

AYES:	Directors Abe, Belza, Griego, Muck, Stocker and Vasquez
NOES:	None
ABSTAIN	None
ABSENT:	Director Nicoletti

Mary Jane Griego, Chair

Attest:

Jeanene Upton, Secretary

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Yuba County Water Agency
2012 Agricultural Water Management Plan
Attachment C:
YCWA Groundwater Management Plan

Prepared By

DAVIDS ENGINEERING, INC
www.de-water.com

December 2012

(Provided as a Compact Disc)

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Yuba County Water Agency
2012 Agricultural Water Management Plan
Attachment D:
YUBA County Integrated Regional Water Management Plan

Prepared By

DAVIDS ENGINEERING, INC
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December 2012

(Provided as a Compact Disk)

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Yuba County Water Agency
2012 Agricultural Water Management Plan
Attachment E:
Measurement Improvement Plan

Prepared By

DAVIDS ENGINEERING, INC
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December 2012

ATTACHMENT E: INTRODUCTION

Yuba County Water Agency (YCWA or Agency) currently measures water to account for water delivered to customers, to operate its water distribution facilities, and to provide data needed to evaluate system and operational performance. While current measurement practices and facilities are generally adequate to meet the water management needs of the Agency and its member units, changing regulations and changing measurement technology have prompted the Agency to comprehensively review its measurement practices and to develop a Measurement Improvement Plan (MIP) for measurement upgrades over the near and long term. Benefits of improved measurement include the following:

- Compliance with agricultural water measurement regulations
- Increased confidence in YCWA water balance flow volumes and improved understanding of baseline water management conditions
- Improved operational decisions and precision for the Agency and member units
- Development of a long term history of water use to support analysis and project design

The MIP includes actions required to comply with California Code of Regulations Title 23 Division 2 Chapter 5.1 Article 2 Section 597 (CCR 23 §597) as well as actions YCWA is taking to implement Efficient Water Management Practices (EWMPs) listed in the Water Conservation Act of 2009, commonly referred to Senate Bill x7-7 (SBx7-7). These EWMPs were evaluated as part of the preparation of YCWA's 2012 Agricultural Water Management Plan (AWMP), to which this MIP is an attachment.

The approach to preparing the MIP involved an inventory and evaluation of sites where flow or water level measurements are currently made for water accounting, operations, or other purposes. Each site was inspected, and existing measurement practices and facilities were inventoried and assessed. The information gathered during the inventory was systematically organized in a database to support evaluation of measurement improvement needs and opportunities.

Three levels of measurement improvement are identified in the MIP for each site. First, for the customer delivery measurement sites subject to CCR 23 §597, improvements needed to achieve compliance are identified. Then, for all sites including those used to measure deliveries to customers, two levels of improvement are provided. In general, the first level of improvements provide improved measurement accuracy and reliability and continuous monitoring and data storage, while the second level provides connection of the site to an Agency Supervisory Control and Data Acquisition (SCADA) system to enable real-time access to and derive the greatest benefit from the data. Costs for each level of improvement for each site are provided based on the necessary components. Additionally, the MIP includes identification of the necessary components and estimation of the cost of establishing the backbone of the SCADA system (e.g., base station, computer, and operator terminals).

In aggregate, the costs associated with the Level 1 and Level 2 improvements sum to more than the Agency is able to implement in the near term with available funds. Therefore, priorities were assigned based on the relative benefits of improving each site to guide implementation, and funding sources such as grants will be sought to support implementation.

Over time, it is anticipated that new sites will be established, and existing sites may be retired. Additionally, priorities are expected to change to some degree. Finally, specific improvements at a given site may be re-evaluated and modified as appropriate. As a result, this MIP will guide implementation of individual improvements but may be deviated from as time progresses. The MIP will be updated accordingly, as needed.

In the following sections, the results of the measurement site inventory are summarized, and the identified improvements, costs, and priorities are described.

MEASUREMENT SITE INVENTORY

Existing measurement sites were identified and inspected through consultation with YCWA operations staff. Additional sites were identified where flow measurements are not currently collected, or are not collected frequently (i.e., daily), but will eventually be collected as part of the Agency's efforts to improve water measurement. A total of 36 existing or new measurement sites were identified. Each site was inspected, its geographic coordinates determined by GPS and, for existing sites, the current measurement method was described. The sites were classified in two ways. One classification was to differentiate between the sites used to determine the quantity of water delivered to the Agency's eight customers, the member units, versus those that are not. The reason for this classification is that the member unit sites are used for customer delivery measurement and are therefore subject to accuracy standards according to CCR 23 §597. Also, the sites were classified according to whether they provide boundary inflow, boundary outflow, or internal measurements. Boundary inflow and internal measurement sites may or may not be used for customer delivery measurement.

With respect to sites not used for customer delivery measurement, boundary inflow and outflow sites tend carry higher priority for measurement upgrades than internal sites because they bound the Agency's Northside and Southside water balances, providing important information to support overall water management. Additionally, improved measurement at boundary outflow sites will support the ongoing efforts of YCWA and the member units to improve water management and control losses to spillage and tailwater.

Internal measurement sites in general carry lesser priority, but individual sites may carry higher priority than some boundary inflow and outflow sites because they are relied on for operation of the YCWA canal system. Among the 36 sites, 12 are used to quantify Member Unit water deliveries[33], and 24 are used for operational purposes. There are five boundary inflow sites, four boundary outflow sites, and 27 internal measurement sites. The 36 sites are listed in Table E-3 at the end of this MIP along with their classifications and certain other attributes.

Various measurement methods are presently used at the existing sites, including rated canal sections; a non-standard, rated Parshall flume; acoustic Doppler devices, totalizing propeller flowmeters; non-standard sharp-crested (board) weirs; and orifice gates of various configurations and dimensions. These are also described in Table E-3, with additional detail and photographs of each site provided in Attachment E-1 of this MIP.

[33] Two customer delivery measurement sites are new sites established for compliance with CCR 23 §597.

MEASUREMENT IMPROVEMENTS AND COSTS

The comprehensive site inventory provides a baseline for developing measurement improvements specific to each site. As mentioned in the preceding sections, improvements were proposed for sites where flow or water level is currently measured as well as sites where measurements (flow or level) are not currently collected on a frequent basis but would be beneficial to operations. A full listing of the sites and proposed measurement improvements can be found in the attached matrix, Table E-3. Improvements at customer delivery sites include those required for compliance with CCR 23 §597. At all sites, improvements recommended for modernization and enhancement of YCWA's measurement capabilities are provided. Those recommended for modernization and enhancement are segmented into Level 1 and Level 2 improvements to allow for phased implementation, as described previously.

Of the 36 sites included in the MIP, 12 are customer delivery sites and subject to CCR 23 §597. Current metering and field testing were performed at nine of these sites to determine the accuracy of the existing flow measurement device. Two of the nine sites failed to meet the accuracy standards of CCR 23 §597. Tests were not performed at one additional site suspected not to meet the accuracy standards of CCR 23 §597 nor at two sites established as part of YCWA's corrective actions to comply with the Regulation. Compliance with CCR 23 §597 has been documented separately as Attachment A of YCWA's AWMP. The compliance documentation addresses compliance with CCR 23 §597 exclusively, including a corrective action plan for those sites requiring improvements to meet the accuracy standard. Improvements required for compliance with CCR 23 §597 have the highest priority for implementation.

All sites were evaluated for improvements that could be completed to enhance or modernize the measurement or operability of the site. Level 1 improvements represent the bulk of infrastructure modifications and instrumentation changes or installations at each site. Major changes in measurement methodology and upgrades occur in Level 1. Upon completion of the Level 1 improvements, sites will typically be SCADA ready[34]. Level 2 improvements are in addition to Level 1 improvements and are typically less intensive, generally involving integration of the sites into the Agency-wide SCADA system. All but one (Waterway 13) site is recommended to be integrated into the SCADA system at this time. Measurement site improvements are categorized by measurement method in Table E-1. The "Proposed in MIP" column is the collective site improvement as recommended through Level 2.

In addition to the improvements required for compliance with CCR 23 §597, the Level 1 improvements, and the Level 2 improvements, an additional, intermediate level of improvements has been identified that involves implementation of the improvements required for compliance with CCR 23 §597, plus the minimum additional improvements required to make all customer delivery sites SCADA ready. In contrast to the Level 1 improvements, this intermediate level of improvement does not include changes in measurement technology recommended for modernization and enhancement at all sites, but rather the minimum changes in measurement technology required to incorporate the customer delivery measurement sites into SCADA. These improvements are summarized as follows:

[34] "SCADA-Ready" describes a package of hardware and software that communicates and operates locally but has been specifically designed and installed to readily accept a data transmission and receiving device (radio, cellular modem, etc) and to provide remote communication with an established base station and SCADA human machine interface (HMI).

- Hallwood North Canal Heading (HLLWDN) – Replace existing water level sensor with MODBUS pressure transducer (INW PT2X or similar). Estimated cost of $2,500.
- Cordua-Ramirez Canal Heading (CRDRMZ) – Replace existing water level sensor with MODBUS pressure transducer (INW PT2X or similar). Estimated cost of $2,500.
- Rue Pump Station (RUEPMP) – Replace McCrometer propeller meters with magnetic flow meters (equivalent to Level 1 Improvements). Estimated cost of $32,034.
- Beukleman Delivery (BUKLMN) – Replace McCrometer propeller meter with SonTek IQ (equivalent to Level 1 Improvements).[35] Estimated cost of $22,322.
- Dry Creek Mutual Water Company Meter 1 (DCMWC1) – Replace McCrometer propeller meter with SonTek IQ (equivalent to Level 1 Improvements). Estimated cost of $32,816.

Table E-1. Existing and Proposed Site Measurement Methods

Measurement Site Type Summary	No. of Sites	
	Existing	Proposed in MIP
Flow Measurement Methods		
→Orifice discharge equation	6	6
→Rated section and stage-discharge chart	5	2
→Rated section and acoustic Doppler meter	1	8
→Acoustic Doppler meter installed in pipeline	1	12
→Magnetic meter	0	2
→Propeller meter	10	0
→Weir equation with stage measurement	4	3
→Visual estimation of flow rate	3	0
→No measurement	3	0
Subtotal=	33	33
Level Measurement Methods (Sites exclusively used for level)		
→Stilling well with stage measurement	0	4
→Visual or "other" stage measurement	3	0
Total =	**36**	**36**

Key:
MIP = Measure Improvement Plan

Reconnaissance level cost estimates were prepared for the improvements recommended in the MIP as a basis for prioritization and funding of site improvements. The total cost of the measurement improvements is summarized in Table E-2. The total estimated cost for each site is provided for each level of improvement in Table E-3. Additionally, the costs of a SCADA base station and mobile operator terminals to serve as the "backbone" of the YCWA SCADA system

[35] A Rubicon Flume Meter could also be considered for this location.

were estimated, along with the cost of spare equipment to be kept on hand to repair or replace individual site components due to theft, vandalism, or other failure. For additional detail, cost tables specific to each site are included as Attachment E-2 of this MIP and list each cost type, quantity and estimated unit cost.

Cost types fall into two categories: Direct Costs and Indirect Costs. Direct costs are associated with physical site improvements, while indirect costs represent other project costs such as engineering and design, construction management, and administration and overhead. For estimation purposes indirect costs were estimated at 20 percent to 50 percent of the direct costs, as follows:

- Site improvements likely to require substantial physical modification and environmental review were assigned indirect costs of 50 percent,
- Site improvements requiring substantial physical modification but not likely to cause significant environmental impacts were assigned indirect costs of 30 percent, and
- Site improvements consisting primarily of hardware upgrades and additions were assigned indirect costs of 20 percent.

Unit costs include materials, installation labor, shipping, and tax. Unit costs obtained directly from suppliers are adjusted to include installation labor or other markups not included in the quoted cost. Additionally, a 15 percent contingency for unlisted items and other uncertainties in quantities and unit costs is included on most items.

Table E-2. Summary of Total Site Measurement Improvement Costs

Site Improvement Category	No. of Sites in Category	Total Cost of Improvement
1a. Required for Compliance with CCR 23 Sec. 597	5	$118,130
1b. Additional Improvements to Make Compliant Sites SCADA Ready	5	$92,172
2. Recommended for Modernization and Enhancement		
a. Level 1 Improvements	30	$837,820
b. Level 2 Improvements	35	$398,310
Total Site Improvement Cost[1] =		**$1,359,260**
SCADA Base Station and Mobile Operator Terminals =		$138,070
Spare Equipment =		$23,700
Total Measurement Improvement Plan Cost =		**$1,521,030**

Note:
[1] The total site improvement cost is calculated as the sum of category 1a, 2a, and 2b improvement costs, plus a marginal cost of $5,000 to install pressure transducers at the Hallwood North Canal and Cordua-Ramirez Canal headings in lieu of the longer-term Level 1 improvements to measurement technology at the sites (see Table E-3). The remainder of the category 1b costs are included in the category 2a costs due to overlap with the Level 1 improvement costs.
Key:
CCR = California Code of Regulations

MEASUREMENT IMPROVEMENT PRIORITIES

As briefly mentioned in earlier sections, within the Level 1 and Level 2 improvement categories, relative priorities were assigned to each site according to the value of the improvement to provide Agency water management benefits.

Flow measurement sites that are used to measure deliveries to the eight member units must comply with CCR 23 §597 and will therefore carry the highest priority. CCR 23 §597 requires these sites to be compliant by December 31, 2015. Improvements to meet the requirements of CCR 23 §597 will be completed within this timeline.

The recommended site modernization and enhancement improvements are provided across two levels or stages, as explained previously. Priorities for both Level 1 and Level 2 improvements for a given site are not differentiated, though it is anticipated that Level 1 improvements will precede Level 2 improvements in many, if not all, cases. Realization of operational benefits from site improvements essentially requires that data from a given site be available remotely through SCADA.

As previously mentioned, priorities were qualitatively assigned using a scale of 1 to 3, with 1 being the highest priority and 3 being the lowest priority. Qualitative ratings are based on a combination of expected benefits of measurement improvements and associated costs. Implementation priorities for each site are presented in Table E-3.

Typically, a prioritized list of improvements would be systematically implemented starting with the highest priority and working to the lowest. However, the priorities defined in the MIP and improvement matrix are subject to change over time at the Agency's discretion. Actual improvements will be implemented according to these potentially evolving priorities and may differ from those described in the MIP. Factors potentially affecting the implementation sequence and schedule include available funding and funding sources, time related constraints, operational limitations, site condition constraints, site access limitations, environmental impacts, or changes in operational or measurement strategies.

MEASUREMENT SITE ENVIRONMENTAL CONSIDERATIONS

Factors to be considered in evaluating potential environmental impacts for each site have been developed. These considerations include the type of waterway to be modified, the amount of anticipated soil disturbance, and any channel modifications that may be required. These considerations provide a basis for a preliminary assessment of impacts during construction of the recommended Level 1 and Level 2 improvements discussed above, and support the identification of necessary permits and other regulatory requirements. One factor that in part determines site sensitivity is whether improvements would be placed in a natural or man-made waterway or existing structure. All but three of the sites involve man-made facilities while three (the Honcut Creek inflow and outflow sites and Jack's Slough Weir) involve natural waterways. Additionally, the type of construction activity at each site was described and estimates were made of the extent of soil disturbance that would occur during construction. The environmental considerations associated with each site are summarized in Table E-4. Detailed environmental review, documentation, and potential mitigation will be required prior to implementation.

Table E-3. YCWA Measurement Sites and Summary of Improvements, Associated Costs, and Implementation Priorities

No.	Site Information								Measurement Improvements								Priority[2]
	SiteID	Site Name	Site Type	Inspection Date	Latitude	Longitude	Member Unit(s)[1]	Existing Measurement Method	Required For Compliance CCR 23 Sec. 597	Compliance Cost	Level 1 Modernization and Enhancement	Estimated Level 1 Cost	Level 2 Modernization and Enhancement	Estimated Level 2 Cost		Total Improve-ment Cost	
CUSTOMER DELIVERY MEASUREMENT SITES																	
	Sites on Northside of Yuba River																
1	HLLWD S	Hallwood South	Internal	7/13/11	39.20983	-121.47897	HIC	Rated section. Stage-discharge relationship created by Surface Water Data. YCWA staff recreated curve in early 2000's.	Install SonTek IQ. Perform velocity-index rating over range of flows. Install solar power system and flow display. Site will be SCADA-Ready	$25,944	Construct control section within channel and reinstall SonTek IQ.	$17,497	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$48,744	1
2	HLLWD N	Hallwood North	Internal	7/13/11	39.20998	-121.47890	HIC	Rated section. Stage-discharge relationship created by Surface Water Data. Last current metering performed in 2007.	None. Existing measurement compliant.	N/A	Construct control section within channel and install SonTek IQ. Perform velocity-index rating over range of flows. Install solar power system and flow display to make site SCADA-Ready	$58,905	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$64,209	1
3	CRDRM Z	Cordua/ Ramirez Canal Heading	Internal	7/13/11	39.21022	-121.47967	RWD, CID	Modified 20' wide Parshall Flume and theoretical rating curve.	None. Existing measurement compliant.	N/A	Install SonTek IQ in upstream section of existing flume. Perform velocity-index rating over range of flows. Install solar power system and flow display to make site SCADA-Ready	$28,106	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,745		$33,852	1
4	RAMIRZ	Cordua/ Ramirez Split	Internal	7/20/11	39.25795	-121.54342	RWD	SonTek Argonaut SW mounted in delivery pipeline to Rameriz.	None. Existing measurement compliant.	N/A	Install 36" sluice gate. Calibrate (e) SonTek Argonaut SW in pipe, perform velocity index rating over a range of flows, install digital flow display and solar system to make site SCADA-Ready. Replace one (e) sluice gate on Cordua canal with flap gate to maintain upstream water level for Ramirez delivery	$44,267	Replace SonTek SW with SonTek IQ. Perform velocity index rating over a range of flows. Add communication hardware to measurement site to integrate with SCADA system to provide real-time monitoring of flow rate and water level	$18,931		$63,198	1
5	RMZD1 0	Ramirez D10	Internal	8/23/12			RWD	Open flow propeller meter.	Install SonTek IQ in existing delivery pipeline. Install solar power system and flow display. Site will be SCADA-Ready	$22,322	None	N/A	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$27,625	1
6	NY0031	NY31 BVID Pump Canal Heading	Boundary Inflow	7/17/12	39.21728	-121.43151	BVID	Rated section. Stage-discharge relationship created and maintained by PG&E. BVID maintains inline propeller meters on pump discharges.	None. Existing measurement compliant.	N/A	Install stilling well with stage measuring instrumentation at site to minimize error due to existing staff gage being mounted in the channel	$18,915	Integrate existing telemetry hardware into new SCADA system to provide real-time monitoring of flow rate and water level	$725		$19,640	1

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Table E-3. YCWA Measurement Sites and Summary of Improvements, Associated Costs, and Implementation Priorities (contd.)

No.	Site Information								Measurement Improvements								Priority[2]
	SiteID	Site Name	Site Type	Inspection Date	Latitude	Longitude	Member Unit(s) [1]	Existing Measurement Method	Required For Compliance CCR 23 Sec. 597	Compliance Cost	Level 1 Modernization and Enhancement	Estimated Level 1 Cost	Level 2 Modernization and Enhancement	Estimated Level 2 Cost		Total Improve-ment Cost	
	Sites on Southside of Yuba River																-
7	NY0033	NY33 Baker Gage	Boundary Inflow	7/10/12	39.16823	-121.45033	BWD, WWD, SYWD, DCMWC	SonTek Argonaut SW installed in rated concrete lined canal section.	None. Existing measurement compliant.	N/A	Calibrate (e) SonTek Argonaut SW by performing a velocity index rating over a range of flows.	$7,970	Replace (e) SonTek Argonaut SW with SonTek IQ, replace flow display and perform velocity index rating over a range of flows. Integrate existing telemetry hardware into new SCADA system to provide real-time monitoring of flow rate and water level	$20,663		$28,632	1
8	RUEPMP	Rue Pump Station	Internal	7/20/11	39.07147	-121.43647	WWD	McCrometer propeller meters on each pump discharge pipe (12", 14" & 24"). Pumps operate in parallel and discharge to open channel.	None. Existing measurement compliant.	N/A	Replace McCrometer Flow Meters with Magnetic Flow Meters. Install centrally located, remote-mounted digital displays to monitor flow rate and volume. Add solar power system so site is SCADA-Ready.	$32,034	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,883		$37,917	1
9	WHTP02	Yuba Wheatland Canal Pump at Beale Road	Internal	7/20/11	39.07017	-121.43572	WWD	Several downstream propeller meters summed to develop flow rate.	Install SonTek IQ in S. Beale Road siphon approximately 500' upstream of pump station and perform velocity-index rating over range of flows. Install solar power system and flow display. Site will be SCADA-Ready	$32,816	None	N/A	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$38,119	1
10	BUKLMN	Beuklemen Delivery	Internal	7/10/12	39.05649	-121.48655	SYWD	Propeller meter installed in delivery pipeline approximately 75' downstream of delivery gate.	Replace non-functioning propeller meter that exists at site with new McCrometer propeller meter	$4,231	Install SonTek IQ in existing delivery pipeline. Install solar power system and flow display to make site SCADA-Ready.	$22,322	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$31,856	1

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Table E-3. YCWA Measurement Sites and Summary of Improvements, Associated Costs, and Implementation Priorities (contd.)

No.	Site Information								Measurement Improvements								Priority[2]
	SiteID	Site Name	Site Type	Inspection Date	Latitude	Longitude	Member Unit(s) [1]	Existing Measurement Method	Required For Compliance CCR 23 Sec. 597	Compliance Cost	Level 1 Modernization and Enhancement	Estimated Level 1 Cost	Level 2 Modernization and Enhancement	Estimated Level 2 Cost		Total Improve-ment Cost	
11	SYWD01	South Yuba Meter 1	Internal	7/20/11	39.04843	-121.49095	SYWD	McCrometer propeller flow meter installed at the outlet of the siphon under Hwy 70. South Yuba's delivery is the difference between this measurement and the measured flow rate to Dry Creek. Turbulent flows at outlet cause inaccurate readings with propeller meter.	Install SonTek IQ in siphon under Hwy 70 and perform velocity-index rating over range of flows. Install solar power system and flow display. Site will be SCADA-Ready	$32,816	None	N/A	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$38,119	1
12	DCMWC1	Dry Creek MWC Meter 1	Internal	7/20/11	39.04823	-121.49075	DCMWC	McCrometer propeller flow meter installed at the outlet of the 80' pipe heading southeast at the South Yuba - Dry Creek split.	None. Existing measurement compliant.	N/A	Install SonTek IQ in 80' long pipe supplying Dry Creek and perform velocity-index rating over range of flows. Install solar power system and local digital flow display. Site will be SCADA-Ready.	$32,816	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$38,119	1
NON CUSTOMER DELIVERY MEASUREMENT SITES																	
	Sites on Northside of Yuba River																
13	NY0032	NY 32	Boundary Inflow	7/13/11	39.20905	-121.45805	RWD, CID, HIC	Rated section. Stage-discharge relationship created and maintained by PG&E. BVID maintains inline propeller meters on pump discharges	N/A	N/A	Install stilling well with stage measuring instrumentation at site to minimize error due to existing staff gage being mounted in the channel	$18,915	Integrate existing telemetry hardware into new SCADA system to provide real-time monitoring of flow rate and water level	$725		$19,640	3
14	RMZLFT	Ramirez Lift	Internal	7/20/11	39.27225	-121.53798	RWD	McCrometer propeller meters on two of the three discharge pipes.	N/A	N/A	Either (1) install magnetic flow meters on all 3 pipe discharges, or (2) install SonTek IQ in 50' concrete lined section upstream of pump intake. Add solar power system and flow display. Site will be SCADA-Ready	$56,503	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,745		$62,248	1
15	HONCK1	Honcut Creek Inflow	Boundary Inflow	7/17/12	39.30440	-121.51464	RWD	None	N/A	N/A	Construct 50' long lined section of channel and install SonTek IQ. Install solar power system and flow display for monitoring of flow rate	$77,180	Install communication hardware and integrate site into SCADA system to provide real-time monitoring of water level and flow	$5,303		$82,483	1

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Table E-3. YCWA Measurement Sites and Summary of Improvements, Associated Costs, and Implementation Priorities (contd.)

No.	Site Information								Measurement Improvements								Priority[2]
	SiteID	Site Name	Site Type	Inspection Date	Latitude	Longitude	Member Unit(s) [1]	Existing Measurement Method	Required For Compliance CCR 23 Sec. 597	Compliance Cost	Level 1 Modernization and Enhancement	Estimated Level 1 Cost	Level 2 Modernization and Enhancement	Estimated Level 2 Cost		Total Improve-ment Cost	
16	HONCK 2	Honcut Creek Outflow	Boundary Outflow	7/17/12	39.30466	-121.56979	RWD	None	N/A	N/A	Construct 25' long lined section of channel and install SonTek IQ. Install solar power system and flow display for monitoring of flow rate	$35,272	Install communication hardware and integrate site into SCADA system to provide real-time monitoring of water level and flow	$5,303		$40,576	1
17	JCKSL W	Jack's Slough Weir	Boundary Outflow	7/20/11	39.17650	-121.58129	BVID, RWD, CID, HIC	7 - 4.5' weir bays with weir boards that possibly move during irrigation season. Weir stick used to calculated flow through each bay and then added.	N/A	N/A	Provide additonal weir stick to Agency staff. Provide training as necessary. Install level sensor upstream of weir bays and perform weir stick measurement for level sensor calibration each time a weir board is moved. Site will be SCADA-Ready.	$13,628	Install semi-permanent (removed during the winter months) steel weir plates in each of the 7 weir bays. Stagger weir crest elevations to gain low flow measurement accuracy. Using upstream water level sensor, develop custom stage-discharge rating curve and verify with current metering measurements. Add communication hardware to site and integrate with SCADA system for monitoring of level and flow.	$23,735		$37,362	1
	Sites on Southside of Yuba River																
18	SDDAGR	South Diversion at Daguerre	Boundary Inflow	7/20/11	39.20732	-121.44068	BWD, WWD, SYWD, DCMWC	3 - 60" Waterman gates. SonTek ADV mounted downstream of pipeline outlets	N/A	N/A	Install SonTek IQ in three delivery pipelines and perform velocity-index rating over range of flows. Install solar power system and centralized flow display near gate operators.	$59,258	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate	$5,303		$64,561	3
19	WTRW13	Waterway 13	Internal	7/13/11	39.20462	-121.43877	-	1 - 8' rectangular orifice gate with overflow utilized for water level control and flow measurement.	N/A	N/A	Install upstream and downstream staff gages to facilitate head pressure measurements and develop theoretical flow rating tables as a function of head pressure and gate opening for each gate.	$12,606	None	N/A		$12,606	3

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Table E-3. YCWA Measurement Sites and Summary of Improvements, Associated Costs, and Implementation Priorities (contd.)

No.	Site Information								Measurement Improvements								Priority[2]
	SiteID	Site Name	Site Type	Inspection Date	Latitude	Longitude	Member Unit(s) [1]	Existing Measurement Method	Required For Compliance CCR 23 Sec. 597	Compliance Cost	Level 1 Modernization and Enhancement	Estimated Level 1 Cost	Level 2 Modernization and Enhancement	Estimated Level 2 Cost		Total Improve-ment Cost	
20	PND017	Pond 17	Internal	7/13/11	39.18940	-121.42238	BWD, WWD, SYWD, DCMWC	2 - 8' rectangular orifice gates utilized for water level control and flow measurement.	N/A	N/A	Install pressure transducers upstream and downstream of gates to measure head pressure and install gate position transducers to track gate opening. Empirically derive orifice coefficient with current metering over range of flows and refine flow rating tables. Install solar power system and digital display. Site will be SCADA-Ready	$46,315	Install communication hardware and integrate site into SCADA system to provide real-time monitoring of water level and flow rate	$5,303		$51,619	3
21	MDWPND	The Meadow Pond	Internal	7/13/11	39.17683	-121.43640	BWD, WWD, SYWD, DCMWC	2 - 8' rectangular orifice gates utilized for water level control and flow measurement.	N/A	N/A	Install pressure transducers upstream and downstream of gates to measure head pressure and install gate position transducers to track gate opening. Empirically derive orifice coefficient with current metering over range of flows and refine flow rating tables. Install solar power system and digital display. Site will be SCADA-Ready	$46,315	Install communication hardware and integrate site into SCADA system to provide real-time monitoring of water level and flow rate	$5,303		$51,619	3
22	NRTHDT	North Ditch (Hammon on Road Weir)	Internal	7/20/11	39.16562	-121.45207	BWD	Several downstream propeller meters summed to develop flow rate.	N/A	N/A	Install SonTek IQ in outlet of 60" pipe. Install solar power system and flow display to make site SCADA-Ready	$24,182	Install communication hardware and integrate with SCADA system to provide real-time monitoring of flow rate.	$5,303		$29,485	2
23	WEIR02	Weir 2, 2nd Check Main Canal	Internal	7/20/11	39.14458	-121.46767	BWD, WWD, SYWD, DCMWC	4 - 5' weir bays that go partially submerged at higher flow rates. Boards do move during irrigation season for upstream water level control.	N/A	N/A	Provide weir stick and train Agency staff for proper measurement of flowrate passing over weir.	$362	Install upstream pressure transducer to measure stage. Install solar power system and communication hardware and integrate with SCADA system to provide real-time monitoring of water level	$19,708		$20,070	3
24	FRTSTD	Fruit Stand Weir	Internal	7/20/11	39.14372	-121.47708	BWD, WWD, SYWD, DCMWC	4 - 4' weir bays that go partially submerged at higher flow rates, and 1 - 6' rectangular orifice gate. Boards do move during irrigation season for upstream water level control.	N/A	N/A	Provide weir stick and train Agency staff for proper measurement of flowrate passing over weir.	$362	Install upstream pressure transducer to measure stage. Install solar power system and communication hardware and integrate with SCADA system to provide real-time monitoring of water level	$19,708		$20,070	3

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Table E-3. YCWA Measurement Sites and Summary of Improvements, Associated Costs, and Implementation Priorities (contd.)

No.	Site Information								Measurement Improvements								Priority[2]
	SiteID	Site Name	Site Type	Inspection Date	Latitude	Longitude	Member Unit(s) [1]	Existing Measurement Method	Required For Compliance CCR 23 Sec. 597	Compliance Cost	Level 1 Modernization and Enhancement	Estimated Level 1 Cost	Level 2 Modernization and Enhancement	Estimated Level 2 Cost		Total Improve-ment Cost	
25	RDSCRK	Reeds Creek at North Beale Road	Internal	7/20/11	39.12898	-121.47180	BWD, SYWD	1 - 5' rectangular orifice gate with weir overflows.	N/A	N/A	Install upstream and downstream staff gages in stilling wells to facilitate head pressure measurements and develop theoretical flow rating tables as a function of head pressure and gate opening for each gate.	$13,657	Install pressure transducers upstream and downstream of gates to measure head pressure and install gate position transducers to track gate opening. Empirically derive orifice coefficient with current metering over range of flows and refine flow rating tables. Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$29,833		$43,490	2
26	BECCNL	Bechtel Canal	Internal	6/20/12	39.12548	-121.46791	BWD, WWD	Existing gate structure. Gate not used for flow control.	N/A	N/A	Install SonTek IQ in outlet of pipe. Install solar power system and flow display to make site SCADA-Ready	$31,253	Install communication hardware and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$36,556	3
27	BLZAGT	Belza Gates	Internal	6/20/12	39.12211	-121.46816	BWD, SYWD, DCMWC	None	N/A	N/A	None	N/A	Install upstream pressure transducer in stilling well to measure stage. Install solar power system and communication hardware to site and integrate with SCADA system to provide real-time monitoring of water level	$19,708		$19,708	3
28	WHTLAT	Wheatland Lateral	Internal	7/20/11	39.12537	-121.46792	BWD, WWD	None	N/A	N/A	Install SonTek IQ in siphon approximately 4300' downstream and perform velocity-index rating over range of flows. Install solar power system and flow display	$32,816	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$38,119	2

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Table E-3. YCWA Measurement Sites and Summary of Improvements, Associated Costs, and Implementation Priorities (contd.)

No.	Site Information								Measurement Improvements								Priority[2]
	SiteID	Site Name	Site Type	Inspection Date	Latitude	Longitude	Member Unit(s) [1]	Existing Measurement Method	Required For Compliance CCR 23 Sec. 597	Compliance Cost	Level 1 Modernization and Enhancement	Estimated Level 1 Cost	Level 2 Modernization and Enhancement	Estimated Level 2 Cost		Total Improve-ment Cost	
29	WHTP01	Yuba Wheatland Canal Pump 1	Internal	7/20/11	39.11932	-121.45140	BWD, WWD	Several downstream propeller meters summed to develop flow rate.	N/A	N/A	See improvements for Wheatland Lateral	N/A	Add communication and processing hardware to pumping plant and integrate with SCADA system to provide real-time monitoring of pump status (on/off), upstream water level, pump drive frequency, RPM and other vitals. Allow remote manual adjustment of variable frequency motor drivers.	$19,504		$19,504	3
30	BLKHD	Bulk Head	Internal	6/20/12	39.12058	-121.46142	BWD	None	N/A	N/A	Install upstream and downstream staff gages in stilling wells to facilitate head pressure measurements and develop theoretical flow rating tables as a function of head pressure and gate opening for each gate.	$12,606	Install stage measurement equipment upstream and downstream of gates. Develop gate rating to determine delivered flow rate. Add communication hardware to site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$28,891		$41,498	3
31	NONAME	No Name Creek Spill	Internal	-	39.10834	-121.46822	Spill and BWD	None	N/A	N/A	Provide weir stick and train Agency staff for proper measurement of flowrate passing over weir.	$362	Install level sensor upstream of weir bays. Install solar system and digital display of water level. Install communication hardware and integrate with SCADA system to provide real-time monitoring of water level	$19,708		$20,070	3
32	HTCHCR	Hutchinso n Creek Spill	Internal	6/20/12	39.09330	-121.46824	Spill and BWD	30" sluice gate is adjusted based on operator experience to control deliveries to Creek for downstream customers.	N/A	N/A	Provide weir stick and train Agency staff for proper measurement of flowrate passing over weir. Temporary install SonTek in 30" pipe and track gate opening (stem height) to develop gate rating across a range of flows.	$2,512	Install level sensor upstream of weir bays. Install solar system and digital display of water level. Install communication hardware and integrate with SCADA system to provide real-time monitoring of water level	$19,708		$22,220	3

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Table E-3. YCWA Measurement Sites and Summary of Improvements, Associated Costs, and Implementation Priorities (contd.)

No.	Site Information								Measurement Improvements								Priority[2]
	SiteID	Site Name	Site Type	Inspection Date	Latitude	Longitude	Member Unit(s) [1]	Existing Measurement Method	Required For Compliance CCR 23 Sec. 597	Compliance Cost	Level 1 Modernization and Enhancement	Estimated Level 1 Cost	Level 2 Modernization and Enhancement	Estimated Level 2 Cost		Total Improve-ment Cost	
33	OSTRRD	Ostrom Road Weir	Internal	6/20/12	39.07126	-121.46814	SYWD, DCMWC	None	N/A	N/A	None	N/A	Install level sensor upstream of weir bays. Install solar system and digital display of water level. Install communication hardware and integrate with SCADA system to provide real-time monitoring of water level	$24,417		$24,417	3
34	SYWC02	South Yuba Meter 2	Internal	7/20/11	39.02717	-121.50547	SYWD	McCrometer propeller flow meter installed at the outlet of a 40' pipe under a canal road crossing just south the Best Slough crossing.	N/A	N/A	Install SonTek IQ near outlet of 40' long pipe near location of existing propeller meter.	$32,816	Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$5,303		$38,119	3
35	INTCPT1	Interceptor at Alferos	Boundary Outflow	7/20/11	39.06398	-121.53557	Spill from BWD	2 - 4.9' weir bays with weir boards that possibly move during irrigation season.	N/A	N/A	Provide weir stick and train Agency staff for proper use.	$362	Install SonTek IQ's near outlets of pipes under road crossing downstream of existing measurement weirs. Install communication hardware and integrate site into SCADA system to provide real-time monitoring of water level and flow	$24,810		$25,172	1
36	INTCPT2	Interceptor at Bear River	Boundary Outflow	7/11/12	39.06398	-121.53557	Spill from BWD, SYWD	None	N/A	N/A	Construct 50' long lined section of channel and install SonTek IQ. Mount enclosure on levee road or construct mobile system on trailer. Mobile system allows removal of hardware during winter months when flood danger is high.	$57,696	Install communication hardware and integrate site into SCADA system to provide real-time monitoring of water level and flow	$5,303		$63,000	3

Notes:
[1] In the case of a supply site, this field indicates the Member Unit(s) to which the water passing through each respective site is ultimately delivered. In the case of a drain site, this field indicates the Member Unit(s) from which the water pass through each respective site originates from.
[2] Qualitative description of improvement priorities. High priority = 1, medium priority = 2 and low priority = 3.

Key:
CID = Cordua Irrigation District
BVID = Browns Valley Irrigation District
RWD = Ramirez Water District
HIC = Hallwood Irrigation Company
BWD = Brophy Water District
WWD = Wheatland Water District
SYWD = South Yuba Water District
DCMWC = Dry Creek Mutual Water Company

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Table E-4. Measurement Site Environmental Considerations

No.	Site Information			Waterway Type, Soil Disturbance, and Channel Modifications (See Notes)				
					Soil Disturbance		Channel Modifications	
	SiteID	Site Name	Member Unit(s) [1]	Natural or Man-Made Waterway	Description of Work (Level I and II)[1]	Affected Area, ft^2	Description of Work (Level I and II)[1]	Affected Area, ft^2
CUSTOMER DELIVERY MEASUREMENT SITES								
	Sites on Northside of Yuba River							
1	HLLWDS	Hallwood South	HIC	Man-made	Excavation for concrete control section, installation of SonTek, trenching for electrical conduit, installation of electronics enclosure and mast with antenna and solar panel	3370	Reshaping of channel cross section, excavation for cut-off walls and construction of concrete section. Affected area included in soil disturbance estimate. Removal of riparian vegetation, mainly grasses, small bushes, etc.	1250
2	HLLWDN	Hallwood North	HIC	Man-made	Excavation for concrete control section, installation of SonTek, trenching for electrical conduit, installation of electronics enclosure and mast with antenna and solar panel	8790	Reshaping of channel cross section, excavation for cut-off walls and construction of concrete section. Affected area included in soil disturbance estimate. Removal of riparian vegetation, mainly grasses, small bushes, etc.	2000
3	CRDRMZ	Cordua/Ramirez Canal Heading	RWD, CID	Man-made	Installation of SonTek in (e) concrete section, trenching for electrical conduit, installation of electronics enclosure and mast with antenna and solar panel	1420	Trenching within side slope for conduit installation. Affected are included in soil disturbance estimate	60
4	RAMIRZ	Cordua/Ramirez Split	RWD	Man-made	Installation of SonTek in (e) pipe, trenching for electrical conduit, installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
5	RMZD10	Ramirez D10	RWD	Man-made	Installation of SonTek in (e) pipe, trenching for electrical conduit, installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
6	NY0031	NY31 BVID Pump Canal Heading	BVID	Man-made	Excavation for off-channel stilling well and trenching for electrical conduit for connection to (e) electronics enclosure	230	Trenching within side slope to install stilling well inlet pipe. Affected area included in soil disturbance estimate	32
	Sites on Southside of Yuba River							
7	NY0033	NY33 Baker Gage	BWD, WWD, SYWD, DCMWC	Man-made	No soil disturbance anticipated	0	No channel modifications required	0
8	RUEPMP	Rue Pump Station	WWD	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	250	No channel modifications required	0
9	WHTP02	Yuba Wheatland Canal Pump at Beale Road	WWD	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	2140	Trenching within side slope for conduit installation. Affected area included in soil disturbance estimate	30
10	BUKLMN	Beukleman Delivery	SYWD	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	95	No channel modifications required	0
11	SYWD01	South Yuba Meter 1	SYWD	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
12	DCMWC1	Dry Creek MWC Meter 1	DCMWC	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	490	No channel modifications required	0
NON CUSTOMER DELIVERY MEASUREMENT SITES								
	Sites on Northside of Yuba River							
13	NY0032	NY 32	RWD, CID, HIC	Man-made	Excavation for off-channel stilling well and trenching for electrical conduit for connection to (e) electronics enclosure	230	Trenching within side slope to install stilling well inlet pipe. Affected area is included in soil disturbance	32
14	RMZLFT	Ramirez Lift	RWD	Man-made	Construction of concrete control section, installation of SonTek, trenching for conduit, installation of electronics enclosure and mast with antenna and solar panel	2830	Reshaping of channel cross section, excavation for cut-off walls and construction of concrete lining. Affected area included in soil disturbance estimate	2300
15	HONCK1	Honcut Creek Inflow	RWD	Natural waterway	Construction of concrete control section, installation of SonTek, trenching for conduit, installation of electronics enclosure and mast with antenna and solar panel	10575	Reshaping of channel cross section, excavation for cut-off walls and construction of concrete lining. Affected area included in soil disturbance estimate. Removal of riparian vegetation, potentially including trees >3" diameter	5000

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Table E-4. Measurement Site Environmental Considerations (contd.)

No.	Site Information			Waterway Type, Soil Disturbance, and Channel Modifications (See Notes)				
					Soil Disturbance		Channel Modifications	
	SiteID	Site Name	Member Unit(s) [1]	Natural or Man-Made Waterway	Description of Work (Level I and II)[1]	Affected Area, ft^2	Description of Work (Level I and II)[1]	Affected Area, ft^2
16	JCKSLW	Jack's Slough Weir	BVID, RWD, CID, HIC	Natural waterway	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
17	HONCK2	Honcut Creek Outflow	RWD	Natural waterway	Excavation for concrete control section, installation of SonTek, trenching for conduit, installation of electronics enclosure and mast with antenna and solar panel	3715	Reshaping of channel cross section, excavation for cut-off walls and construction of concrete lining. Affected area included in soil disturbance estimate. Removal of riparian vegetation, potentially including trees >3" diameter	875
	Sites on Southside of Yuba River							
18	SDDAGR	South Diversion at Daguerre	BWD, WWD, SYWD, DCMWC	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	2300	No channel modifications required	0
19	WTRW13	Waterway 13	-	Man-made	Trenching for conduit and installation of small electronics enclosure and mast with solar panel	190	No channel modifications required	0
20	PND017	Pond 17	BWD, WWD, SYWD, DCMWC	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
21	MDWPND	The Meadow Pond	BWD, WWD, SYWD, DCMWC	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
22	NRTHDT	North Ditch (Hammonton Road Weir)	BWD	Man-made	Installation of SonTek in (e) pipe, trenching for electrical conduit, installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
23	WEIR02	Weir 2, 2nd Check Main Canal	BWD, WWD, SYWD, DCMWC	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
24	FRTSTD	Fruit Stand Weir	BWD, WWD, SYWD, DCMWC	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
25	RDSCRK	Reeds Creek at North Beale Road	BWD, SYWD	Man-made	Excavation for two off-channel stilling wells, trenching for electrical conduit and installation of electronics enclosure and mast with antenna and solar panel	460	Trenching within side slope to install stilling well inlet pipe. Affected area included in soil disturbance estimate	64
26	BECCNL	Bechtel Canal	WWD, BWD	Man-made	Excavation for two off-channel stilling wells, trenching for electrical conduit and installation of electronics enclosure and mast with antenna and solar panel	460	Trenching within side slope to install stilling well inlet pipe. Affected area included in soil disturbance estimate	64
27	BLZAGT	Belza Gates	BWD, SYWD, DCMCW	Man-made	Excavation for off-channel stilling well, trenching for electrical conduit and installation of electronics enclosure and mast with antenna and solar panel	230	Trenching within side slope to install stilling well inlet pipe. Area is included in soil disturbance	32
28	WHTLAT	Wheatland Lateral	BWD, WWD	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
29	WHTP01	Yuba Wheatland Canal Pump 1	BWD, WWD	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel at pumping plant	190	No channel modifications required	0
30	BLKHD	Bulk Head	BWD	Man-made	Excavation for off-channel stilling well, trenching for electrical conduit and installation of electronics enclosure and mast with antenna and solar panel	230	Trenching within side slope to install stilling well inlet pipe. Area is included in soil disturbance	32
31	NONAME	No Name Creek Spill	BWD	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0

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Table E-4. Measurement Site Environmental Considerations (contd.)

No.	Site Information			Waterway Type, Soil Disturbance, and Channel Modifications (See Notes)				
					Soil Disturbance		Channel Modifications	
	SiteID	Site Name	Member Unit(s) [1]	Natural or Man-Made Waterway	Description of Work (Level I and II)[1]	Affected Area, ft^2	Description of Work (Level I and II)[1]	Affected Area, ft^2
32	HTCHCR	Hutchinson Creek Spill	BWD	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
33	OSTRRD	Ostrom Road Weir	SYWD, DCMWC	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
34	INTCPT1	Interceptor at Alferos	BWD	Man-made	Installation of SonTeks in (e) pipes, trenching for electrical conduit, installation of electronics enclosure and mast with antenna and solar panel	250	No channel modifications required	0
35	INTCPT2	Interceptor at Bear River	BWD	Man-made	Excavation for concrete control section, installation of SonTek, trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	8830	Reshaping of channel cross section, excavation for cut-off walls and construction of concrete lining. Affected area included in soil disturbance estimate. Removal of riparian vegetation	3250
36	SYWC02	South Yuba Meter 2	SYWD	Man-made	Trenching for conduit and installation of electronics enclosure and mast with antenna and solar panel	190	No channel modifications required	0
					Totals =	49,935	ft^2	15,021 ft^2
						1.1	Acres	0.3 Acres

Notes:
[1] For most sites, environmental impacts are greater during the Level 1 improvements than during Level 2.
[2] Excavation for structural improvements is anticipated to range in depth from 0.5 feet to 4 feet
[3] Excavation for stilling wells is anticipated to range in depth from 3 feet to 10 feet
[4] Reseeding or reestablishment of riparian vegetation may be required at all sites where soil was disturbed, especially where existing vegetation is removed
[5] Erosion control measures (both physical and permitting/reporting) may be required for construction
[6] An archaeological survey may need to be performed by qualified persons prior to construction
[7] A biological review and survey of the area may need to be performed by qualified persons prior to construction
[8] Permits or consultation may be required from: U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Fish and Wildlife Service, CA Fish and Game and the CA Department of Water Resources. This list is not exhaustive; others may be required.

Key:
BVID = Browns Valley Irrigation District
BWD = Brophy Water District
CID = Cordua Irrigation District
DCMWC = Dry Creek Municipal Water Company
ft^2 =square foot
HIC = Hallwood Irrigation Company
RWD = Ramirez Water District
SYWD = South Yuba Water District
WWD = Wheatland Water District

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Yuba County Water Agency
2012 Agricultural Water Management Plan
Attachment E-1:
Measurement Site Inspection Reports

Prepared By

DAVIDS ENGINEERING, INC
www.de-water.com

December 2012

Site Name: NY 31	**MU:** BVID	**Inspection Date:** 2/16/2012
Structure Type: Lift Station	**Accuracy Range:**	**Estimated CI:**
Flow Range: 0-65 cfs	**Flow Depth:** 3-4 ft	**Canal Msmnts (Tw, Bw, H):** 20', 7', 5'
Existing Flow Measurement Method: McCrometer propeller meters on both pipe outlets		
Sensing Device: N/A	**Recording Device:** N/A	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:** N/A	
Current Metered: Yes / No	**Flow Coefficient:** N/A	
Water Characteristics:		
Comments: Lift station has two 100hp pumps, one 125 hp pump, and one 50 hp pump. Rated section (???) maintained by PG&E.		

Photos:

Pump Station

Pipe Outlet Canal Downstream of Bridge

Site Name: North Diversion at Daguerre	**MU:** All North	**Inspection Date:** 7/13/11
Structure Type: 2 Screw Gates	**Accuracy Range:**	**Estimated CI:**
Flow Range: 50-500 cfs	**Flow Depth:** 5-6 ft	**Canal Msmnts (Tw, Bw, H):** Pipes: 6 ft, Canal: 30 ft
Existing Flow Measurement Method: Not Measured		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Some turbulence on the downstream side of the gates.		
Comments: Water is measured downstream, then adjusted with the gates.		

Photos:

Two Head gates on Right Bank

Looking Downstream

Site Name: NY 32	**MU:** All North	**Inspection Date:** 7/13/11
Structure Type: Earthen Canal	**Accuracy Range:** Unknown	**Estimated CI:**
Flow Range: 50-500 cfs	**Flow Depth:** 8ft	**Canal Msmnts (Tw, Bw, H):** 35ft, 10ft, 9ft
Existing Flow Measurement Method: Staff Gage, USGS Bubbler Gate		
Sensing Device: Bubbler Gate	**Recording Device:** Stevens	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: 55.7 Deg. F., 30 ppm salinity, canal runs straight, before and through the site, keeping the water characteristics consistent.		
Comments: PG&E created and maintains the stage-discharge curve using a Price AA meter. Staff gage reading 513 cfs, RiverSurveyor reading was 498 cfs.		

Photos:

Looking Downstream

Staff Gage Downstream of Bridge

Site Name: Hallwood South	**MU:** All North	**Inspection Date:** 7/13/11
Structure Type: 1 Screw Gate, Cement Lined Canal	**Accuracy Range:**	**Estimated CI:**
Flow Range: 0-100 cfs	**Flow Depth:** 2 ft	**Canal Msmnts (Tw, Bw, H):** 15 ft, 12 ft, 5 ft
Existing Flow Measurement Method: Stage-Discharge Curve		
Sensing Device: Float with digital reading	**Recording Device:** ACRO / High Sierra Electronics	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:** PG&E/USGS rating curve still used	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Canal bends on upstream approach		
Comments: Reading 44 cfs at time of Inspection. Pond at the downstream end takes 1/2 to 1/3 of canal flow.		

Photos:

Looking Upstream from Float

Looking Downstream from Float

Site Name: Hallwood North	**MU:** Hallwood	**Inspection Date:** 7/13/11
Structure Type: 2 4ft Screw Gates	**Accuracy Range:**	**Estimated CI:**
Flow Range: 0-200 cfs	**Flow Depth:** 4-5ft	**Canal Msmnts (Tw, Bw, H):** 24ft, 12ft,
Existing Flow Measurement Method: Stage-Discharge Curve		
Sensing Device: Float with Digital Reading	**Recording Device:** ACRO / High Sierra Electronics	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:** Tom recreated curve in 2001-2002	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Good upstream approach.		
Comments: 2 Places to spill originally, now only 1, but SW did not make it to the river except for the sub-flow.		

Photos:

Looking Downstream from Gates

Stilling Well Looking Upstream

Site Name: Cordua/Ramirez Canal	**MU:** Cordua, Ramirez	**Inspection Date:** 7/13/20
Structure Type: Parshall Flume	**Accuracy Range:**	**Estimated CI:**
Flow Range: 0-330 cfs	**Flow Depth:** 6'	**Canal Msmnts (Tw, Bw, H):** 25ft, 15ft, 10ft
Existing Flow Measurement Method: Parshall Flume, Stage Discharge Curve		
Sensing Device: Float, Flume	**Recording Device:** ACRO / High Sierra Electronics	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No (Tom @ low flows)	**Flow Coefficient:**	
Water Characteristics: Good Upstream Approach, Flume is often submerged		

Comments: High flows cause the flume to produce inaccurate readings. 2.49 was read on staff gage, which amounted to 276cfs from the table. Upstream level:8.23ft, downstream level: 8.85ft. Kit Burton designed and built the modified Parshall Flume.

Photos:

Parshall Flume, Stilling Well and Gage

Flume looking Upstream

Site Name: Cordua / Ramirez Split	**MU:** Cordua, Ramirez	**Inspection Date:** 7/20/11
Structure Type: Earthen Canal, Weirs, Gates	**Accuracy Range:**	**Estimated CI:**
Flow Range: 0-330 cfs	**Flow Depth:** 5'	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: Flow meter, Level Sensors		
Sensing Device: Prop. Meter, Accusonic meter, Ultrasoni	**Recording Device:** McCrometer, Accusonic	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Ramirez inlet goes from box to pipe, making a turbulent transition.		

Comments: Prop. Meter to Ramirez reading 89 cfs (reads high). Ramirez Weir leads to 36in pipe, which contains an accusonic meter and prop. meter. Cordua has 2 outlets, one has 2 4ft head gates, the other has 3 3ft head gates. Ultrasonic downward looking level sensor was placed in main canal right after Ramirez splits. Installation of the ultrasonic sensor was done poorly leaving room for level errors.

Photos:

Ramirez Split Outlet to Canal w/ Meter

Ramirez Inlet Foreground, Cordua Inlet Background

Site Name: Ramirez Lift	**MU:** Ramirez	**Inspection Date:** 7/20/11
Structure Type: Lift Pumps, Head Gates, Earthen Canals	**Accuracy Range:**	**Estimated CI:**
Flow Range: 0-100 cfs	**Flow Depth:** N/A	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: Flow Meters		
Sensing Device: Propeller Meters	**Recording Device:** McCrometer	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Pumps lead directly into 2 canals, with the main canl supplying 2 more canals at the pumps outlet.		
Comments: Both pumps are metered, but one of the pumps has an offshoot that is not metered. Typically these meter's read drastically different than the meter at the split. The agency takes its readings from this site. Propeller flow meters currently reading a total of 54 cfs (31 and 23 cfs respectively).		

Photos:

Pump Station Looking Downstream

Lift Outlet with Head Gates for 2 Ditches

Site Name: Ramirez D10 Delivery	**MU:** Ramirez	**Inspection Date:** 8/23/12
Structure Type: Pipe w/ prop meter	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 4ft	**Canal Msmnts (Tw, Bw, H):** 25ft, 10ft, 6ft
Existing Flow Measurement Method: Propeller meter		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Site prone to flow restrictions and measurement problems due to weeds and algae.		
Comments: 30" delivery pipe. Typical flood delivery of 25 to 35 cfs with a maintenance delivery of 5 to 10 cfs		

Photos:

D10 delivery looking downstream from delivery box

D10 delivery head gate looking downstream

Site Name: Jacks Slew Weir	**MU:** All North	**Inspection Date:** 7/20/11
Structure Type: Weir w/ Wood & Iron Panels	**Accuracy Range:**	**Estimated CI:**
Flow Range: 0-100 cfs	**Flow Depth:** 6'	**Canal Msmnts (Tw, Bw, H):** 35ft, 25ft, 9ft
Existing Flow Measurement Method: Weir		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: There is a long freefall over the weir.		

Comments: No sensing device in place, but a possible site for a sensor. It is unclear why the canal is backed up with a weir. The following data was taken from each weir bay, which are as follows (length of weir/head); 4.5'/.57', 4.54'/.63', 4.54'/.63', 4.67'/.68',4.5/.72, 4.58'/.8', 4.58'/.77'. Giving an average flow of 54 cfs over the weir.

Photos:

Weir from Downstream

Weir from Upstream

Site Name: Hallwood North Spill	**MU:** Hallwood	**Inspection Date:** 7/13/11
Structure Type: Conc. Canal/ Weir	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 4ft	**Canal Msmnts (Tw, Bw, H):** 10ft, 10ft, 6ft
Existing Flow Measurement Method: Weir		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Weir has at least 10ft of fall, good upstream approach.		
Comments: 60-70 cfs going through Hallwood canal.		

Photos:

Hallwood Canal with Spill on Left Bank

Spill Looking Downstream

Site Name: Cordua Tail Water (Jacks Slew)	**MU:** Cordua	**Inspection Date:** 7/20/11
Structure Type: Iron Weir to Pipe Culvert	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 5'	**Canal Msmnts (Tw, Bw, H):** 25ft, 15ft
Existing Flow Measurement Method: Weir		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: If WSE gets to high, it spills over the road into the lower canal		
Comments: Weir has a 50in opening leading into a 60in pipe. Weir measured 1.3ft head. Measured 21 cfs at time of inspection.		

Photos:

Weir Bay Looking Upstream

Site Name: Honcut Creek Inflow	**MU:** Ramirez	**Inspection Date:** 7/16/12
Structure Type: Natural channel	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 3ft	**Canal Msmnts (Tw, Bw, H):** 60ft, 45ft, 15ft
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Natural channel with overgrown vegetation on banks. Low, uneven velocity profiles. Channel gradient is slight		
Comments: No measurement at this site. Operator visually estimates flow periodically. Natural flow is supplemented by BVID for d/s deliveries. Customers who receive water out of the creek must pump		

Photos:

Creek looking downstream at Ramirez Road

Creek looking downstream from Ramirez Rd

Site Name: Honcut Creek Outflow	**MU:** Ramirez	**Inspection Date:** 7/16/12
Structure Type: Natural channel	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 2ft	**Canal Msmnts (Tw, Bw, H):** 20ft, 10ft, 4ft
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Meandering natural stream with vegetation on banks that cause flow restrictions. Slight channel gradient		
Comments: Flow measured at confluence of two branches.		

Photos:

Honcut Creek outflow looking downstream

Aerial view of confluence of two branches of Honcut creek

Site Name: South Diversion at Daguerre	**MU:** All South	**Inspection Date:** 7/13/11
Structure Type: 3 Head Gates	**Accuracy Range:**	**Estimated CI:**
Flow Range: 300-480 cfs	**Flow Depth:** N/A	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		
Comments: Between 12-14' of head. 6' circular covers on 5' pipes.		

Photos:

South Diversion Pond

3 head gates

Site Name: Pond 17	**MU:** All South	**Inspection Date:** 7/13/11
Structure Type: 2 Head Gates	**Accuracy Range:**	**Estimated CI:**
Flow Range: 300-480 cfs	**Flow Depth:** N/A	**Canal Msmnts (Tw, Bw, H):** 50ft
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		
Comments: Stem measured from the top of the gearbox to grease mark on stem to find gate opening. Both pipes are 96in. across.		

Photos:

Looking Down at the Head Gates

Looking Upstream from the Gates

Site Name: Waterway 13	**MU:** All South	**Inspection Date:** 7/13/11
Structure Type: Earthen Canal, Head Gate	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** N/A	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		

Comments: Utilized to get water back into the river. The gate is opened when the gates from the river are opened and the overflow needs to be spilled back. If the Pond level gets to high the water will spill over the gate and into the waterway.

Photos:

Head Gate and Pond 17

Gate Overspill

Site Name: Meadow Pond	**MU:** All South	**Inspection Date:** 7/13/11
Structure Type: 2 Head Gates	**Accuracy Range:**	**Estimated CI:**
Flow Range: 300-480 cfs	**Flow Depth:** 5'	**Canal Msmnts (Tw, Bw, H):** 20ft, 15ft, over 10ft
Existing Flow Measurement Method: Staff Gage		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		
Comments: The pond levels are kept between 4.5-5.5'. There are three gates total but one is unused.		

Photos:

Downstream from Gates

Looking Upstream into the Meadow

Site Name: Baker Gage	**MU:** All South	**Inspection Date:** 7/13/11
Structure Type: Earthen Canal	**Accuracy Range:**	**Estimated CI:**
Flow Range: 300-480 cfs	**Flow Depth:** 5'	**Canal Msmnts (Tw, Bw, H):** 35ft, 20ft, 8ft
Existing Flow Measurement Method: Stage-Discharge Curve		
Sensing Device: Bubbler Gate	**Recording Device:** Paroscientific Inc, Campbell Scientific	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Upstream approach comes from 3 pipes, downstream of gage is a weir with no freefall.		

Comments: 3 Head Gates at inlet with 96in pipes. Outlet Weir has 7 bays, each 7.5' across, which leads to 3 96in pipes. Chris from PG&E developed the rating curve. At time of inspection, the gage read 5.23 which was tabulated as 437 cfs. RiverSurveyor measurements put the average at 400 cfs.

Photos:

Looking Upstream from Bridge

Looking Downstream from Bridge

Site Name: North Ditch	**MU:** All South	**Inspection Date:** 7/20/11
Structure Type: Earthen Canal, Head Gate, Pipe	**Accuracy Range:**	**Estimated CI:**
Flow Range: 300-480 cfs	**Flow Depth:** 5'	**Canal Msmnts (Tw, Bw, H):** 30ft
Existing Flow Measurement Method: Stage-Discharge Curve		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Inlet pipe for the north ditch is 6' inside the main canal.		

Comments: The north ditch splits off the main canal to deliver to Brophy. The level of the main canal was reading 2.20ft (at 1.5ft the Baker Gage becomes submerged) The north ditch was reading about 55 cfs from the tabulated values on Ronnies run sheets. Flow rate is determined by summing several propeller meters downstream. The main canal has a head gate and weirs downstream of the north ditch to act as a check structure for level control.

Photos:

North Ditch Inlet from Main Canal

1st Weir for Main Canal D/S from North Ditch

Site Name: Weir 2 / 2nd Check Main Canal	**MU:** All South	**Inspection Date:** 7/20/11
Structure Type: Earthen Canal, Weir Bays	**Accuracy Range:**	**Estimated CI:**
Flow Range: 300-480 cfs, avg. 375 cfs	**Flow Depth:** 5-6ft	**Canal Msmnts (Tw, Bw, H):** 25ft
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		
Comments: Not used as a measurement site, but just as a check structure. 4 Weir Bays each 57in across. Weirs lead into 2 pipes, then back into open channel.		

Photos:

Weir Bays

Downstream Pipe Outlet

Site Name: Fruit Stand Weir	**MU:** All South	**Inspection Date:** 7/20/11
Structure Type: Head Gates, Weirs	**Accuracy Range:**	**Estimated CI:**
Flow Range: 300-480 cfs	**Flow Depth:** 5-6ft	**Canal Msmnts (Tw, Bw, H):** 25ft
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Water has to be kept high enough to irrigate nearby fields that feed directly off of the main canal.		
Comments: The transition consists of 4 weir bays and one head gate that is 6ft long with a wheel on either side. 2/3 of the water is pumped, the rest is gravity fed to fields.		

Photos:

Weir Bays with Head Gate in Background

Head Gates Leading to Fields

Site Name: Reeds Creek at Bill Rd.	**MU:** All South/Brophy	**Inspection Date:** 7/20/11
Structure Type: Earthen Canal	**Accuracy Range:**	**Estimated CI:**
Flow Range: 300-480 cfs	**Flow Depth:** 5-6ft	**Canal Msmnts (Tw, Bw, H):** 30ft
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		

Comments: Reeds Creek branches off the main canal and delivers to Brophy. The split is at the outlet of two pipes. Reeds creek has a head gate at the inlet. Nothing is measured at Brophy, and there are roughly 39 deliveries off Reeds Creek. At time of inspection, the amount of flow in the main canal and Reeds Creek were, 275 cfs and 100cfs respectively.

Photos:

Reed Creek Inlet w/ Main Canal Off to Left

Site Name: Bulkhead	**MU:** Brophy Water District	**Inspection Date:** 6/13/12
Structure Type: Steel headwall w/ 2, ~24" gates	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 4ft	**Canal Msmnts (Tw, Bw, H):** 15ft, 10ft, 6ft
Existing Flow Measurement Method: Orifice		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: approximately 1'+ headloss across gates during inspection		

Comments: Two side-by-side gates that operate independently but discharge into a common culvert. Very few downstream deliveries Delivery to customer(s) within Brophy. Upstream water level appeared to be fairly constant

Photos:

Bulkhead looking downstream

Site Name: Wheatland Lateral	**MU:** Wheatland	**Inspection Date:** 7/20/11
Structure Type: Head gate, Earthen Canal	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 5-6ft	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		
Comments: Wheatland lateral branches off the main canal, from one head gate.		
Photos:		

Site Name: Wheatland Culvert	**MU:** Wheatland	**Inspection Date:** 7/20/11
Structure Type: Earthen Canal, 2 Pipes	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:**	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Water has a good upstream approach		
Comments: The Culvert leads to the Wheatland Pump Station 1 and is a siphon under No Name Creek		
Photos:		

Site Name: Pump Station 1 Wheatland	**MU:** Wheatland	**Inspection Date:** 7/20/11
Structure Type: 5 Pumps	**Accuracy Range:**	**Estimated CI:**
Flow Range: 300-480 cfs	**Flow Depth:**	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		

Comments: The water level is monitored to use the pumps to balance the canal. Pumps 1-4 are 100hp, 5 is 200hp, 3-4 are variable speed. They are typically able to meet the necessary requirements with 2-3 pumps.

Photos:

Pump Looking Upstream

Pump Outlet

Site Name: Rue Pump Station	**MU:** Wheatland	**Inspection Date:** 7/20/11
Structure Type: Pump Sta., Earthen Canal	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 3-4ft	**Canal Msmnts (Tw, Bw, H):** 10ft
Existing Flow Measurement Method: Flow meter		
Sensing Device: McCrometer Propeller meter	**Recording Device:** McCrometer	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Water flows through culvert directly upstream and downstream of the pump station		
Comments: The pump station diverts off of the Wheatland canal, upstream from the Wheatland number 2 pump station.		

Photos:

Pumps Viewed From Upstream Side

Culvert Outlet Downstream of Pumps

Site Name: Pump Station 2, Wheatland	**MU:** Wheatland	**Inspection Date:** 7/20/11
Structure Type: 4 pumps, Earthen Canal	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:**	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		

Comments: Pumps 3-4 are variable speed, 2-4 are 100hp, 1 is 50hp. The downstream canal has 2 limit switches for water levels. Limit switch 1 on the left bank signals a call alarm, limit switch 2 shuts off the pumps.

Photos:

4 Pumps Looking Upstream

Pump Outlet with Limit Switch 1 Next to Gate

Site Name: Belza Gates	**MU:**	**Inspection Date:** 6/13/12
Structure Type: Steel head wall w/ 2 rect. Steel gates	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 6ft	**Canal Msmnts (Tw, Bw, H):** 40ft, 15ft, 10ft
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Flow not measured at this site. Site used for upstream water level control.		
Comments: Gates operated independently but discharge into common culvert pipe. Gates are non-standard. Two upstream pump deliveries. Gates control u/s level and provide delivery to the Bechtel Canal and Wheatland Lateral		

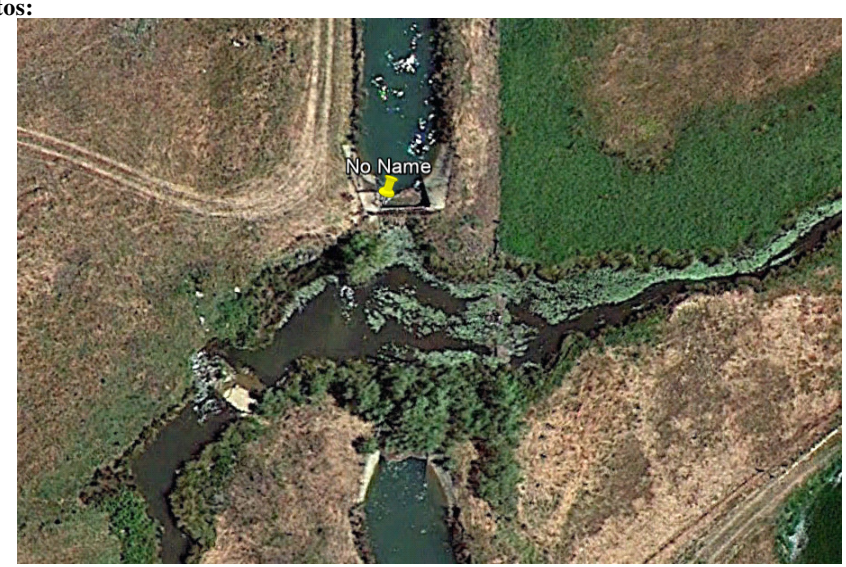
Photos:

Belza Gates looking downstream

Belza Gates from the right bank

Site Name: No Name Creek Spill	**MU:**	**Inspection Date:**
Structure Type: Earthen canal, sipon, weir bds	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:**	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: Weir		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics:		
Comments: Site passes little water over weir to creek. Site not inspected		

Photos:



Aerial view of No Name Spill

Site Name: Hutchinson Creek Siphon and Spill	**MU:** Brophy Water District	**Inspection Date:** 6/13/12
Structure Type: Earthen Canal/ Weir with Sluice Gate	**Accuracy Range:**	**Estimated CI:**
Flow Range: 250-350cfs	**Flow Depth:** 4ft	**Canal Msmnts (Tw, Bw, H):** 40ft, 15ft, 6ft
Existing Flow Measurement Method: Weir and sluice gate		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Water being released through gate and over weirs during visit. 10' drop from top of weir boards to creek		
Comments: Overpour weirs on either side of the creek, each 15ft long (3, 5'weir bays). 30" sluice gate on u/s side discharge directly to creek for d/s delivery to Brophy customers. No flow measurement at site.		

Photos:

Hutchinson Creek weir with gate on Left Bank

Spill Looking Downstream

Site Name: Ostrom Road Weir	**MU:**	**Inspection Date:** 6/13/12
Structure Type: Conc. piers with board slots. 2 ~36" undershot gates	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 4ft	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: Weir		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: W		
Comments: Weir and gates operated to maintain specific water level for upstream deliveries		

Photos:

Weir looking downstream

Weir Looking Upstream

Site Name: Beukleman Delivery	**MU:** South Yuba Water District	**Inspection Date:** 7/12/12
Structure Type: 18" steel pipe to 36" CMP riser, 18" PVC pipe out	**Accuracy Range:**	**Estimated CI:**
Flow Range: ~2-4cfs	**Flow Depth:** 2ft in riser	**Canal Msmnts (Tw, Bw, H):** n/a
Existing Flow Measurement Method: Water Specialties Open Flow Propeller Meter		
Sensing Device: None	**Recording Device:** Prop meter totalizer	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Approximately 70' of straight pipe u/s of propeller meter location. Pipe appears to flow full most of the time		
Comments: Measured 2.2cfs using SonTek IQ. Propeller meter gear was badly corroded and propeller was broken with pieces missing.		

Photos:

Plan view of Beukleman Delivery

36" CMP

Site Name: S. Yuba Meter/Siphon (The Box)	**MU:** South Yuba	**Inspection Date:** 7/20/11
Structure Type: Mixing box through Weirs/Head gates	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 5'	**Canal Msmnts (Tw, Bw, H):** 25-30ft
Existing Flow Measurement Method: Flow Meters		
Sensing Device: Flow Meter	**Recording Device:** McCrometer	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Inlet at the box is through a pipe, and both outlets are controlled with a head gate and weir bays for each canal.		
Comments: Inlet pipe to box is metered, and read 125 cfs at time of inspection. This is the only entrance of water for S. Yuba. The other outlet leads to Dry Creek through a 60in pipe which is metered, that read 55cfs at time of inspection. There are only weirs and a head gate that lead directly to the canal at the S. Yuba inlet, no pipe.		

Photos:

Site from Above

Meter at Box Inlet

Site Name: S. Yuba Meter/Siphon (The Box)	**MU:** DCMWC	**Inspection Date:** 7/20/11
Structure Type: Mixing box through Weirs/Head gates	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 5'	**Canal Msmnts (Tw, Bw, H):** 25-30ft
Existing Flow Measurement Method: Flow Meters		
Sensing Device: Flow Meter	**Recording Device:** McCrometer Propeller Meter	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Inlet at the box is through a pipe, and both outlets are controlled with a head gate and weir bays for each canal.		
Comments: Inlet pipe to box is metered, and read 125 cfs at time of inspection. Water splits between SYWD and DCMWC. South East canal is the only source of water to the DCMWC. Dry Creek has a 60in inlet pipe which is metered, that read 55 cfs at time of inspection.		

Photos:

Site from Above

Meter at Box Inlet

Site Name: South Yuba Meter 2, 3	**MU:** South Yuba	**Inspection Date:** 7/20/11
Structure Type: Earthen Canal to Pipes	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:**	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: Flow Meter		
Sensing Device: Flow Meter	**Recording Device:** McCrometer	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Good upstream approach.		
Comments: Canal leads to 72in pipe, with a meter at the pipes outlet, which read about 33 cfs at time of inspection. Meter 3 lies downstream from meter 2 which leads to another canal. Meter 3 was not functioning properly at time of inspection		

Photos:

Meter 2 and 3 Looking Downstream

Meter 2 Reading

Site Name: Interceptor	**MU:** Brophy	**Inspection Date:** 7/20/11
Structure Type: Earthen Canal, Weirs to Pipes	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:**	**Canal Msmnts (Tw, Bw, H):**
Existing Flow Measurement Method: Weirs		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Good Amount of fall from upstream to downstream.		
Comments: All of Brophy's tail water goes through this site with two 4.9ft weir bays. Weir 1 was reading 19.1cfs at time of inspection.		

Photos:

Weir Bay Looking Upstream

Pipe Outlet

Site Name: Interceptor at Bear River	**MU: Spill from BWD and SYWD**	**Inspection Date:** 7/11/12
Structure Type: None	**Accuracy Range:**	**Estimated CI:**
Flow Range:	**Flow Depth:** 3ft	**Canal Msmnts (Tw, Bw, H):** 65ft, 30ft, 15ft
Existing Flow Measurement Method: None		
Sensing Device: None	**Recording Device:** None	
Parameters Recorded: Level Velocity Flow Other:		
As Built Rating: Yes / No	**Flow Equation:**	
Current Metered: Yes / No	**Flow Coefficient:**	
Water Characteristics: Low velocity during inspection. Channel is subject to flooding during winter months		
Comments: 40 cfs during inspection. Site is total spillage outflow from Brophy, SYWD and any tailwater or spillage that drains to the southwest		

Photos:

Interceptor @ Bear River looking upstream

Looking downstream

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Yuba County Water Agency
2012 Agricultural Water Management Plan
Attachment E-2:
Reconnaissance Level Improvement Cost Estimates

Prepared By

DAVIDS ENGINEERING, INC
www.de-water.com

December 2012

SCADA Base Station and HMI

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$5,003	0%	$5,003	
2	Base Station Computer System	1	LS	$47,000	$47,000	15%	$54,050	
3	Base Station antenna, mast, cables and lightening arrestor	1	EA	$1,500	$1,500	15%	$1,725	
4	Hardened Ditchtender laptop and mount	5	EA	$7,400	$37,000	15%	$42,550	
5	Programming, start-up and debug	1	LS	$1,500	$1,500	15%	$1,725	
6	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal of Direct Costs(including Mobilization)=	**$106,203**	
INDIRECT COSTS								
7	Planning, Design and Engineering	1	LS	15%	$15,930	0%	$15,930	
8	Construction Administration and Overhead	1	LS	15%	$15,930	0%	$15,930	
	TOTAL CONSTRUCTION COST =							**$138,063**

Yuba County Water Agency

Measurement Improvement Plan

Estimate of Capital and Implementation Costs

Spare Equipment

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	F&I SonTek-IQ flowmeter and cable	2	EA	$6,450	$12,900	15%	$14,835	
2	F&I 80W solar panel	2	EA	$400	$800	15%	$920	
3	F&I Submersible pressure transducer	2	EA	$950	$1,900	15%	$2,185	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	F&I gate position sensor	2	EA	$1,501	$3,002	15%	$3,452	
						Subtotal of Direct Costs =	**$23,692**	
	TOTAL CONSTRUCTION COST =							**$23,692**

South Diversion At Daquerre

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$2,171	0%	$2,171	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I SonTek-IQ flowmeter and cable	3	EA	$6,450	$19,350	15%	$22,253	
5	F&I flowmeter mounting bracket	3	EA	$550	$1,650	15%	$1,898	
6	F&I SonTek-IQ flow display	3	EA	$1,400	$4,200	15%	$4,830	
7	F&I 30"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$875	$875	15%	$1,006	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
13	Velocity Index Calibration - non-Wadeable	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$39,549**	
						Subtotal of Direct Costs(including Mobilization)=	**$45,583**	
INDIRECT COSTS								
14	Planning, Design and Engineering	1	LS	15%	$6,837	0%	$6,837	
15	Construction Administration and Overhead	1	LS	15%	$6,837	0%	$6,837	
	TOTAL LEVEL 1 COST =							**$59,258**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal (including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

Waterway 13

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$500	0%	$500	
Structures								
2	10-12" Galv. stilling well - Canal water level	2	EA	$1,300	$2,600	15%	$2,990	
						Subtotal=	**$2,990**	
Measurement Equipment and Materials								
3	F&I Staff Gage	2	EA	$300	$600	15%	$690	
4	Calibration and rating - Non-Standard Orifice Gate	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$7,015**	
						Subtotal of Direct Costs(including Mobilization)=	**$10,505**	
INDIRECT COSTS								
5	Planning, Design and Engineering	1	LS	10%	$1,051	0%	$1,051	
6	Construction Administration and Overhead	1	LS	10%	$1,051	0%	$1,051	
	TOTAL LEVEL 1 COST =							**$12,606**

Pond 17

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,697	0%	$1,697	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I Submersible pressure transducer	2	EA	$950	$1,900	15%	$2,185	
5	4-6" PVC stilling well - PT	2	EA	$600	$1,200	15%	$1,380	
6	F&I gate position sensor	2	EA	$1,700	$3,400	15%	$3,910	
7	F&I Digital display	2	EA	$1,400	$2,800	15%	$3,220	
8	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
9	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
10	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
11	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
12	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
13	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
14	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
15	Calibration and rating - Non-Standard Orifice Gate	2	LS	$5,500	$11,000	15%	$12,650	
						Subtotal=	**$30,067**	
						Subtotal of Direct Costs(including Mobilization)=	**$35,627**	
INDIRECT COSTS								
16	Planning, Design and Engineering	1	LS	15%	$5,344	0%	$5,344	
17	Construction Administration and Overhead	1	LS	15%	$5,344	0%	$5,344	
	TOTAL LEVEL 1 COST =							**$46,315**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

Meadow Pond

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,697	0%	$1,697	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I Submersible pressure transducer	2	EA	$950	$1,900	15%	$2,185	
5	4-6" PVC stilling well - PT	2	EA	$600	$1,200	15%	$1,380	
6	F&I gate position sensor	2	EA	$1,700	$3,400	15%	$3,910	
7	F&I Digital display	2	EA	$1,400	$2,800	15%	$3,220	
8	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
9	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
10	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
11	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
12	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
13	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
14	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
15	Calibration and rating - Non-Standard Orifice Gate	2	LS	$5,500	$11,000	15%	$12,650	
						Subtotal=	**$30,067**	
						Subtotal of Direct Costs(including Mobilization)=	**$35,627**	
INDIRECT COSTS								
16	Planning, Design and Engineering	1	LS	15%	$5,344	0%	$5,344	
17	Construction Administration and Overhead	1	LS	15%	$5,344	0%	$5,344	
	TOTAL LEVEL 1 COST =							**$46,315**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

NY33- Baker Gage

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$316	0%	$316	
Measurement Equipment and Materials								
2	Velocity Index Calibration - non-Wadeable	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$6,325**	
						Subtotal of Direct Costs(including Mobilization)=	**$6,641**	
INDIRECT COSTS								
3	Planning, Design and Engineering	1	LS	10%	$664	0%	$664	
4	Construction Administration and Overhead	1	LS	10%	$664	0%	$664	
	TOTAL LEVEL 1 COST =							**$7,970**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$820	0%	$820	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
4	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
5	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
6	Velocity Index Calibration - non-Wadeable	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$15,985**	
						Subtotal of Direct Costs(including Mobilization)=	**$17,219**	
INDIRECT COSTS								
7	Planning, Design and Engineering	1	LS	10%	$1,722	0%	$1,722	
8	Construction Administration and Overhead	1	LS	10%	$1,722	0%	$1,722	
	TOTAL LEVEL 2 COST =							**$20,663**

North Ditch- Hammonton Road Weir

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$886	0%	$886	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
						Subtotal=	**$13,852**	
						Subtotal of Direct Costs(including Mobilization)=	**$18,602**	
INDIRECT COSTS								
15	Planning, Design and Engineering	1	LS	15%	$2,790	0%	$2,790	
16	Construction Administration and Overhead	1	LS	15%	$2,790	0%	$2,790	
	TOTAL LEVEL 1 COST =							**$24,182**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

Weir 2

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$14	0%	$14	
Measurement Equipment and Materials								
2	Calibrated weir stick and training	1	EA	$250	$250	15%	$288	
						Subtotal=	**$288**	
						Subtotal of Direct Costs(including Mobilization)=	**$302**	
INDIRECT COSTS								
15	Planning, Design and Engineering	1	LS	10%	$30	0%	$30	
16	Construction Administration and Overhead	1	LS	10%	$30	0%	$30	
	TOTAL LEVEL 1 COST =							**$362**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$722	0%	$722	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	
4	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	
5	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	
6	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
14	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$14,024**	
						Subtotal of Direct Costs(including Mobilization)=	**$15,160**	
INDIRECT COST								
15	Planning, Design and Engineering	1	LS	15%	$2,274	0%	$2,274	
16	Construction Administration and Overhead	1	LS	15%	$2,274	0%	$2,274	
	TOTAL LEVEL 2 COST =							**$19,708**

Fruit Stand Weir

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$14	0%	$14	
	Measurement Equipment and Materials							
2	Calibrated weir stick and training	1	EA	$250	$250	15%	$288	
						Subtotal=	**$288**	
						Subtotal of Direct Costs(including Mobilization)=	**$302**	
INDIRECT COSTS								
3	Planning, Design and Engineering	1	LS	10%	$30	0%	$30	
4	Construction Administration and Overhead	1	LS	10%	$30	0%	$30	
	TOTAL LEVEL 1 COST =							**$362**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$722	0%	$722	
	General							
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
	Measurement Equipment and Materials							
3	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	
4	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	
5	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	
6	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
14	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$14,024**	
						Subtotal of Direct Costs(including Mobilization)=	**$15,160**	
INDIRECT COST								
15	Planning, Design and Engineering	1	LS	15%	$2,274	0%	$2,274	
16	Construction Administration and Overhead	1	LS	15%	$2,274	0%	$2,274	
	TOTAL LEVEL 2 COST =							**$19,708**

Reeds Creek at North Beale Road

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$500	0%	$500	
Structures								
2	10-12" Galv. stilling well - Canal water level	2	EA	$1,300	$2,600	15%	$2,990	
						Subtotal=	**$2,990**	
Measurement Equipment and Materials								
3	F&I Staff gage	2	EA	$300	$600	15%	$690	
4	Calibration and rating - Non-Standard Orifice Gate	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$7,015**	
						Subtotal pf Direct Costs (including Mobilization)=	**$10,505**	
INDIRECT COSTS								
5	Planning, Design and Engineering	1	LS	15%	$1,576	0%	$1,576	
6	Construction Administration and Overhead	1	LS	15%	$1,576	0%	$1,576	
	TOTAL LEVEL 1 COST =							**$13,657**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,093	0%	$1,093	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I Submersible pressure transducer	2	EA	$950	$1,900	15%	$2,185	
5	F&I gate position sensor	1	EA	$1,700	$1,700	15%	$1,955	
6	F&I Digital display	2	EA	$1,400	$2,800	15%	$3,220	
7	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
8	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
9	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
10	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
11	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
12	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
13	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
14	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
15	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$17,992**	
						Subtotal of Direct Costs(including Mobilization)=	**$22,949**	
INDIRECT COSTS								
16	Planning, Design and Engineering	1	LS	15%	$3,442	0%	$3,442	
17	Construction Administration and Overhead	1	LS	15%	$3,442	0%	$3,442	
	TOTAL LEVEL 2 COST =							**$29,833**

Bechtel Canal

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,202	0%	$1,202	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
13	Velocity Index Calibration - non-Wadeable	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$20,177**	
						Subtotal of Direct Costs(including Mobilization)=	**$24,041**	
INDIRECT COSTS								
14	Planning, Design and Engineering	1	LS	15%	$3,606	0%	$3,606	
15	Construction Administration and Overhead	1	LS	15%	$3,606	0%	$3,606	
	TOTAL LEVEL 1 COST =							**$31,253**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

Wheatland Lateral

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,202	0%	$1,202	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
13	Velocity Index Calibration - non-Wadeable	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$20,177**	
						Subtotal of Direct Cost(including Mobilization)=	**$25,243**	
INDIRECT COST								
14	Planning, Design and Engineering	1	LS	15%	$3,786	0%	$3,786	
15	Construction Administration and Overhead	1	LS	15%	$3,786	0%	$3,786	
	TOTAL LEVEL 1 COST =							**$32,816**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COST								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Cost(including Mobilization)=	**$4,419**	
INDIRECT COST								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

Belza Gates

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
						Subtotal of Direct Costs(including Mobilization)=	**$0**	
INDIRECT COSTS								
	TOTAL LEVEL 1 COST =							**$0**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$722	0%	$722	
	General							
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
	Measurement Equipment and Materials							
3	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	
4	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	
5	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	
6	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
14	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$14,024**	
						Subtotal of Direct Costs (including Mobilization)=	**$15,160**	
INDIRECT COSTS								
15	Planning, Design and Engineering	1	LS	15%	$2,274	0%	$2,274	
16	Construction Administration and Overhead	1	LS	15%	$2,274	0%	$2,274	
	TOTAL LEVEL 2 COST =							**$19,708**

Bulk Head

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$500	0%	$500	
	Structures							
2	10-12" Galv. stilling well - Canal water level	2	EA	$1,300	$2,600	15%	$2,990	
						Subtotal=	**$2,990**	
	Measurement Equipment and Materials							
3	F&I Staff gage	2	EA	$300	$600	15%	$690	
4	Calibration and rating - Non-Standard Orifice Gate	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$7,015**	
						Subtotal of Direct Costs(including Mobilization)=	**$10,505**	
INDIRECT COSTS								
5	Planning, Design and Engineering	1	LS	10%	$1,051	0%	$1,051	
6	Construction Administration and Overhead	1	LS	10%	$1,051	0%	$1,051	
	TOTAL LEVEL 1 COST =							**$12,606**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,058	0%	$1,058	
	General							
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
	Measurement Equipment and Materials							
3	F&I Submersible pressure transducer	2	EA	$950	$1,900	15%	$2,185	
4	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	
5	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
6	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
7	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
13	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
14	Calibration and rating - Non-Standard Orifice Gate	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$20,752**	
						Subtotal of Direct Costs (including Mobilization)=	**$22,224**	
INDIRECT COSTS								
15	Planning, Design and Engineering	1	LS	15%	$3,334	0%	$3,334	
16	Construction Administration and Overhead	1	LS	15%	$3,334	0%	$3,334	
	TOTAL LEVEL 2 COST =							**$28,891**

No Name Creek Spill

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$14	0%	$14	
	Measurement Equipment and Materials							
2	Calibrated weir stick and training	1	EA	$250	$250	15%	$288	
						Subtotal=	**$288**	
						Subtotal of Direct Costs(including Mobilization)=	**$302**	
INDIRECT COSTS								
3	Planning, Design and Engineering	1	LS	10%	$30	0%	$30	
4	Construction Administration and Overhead	1	LS	10%	$30	0%	$30	
	TOTAL LEVEL 1 COST =							**$362**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$722	0%	$722	
	General							
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
	Measurement Equipment and Materials							
3	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	
4	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	
5	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	
6	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
14	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$14,024**	
						Subtotal of Direct Costs(including Mobilization)=	**$15,160**	
INDIRECT COSTS								
15	Planning, Design and Engineering	1	LS	15%	$2,274	0%	$2,274	
16	Construction Administration and Overhead	1	LS	15%	$2,274	0%	$2,274	
	TOTAL LEVEL 2 COST =							**$19,708**

Hutchinson Creek Spill

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$92	0%	$92	
Measurement Equipment and Materials								
2	Calibrated weir stick and training	1	EA	$250	$250	15%	$288	
3	Daily rental of SonTek-IQ	7	EA	$50	$350	15%	$403	
4	Calibration and rating - Standard Orifice Gate	1	LS	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$1,840**	
						Subtotal of Direct Costs(including Mobilization)=	**$1,932**	
INDIRECT COSTS								
5	Planning, Design and Engineering	1	LS	15%	$290	0%	$290	
6	Construction Administration and Overhead	1	LS	15%	$290	0%	$290	
	TOTAL LEVEL 1 COST =							**$2,512**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$722	0%	$722	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	
4	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	
5	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	
6	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
14	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$14,024**	
						Subtotal of Direct Costs(including Mobilization)=	**$15,160**	
INDIRECT COSTS								
15	Planning, Design and Engineering	1	LS	15%	$2,274	0%	$2,274	
16	Construction Administration and Overhead	1	LS	15%	$2,274	0%	$2,274	
	TOTAL LEVEL 2 COST =							**$19,708**

Ostrom Road Weir

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
						Subtotal of Direct Costs(including Mobilization)=	**$0**	
INDIRECT COSTS								
	TOTAL LEVEL 1 COST =							**$0**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$894	0%	$894	
	General							
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
	Structures							
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
	Measurement Equipment and Materials							
4	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	
5	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	
6	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	
7	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
8	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
9	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
10	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
11	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
12	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
13	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
14	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
15	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$14,024**	
						Subtotal of Direct Costs(including Mobilization)=	**$18,783**	
INDIRECT COSTS								
16	Planning, Design and Engineering	1	LS	15%	$2,817	0%	$2,817	
17	Construction Administration and Overhead	1	LS	15%	$2,817	0%	$2,817	
	TOTAL LEVEL 2 COST =							**$24,417**

Beukleman Delivery

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$168	0%	$168	
	Measurement Equipment and Materials							
2	F&I 18" Open flow propeller meter	1	EA	$2,920	$2,920	15%	$3,358	
						Subtotal=	**$3,358**	
						Subtotal of Direct Costs(including Mobilization)=	**$3,526**	
INDIRECT COSTS								
13	Planning, Design and Engineering	1	LS	10%	$353	0%	$353	
14	Construction Administration and Overhead	1	LS	10%	$353	0%	$353	
	TOTAL COST FOR SBx7-7 COMPLIANCE=							**$4,231**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$886	0%	$886	
	General							
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
	Structures							
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
	Measurement Equipment and Materials							
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
						Subtotal=	**$13,852**	
						Subtotal of Direct Costs(including Mobilization)=	**$18,602**	
INDIRECT COSTS								
13	Planning, Design and Engineering	1	LS	10%	$1,860	0%	$1,860	
14	Construction Administration and Overhead	1	LS	10%	$1,860	0%	$1,860	
	TOTAL LEVEL 1 COST =							**$22,322**

Wheatland Pump Station #1

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
						Subtotal of Direct Costs(including Mobilization)=	**$0**	
INDIRECT COSTS								
	TOTAL LEVEL 1 COST =							**$0**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$714	0%	$714	
	General							
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
	Structures							
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
	Measurement Equipment and Materials							
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	
6	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
7	F&I 20W solar panel, mounting bracket and charge controller	1	EA	$710	$710	15%	$817	
8	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
9	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
10	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
11	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
12	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$10,425**	
						Subtotal of Direct Costs(including Mobilization)=	**$15,003**	
INDIRECT COSTS								
13	Planning, Design and Engineering	1	LS	15%	$2,250	0%	$2,250	
14	Construction Administration and Overhead	1	LS	15%	$2,250	0%	$2,250	
	TOTAL LEVEL 2 COST =							**$19,504**

Rue Pump Station

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,173	0%	$1,173	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I magnetic flowmeter (8"-12")	1	EA	$3,424	$3,424	15%	$3,938	
4	F&I magnetic flowmeter (14"-18")	1	EA	$5,200	$5,200	15%	$5,980	
5	F&I magnetic flowmeter (20"-24")	1	EA	$6,848	$6,848	15%	$7,875	
6	Internal magmeter datalogger, software and cable	3	EA	$160	$480	15%	$552	
7	Remote mounted flow display	3	EA	$150	$450	15%	$518	
8	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
11	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
						Subtotal=	**$23,054**	
						Subtotal of Direct Costs(including Mobilization)=	**$24,641**	
INDIRECT COSTS								
14	Planning, Design and Engineering	1	LS	15%	$3,696	0%	$3,696	
15	Construction Administration and Overhead	1	LS	15%	$3,696	0%	$3,696	
	TOTAL LEVEL 1 COST =							**$32,034**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$233	0%	$233	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	F&I pulse frequency meter/counter module (pulse to Modbus)	1	EA	$400	$400	15%	$460	
6	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$4,255**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,902**	
INDIRECT COSTS								
7	Planning, Design and Engineering	1	LS	10%	$490	0%	$490	
8	Construction Administration and Overhead	1	LS	10%	$490	0%	$490	
	TOTAL LEVEL 2 COST =							**$5,883**

Wheatland Pump Station #2

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,202	0%	$1,202	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
13	Velocity Index Calibration - non-Wadeable	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$20,177**	
						Subtotal of Direct Costs(including Mobilization)=	**$25,243**	
INDIRECT COSTS								
14	Planning, Design and Engineering	1	LS	15%	$3,786	0%	$3,786	
15	Construction Administration and Overhead	1	LS	15%	$3,786	0%	$3,786	
	TOTAL COST FOR SBx7-7 COMPLIANCE=							**$32,816**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

South Yuba Water District Meter #1

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,202	0%	$1,202	
	General							
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
	Structures							
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
	Measurement Equipment and Materials							
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
13	Velocity index calibration - non-wadeable	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$20,177**	
						Subtotal of Direct Costs(including Mobilization)=	**$25,243**	
INDIRECT COSTS								
14	Planning, Design and Engineering	1	LS	15%	$3,786	0%	$3,786	
15	Construction Administration and Overhead	1	LS	15%	$3,786	0%	$3,786	
	TOTAL COST FOR SBx7-7 COMPLIANCE=							**$32,816**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
	General							
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
	Measurement Equipment and Materials							
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

Dry Creek Mutual Water Company Meter #1

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,202	0%	$1,202	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
13	Velocity index calibration - non-wadeable	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$20,177**	
						Subtotal of Direct Costs(including Mobilization)=	**$25,243**	
INDIRECT COSTS								
14	Planning, Design and Engineering	1	LS	15%	$3,786	0%	$3,786	
15	Construction Administration and Overhead	1	LS	15%	$3,786	0%	$3,786	
	TOTAL LEVEL 1 COST =							**$32,816**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

South Yuba Water District Meter #2

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,202	0%	$1,202	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Structures								
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$3,450**	
Measurement Equipment and Materials								
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
13	Velocity index calibration - non-wadeable	1	LS	$5,500	$5,500	15%	$6,325	
						Subtotal=	**$20,177**	
						Subtotal of Direct Costs (including Mobilization)=	**$25,243**	
INDIRECT COSTS								
14	Planning, Design and Engineering	1	LS	15%	$3,786	0%	$3,786	
15	Construction Administration and Overhead	1	LS	15%	$3,786	0%	$3,786	
	TOTAL LEVEL 1 COST =							**$32,816**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

Interceptor at Alferos

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$14	0%	$14	
Measurement Equipment and Materials								
2	Calibrated weir stick and training	1	EA	$250	$250	15%	$288	
						Subtotal=	**$288**	
						Subtotal of Direct Costs(including Mobilization)=	**$302**	
INDIRECT COSTS								
3	Planning, Design and Engineering	1	LS	10%	$30	0%	$30	
4	Construction Administration and Overhead	1	LS	10%	$30	0%	$30	
	TOTAL LEVEL 1 COST =							**$362**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$909	0%	$909	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
4	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
5	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
6	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
7	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
10	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
13	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$17,762**	
						Subtotal of Direct Costs(including Mobilization)=	**$19,085**	
INDIRECT COSTS								
14	Planning, Design and Engineering	1	LS	15%	$2,863	0%	$2,863	
15	Construction Administration and Overhead	1	LS	15%	$2,863	0%	$2,863	
	TOTAL LEVEL 2 COST =							**$24,810**

Interceptor at Bear River

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$2,113	0%	$2,113	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Earthwork								
3	Excavation - Excavator	150	CY	$7	$975	15%	$1,121	
4	Compacted In-Place Fill	50	CY	$9	$450	15%	$518	
						Subtotal=	**$1,639**	
Structures								
5	Concrete canal lining - 6" thick, reinforced	1200	SF	$8	$9,600	15%	$11,040	
6	Reinforced Concrete	10	CY	$1,000	$10,000	15%	$11,500	
						Subtotal=	**$22,540**	
Measurement Equipment and Materials								
7	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	
8	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	
9	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	
10	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	
11	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	
12	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	
13	F&I mast, cables, and lightening arrestor	1	LS	$700	$700	15%	$805	
14	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$975	$975	15%	$1,121	
15	Assembly of electronics panel	1	LS	$400	$400	15%	$460	
16	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	
						Subtotal=	**$17,676**	
						Subtotal of Direct Costs(including Mobilization)=	**$44,382**	
INDIRECT COSTS								
17	Planning, Design and Engineering	1	LS	15%	$6,657	0%	$6,657	
18	Construction Administration and Overhead	1	LS	15%	$6,657	0%	$6,657	
	TOTAL LEVEL 1 COST =							**$57,696**

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Total Cost, ($)
DIRECT COSTS								
1	Mobilization (% of Direct Costs)	1	LS	5%	$210	0%	$210	
General								
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	
						Subtotal=	**$414**	
Measurement Equipment and Materials								
3	F&I antenna	1	EA	$300	$300	15%	$345	
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	
5	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	
						Subtotal=	**$3,795**	
						Subtotal of Direct Costs(including Mobilization)=	**$4,419**	
INDIRECT COSTS								
6	Planning, Design and Engineering	1	LS	10%	$442	0%	$442	
7	Construction Administration and Overhead	1	LS	10%	$442	0%	$442	
	TOTAL LEVEL 2 COST =							**$5,303**

Yuba County Water Agency
2012 Agricultural Water Management Plan

Attachment F: Net Benefit Analysis for Canal Automation Alternatives

Prepared By

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December 2012

BACKGROUND AND EXEMPTION

Under SBx7-7, a water supplier may be exempt from performing an NBA if either an EWMP is being implemented at a satisfactory level or an EWMP is technically infeasible. YCWA currently owns and operates three automated lift pump stations on the Yuba Wheatland Canal that are used to serve the Wheatland Water District (WWD) member unit. These pump stations operate to automatically vary flow rates to maintain a set downstream water level, essentially providing on-demand irrigation service to WWD. Additionally, YCWA is implementing a Measurement Improvement Program (MIP), which includes remote, real-time monitoring of flows and water levels at key boundary inflow, boundary outflow, and internal operational sites, many of which are used to measure deliveries to the Agency's customers, the member units. The MIP is included as Attachment E of YCWA's 2012 Agricultural Water Management Plan (AWMP). Despite this existing satisfactory level of implementation of this EWMP, YCWA is interested in further evaluating alternatives to increase the automation of its distribution system, which consists of the South Canal, Yuba Wheatland Canal, Yuba Wheatland Canal Pump Stations 1, 2 and 3, and various water control structures associated with these facilities.

AUTOMATION ALTERNATIVES

YCWA has developed and evaluated two automation alternatives being considered for the distribution system owned and operated by YCWA south of the Yuba River. YCWA does not own any facilities within its member unit service areas north of the Yuba River. The two alternatives considered include the following:

- Alternative 1: Automation and routing of excess flows in event of Yuba Wheatland Canal pump station failure.
- Alternative 2: Automated flow and level control to minimize head fluctuations resulting from time-of-use delivery pump operation by irrigators.

Facilities to be improved as part of automation Alternatives 1 and 2 are shown in Figure F-1. In the figure, facilities included in Alternative 1 are labeled with a blue background, while additional facilities included as part of Alternative 2 are labeled with a yellow background.

These alternatives have been developed at the reconnaissance level and require additional hydraulic analysis and design prior to being implemented. It is anticipated that YCWA will refine the evaluation of these alternatives prior to preparation of its 2015 AWMP.

ALTERNATIVE 1. CONVEYANCE OF EXCESS FLOW FROM YUBA WHEATLAND CANAL PUMP FAILURE

The maximum operating capacities of Yuba Wheatland Canal Pump Station 1 (WPS1) and Yuba Wheatland Canal Pump Station 2 (WPS2) are approximately 200 cfs. The pump stations currently supply a peak demand of approximately 100 cfs, which is sufficient to supply the current amount of land receiving surface water in WWD. The pump stations are fitted with a combination of single speed and variable speed pumps that are designed to automatically respond to changes in downstream water levels; which are set locally by YCWA operators. Water level limits are set to turn the pumps off if the upstream water level drops below a specific

threshold. Malfunctions within the system trigger alarms that are relayed to the system operators via cell phone.

The section of the Yuba Wheatland Canal upstream of WPS1 is relatively flat and creates a long pool that extends upstream into the Bechtel Lateral and back to the South Canal. The canal has minimal freeboard and may overtop its banks if there is an extended pump failure or flow mismatch. There is no water control structure at the division of the Bechtel Lateral and the Yuba Wheatland Canal, and the manual operation, limited capacity, and undershot configuration of the Belza Gates cause surplus flows (due to pump failure, etc.) to increase water levels in the Bechtel Lateral and the South Canal up to the Reeds Creek head gates downstream of the North Beale Road crossing. The resulting spillage into lower Reeds Creek (over the weir boards at the head gates), infringement on freeboard in the South Canal, and potential flooding of Reeds Creek upstream of the road crossing are major operational issues for YCWA and also impact operations on Beale Air Force Base (through which upper Reeds Creek flows). From an operational perspective, it would be preferable to convey excess flows down the South Canal to the Hutchison Creek siphon, where they could be discharged to the Creek and safely conveyed out of the distribution system until adjustments at the heading of the South Canal can be made.

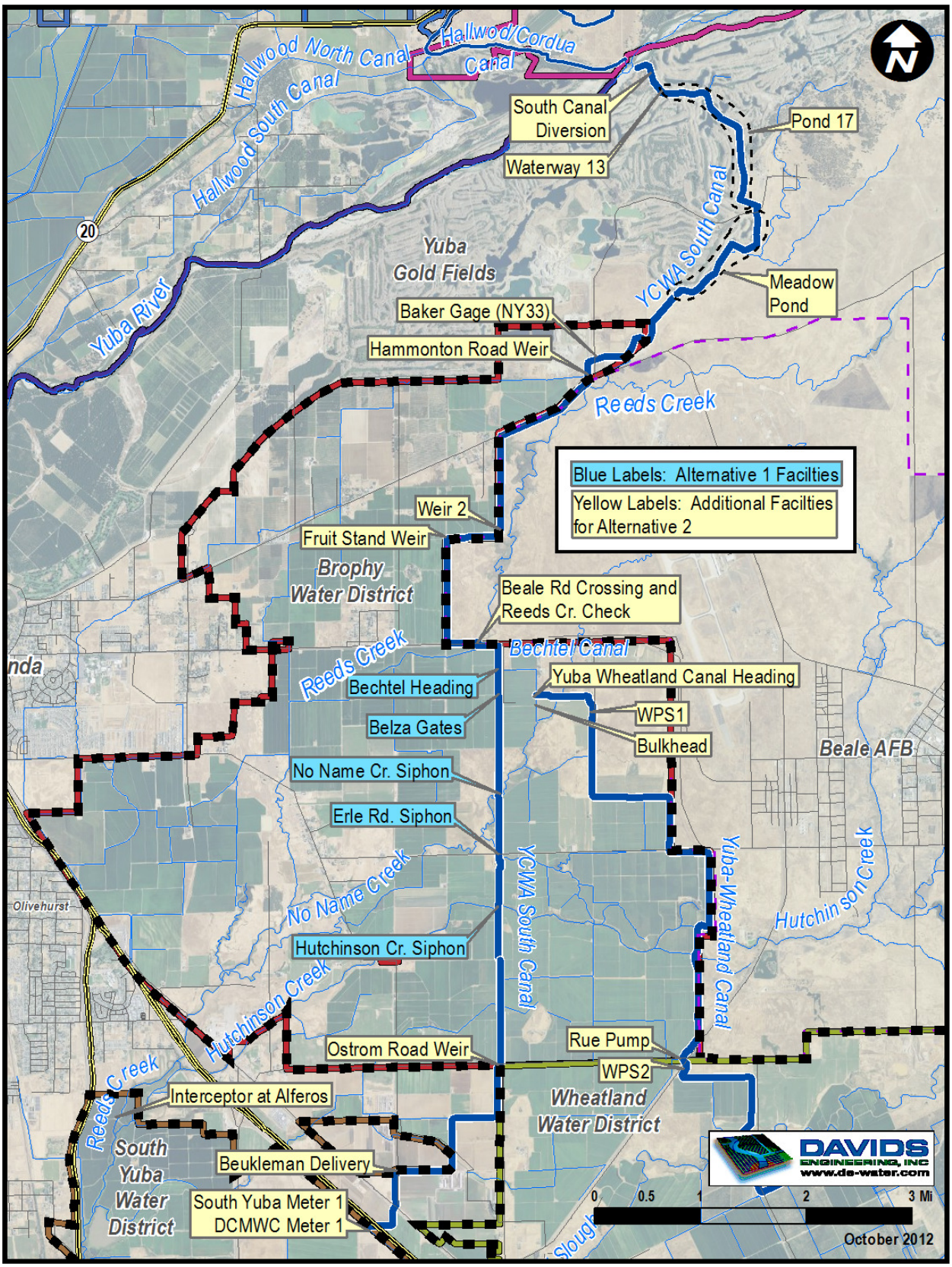

Figure F-1. Facilities Included as Part of YCWA Automation Alternatives 1 and 2

In order to evaluate this alternative, YCWA has identified conceptual improvements to automatically route excess flow to Hutchison Creek, and to a lesser extent, No Name Creek, rather than to Reed's Creek. This alternative is described in greater detail below.

ALTERNATIVE 2. AUTOMATED FLOW AND LEVEL CONTROL OF SOUTH CANAL

The member units served by the South Canal system consist of approximately 50 percent rice and 50 percent non-ponded crops, although fields receiving water directly from the South Canal or Yuba Wheatland Canal are primarily rice. Following flood up in the spring, rice irrigation generally consists of delivering a relatively small, continuous inflow to the field to maintain pond storage and a small amount of runoff to maintain the flow of water through the ponds. Many portions of the South Canal are below grade, making it necessary to use pumps at individual delivery locations to lift water from the canal to the field. Additionally, in some locations gravity deliveries are possible. It is estimated that approximately 15 of 30 total deliveries to individual member unit irrigators from the South Canal downstream of North Beale Road and from the Yuba Wheatland Canal and Bechtel Lateral upstream of WPS1 are gravity deliveries.

The system is operated to accommodate shut down of delivery pumps by irrigators during peak electrical use periods (i.e., 11 a.m. to 6 p.m.) to avoid time-of-use electrical rates. In order to maximize the ability to deliver water via gravity while preventing overtopping of the canal, water levels are maintained such that the maximum water level occurs prior to restart of the delivery pumps each evening. Over the course of a typical day water levels begin to decline once the pumps are turned on in the evening, decrease until the pumps are turned off at around 11 a.m. the next day, and then increase as storage in the system increases prior to the pumps being turned back on. This operational strategy takes advantage of available storage capacity in the canal and avoids the need to make extensive adjustments during the day to reduce and increase inflows to account for pump shutoff and restart, respectively, while attempting to maintain constant water levels for gravity deliveries.

A consequence of the operational strategy described above is that both pump flow rates and gravity delivery rates vary over the course of the day due to changes in the canal water level. Automation of diversion and control structures throughout the system could help reduce the water level fluctuations, providing more steady delivery to individual fields and at member unit delivery locations. Increased delivery steadiness would allow for improved irrigation management, particularly for non-rice crops using surface irrigation. Additionally, improved control of system water levels and inflows could allow for reductions in operational spillage.

In order to allow for reduced operational spillage from YCWA facilities, improved delivery steadiness for deliveries directly to fields from the South Canal and Yuba Wheatland Canal, and improved delivery steadiness to individual member units (enabling reduced spillage by member units and improved on-farm irrigation management by member unit customers), opportunities to automate the South Canal and Yuba Wheatland Canal have been evaluated. Specifically, improvements at key operational sites have been identified to provide strategic flow and water level control and spill routing throughout the system. A key component of this alternative would be automated flow control at the Meadow Pond outlet, the primary flow regulation point for inflows into the South Canal, along with increased ability to exercise available regulating storage in Pond 17 and the Meadow Pond. Additionally, Alternative 2 includes the improvements for routing of excess flows in the event of failure of the Yuba Wheatland Canal pump stations as

described for Alternative 1. This alternative is described in greater detail in the following sections.

RECONNAISSANCE LEVEL IMPROVEMENTS AND COSTS

ALTERNATIVE 1. CONVEYANCE OF EXCESS FLOWS FROM YUBA WHEATLAND CANAL PUMP FAILURE

For Alternative 1, improvements would be made at six sites. Individual site improvements are listed in Table F-2. For each site, the following information is provided:

- Site name
- Site location (latitude and longitude)
- Site type (division structure, control structure, spill, or conveyance)
- Downstream member unit(s)
- Approximate stationing on the South Canal
- Site operational objective (description of rationale for improvements)
- Site physical improvements (description of anticipated upgrades to achieve operational objectives)
- Total, upfront improvement cost
- Annualized cost of initial capital and ongoing maintenance

In addition to the site improvements, the costs of establishing a SCADA base station and acquiring spare equipment to support timely repair or replacement of SCADA components are provided. As indicated in Table F-2, the total estimated upfront improvement cost for alternative 1 is $3.8 million with an annualized cost of $230,000. Detailed costs for each site and to establish SCADA are provided in attachment F-1. Conceptual layouts for selected sites are detailed in Figures F-2 through F-4.

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Table F-1. YCWA Automation Alternative 1: Reconnaissance Level Improvements and Costs

No.	SiteID	Site Name	Latitude	Longitude	Site Type	Member Unit(s)	Station on South Main Canal	Description of Operational Objective	Description of Physical Improvements	Improve-ment Cost	Annualized Cost
1	BECCNL	Bechtel Canal	39.12548	-121.46791	Division	BWD, WWD	474+57	Provide flow control to Bechtel Canal and to Wheatland Lateral, and allow redirection of excess flows to South Canal in the event of Yuba Wheatland Canal pump malfunction and shutoff. Improvements prevent canal overtopping and excessive changes in water levels. Additionally, provides option of downstream level control to automatically limit inflow if pumps shut off.	Remove existing structure, construct new concrete structure, and install automated flow control overshot gates. Gates discharge into parallel pipelines through embankment into Bechtel Canal. Install solar power system, digital display, PLC and full SCADA site for remote monitoring and control.	$305,000	$24,000
2	BLZAGT	Belza Gates	39.12211	-121.46816	Control	BWD, SYWD, DCMWC	486+75	Improvements provide upstream level control over a large range of flows (0 - 450 cfs) to minimize fluctuations in deliveries to the Bechtel Canal, Reeds Creek, upstream pump intakes, and gravity deliveries.	Remove existing structure and vehicle crossing. Replace with concrete combination structure including long crested weir and automated overshot gate for upstream level control. Construct new vehicle bridge/crossing. Install solar power system and flow display; add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level	$536,000	$32,000
3	NONAME	No Name Creek Spill	39.10834	-121.46822	Spill	BWD, SYWD, DCMWC	537+67	Increase capacity of siphon to route excess flows to Hutchinson Creek in the case of Yuba Wheatland Canal pump failure. Discharge spillage quantities up to 50 cfs to No Name Creek to prevent canal overtopping.	Install approximately 115 ft of 72" RCP as a second, parallel siphon to convey additional flow. Install new u/s headwall/weir structure with flap gate to discharge portion of excess flows to No Name Creek. Install upstream pressure transducer, solar power system and integrate into new SCADA system to provide real-time monitoring of upstream water level.	$256,000	$15,000
4	ERLERD	Erle Road Siphon	39.10010	-121.46822	Conveyance	BWD, SYWD, DCMWC	567+27	Increase capacity of siphon to route excess flows to Hutchinson Creek in the case of Yuba Wheatland Canal pump failure.	Install approximately 130ft of 72" RCP as a second, parallel siphon to convey additional flow.	$137,000	$8,000
5	SMNCNL	Enlarging canal cross section of South Main Canal	-	-	Conveyance	-	486+75 to 593+90	Increase capacity of canal to route excess flows to Hutchinson Creek in the case of Yuba Wheatland Canal pump failure.	Increase the average cross sectional area of the existing channel from the Belza Gates to Hutchinson Creek Spill (approximately 2 miles) by approximately 10% to provide an estimated total capacity of 450 cfs from the Belza Gates to Hutchinson Creek Spill, approximately 2 miles.	$1,823,000	$98,000

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Table F-1. YCWA Automation Alternative 1: Reconnaissance Level Improvements and Costs (contd.)

No.	SiteID	Site Name	Latitude	Longitude	Site Type	Member Unit(s)	Station on South Main Canal	Description of Operational Objective	Description of Physical Improvements	Improve-ment Cost	Annualized Cost
6	HTCHCR	Hutchinson Creek Spill	39.09330	-121.46824	Spill	BWD, SYWD, DCMWC	593+90	Primary spill site for discharging excess flow in the event of Yuba Wheatland Canal pump failure. Increase discharge capacity to prevent canal overtopping and excessive changes in upstream water level.	Remove existing weir structure and 30" orifice gate. Replace with 60' long side spill weir and integral delivery gate. Install flap gate within weir crest to spill high volumes of water while minimizing changes in upstream water level. Install upstream pressure transducer, solar power system and integrate into new SCADA system to provide real-time monitoring of upstream water level. Improve farm crossings in Hutchinson Creek downstream of spill to allow for passage of excess flows.	$574,000	$34,000
									Site Improvement Subtotal =	$3,631,000	$211,000
		SCADA Office Base Station	-	-			-	Allows remote monitoring of measured parameters at SCADA equipped sites. Also allows remote control and adjustment of set points at automated water level or flow control sites. Provides for storage of data and interface for developing comprehensive status reports, usage statistics and monitoring information for improved water management, accounting and reporting.	Furnish and install one desktop personal computer, including: processor, monitor, keyboard, mouse, drivers, USB, RS232 and Ethernet communication ports, cables, adapters, modems, printer, operating system software and HMI software. Base station spread spectrum radio, mast and antenna for communication with remote sites. Five hardened laptops and vehicle mounts for operator/in-field use; vehicle mounted radios and antennas for remote communications and monitoring of sites.	$125,000	$13,000
		Spare Equipment	-	-			-	Minimize down time associated with simple equipment maintenance or malfunctions and/or procurement of site or system specific hardware.	Small inventory of site and system specific equipment that is critical for proper operation of improvements.	$24,000	$3,000
									AUTOMATION AND IMPROVEMENT TOTAL =	**$3,780,000**	**$227,000**

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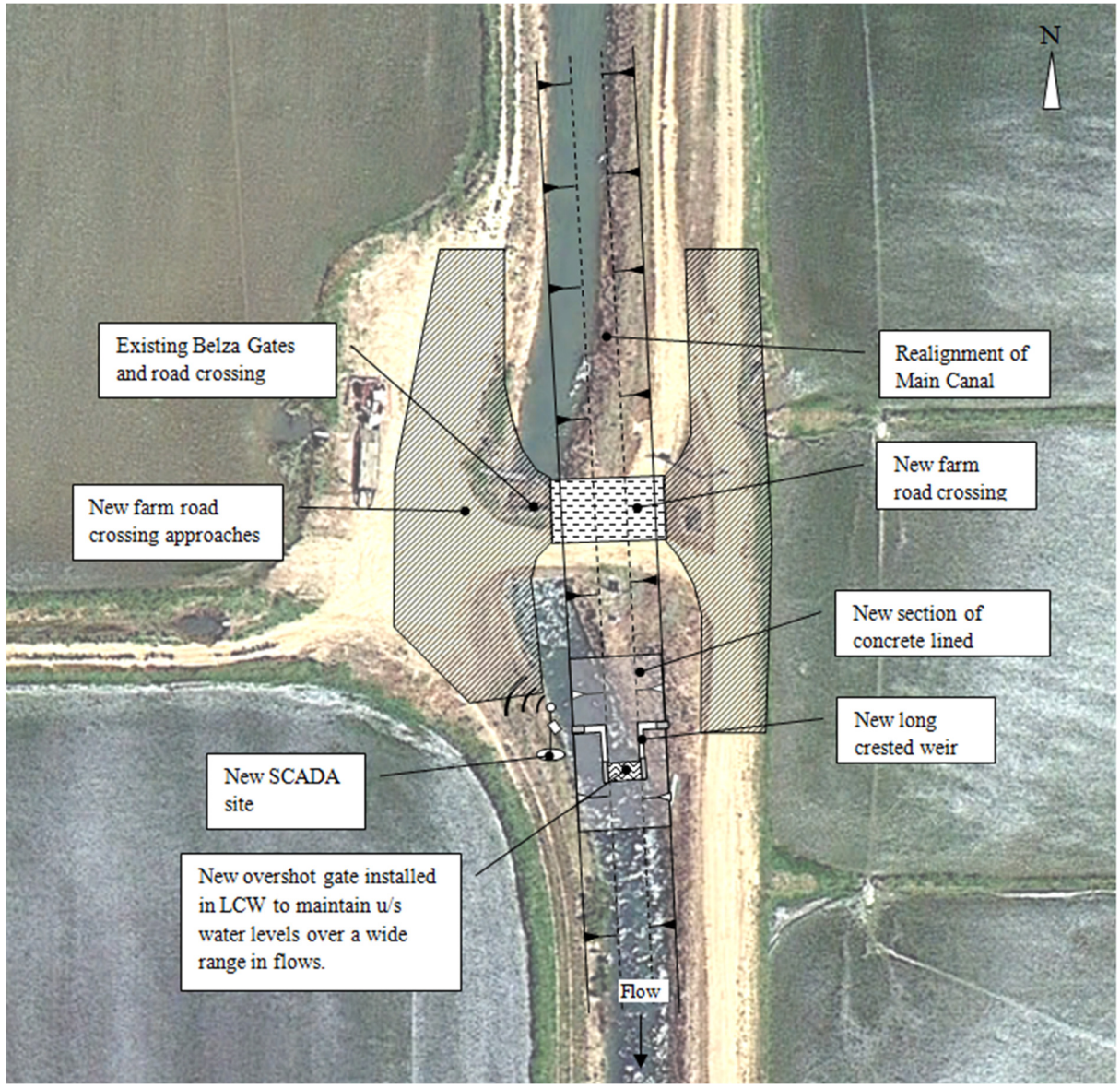

Figure F-2. Conceptual Layout for Improvements to Belza Gates

Figure F-3. Conceptual Layout for Improvements to Bechtel Canal Heading

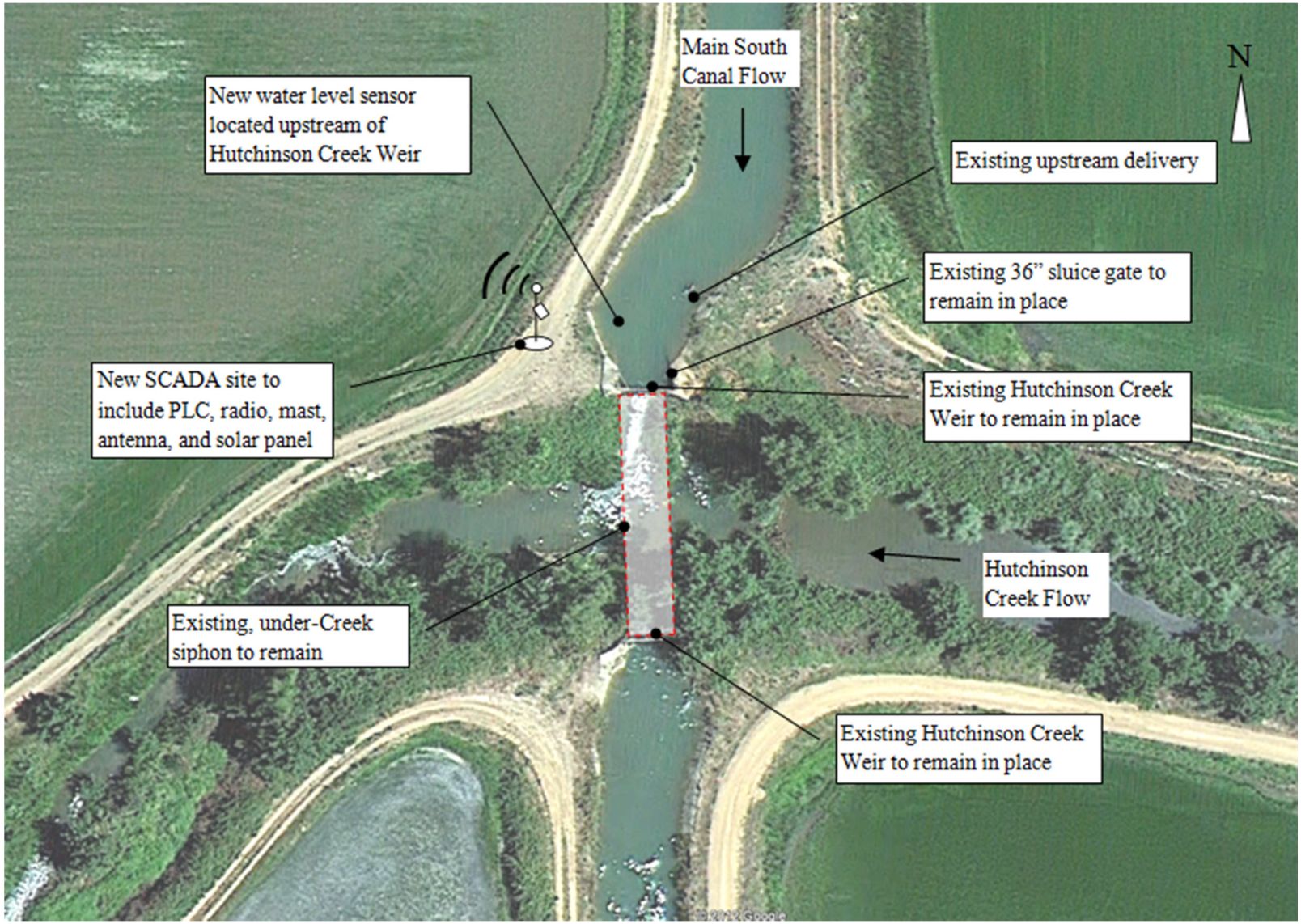

Figure F-4. Conceptual Layout for Improvements to Hutchinson Creek Spill and Siphon

ALTERNATIVE 2. AUTOMATED FLOW AND LEVEL CONTROL OF SOUTH CANAL.

For Alternative 2, improvements would be made at 27 sites. These improvements include flow measurement improvements included as part of YCWA's MIP. Individual site improvements are listed in Table F-3. For each site, the following information is provided:

- Site name
- Site location (latitude and longitude)
- Site type (division structure, control structure, spill, conveyance, or measurement)
- Downstream member unit(s)
- Approximate stationing on the South Canal (if applicable)
- Site operational objective (description of rationale for improvements)
- Site physical improvements (description of anticipated upgrades to achieve operational objectives)
- Total, upfront improvement cost
- Annualized cost of initial capital and ongoing maintenance

In addition to the site improvements, the costs of establishing a SCADA base station and acquiring spare equipment to support timely repair or replacement of SCADA components are provided. As indicated in Table F-3, the total estimated upfront improvement cost for alternative 1 is $5.6 million with an annualized cost of $390,000. Detailed costs for each site and to establish SCADA are provided in attachment F-1. Conceptual layouts for selected sites are detailed in Figures F-5 through F-13.

Table F-2. YCWA Automation Alternative 2: Reconnaissance Level Improvements and Costs

No.	SiteID	Site Name	Latitude	Longitude	Site Type	Member Unit(s)	Station on South Main Canal	Description of Operational Objective	Description of Physical Improvements	Improve-ment Cost	Annualized Cost
1	SDDAGR	South Diversion at Daguerre	39.20732	-121.44068	Diversion	BWD, WWD, SYWD, DCMWC	0+00	Gates are automated to maintain an operator-set water level at the Pond 17 outlet structure to provide steady outflow and compensate for underflow from the Yuba River.	Install electromechanical gate actuators, position sensors and limit switches on 3 existing gates. Install solar power system, PLC and full SCADA site for remote monitoring and control	$68,000	$7,000
2	WTRW13	Waterway 13	39.20462	-121.43877	Delivery	-	12+08	Provide flow measurement for any deliveries made at this site. No automation at this site.	Install upstream and downstream staff gages to facilitate head pressure measurements and develop theoretical flow rating tables as a function of head pressure and gate opening for each gate.	$14,000	$2,000
3	PND017	Pond 17	39.18940	-121.42238	Control	BWD, WWD, SYWD, DCMWC	103+12	Gates are automated to maintain an operator-set water level at the Meadow Pond outlet structure to provide steady outflow and compensate for any underflow from Yuba River.	Install electromechanical gate actuators, position sensors and limit switches on 2 existing gates. Install solar power system, digital display, PLC and full SCADA site for remote monitoring and control. Install u/s and d/s stilling wells and pressure transducers to provide water level for SDDAGR control logic feedback. Empirically derive orifice coefficient with current metering over range of flows and refine flow rating tables.	$85,000	$9,000
4	MDWPND	Meadow Pond	39.17683	-121.43640	Control	BWD, WWD, SYWD, DCMWC	180+85	Gates are automated to maintain an operator-set flow rate into the South Main Canal. Remote access and control allows real-time changes to be made based on system conditions or delivery requirements.	Construct new concrete structure and install automated flow control overshot gates. Install solar power system, digital display, PLC and full SCADA site for remote monitoring and control. Gates provide upstream water level used by control logic at Pond 17 outlet gates. Existing structure may be retained (subject to evaluation of flow restrictions) to serve as vehicle crossing.	$420,000	$35,000
5	NY0033	Baker Gage	39.16823	-121.45033	Measure-ment	BWD, WWD, SYWD, DCMWC	239+90	Provide flow measurement at this site as verification of inflow at the Meadow Pond gates. No automation at this site.	Replace (e) SonTek Argonaut SW/SL with SonTek IQ, replace flow display and perform velocity index rating over a range of flows. Integrate existing telemetry hardware into new SCADA system to provide real-time monitoring of flow rate and water level	$23,000	$3,000
6	NRTHDT	North Ditch (Hammonton Road Weir)	39.16562	-121.45207	Division	BWD	251+80	Maintain upstream water level for constant delivery to the North Ditch and to route any flow fluctuations down the South Canal. Long weir crest allows large changes in flow rate over the weir with minimal change in upstream water level.	Install SonTek IQ in outlet of 60" North Ditch delivery pipe. Remove existing structure at Hammonton Road and replace with long crested weir designed to maintain u/s level across range of flows. Install upstream pressure transducer, solar power system, flow display and integrate into new SCADA system to provide real-time monitoring of North Ditch delivery flow and upstream water level at weir.	$169,000	$11,000
7	WEIR02	Weir 2, 2nd Check Main Canal	39.14458	-121.46767	Control	BWD, WWD, SYWD, DCMWC	354+46	Maintain upstream water level for constant upstream deliveries and to route any flow fluctuations down the South Canal. Long weir crest allows large changes in flow rate over the weir with minimal change in upstream water level.	Remove existing structure and replace with long crested weir designed to maintain u/s level across range of flows. Install upstream pressure transducer, solar power system, digital display and integrate into new SCADA system to provide real-time monitoring of upstream water level.	$153,000	$9,000
8	FRTSTD	Fruit Stand Weir	39.14372	-121.47708	Control	BWD, WWD, SYWD, DCMWC	382+66	Maintain upstream water level for constant upstream deliveries and to route any flow fluctuations down the South Canal. Long weir crest allows large changes in flow rate over the weir with minimal change in upstream water level.	Remove existing structure and replace with long crested weir designed to maintain u/s level across range of flows. Install upstream pressure transducer, solar power system, digital display and integrate into new SCADA system to provide real-time monitoring of upstream water level.	$153,000	$9,000

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Table F-2. YCWA Automation Alternative 2: Reconnaissance Level Improvements and Costs (contd.)

No.	SiteID	Site Name	Latitude	Longitude	Site Type	Member Unit(s)	Station on South Main Canal	Description of Operational Objective	Description of Physical Improvements	Improve-ment Cost	Annualized Cost
9	RDSCRK	Reeds Creek at North Beale Road	39.12898	-121.47180	Division	BWD, SYWD	452+27	Provide accurate and repeatable flow control to Reeds Creek to supply downstream deliveries.	Remove existing structure, construct new concrete structure, and install automated flow control overshot gates. Install solar power system, digital display, PLC and full SCADA site for remote monitoring and control.	$269,000	$21,000
10	BECCNL	Bechtel Canal	39.12548	-121.46791	Division	BWD, WWD	474+57	Provide flow control to Bechtel Canal and to Wheatland Lateral, and allow redirection of excess flows to South Canal in the event of Yuba Wheatland Canal pump malfunction and shutoff. Improvements prevent canal overtopping and excessive changes in water levels. Additionally, provides option of downstream level control to automatically limit inflow if pumps shut off.	Remove existing structure, construct new concrete structure, and install automated flow control overshot gates. Gates discharge into parallel pipelines through embankment into Bechtel Canal. Install solar power system, digital display, PLC and full SCADA site for remote monitoring and control.	$305,000	$24,000
11	WHTLAT	Yuba Wheatland Canal Heading	39.12537	-121.46792	Division	BWD, WWD	-	Flow measurement at this site allows informed and precise control of the automated gate at the Bechtel Canal heading and provides long term data collection on water usage.	Install SonTek IQ in siphon approximately 4300' downstream and perform velocity-index rating over range of flows. Install solar power system and flow display; add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level.	$39,000	$4,000
12	BLZAGT	Belza Gates	39.12211	-121.46816	Control	BWD, SYWD, DCMWC	486+75	Improvements provide upstream level control over a large range of flows (0 - 450 cfs) to minimize fluctuations in deliveries to the Bechtel Canal, Reeds Creek, upstream pump intakes, and gravity deliveries.	Remove existing structure and vehicle crossing. Replace with concrete combination structure including long crested weir and automated overshot gate for upstream level control. Construct new vehicle bridge/crossing. Install solar power system and flow display; add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level.	$536,000	$32,000
13	BULKHD	Bulkhead	39.12058	-121.46142	Delivery	BWD	-	Flow measurement at this site allows informed and precise control of the automated gate at the Bechtel Canal heading	Install upstream and downstream staff gages to facilitate head pressure measurements and develop theoretical flow rating tables as a function of head pressure and gate opening for each gate. Install stage measurement equipment upstream and downstream of gates. Develop gate rating to determine delivered flow rate. Add communication hardware to site and integrate with SCADA system to provide real-time monitoring of flow rate and water level.	$31,000	$4,000
14	NONAME	No Name Creek Spill	39.10834	-121.46822	Spill	BWD, SYWD, DCMWC	537+67	Increase capacity of siphon to route excess flows to Hutchinson Creek in the case of Yuba Wheatland Canal pump failure. Discharge spillage quantities up to 50 cfs to No Name Creek to prevent canal overtopping.	Install approximately 115 ft of 72" RCP as a second, parallel siphon to convey additional flow. Install new u/s headwall/weir structure with flap gate to discharge portion of excess flows to No Name Creek. Install upstream pressure transducer, solar power system and integrate into new SCADA system to provide real-time monitoring of upstream water level.	$256,000	$15,000
15	ERLERD	Erle Road Siphon	39.10010	-121.46822	Convey-ance	BWD, SYWD, DCMWC	567+27	Increase capacity of siphon to route excess flows to Hutchinson Creek in the case of Yuba Wheatland Canal pump failure.	Install approximately 130ft of 72" RCP as a second, parallel siphon to convey additional flow.	$137,000	$8,000
16	SMNCNL	Enlarging canal cross section of South Main Canal	-	-	Convey-ance		486+75 to 593+90	Increase capacity of canal to route excess flows to Hutchinson Creek in the case of Yuba Wheatland Canal pump failure.	Increase the average cross sectional area of the existing channel from the Belza Gates to Hutchinson Creek Spill (approximately 2 miles) by approximately 10% to provide an estimated total capacity of 450 cfs from the Belza Gates to Hutchinson Creek Spill, approximately 2 miles.	$1,823,000	$98,000

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Table F-2. YCWA Automation Alternative 2: Reconnaissance Level Improvements and Costs (contd.)

No.	SiteID	Site Name	Latitude	Longitude	Site Type	Member Unit(s)	Station on South Main Canal	Description of Operational Objective	Description of Physical Improvements	Improve-ment Cost	Annualized Cost
17	HTCHCR	Hutchinson Creek Spill	39.09330	-121.46824	Spill	BWD, SYWD, DCMWC	593+90	Primary spill site for discharging excess flow in the event of Yuba Wheatland Canal pump failure. Increase discharge capacity to prevent canal overtopping and excessive changes in upstream water level.	Remove existing weir structure and 30" orifice gate. Replace with 60' long side spill weir and integral delivery gate. Install flap gate within weir crest to spill high volumes of water while minimizing changes in upstream water level. Install upstream pressure transducer, solar power system and integrate into new SCADA system to provide real-time monitoring of upstream water level. Improve farm crossings in Hutchinson Creek downstream of spill to allow for passage of excess flows.	$574,000	$34,000
18	OSTRRD	Ostrom Road Weir	39.07126	-121.46814	Control	SYWD, DCMWC	674+21	Provide upstream water level control for upstream deliveries. Provide accurate measurement of level to allow informed operation of system.	Install level sensor upstream of weir bays. Install solar system and digital display of water level. Install communication hardware and integrate with SCADA system to provide real-time monitoring of water level.	$25,000	$3,000
19	BUKLMN	Beuklman Delivery	39.05649	-121.48655	Delivery	SYWD	777+01	Flow measurement at this site allows informed and precise control of the automated gate at the Bechtel Canal heading.	Install SonTek IQ in existing delivery pipeline. Install solar power system and flow display; add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level.	$30,000	$3,000
20	WHTP01	Yuba Wheatland Canal Pump 1	39.11932	-121.45140	Division	BWD, WWD	-	Remote-manual control of pump operation and monitoring of diagnostic information to allow informed and precise control and minimize malfunctions.	Add communication and processing hardware to pumping plant and integrate with SCADA system to provide real-time monitoring of pump status (on/off), upstream water level, pump drive frequency, RPM and other vitals. Allow remote manual adjustment of variable frequency motor drivers.	$20,000	$2,000
21	RUEPMP	Rue Pump Station	39.07147	-121.43647	Division	BWD	-	Remote-manual control of pump operation and monitoring of diagnostic information to allow informed and precise control and minimize malfunctions.	Install VFD controller on medium or large pump to provide maximum flexibility in delivery flow rate. Replace propeller flow meters with magnetic flow meters. Install centrally located, remote-mounted digital displays to monitor flow rate and volume. Add solar power system and communication hardware and integrate with SCADA system to provide real-time monitoring and control.	$105,000	$13,000
22	WHTP02	Yuba Wheatland Canal Pump 2	39.07017	-121.43572	Division	WWD	-	Remote-manual control of pump operation and monitoring of diagnostic information to allow informed and precise control and minimize malfunctions.	Install SonTek IQ in S. Beale Road siphon approximately 500' upstream of pump station and perform velocity-index rating over range of flows. Install solar power system and flow display. Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level.	$39,000	$4,000
23	SYWC01	South Yuba Meter 1	39.04843	-121.49095	Measure-ment	SYWD	815+41	Flow measurement at this site allows informed and precise control of the system.	Install SonTek IQ in siphon under Hwy 70 and perform velocity-index rating over range of flows. Install solar power system and flow display. Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level.	$39,000	$4,000
24	DCMWC1	Dry Creek MWC Meter 1	39.04823	-121.49075	Division	DCMWC	815+41	Flow measurement at this site allows informed and precise control of the system.	Install SonTek IQ in 80' long pipe supplying Dry Creek and perform velocity-index rating over range of flows. Install solar power system and local digital flow display. Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level.	$39,000	$4,000
25	SYWC02	South Yuba Meter 2	39.02717	-121.50547	Division	SYWD	-	Flow measurement at this site allows informed and precise control of the system.	Install SonTek IQ near outlet of 40' long pipe near location of existing propeller meter. Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level.	$39,000	$4,000

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Table F-2. YCWA Automation Alternative 2: Reconnaissance Level Improvements and Costs (contd.)

No.	SiteID	Site Name	Latitude	Longitude	Site Type	Member Unit(s)	Station on South Main Canal	Description of Operational Objective	Description of Physical Improvements	Improve-ment Cost	Annualized Cost
26	INTCPT1	Interceptor at Alferos	39.06398	-121.53557	Boundary Outflow	BWD	-	Flow measurement at this site allows informed management of operations and irrigation practices within the member units.	Install SonTek IQs near outlets of pipes under road crossing downstream of existing measurement weirs. Install communication hardware and integrate site into SCADA system to provide real-time monitoring of water level and flow.	$25,000	$3,000
27	INTCPT2	Interceptor at Bear River	39.06398	-121.53557	Boundary Outflow	BWD, SYWD	-	Flow measurement at this site allows informed management of operations and irrigation practices within the member units.	Construct 50' long lined section of channel and install SonTek IQ. Mount enclosure on levee road or construct mobile system on trailer. Mobile system allows removal of hardware during winter months when flood danger is high. Add communication hardware to measurement site and integrate with SCADA system to provide real-time monitoring of flow rate and water level.	$64,000	$5,000
									Site Improvement Subtotal =	$5,480,000	$370,000
		SCADA Office Base Station	-	-	-	-	-	Allows remote monitoring of measured parameters at SCADA equipped sites. Also allows remote control and adjustment of set points at automated water level or flow control sites. Provides for storage of data and interface for developing comprehensive status reports, usage statistics and monitoring information for improved water management, accounting and reporting.	Furnish and install one desktop personal computer, including: processor, monitor, keyboard, mouse, drivers, USB, RS232 and Ethernet communication ports, cables, adapters, modems, printer, operating system software and HMI software. Base station spread spectrum radio, mast and antenna for communication with remote sites. Five hardened laptops and vehicle mounts for operator/in-field use; vehicle mounted radios and antennas for remote communications and monitoring of sites.	$125,000	$13,000
		Spare Equipment	-	-	-	-	-	Minimize down time associated with simple equipment maintenance or malfunctions and/or procurement of site or system specific hardware.	Small inventory of site and system specific equipment that is critical for proper operation of improvements.	$24,000	$3,000
									AUTOMATION AND IMPROVEMENT TOTAL =	**$5,629,000**	**$386,000**

Key:
BVID = Browns Valley Irrigation District
BWD = Brophy Water District
CID = Cordua Irrigation District
DCMWC = Dry Creek Municipal Water Company
HIC = Hallwood Irrigation Company
RWD = Ramirez Water District
SYWD = South Yuba Water District
WWD = Wheatland Water District

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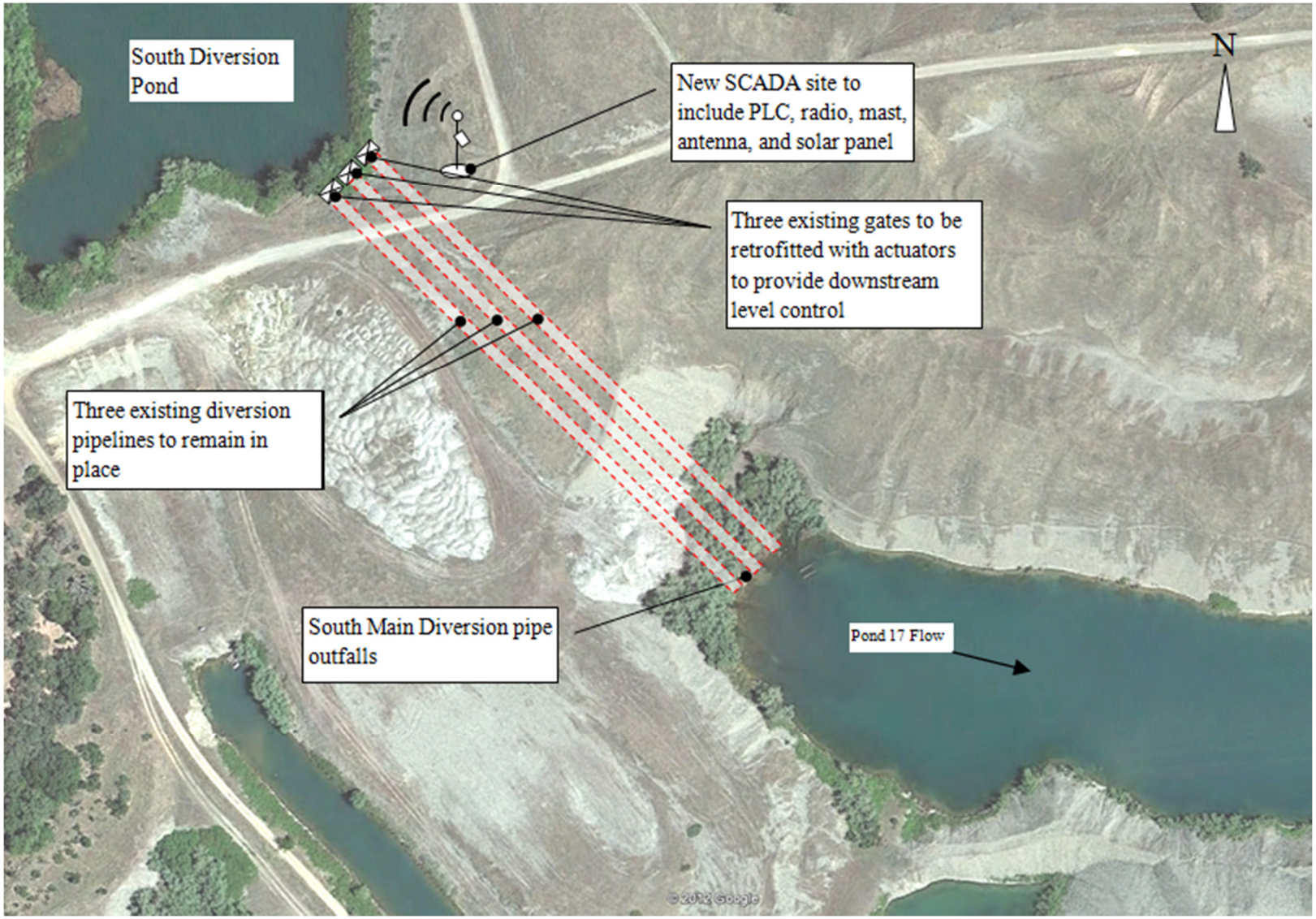

Figure F-5. Conceptual Layout for Improvements to South Diversion at Daguerre

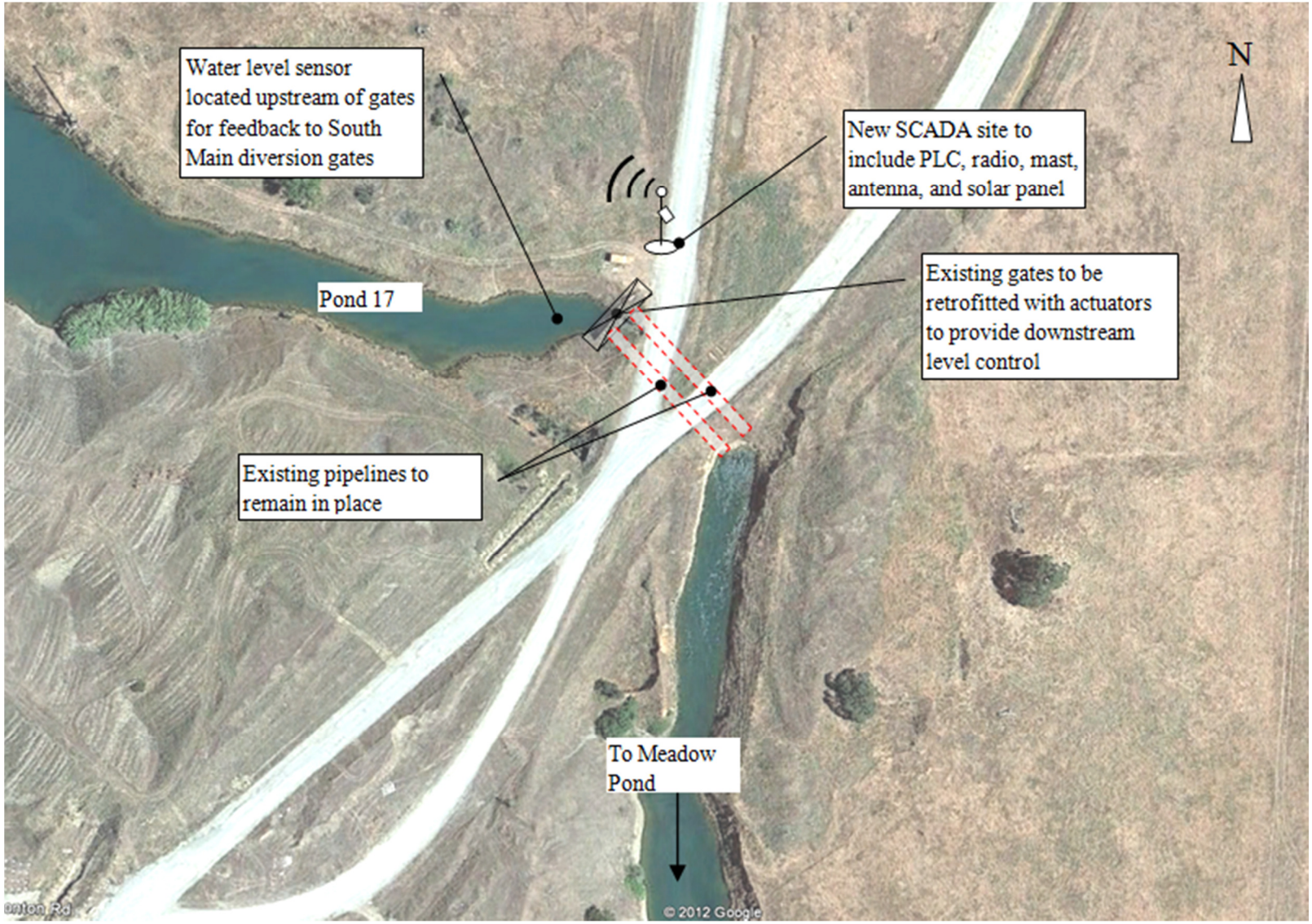

Figure F-6. Conceptual Layout for Improvements to Pond 17 Outlet

Figure F-7. Conceptual Layout for Improvements to Pond 17 Outlet

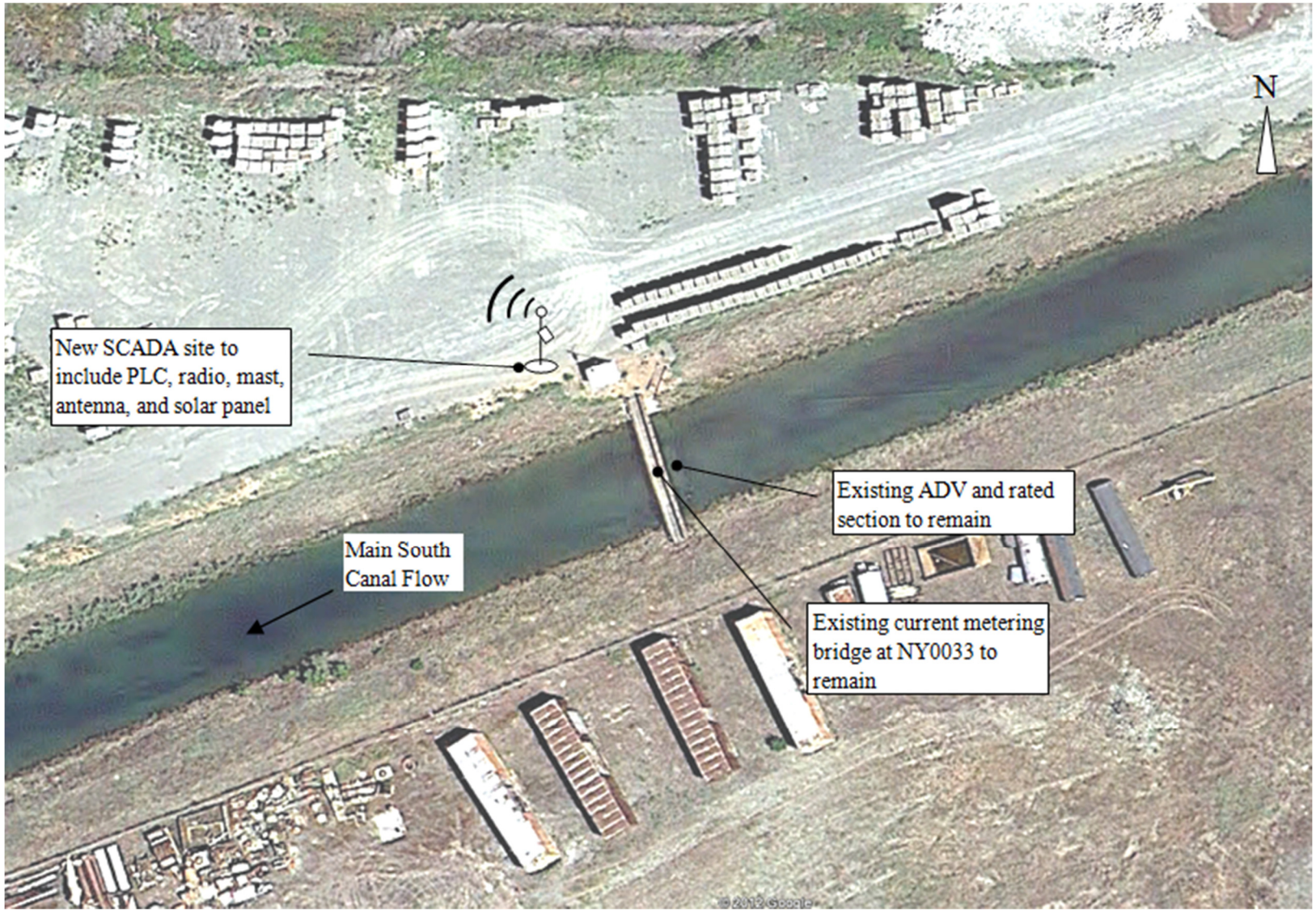

Figure F-8. Conceptual Layout for Improvements to Pond 17 Outlet

Figure F-9. Conceptual Layout for Improvements to Hammonton Road Weir

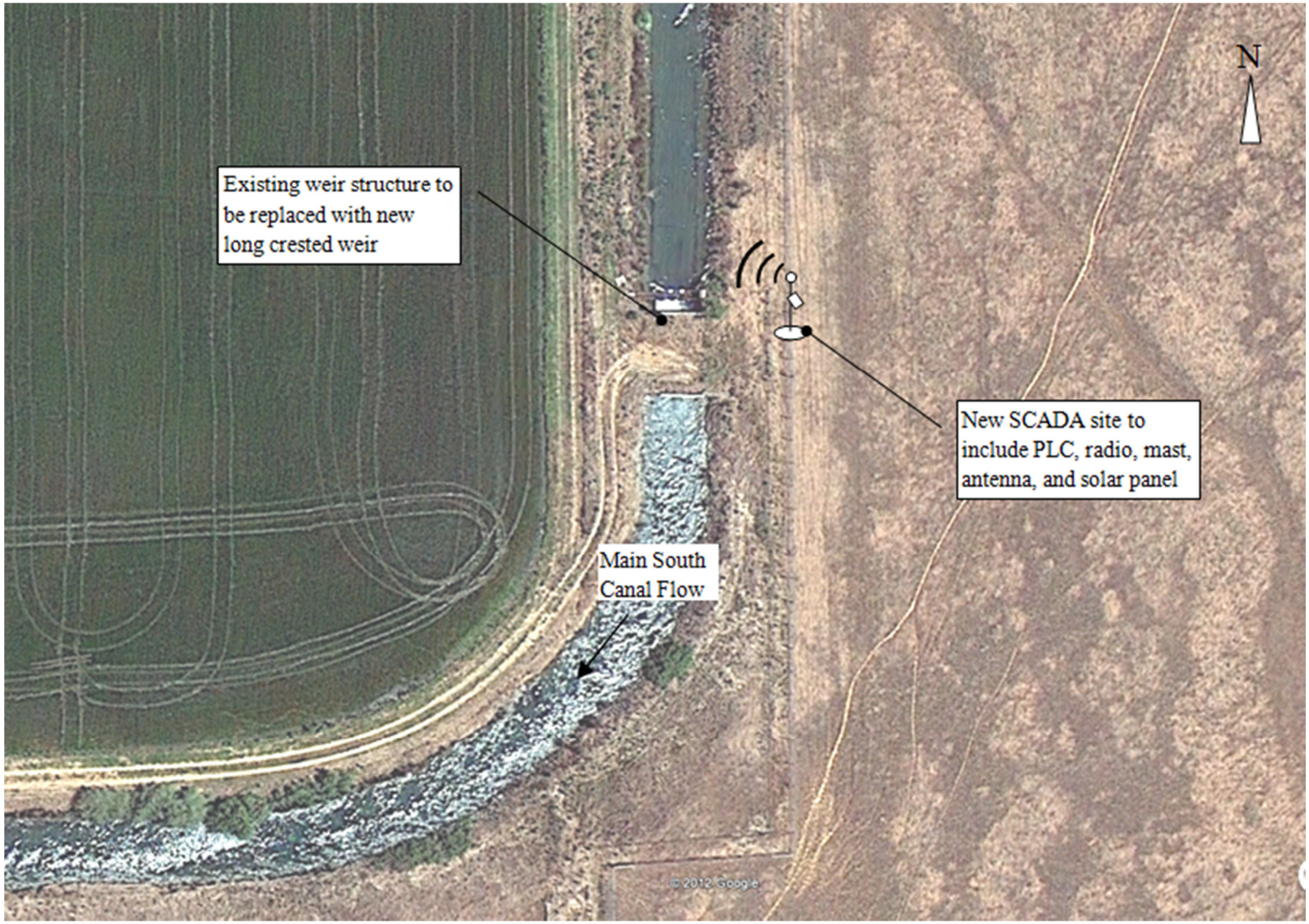

Figure F-10. Conceptual Layout for Improvements to Weir 2

Figure F-11. Conceptual Layout for Improvements to Fruit Stand Weir

Figure F-12. Conceptual Layout for Improvements to Ostrom Road Weir

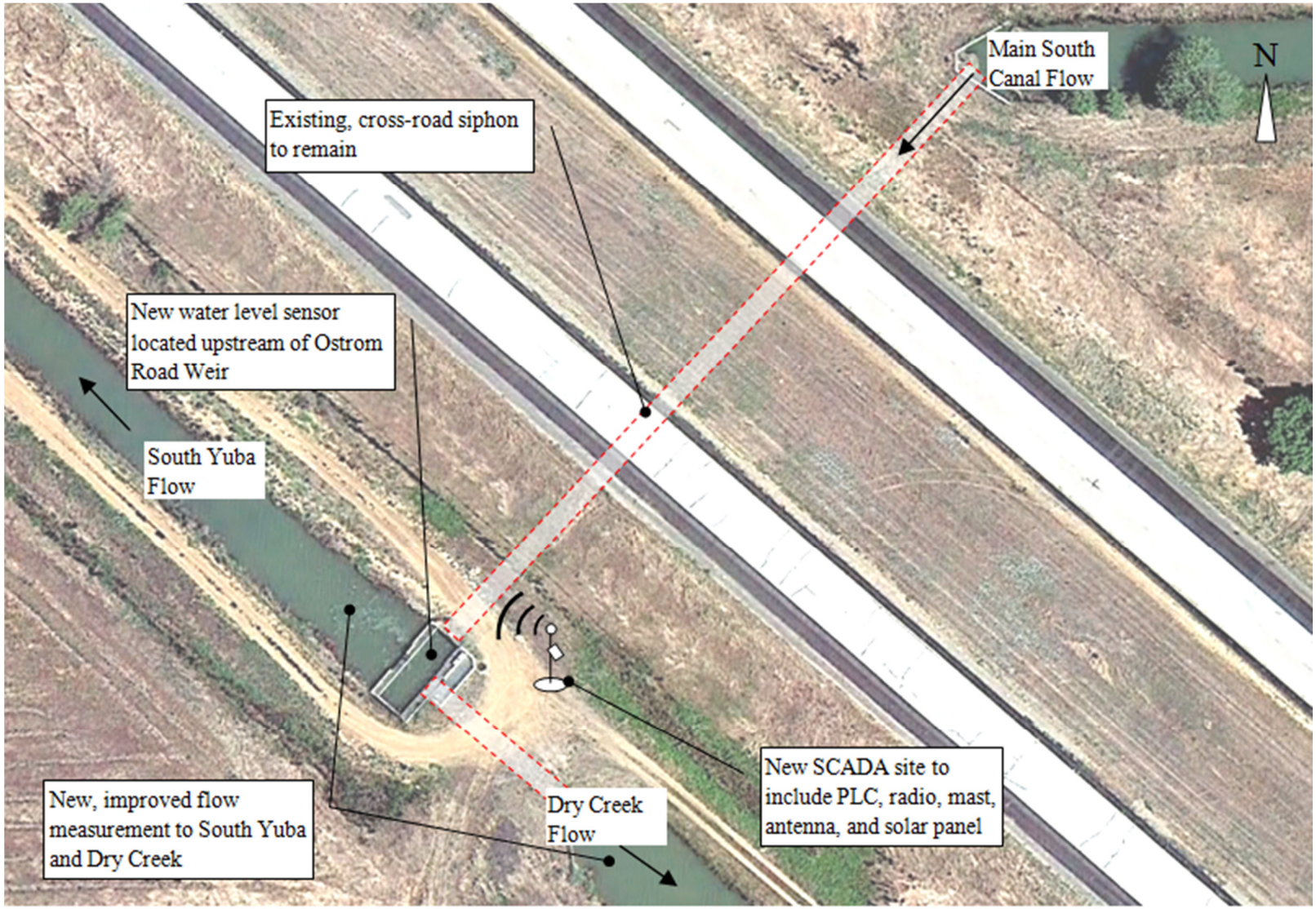

Figure F-13. Conceptual Layout for Improvements to Ostrom Road Weir

BENEFITS

OVERVIEW

ALTERNATIVE 1. CONVEYANCE OF EXCESS FLOWS FROM YUBA WHEATLAND CANAL PUMP FAILURE.

The primary benefit of implementing system automation to convey excess flows resulting from Yuba Wheatland Canal pump failure to No Name Creek and Hutchinson Creek is to avoid or greatly reduce the risk of canal overtopping and washout of primary control structures. In particular, failure of the Yuba Wheatland Canal pumps could result in water backing up in the system to Reeds Creek weir, a primary control structure used to control deliveries to Brophy Water District. In the event of prolonged pump failure at high inflows to the system, operators anticipate that the structure could be overtopped and washed out, along with potential damage to embankments upstream or downstream of the structure.

In order to quantify the benefits of automation to reroute excess flows resulting from Yuba Wheatland Canal pump failure, the following costs to be avoided through automation were estimated:

- Temporary repairs to Reeds Creek Weir to avoid prolonged outages during the irrigation season ($130,000)
    - Mobilization
    - Earthwork – excavation, canal reshaping, and rip rap at and in the vicinity of Reeds Creek Weir
    - Structures – demolition and removal of existing structure, installation of sheet piling and grade control structure, construction of walkway
    - Indirect Costs – engineering, environmental, legal and administrative
- Permanent replacement of Reeds Creek Weir during the winter maintenance period following failure ($142,000)
    - Mobilization
    - Earthwork – Excavation, compacted fill, canal reshaping, and rip rap
    - Structures – Remove sheet piling; build reinforced concrete structure; install orifice gate, staff gage, and walkway
    - Indirect Costs – engineering, environmental, legal and administrative

As described above, the total estimated cost of repairing and replacing Reeds Creek Weir, along with repair of embankments in the vicinity of Reeds Creek weir is $272,000. Detailed cost estimates are provided in Attachment F-2.

The probability of Yuba Wheatland Canal pump failure, followed by Reeds Creek weir failure is influenced by two primary factors:

- The duration of power failure at the Yuba Wheatland Canal Pump stations
- The notification and response time of YCWA staff to reduce system inflows following pump failure

The overall risk, in terms of percent likelihood of Reeds Creek weir failing in any given year has not been evaluated in detail, but has been estimated as 1 in 25 years for purposes of the net benefit analysis. Based on this assumption, the annual benefit of the automation improvements is approximately $10,880 per year ($10,880 = $272,000 / 25). The net benefit analysis presented in a subsequent section also evaluates the probability required to justify the identified improvements based on a comparison of the annualized costs of automation improvements compared to the lump sum costs of repairs at Reeds Creek to be avoided.

ALTERNATIVE 2. AUTOMATED FLOW AND LEVEL CONTROL OF SOUTH CANAL

Alternative 2 incorporates the improvements of Alternative 1, but also adds essentially head-to-tail automation of YCWA's facilities south of the Yuba River to provide improved flow and water level control. Improved flow and water level control would additionally allow for reductions in boundary outflows from reduced YCWA operational spillage and potentially, through improved delivery service to the member units, from member unit operational spillage and tailwater production. Typical spillage and tailwater outflows from the Southside area are estimated to be 24,000 AF annually. Through implementation of Alternative 2, it is estimated that approximately 30 to 35 percent of boundary outflows could be conserved annually, or approximately 8,000 AF per year. This conserved water could be used to meet local supply deficiencies in shortage years, offsetting the need for private pumping to meet local demands. Additionally, conservation of boundary outflows could provide additional carryover storage, which could affect Yuba Accord year type, triggering an increase in instream flows and corresponding fishery benefits.

For purposes of this analysis, quantified benefits to fisheries have not been estimated. Rather, local supply benefits have been estimated based on the following assumptions:

- Boundary outflows would be reduced by approximately 8,000 AF per year.
- Conserved water could be stored in New Bullards Bar and used to help meet demand in shortage years, reducing local groundwater pumping.
- In water shortage years, the total available conserved water would be 16,000 AF, representing conserved water carried over from the prior year and conservation during the year of the water shortage.
- Based on the Yuba Accord flow schedules and Yuba River hydrology, water shortages are expected in approximately 1 out of 10 years.
- The average pumping cost for groundwater is approximately $25 per AF

A result of these assumptions is that the total monetary benefit of conservation in shortage years is $400,000 to private pumpers ($400,000 = 16,000 AF x $25/AF). Or, around $40,000 per year, on average ($40,000 = $400,000 / 10).

NET BENEFIT ANALYSIS

ALTERNATIVE 1. CONVEYANCE OF EXCESS FLOW FROM YUBA WHEATLAND CANAL PUMP FAILURE

As described previously, the estimated annual cost of implementing automation Alternative 1 is $227,000 per year. The estimated benefit of avoiding washout of the Reeds Creek weir is approximately $11,000 per year, based on an assumed probability of washout occurring once in 25 years. Based on an estimated repair cost of $272,000, failure of the Reeds Creek weir would need to occur in approximately 8 out of 10 years to justify the improvements through local funding. The net cost of implementing Alternative 1 is estimated to be $216,000 per year, with a benefit-cost ratio of 0.05. In the future, it is anticipated that the costs and estimated benefits of this alternative will be re-evaluated and revised as additional information becomes available.

ALTERNATIVE 2. AUTOMATED FLOW AND LEVEL CONTROL OF SOUTH CANAL

As described previously, the estimated annual cost of implementing automation Alternative 2 is $386,000 per year. The estimated benefits of implementing Alternative 2 are:

- Avoiding washout of the Reeds Creek weir - $11,000 per year
- Increasing local surface water supply in shortage years - $40,000 per year[36]

The estimated net cost of implementing Alternative 2 is $335,000, with a benefit-cost ratio of 0.13.

Looking at only the marginal costs ($159,000 per year) and benefits ($40,000 AF per year) of implementing Alternative 2, the estimated net marginal cost is $119,000 per year, with a benefit-cost ratio of 0.25. In order to realize the full benefits of Alternative 2, however, it would be necessary to implement the Alternative 1 improvements to some degree.

In the future, it is anticipated that the costs and estimated benefits of this alternative will be re-evaluated and revised as additional information becomes available.

CONCLUSIONS

YCWA currently owns and operates three automated lift pump stations on the Yuba Wheatland Canal that are used to serve the Wheatland Water District (WWD) member unit. Additionally, YCWA is implementing a Measurement Improvement Program (MIP), which includes remote, real-time monitoring of flows and water levels at key boundary inflow, boundary outflow, and internal operational sites, many of which are used to measure deliveries to the Agency's customers, the member units. Despite this existing satisfactory level of implementation of this EWMP, YCWA developed and evaluated additional alternatives to increase the automation of its distribution system.

YCWA evaluated two automation alternatives for the YCWA distribution system south of the Yuba River. YCWA does not own any facilities within its member unit service areas north of the Yuba River. The two alternatives considered include the following:

- **Alternative 1** – Automation and routing of excess flows in event of Yuba Wheatland Canal pump station failure.

[36] These benefits represent a benefit to local groundwater pumpers due to reduced pumping costs.

- **Alternative 2** – Automated flow and level control to minimize head fluctuations resulting from time-of-use delivery pump operation by irrigators.

The estimated annual cost of implementing Alternative 1 is $227,000 with an estimated annual benefit of approximately $11,000 based on assumed risk of washout of the Reeds Creek weir in one out of 25 years. In order for benefits to exceed costs, the probability of washout would need to be approximately 8 out of 10 years.

The estimated annual cost of implementing Alternative 2 is $386,000 with an estimated annual benefit of approximately $51,000. These benefits and costs include improvements identified under Alternative 1. Looking at only the marginal costs ($159,000 per year) and benefits ($40,000 AF per year) of implementing Alternative 2, the estimated net marginal cost is $119,000 per year, with a benefit-cost ratio of 0.25. In order to realize the full benefits of Alternative 2, however, it would be necessary to implement the Alternative 1 improvements to some degree.

In the future, it is anticipated that the costs and estimated benefits of this alternative will be re-evaluated and revised as additional information becomes available.

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Yuba County Water Agency
2012 Agricultural Water Management Plan

Attachment F-1: Reconnaissance Level Cost Estimates for Site Improvements and SCADA Establishment

Prepared By

DAVIDS ENGINEERING, INC
www.de-water.com

December 2012

Notes:

All costs are subject to revision following refinement of site improvements following more detailed review and design.

Annual construction costs based on interest rates and service lives:

SCADA and Measurement Equipment

Interest rate	3%
Life (yr)	20
CRF	0.067

Canals, Pipelines and Control Structures

Interest rate	3%
Life (yr)	50
CRF	0.039

Pumps and Electrical

Interest rate	3%
Life (yr)	20
CRF	0.067

Estimate of Capital and Implementation Costs

SCADA Base Station and HMI

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$4,859	0%	$4,859	15	0%		$407
2	Base Station Computer System	1	LS	$45,000	$45,000	15%	$51,750	15	3%		$5,887
3	Base Station antenna, mast, lightening arrestor	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
4	Hardened Ditchtender Laptop and mount	5	EA	$7,400	$37,000	15%	$42,550	15	2%		$4,415
5	Programming, start-up and debug	1	LS	$1,500	$1,500	15%	$1,725	15	2%		$179
6	Radio path and signal strength testing	1	EA	$1,501	$1,501	15%	$1,726	15	2%		$179
						Subtotal of Direct Costs(including Mobilization)=	**$103,760**				
INDIRECT COSTS											
15	Engineering & Construction Management	1	LS	10%	$10,376	0%	$10,376	15	0%		$869
16	Legal, Environmental and Administration	1	LS	10%	$10,376	0%	$10,376	15	0%		$869
	TOTAL CONSTRUCTION COST =									**$124,512**	
	TOTAL ANNUAL COST =										**$12,925**

Estimate of Capital and Implementation Costs

Spare Equipment

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	F&I SonTek-IQ flowmeter and cable	2	EA	$6,450	$12,900	15%	$14,835	15	3%		$1,688
2	F&I 80W solar panel	2	EA	$400	$800	15%	$920	15	3%		$105
3	F&I Submersible pressure transducer	2	EA	$950	$1,900	15%	$2,185	15	3%		$249
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
5	F&I gate position sensor	2	EA	$1,501	$3,002	15%	$3,452	15	3%		$393
						Subtotal of Direct Costs =	**$23,692**				
INDIRECT COSTS											
	TOTAL CONSTRUCTION COST =									**$23,692**	
	TOTAL ANNUAL COST =										**$2,695**

Estimate of Capital, Implementation and Annual Costs

South Diversion At Daquerre

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$2,253	0%	$2,253	20	0%		$151
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Structures											
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
Equipment and Materials											
4	Sluice gate actuator, motor and controls	3	EA	$5,500	$16,500	15%	$18,975	20	5%		$2,224
5	F&I gate position sensor	3	EA	$1,700	$5,100	15%	$5,865	15	3%		$667
6	F&I Limit switches (2)	3	EA	$1,000	$3,000	15%	$3,450	15	3%		$392
7	F&I 30"x24" (NEMA 4/12) electronics enclosure w/ back panel	2	EA	$875	$1,750	15%	$2,013	20	2%		$176
8	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
9	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
10	F&I 80W solar panel, mounting bracket and charge controller	2	EA	$890	$1,780	15%	$2,047	15	3%		$233
11	F&I 12v battery and wiring	2	EA	$175	$350	15%	$403	15	3%		$46
12	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
13	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
14	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
15	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$41,205**				
					Unlisted Items Contingency =	10%	**$4,732**	15	3%		$538
					Subtotal of Direct Costs(including Mobilization) =		**$52,054**				
INDIRECT COSTS											
16	Engineering & Construction Management	1	LS	15%	$7,808	0%	$7,808	20	0%		$525
17	Legal, Environmental and Administration	1	LS	15%	$7,808	0%	$7,808	20	0%		$525
	TOTAL CONSTRUCTION COST =									**$67,670**	
	TOTAL ANNUAL COST =										**$6,747**

Estimate of Capital, Implementation and Annual Costs

Waterway 13

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$500	0%	$500	50	0%		$19
Structures											
2	10-12" Galv. stilling well - Canal water level	2	EA	$1,300	$2,600	15%	$2,990	50	2%		$176
						Subtotal=	**$2,990**				
Measurement Equipment and Materials											
3	F&I Staff Gage	2	EA	$300	$600	15%	$690	15	2%		$72
4	Calibration and rating - Non-Standard Orifice Gate	1	LS	$5,500	$5,500	15%	$6,325	15	3%		$720
						Subtotal=	**$7,015**				
						Subtotal of Direct Costs(including Mobilization)=	**$10,505**				
INDIRECT COSTS											
5	Engineering & Construction Management	1	LS	15%	$1,576	0%	$1,576	50	0%		$61
6	Legal, Environmental and Administration	1	LS	15%	$1,576	0%	$1,576	50	0%		$61
	TOTAL CONSTRUCTION COST =									**$13,657**	
	TOTAL ANNUAL COST =										**$1,109**

Estimate of Capital, Implementation and Annual Costs

Pond 17

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$2,703	0%	$2,703	20	0%		$182
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Structures											
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
Equipment and Materials											
4	F&I Submersible pressure transducer	2	EA	$950	$1,900	15%	$2,185	15	3%		$249
5	4-6" PVC stilling well - PT	2	EA	$600	$1,200	15%	$1,380	20	2%		$120
6	Sluice gate actuator, motor and controls	2	EA	$5,500	$11,000	15%	$12,650	20	5%		$1,483
7	F&I gate position sensor	2	EA	$1,700	$3,400	15%	$3,910	15	3%		$445
8	F&I Limit switches (2)	2	EA	$1,000	$2,000	15%	$2,300	15	3%		$262
9	F&I Digital display	2	EA	$1,400	$2,800	15%	$3,220	15	3%		$366
10	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
11	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
12	F&I 30"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$875	$875	15%	$1,006	20	2%		$88
13	F&I 80W solar panel, mounting bracket and charge controller	2	EA	$890	$1,780	15%	$2,047	15	3%		$233
14	F&I 12v battery and wiring	2	EA	$175	$350	15%	$403	15	3%		$46
15	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
16	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
17	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
18	Calibration and rating - Non-Standard Orifice Gate	2	LS	$5,500	$11,000	15%	$12,650	15	3%		$1,439
19	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$50,203**				
					Unlisted Items Contingency =	10%	**$8,516**	20	3%		$828
					Subtotal of Direct Costs(including Mobilization)=		**$65,286**				
INDIRECT COSTS											
16	Engineering & Construction Management	1	LS	15%	$9,793	0%	$9,793	20	0%		$658
17	Legal, Environmental and Administration	1	LS	15%	$9,793	0%	$9,793	20	0%		$658
	TOTAL CONSTRUCTION COST =									**$84,872**	
	TOTAL ANNUAL COST =										**$8,325**

Estimate of Capital, Implementation and Annual Costs

Meadow Pond

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$12,398	0%	$12,398	50	0%		$482
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Excavation - Excavator	100	CY	$7	$650	15%	$748	50	2%		$44
4	Compacted in-place fill	50	CY	$9	$450	15%	$518	50	2%		$30
5	Riprap	145	TN	$90	$13,050	15%	$15,008	50	2%		$883
						Subtotal=	**$15,008**				
Structures											
3	Demo and remove concrete- w/rebar	30	CY	$300	$9,000	15%	$10,350	50	0%		$402
4	Reinforced Concrete	40	CY	$1,000	$40,000	15%	$46,000	50	2%		$2,708
6	F&I Rubicon FlumeGate - 6' x 5', 130cfs	4	EA	$33,000	$132,000	15%	$151,800	50	10%		$21,080
7	Fabricated Steel Walkway -2.5'W	70	FT	$150	$10,500	15%	$12,075	50	2%		$711
9	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$223,675**				
Equipment and Materials											
10	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
12	F&I 30"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$875	$875	15%	$1,006	20	2%		$88
14	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
15	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
16	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
17	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
18	Gate calibration and flow verification	1	EA	$1,500	$1,500	15%	$1,725	50	3%		$119
19	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$8,855**				
					Unlisted Items Contingency =	10%	**$39,052**	50	3%		$2,689
					Subtotal of Direct Costs(including Mobilization)=		**$299,401**				
INDIRECT COSTS											
16	Engineering & Construction Management	1	LS	20%	$59,880	0%	$59,880	50	0%		$2,327
17	Legal, Environmental and Administration	1	LS	20%	$59,880	0%	$59,880	50	0%		$2,327
	TOTAL CONSTRUCTION COST =									**$419,162**	
	TOTAL ANNUAL COST =										**$34,895**

Estimate of Capital, Implementation and Annual Costs

NY33- Baker Gage

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$820	0%	$820	15	0%		$69
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Measurement Equipment and Materials											
3	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
4	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
5	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
6	Velocity Index Calibration - non-Wadeable	1	LS	$5,500	$5,500	15%	$6,325	15	3%		$720
						Subtotal=	**$15,985**				
						Subtotal of Direct Costs(including Mobilization)=	**$17,219**				
INDIRECT COSTS											
7	Engineering & Construction Management	1	LS	15%	$2,583	0%	$2,583	15	0%		$216
8	Legal, Environmental and Administration	1	LS	15%	$2,583	0%	$2,583	15	0%		$216
	TOTAL CONSTRUCTION COST =									**$22,385**	
	TOTAL ANNUAL COST =										**$2,363**

Estimate of Capital, Implementation and Annual Costs

North Ditch- Hammonton Road Weir

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$4,990	0%	$4,990	50	0%		$194
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Excavation - Excavator	50	CY	$7	$325	15%	$374	50	2%		$22
4	Canal reshaping	100	LF	$25	$2,500	15%	$2,875	50	5%		$255
						Subtotal=	**$3,249**				
Structures											
5	Demo and remove concrete- w/rebar	10	CY	$300	$3,000	15%	$3,450	50	0%		$134
6	Reinforced Concrete	48	CY	$1,000	$48,000	15%	$55,200	50	2%		$3,249
7	Fabricated Steel Walkway -2.5'W	60	FT	$150	$9,000	15%	$10,350	50	2%		$609
8	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$72,450**				
Equipment and Materials											
9	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	15	3%		$124
10	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	20	2%		$60
11	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
12	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
13	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
14	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
15	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
16	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
17	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
18	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
19	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
20	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
21	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
22	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
23	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$23,684**				
					Unlisted Items Contingency =	10%	**$15,718**	50	3%		$1,082
					Subtotal of Direct Costs(including Mobilization)=		**$120,505**				
INDIRECT COSTS											
24	Engineering & Construction Management	1	LS	20%	$24,101	0%	$24,101	50	0%		$937
25	Legal, Environmental and Administration	1	LS	20%	$24,101	0%	$24,101	50	0%		$937
	TOTAL CONSTRUCTION COST =									**$168,707**	
	TOTAL ANNUAL COST =										**$10,378**

Estimate of Capital, Implementation and Annual Costs

Weir 2

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$4,507	0%	$4,507	50	0%		$175
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Excavation - Excavator	50	CY	$7	$325	15%	$374	50	2%		$22
4	Canal reshaping	100	LF	$25	$2,500	15%	$2,875	50	5%		$255
						Subtotal=	**$3,249**				
Structures											
5	Demo and remove concrete- w/rebar	10	CY	$300	$3,000	15%	$3,450	50	0%		$134
6	Reinforced Concrete	48	CY	$1,000	$48,000	15%	$55,200	50	2%		$3,249
7	Fabricated Steel Walkway -2.5'W	60	FT	$150	$9,000	15%	$10,350	50	2%		$609
8	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$72,450**				
Measurement Equipment and Materials											
9	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	15	3%		$124
10	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	20	2%		$60
11	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
12	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
13	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
14	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
15	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
16	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
17	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
18	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
19	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
20	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$14,024**				
					Unlisted Items Contingency =	10%	**$14,197**	50	3%		$978
					Subtotal of Direct Costs(including Mobilization)=		**$108,840**				
INDIRECT COST											
21	Engineering & Construction Management	1	LS	20%	$21,768	0%	$21,768	50	0%		$846
22	Legal, Environmental and Administration	1	LS	20%	$21,768	0%	$21,768	50	0%		$846
	TOTAL CONSTRUCTION COST =									**$152,377**	
	TOTAL ANNUAL COST =										**$8,975**

Estimate of Capital, Implementation and Annual Costs

Fruit Stand Weir

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$4,507	0%	$4,507	50	0%		$175
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Excavation - Excavator	50	CY	$7	$325	15%	$374	50	2%		$22
4	Canal reshaping	100	LF	$25	$2,500	15%	$2,875	50	5%		$255
						Subtotal=	**$3,249**				
Structures											
5	Demo and remove concrete- w/rebar	10	CY	$300	$3,000	15%	$3,450	50	0%		$134
6	Reinforced Concrete	48	CY	$1,000	$48,000	15%	$55,200	50	2%		$3,249
7	Fabricated Steel Walkway -2.5'W	60	FT	$150	$9,000	15%	$10,350	50	2%		$609
8	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$72,450**				
Measurement Equipment and Materials											
9	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	15	3%		$124
10	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	20	2%		$60
11	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
12	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
13	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
14	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
15	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
16	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
17	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
18	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
19	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
20	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$14,024**				
					Unlisted Items Contingency =	10%	**$14,197**	50	3%		$978
					Subtotal of Direct Costs(including Mobilization)=		**$108,840**				
INDIRECT COST											
21	Engineering & Construction Management	1	LS	20%	$21,768	0%	$21,768	50	0%		$846
22	Legal, Environmental and Administration	1	LS	20%	$21,768	0%	$21,768	50	0%		$846
	TOTAL CONSTRUCTION COST =									**$152,377**	
	TOTAL ANNUAL COST =										**$8,975**

Estimate of Capital, Implementation and Annual Costs

Reeds Creek at North Beale Road

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$7,410	0%	$7,410	50	0%		$288
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Excavation - Excavator	100	CY	$7	$650	15%	$748	50	2%		$44
4	Canal reshaping	100	LF	$25	$2,500	15%	$2,875	50	3%		$198
	Riprap	114	TN	$90	$10,260	15%	$11,799	50	2%		$695
						Subtotal=	**$15,422**				
Structures											
5	Demo and remove concrete- w/rebar	8	CY	$300	$2,400	15%	$2,760	50	0%		$107
6	Reinforced Concrete	30	CY	$1,000	$30,000	15%	$34,500	50	2%		$2,031
7	F&I Rubicon FlumeGate - 6' x 5', 130cfs	2	EA	$33,000	$66,000	15%	$75,900	50	10%		$10,540
8	Fabricated Steel Walkway -2.5'W	40	FT	$150	$6,000	15%	$6,900	50	2%		$406
10	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$123,510**				
Equipment and Materials											
11	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
12	F&I 30"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$875	$875	15%	$1,006	20	2%		$88
13	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
14	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
15	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
16	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
17	Gate calibration and flow verification	1	EA	$1,500	$1,500	15%	$1,725	50	3%		$119
18	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$8,855**				
					Unlisted Items Contingency =	10%	**$23,342**	50	3%		$1,607
					Subtotal of Direct Costs(including Mobilization)=		**$178,952**				
INDIRECT COSTS											
19	Engineering & Construction Management	1	LS	25%	$44,738	0%	$44,738	50	0%		$1,739
20	Legal, Environmental and Administration	1	LS	25%	$44,738	0%	$44,738	50	0%		$1,739
	TOTAL CONSTRUCTION COST =									**$268,428**	
	TOTAL ANNUAL COST =										**$20,605**

Estimate of Capital, Implementation and Annual Costs

Bechtel Canal

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$8,999	0%	$8,999	50	0%		$350
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Excavation - Excavator	100	CY	$7	$650	15%	$748	50	2%		$44
4	Canal reshaping	100	LF	$25	$2,500	15%	$2,875	50	3%		$198
						Subtotal=	**$3,623**				
Structures											
5	Demo and remove concrete- w/rebar	5	CY	$300	$1,500	15%	$1,725	50	0%		$67
6	Reinforced Concrete	35	CY	$1,000	$35,000	15%	$40,250	50	2%		$2,369
7	Concrete canal lining - 6" thick, reinforced	2500	SF	$8	$20,000	15%	$23,000	50	3%		$1,584
8	F&I Rubicon FlumeGate - 6' x 5', 130cfs	2	EA	$33,000	$66,000	15%	$75,900	50	10%		$10,540
9	F&I 66" Low Head RCP	100	LF	$177	$17,700	15%	$20,355	50	2%		$1,198
10	Fabricated Steel Walkway -2.5'W	14	FT	$150	$2,100	15%	$2,415	50	2%		$142
11	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$167,095**				
Equipment and Materials											
12	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
13	F&I 30"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$875	$875	15%	$1,006	20	2%		$88
14	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
15	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
16	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
17	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
18	Gate calibration and flow verification	1	EA	$1,500	$1,500	15%	$1,725	50	3%		$119
19	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$8,855**				
					Unlisted Items Contingency =	10%	**$28,348**	50	3%		$1,952
					Subtotal of Direct Costs(including Mobilization)=		**$217,334**				
INDIRECT COSTS											
20	Engineering & Construction Management	1	LS	20%	$43,467	0%	$43,467	50	0%		$1,689
21	Legal, Environmental and Administration	1	LS	20%	$43,467	0%	$43,467	50	0%		$1,689
	TOTAL CONSTRUCTION COST =									**$304,267**	
	TOTAL ANNUAL COST =										**$23,034**

Wheatland Lateral

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,398	0%	$1,398	20	0%		$94
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Structures											
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
Measurement Equipment and Materials											
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
8	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
14	Velocity Index Calibration - non-Wadeable	1	LS	$5,500	$5,500	15%	$6,325	15	3%		$720
15	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$24,087**				
						Subtotal of Direct Cost(including Mobilization)=	**$29,348**				
INDIRECT COST											
14	Engineering & Construction Management	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
15	Legal, Environmental and Administration	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
TOTAL CONSTRUCTION COST =										**$38,153**	
TOTAL ANNUAL COST =											**$3,708**

Estimate of Capital, Implementation and Annual Costs

Belza Gates

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$15,836	0%	$15,836	50	0%		$615
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Site Clearing and Preparation	1	LS	$1,500	$1,500	15%	$1,725	50	2%		$102
4	Excavation - Excavator	150	CY	$7	$975	15%	$1,121	50	2%		$66
5	Canal reshaping	200	LF	$25	$5,000	15%	$5,750	50	3%		$396
6	Riprap	125	TN	$90	$11,250	15%	$12,938	50	2%		$762
						Subtotal=	**$21,534**				
Structures											
7	Demo and remove concrete- w/rebar	5	CY	$300	$1,500	15%	$1,725	50	0%		$67
8	Demo existing crossing	1	LS	$1,200	$1,200	15%	$1,380	50	0%		$54
9	Reinforced Concrete	70	CY	$1,000	$70,000	15%	$80,500	50	2%		$4,739
10	Concrete canal lining - 6" thick, reinforced	4000	SF	$8	$32,000	15%	$36,800	50	3%		$2,534
11	Excavation - Excavator	150	CY	$7	$975	15%	$1,121	50	2%		$66
12	F&I AS2000 Langemann Gate- 12' x 6.5', 320+cfs	1	EA	$48,000	$48,000	15%	$55,200	50	10%		$7,665
13	Fabricated Steel Walkway -2.5'W	80	FT	$150	$12,000	15%	$13,800	50	2%		$812
14	New vehicle crossing - bridge	1	LS	$80,000	$80,000	15%	$92,000	50	3%		$6,336
15	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$285,976**				
Equipment and Materials											
16	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
17	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
18	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
19	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
20	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
21	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
22	Gate calibration and flow verification	1	EA	$1,500	$1,500	15%	$1,725	50	3%		$119
23	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$8,803**				
					Unlisted Items Contingency =	10%	**$49,885**				
					Subtotal of Direct Costs(including Mobilization)=		**$382,448**				
INDIRECT COSTS											
24	Engineering & Construction Management	1	LS	20%	$76,490	0%	$76,490	50	0%		$2,973
25	Legal, Environmental and Administration	1	LS	20%	$76,490	0%	$76,490	50	0%		$2,973
	TOTAL CONSTRUCTION COST =									**$535,427**	
	TOTAL ANNUAL COST =										**$31,365**

Estimate of Capital, Implementation and Annual Costs

Bulk Head

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,127	0%	$1,127	20	0%		$76
	General										
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
	Measurement Equipment and Materials										
3	4-6" PVC stilling well - PT	2	EA	$600	$1,200	15%	$1,380	20	2%		$120
3	F&I Submersible pressure transducer	2	EA	$950	$1,900	15%	$2,185	15	3%		$249
5	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
6	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
7	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
8	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
14	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
15	Calibration and rating - Non-Standard Orifice Gate	1	LS	$5,500	$5,500	15%	$6,325	15	3%		$720
						Subtotal=	**$22,132**				
						Subtotal of Direct Costs (including Mobilization)=	**$23,673**				
INDIRECT COSTS											
16	Engineering & Construction Management	1	LS	15%	$3,551	0%	$3,551	20	0%		$239
17	Legal, Environmental and Administration	1	LS	15%	$3,551	0%	$3,551	20	0%		$239
	TOTAL CONSTRUCTION COST =									**$30,775**	
	TOTAL ANNUAL COST =										**$3,016**

Estimate of Capital, Implementation and Annual Costs

No Name Creek Spill

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$7,042	0%	$7,042	50	0%		$274
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Site Clearing and Preparation	1	LS	$2,500	$2,500	15%	$2,875	50	2%		$169
4	Excavation - Excavator	65	CY	$7	$423	15%	$486	50	2%		$29
5	Canal reshaping	100	LF	$25	$2,500	15%	$2,875	50	3%		$198
6	Channel restoration	1	LS	$6,000	$6,000	15%	$6,900	50	2%		$406
						Subtotal=	**$13,136**				
Structures											
7	Demo and remove concrete- w/rebar	12	CY	$300	$3,600	15%	$4,140	50	0%		$161
8	Reinforced Concrete	20	CY	$1,000	$20,000	15%	$23,000	50	2%		$1,354
9	Concrete canal lining - 6" thick, reinforced	1600	SF	$8	$12,800	15%	$14,720	50	3%		$1,014
10	Cofferdam and Bypass	1	LS	$20,000	$20,000	15%	$23,000	50	1%		$1,124
11	F&I 72" RCP	115	LF	$240	$27,600	15%	$31,740	50	2%		$1,868
12	48" Flap Gate	1	EA	$14,500	$14,500	15%	$16,675	50	5%		$1,482
						Subtotal=	**$113,275**				
Measurement Equipment and Materials											
13	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	15	3%		$124
14	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	20	2%		$60
15	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
16	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
17	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
18	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
19	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
20	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
21	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
22	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
23	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
24	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$14,024**				
					Unlisted Items Contingency =	10%	**$22,184**	50	3%		$1,528
					Subtotal of Direct Costs(including Mobilization)=		**$170,075**				
INDIRECT COSTS											
23	Engineering & Construction Management	1	LS	25%	$42,519	0%	$42,519	50	0%		$1,653
24	Legal, Environmental and Administration	1	LS	25%	$42,519	0%	$42,519	50	0%		$1,653
	TOTAL CONSTRUCTION COST =									**$255,113**	
	TOTAL ANNUAL COST =										**$14,470**

Estimate of Capital, Implementation and Annual Costs

Erle Road Siphon

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$4,219	0%	$4,219	50	0%		$164
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Excavation - Excavator	65	CY	$7	$423	15%	$486	50	2%		$29
4	Canal reshaping	100	LF	$25	$2,500	15%	$2,875	50	3%		$198
5	Site Clearing and Preparation	1	LS	$2,500	$2,500	15%	$2,875	50	2%		$169
						Subtotal=	**$6,236**				
Structures											
6	Demo and remove concrete- w/rebar	12	CY	$300	$3,600	15%	$4,140	50	0%		$161
7	Reinforced Concrete	20	CY	$1,000	$20,000	15%	$23,000	50	2%		$1,354
8	Concrete canal lining - 6" thick, reinforced	1600	SF	$8	$12,800	15%	$14,720	50	3%		$1,014
9	F&I 72" RCP	130	LF	$240	$31,200	15%	$35,880	50	2%		$2,112
						Subtotal=	**$77,740**				
					Unlisted Items Contingency =	10%	**$8,861**	50	3%		$610
					Subtotal of Direct Costs(including Mobilization)=		**$97,470**				
INDIRECT COSTS											
10	Engineering & Construction Management	1	LS	20%	$19,494	0%	$19,494	50	0%		$758
11	Legal, Environmental and Administration	1	LS	20%	$19,494	0%	$19,494	50	0%		$758
	TOTAL CONSTRUCTION COST =									**$136,458**	
	TOTAL ANNUAL COST =										**$7,369**

Estimate of Capital, Implementation and Annual Costs

Hutchinson Creek Spill

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$16,563	0%	$16,563	50	0%		$644
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Site Clearing and Preparation	1	LS	$1,500	$1,500	15%	$1,725	50	2%		$102
4	Excavation - Excavator	150	CY	$7	$975	15%	$1,121	50	2%		$66
5	Canal reshaping	100	LF	$25	$2,500	15%	$2,875	50	3%		$198
						Subtotal=	**$5,721**				
Structures											
6	Demo and remove concrete- w/rebar	8	CY	$300	$2,400	15%	$2,760	50	0%		$107
7	Demo existing weir	1	LS	$1,200	$1,200	15%	$1,380	50	0%		$54
8	Reinforced Concrete	24	CY	$1,000	$24,000	15%	$27,600	50	2%		$1,625
9	Concrete canal lining - 6" thick, reinforced	2800	SF	$8	$22,400	15%	$25,760	50	3%		$1,774
10	Fabricated Steel Walkway -2.5'W	80	FT	$150	$12,000	15%	$13,800	50	2%		$812
11	Riprap	60	TN	$90	$5,400	15%	$6,210	50	2%		$366
12	36" Flap Gate	1	LS	$12,000	$12,000	15%	$13,800	50	5%		$1,226
13	F&I 30" Orifice Gate	1	LS	$3,130	$3,130	15%	$3,600	50	5%		$320
14	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
15	Improve farm road crossings across Hutch.Crk	2	EA	$80,000	$160,000	15%	$184,000	50	3%		$12,671
16	Improve private weir in Hutch. Crk.	1	EA	$25,000	$25,000	15%	$28,750	50	3%		$1,980
						Subtotal=	**$311,110**				
Measurement Equipment and Materials											
17	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	15	3%		$124
18	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	20	2%		$60
19	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
20	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
21	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
22	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
23	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
24	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
25	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
26	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
27	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
28	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$14,024**				
					Unlisted Items Contingency =	10%	**$34,783**	50	3%		$2,395
					Subtotal of Direct Costs(including Mobilization)=		**$382,616**				
INDIRECT COSTS											
29	Engineering & Construction Management	1	LS	25%	$95,654	0%	$95,654	50	0%		$3,718
30	Legal, Environmental and Administration	1	LS	25%	$95,654	0%	$95,654	50	0%		$3,718
	TOTAL CONSTRUCTION COST =									**$573,924**	
	TOTAL ANNUAL COST =										**$33,634**

Estimate of Capital, Implementation and Annual Costs

Increasing Canal Capacity

Belza Gates to Hutchinson Creek Spill

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	2%	$24,305	0%	$24,305	50	0%		$945
Earthwork											
2	Site Clearing and Preparation	1	LS	$1,500	$1,500	15%	$1,725	50	2%		$102
3	Import	10500	CY	$24	$252,000	15%	$289,800	50	1%		$14,161
4	Excavation - Excavator	31500	CY	$7	$204,750	15%	$235,463	50	2%		$13,861
5	Compacted in-place fill	31500	CY	$9	$283,500	15%	$326,025	50	2%		$19,192
6	Canal reshaping	10500	LF	$30	$315,000	15%	$362,250	50	3%		$24,947
						Subtotal=	**$1,215,263**				
					Unlisted Items Contingency =	5%	**$61,978**	50	3%		$4,268
					Subtotal of Direct Costs(including Mobilization)=		**$1,301,546**				
INDIRECT COSTS											
7	Engineering & Construction Management	1	LS	20%	$260,309	0%	$260,309	50	0%		$10,117
8	Legal, Environmental and Administration	1	LS	20%	$260,309	0%	$260,309	50	0%		$10,117
TOTAL CONSTRUCTION COST =										**$1,822,165**	
TOTAL ANNUAL COST =											**$97,708**

Estimate of Capital, Implementation and Annual Costs

Ostrom Road Weir

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$894	0%	$894	20	0%		$60
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Structures											
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
Measurement Equipment and Materials											
4	F&I Submersible pressure transducer	1	EA	$950	$950	15%	$1,093	15	3%		$124
5	4-6" PVC stilling well - PT	1	EA	$600	$600	15%	$690	20	2%		$60
6	F&I Digital display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
7	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
8	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
9	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
10	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
11	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
12	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
13	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
14	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
15	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$14,024**				
						Subtotal of Direct Costs(including Mobilization)=	**$18,783**				
INDIRECT COSTS											
16	Engineering & Construction Management	1	LS	15%	$2,817	0%	$2,817	20	0%		$189
17	Legal, Environmental and Administration	1	LS	15%	$2,817	0%	$2,817	20	0%		$189
	TOTAL CONSTRUCTION COST =									**$24,417**	
	TOTAL ANNUAL COST =										**$2,298**

Estimate of Capital, Implementation and Annual Costs

Beukleman Delivery

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,081	0%	$1,081	20	0%		$73
	General										
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
	Structures										
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
	Measurement Equipment and Materials										
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
7	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
8	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
14	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$17,762**				
						Subtotal of Direct Costs(including Mobilization)=	**$22,707**				
INDIRECT COSTS											
15	Engineering & Construction Management	1	LS	15%	$3,406	0%	$3,406	20	0%		$229
16	Legal, Environmental and Administration	1	LS	15%	$3,406	0%	$3,406	20	0%		$229
	TOTAL CONSTRUCTION COST =									**$29,519**	
	TOTAL ANNUAL COST =										**$2,834**

Estimate of Capital, Implementation and Annual Costs

Tollcrest Delivery

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,081	0%	$1,081	20	0%		$73
	General										
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
	Structures										
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
	Measurement Equipment and Materials										
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
7	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
8	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
14	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$17,762**				
						Subtotal of Direct Costs(including Mobilization)=	**$22,707**				
INDIRECT COSTS											
15	Engineering & Construction Management	1	LS	15%	$3,406	0%	$3,406	20	0%		$229
16	Legal, Environmental and Administration	1	LS	15%	$3,406	0%	$3,406	20	0%		$229
	TOTAL CONSTRUCTION COST =									**$29,519**	
	TOTAL ANNUAL COST =										**$2,834**

Estimate of Capital, Implementation and Annual Costs

Wheatland Pump Station #1

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$714	0%	$714	20	0%		$48
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Structures											
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
Measurement Equipment and Materials											
4	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
5	F&I PLC	1	EA	$2,200	$2,200	15%	$2,530	15	3%		$288
6	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
7	F&I 20W solar panel, mounting bracket and charge controller	1	EA	$710	$710	15%	$817	15	3%		$93
8	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
9	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
10	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
11	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
12	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$10,425**				
						Subtotal of Direct Costs(including Mobilization)=	**$15,003**				
INDIRECT COSTS											
13	Engineering & Construction Management	1	LS	15%	$2,250	0%	$2,250	20	0%		$151
14	Legal, Environmental and Administration	1	LS	15%	$2,250	0%	$2,250	20	0%		$151
	TOTAL CONSTRUCTION COST =									**$19,504**	
	TOTAL ANNUAL COST =										**$1,819**

Estimate of Capital, Implementation and Annual Costs

Rue Pump Station

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$3,634	0%	$3,634	20	0%		$244
	General										
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
	Measurement Equipment and Materials										
3	50HP VFD	1	EA	$36,000	$36,000	15%	$41,400	20	10%		$6,923
4	VFD panel w/ cooling	1	EA	$3,000	$3,000	15%	$3,450	20	10%		$577
5	F&I magnetic flowmeter (8"-12")	1	EA	$3,424	$3,424	15%	$3,938	15	3%		$448
6	F&I magnetic flowmeter (14"-18")	1	EA	$5,200	$5,200	15%	$5,980	15	3%		$680
7	F&I magnetic flowmeter (20"-24")	1	EA	$6,848	$6,848	15%	$7,875	15	3%		$896
8	Internal magmeter datalogger, software and cable	3	EA	$160	$480	15%	$552	15	3%		$63
9	F&I pulse frequency meter/counter module (pulse to Modbus)	1	EA	$400	$400	15%	$460	15	3%		$52
10	Remote mounted flow display	3	EA	$150	$450	15%	$518	15	2%		$54
11	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
12	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
13	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
14	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
15	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
16	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
17	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
18	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$72,274**				
					Unlisted Items Contingency =	5%	**$3,816**	20	3%		$371
					Subtotal of Direct Costs(including Mobilization)=		**$80,139**				
INDIRECT COSTS											
19	Engineering & Construction Management	1	LS	15%	$12,021	0%	$12,021	20	0%		$808
20	Legal, Environmental and Administration	1	LS	15%	$12,021	0%	$12,021	20	0%		$808
	TOTAL CONSTRUCTION COST =									**$104,180**	
	TOTAL ANNUAL COST =										**$12,827**

Estimate of Capital, Implementation and Annual Costs

Wheatland Pump Station #2

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,398	0%	$1,398	20	0%		$94
	General										
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
	Structures										
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
	Measurement Equipment and Materials										
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
7	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
8	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
14	Velocity Index Calibration - non-Wadeable	1	LS	$5,500	$5,500	15%	$6,325	15	3%		$720
15	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$24,087**				
						Subtotal of Direct Costs(including Mobilization)=	**$29,348**				
INDIRECT COSTS											
16	Engineering & Construction Management	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
17	Legal, Environmental and Administration	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
	TOTAL CONSTRUCTION COST=									**$38,153**	
	TOTAL ANNUAL COST =										**$3,708**

Estimate of Capital, Implementation and Annual Costs

South Yuba Water District Meter #1

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,398	0%	$1,398	20	0%		$94
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Structures											
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
Measurement Equipment and Materials											
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
7	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
8	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
14	Velocity index calibration - non-wadeable	1	LS	$5,500	$5,500	15%	$6,325	15	3%		$720
15	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$24,087**				
						Subtotal of Direct Costs(including Mobilization)=	**$29,348**				
INDIRECT COSTS											
16	Engineering & Construction Management	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
17	Legal, Environmental and Administration	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
	TOTALCONSTRUCTION COST=									**$38,153**	
	TOTAL ANNUAL COST =										**$3,708**

Estimate of Capital, Implementation and Annual Costs

Dry Creek Mutual Water Company Meter #1

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,398	0%	$1,398	20	0%		$94
	General										
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
	Structures										
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
	Measurement Equipment and Materials										
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
7	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
8	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
14	Velocity index calibration - non-wadeable	1	LS	$5,500	$5,500	15%	$6,325	15	3%		$720
15	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$24,087**				
						Subtotal of Direct Costs(including Mobilization)=	**$29,348**				
INDIRECT COSTS											
16	Engineering & Construction Management	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
17	Legal, Environmental and Administration	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
	TOTAL CONSTRUCTION COST =									**$38,153**	
	TOTAL ANNUAL COST =										**$3,708**

Estimate of Capital, Implementation and Annual Costs

South Yuba Water District Meter #2

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$1,398	0%	$1,398	20	0%		$94
	General										
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
	Structures										
3	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$3,450**				
	Measurement Equipment and Materials										
4	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
5	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
6	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
7	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
8	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
9	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
10	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
11	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
12	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
13	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
14	Velocity index calibration - non-wadeable	1	LS	$5,500	$5,500	15%	$6,325	15	3%		$720
15	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$24,087**				
						Subtotal of Direct Costs (including Mobilization)=	**$29,348**				
INDIRECT COSTS											
16	Engineering & Construction Management	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
17	Legal, Environmental and Administration	1	LS	15%	$4,402	0%	$4,402	20	0%		$296
	TOTAL CONSTRUCTION COST =									**$38,153**	
	TOTAL ANNUAL COST =										**$3,708**

Estimate of Capital, Implementation and Annual Costs

Interceptor at Alferos

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$909	0%	$909	20	0%		$61
	General										
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
	Measurement Equipment and Materials										
3	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
4	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
5	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
6	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
7	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
8	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
9	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
10	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
11	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$650	$650	15%	$748	15	2%		$78
12	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
13	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$17,762**				
						Subtotal of Direct Costs(including Mobilization)=	**$19,085**				
INDIRECT COSTS											
14	Engineering & Construction Management	1	LS	15%	$2,863	0%	$2,863	20	0%		$192
15	Legal, Environmental and Administration	1	LS	15%	$2,863	0%	$2,863	20	0%		$192
	TOTAL CONSTRUCTION COST =									**$24,810**	
	TOTAL ANNUAL COST =										**$2,448**

Estimate of Capital, Implementation and Annual Costs

Interceptor at Bear River

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$2,309	0%	$2,309	50	0%		$90
General											
2	Programming, start-up and debug	1	LS	$360	$360	15%	$414	15	2%		$43
						Subtotal=	**$414**				
Earthwork											
3	Excavation - Excavator	150	CY	$7	$975	15%	$1,121	50	2%		$66
4	Compacted In-Place Fill	50	CY	$9	$450	15%	$518	50	2%		$30
						Subtotal=	**$1,639**				
Structures											
5	Concrete canal lining - 6" thick, reinforced	1200	SF	$8	$9,600	15%	$11,040	50	3%		$760
6	Reinforced Concrete	10	CY	$1,000	$10,000	15%	$11,500	50	2%		$677
7	Vandalism enclosure	1	EA	$3,000	$3,000	15%	$3,450	20	2%		$301
						Subtotal=	**$25,990**				
Measurement Equipment and Materials											
8	F&I SonTek-IQ flowmeter and cable	1	EA	$6,450	$6,450	15%	$7,418	15	3%		$844
9	F&I flowmeter mounting bracket	1	EA	$550	$550	15%	$633	15	3%		$72
10	F&I SonTek-IQ flow display	1	EA	$1,400	$1,400	15%	$1,610	15	3%		$183
11	F&I 800-960MHz spread spectrum radio	1	EA	$2,000	$2,000	15%	$2,300	15	3%		$262
12	F&I 24"x24" (NEMA 4/12) electronics enclosure w/ back panel	1	EA	$830	$830	15%	$955	20	2%		$83
13	F&I 80W solar panel, mounting bracket and charge controller	1	EA	$890	$890	15%	$1,024	15	3%		$116
14	F&I 12v battery and wiring	1	EA	$175	$175	15%	$201	15	3%		$23
15	F&I antenna, mast, cables, and lightening arrestor	1	LS	$1,100	$1,100	15%	$1,265	15	2%		$131
16	Wire, connectors, fuse and terminal blocks and conduit	1	LS	$975	$975	15%	$1,121	15	2%		$116
17	Assembly of electronics panel	1	LS	$400	$400	15%	$460	15	2%		$48
18	Radio path and signal strength testing	1	EA	$1,000	$1,000	15%	$1,150	15	2%		$119
						Subtotal=	**$18,136**				
						Subtotal of Direct Costs(including Mobilization)=	**$48,487**				
INDIRECT COSTS											
19	Engineering & Construction Management	1	LS	15%	$7,273	0%	$7,273	50	0%		$283
20	Legal, Environmental and Administration	1	LS	15%	$7,273	0%	$7,273	50	0%		$283
	TOTAL CONSTRUCTION COST =									**$63,033**	
	TOTAL ANNUAL COST =										**$4,531**

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Yuba County Water Agency
2012 Agricultural Water Management Plan

Attachment F-2: Reconnaissance Level Estimates of Avoided Costs Through Automation Alternatives

Prepared By

DAVIDS ENGINEERING, INC
www.de-water.com

December 2012

Notes:

All costs are subject to revision following refinement of estimates following more detailed review and design.

Permanent Rebuild of Reeds Creek at North Beale Road

Item	Description	Quantity	Units	Unit Price, ($)	Extended Cost, ($)	Contingency	Cost + Contingency ($)	Useful Life, yrs	% O&M	Total Cost, ($)	Annual Cost, $
DIRECT COSTS											
1	Mobilization (% of Direct Costs)	1	LS	5%	$4,300	0%	$4,300	50	0%		$167
	Earthwork										
2	Excavation - Excavator	1000	CY	$7	$6,500	15%	$7,475	50	2%		$440
3	Compacted In-Place Fill	1200	CY	$9	$10,800	15%	$12,420	50	2%		
4	Canal reshaping	700	LF	$25	$17,500	15%	$20,125	50	3%		$1,386
5	Riprap	100	TN	$90	$9,000	15%	$10,350	50	2%		$609
						Subtotal=	**$50,370**				
	Structures										
6	Remove sheet piling	1	LS	$2,000	$2,000	15%	$2,300	50			$89
7	Reinforced Concrete	15	CY	$1,000	$15,000	15%	$17,250	50	2%		$1,015
8	F&I 36" Orifice Gate	2	EA	$3,695	$7,390	15%	$8,499	50	5%		$755
9	Fabricated Steel Walkway -2.5'W	40	FT	$150	$6,000	15%	$6,900	50	2%		$406
10	F&I Staff gage	2	EA	$300	$600	15%	$690	15	2%		
						Subtotal=	**$35,639**				
					Unlisted Items Contingency =	5%	**$4,515**	50	3%		$311
					Subtotal of Direct Costs(including Mobilization)=		**$94,824**				
INDIRECT COSTS											
11	Engineering & Construction Management	1	LS	25%	$23,706	0%	$23,706	50	0%		$921
12	Legal, Environmental and Administration	1	LS	25%	$23,706	0%	$23,706	50	0%		$921
	TOTAL CONSTRUCTION COST =									**$142,237**	
	TOTAL ANNUAL COST =										**$7,022**