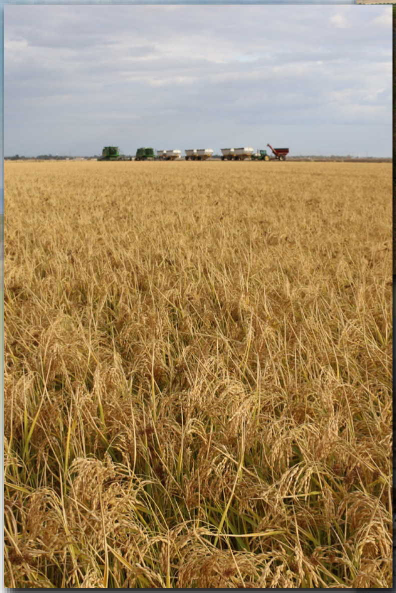
Conditional Waiver for Rice 2014 Annual Monitoring Report

December 2014



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Prepared for

California Rice Commission

California Rice

Prepared by

CH2MHILL®

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Acronyms and Abbreviations

2008 Coalition MRP	CVRWQCB adopted Order No. R5-2008-0005
µmhos/cm	micromhos per centimeter
µS/cm	microSiemens per centimeter
AMR	Annual Monitoring Report
Basin Plan	*Water Quality Control Plan for the Sacramento and San Joaquin River Basins*
$CaCO_3$	calcium carbonate
CACs	County Agricultural Commissioners
CDEC	California Data Exchange Center
cfs	cubic feet per second
CLS	California Laboratory Services
COC	chain-of-custody
CRC	California Rice Commission
CRC MRP	CVRWQCB Order No. R5-2010-0805
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
CWFR	Conditional Waiver for Rice
DO	dissolved oxygen
DPR	California Department of Pesticide Regulation
DWR	California Department of Water Resources
DWR PP	DWR pumping plant
EC	electrical conductivity
Irrigated Lands Conditional Waiver	CVRWQCB Resolution R5-2003-0105, *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands within the Central Valley*
Irrigated Lands Regulatory Program	CVRWQCB *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands*
K	potassium

LCS/LCSD	laboratory control spike and laboratory control spike duplicate
MCLs	maximum contaminant levels
MDL	method detection limit
mg/L	milligrams per liter
MRLs	method reporting limits
MRP	Monitoring and Reporting Program
MRP Order	Monitoring and Reporting Program Order
MS/MSD	matrix spike and matrix spike duplicate
N	nitrogen
ND	non-detect
NOA	Notice of Applicability
NPS	nonpoint source
NTU	nephelometric turbidity unit
P	phosphorus
PUR	Pesticide Use Report
QA/QC	Quality Assurance/Quality Control
QAO	quality assurance objective
QAPP	Quality Assurance Project Plan
RPD	relative percent difference
RPP	Rice Pesticides Program
SOP	standard operating procedure
TDS	total dissolved solids
TOC	total organic carbon
TMDL	total maximum daily load
UC	University of California
UC IPM	University of California Integrated Pest Management
WDRs	Waste Discharge Requirements
WQO	water quality objective
Zn	zinc

SECTION 1

Introduction

The California Rice Commission (CRC) is a statutory organization representing approximately 2,500 rice farmers who farm approximately 500,000 acres of California farmland. Rice is one of the top 20 crops produced in California, and adds nearly a half billion dollars in revenue and thousands of jobs vital to the state's economy. The California rice industry contributes significantly to the foundation of many rural economies and the positive balance of international trade. Rice produced in the United States provides 1.5 to 2 percent of global production, competes in the global market, and constitutes a large proportion of internationally traded medium-grain (north Asian) rice.

The CRC implements water quality monitoring and reporting activities in compliance with the Central Valley Regional Water Quality Control Board (CVRWQCB) Conditional Waiver for Rice (CWFR) monitoring and reporting. The CWFR is a rice-specific Monitoring and Reporting Program (MRP) under the CVRWQCB's *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands* (Irrigated Lands Regulatory Program). Monitoring and reporting requirements for the 2014 CWFR are specified in CVRWQCB Order No. R5-2010-0805 (CRC MRP) (Appendix A).

This report serves as the 2014 Annual Monitoring Report (AMR) for the CWFR effort, and describes CRC-conducted program activities for the 2014 calendar year.

Key CWFR activities include:

- Rice acreage information reporting
- Rice pesticide use information reporting
- Water quality monitoring
- Laboratory coordination
- Laboratory analysis and reporting
- Data validation and review
- Coordination of early season data submittals between the County Agricultural Commissioners (CACs) and the California Department of Pesticide Regulation (DPR)
- Interaction with pesticide registrants to support the development of reduced-risk pesticides
- Annual reporting and review

Program Administration

The CRC has long been recognized by the CVRWQCB as an entity with the authority and capacity to implement water quality program activities to achieve water quality protection. The CRC is a statutory organization with authorities and restrictions as established in the California Food and Agricultural Code. In July 2003, the CRC was issued a Notice of

Applicability (NOA) as a watershed coalition under the CVRWQCB's Irrigated Lands Regulatory Program and has implemented rice-specific program activities since then.

To implement the monitoring and reporting requirements of this program, a consultant team was retained by the CRC. Kleinfelder was contracted by the CRC to collect water samples at specified sites to obtain data to characterize water quality. CH2M HILL reviewed and compiled the data and prepared this AMR under contract to the CRC.

California Rice

Rice is grown in nine Sacramento Valley counties (Butte, Colusa, Glenn, Placer, Sacramento, Sutter, Tehama, Yolo, and Yuba). Rice is also farmed in counties outside the Sacramento Valley; however, the acreages are generally small, and rice is not the dominant crop in these areas. For the purposes of the rice-specific MRP, the monitoring area is defined as the nine rice-producing counties in the Sacramento Valley.

Rice fields provide numerous environmental and commercial advantages that no alternative land use would, including a variety of upland and shallow aquatic habitat. In efforts to reduce rice straw burning and improve wildlife habitat, rice farmers routinely flood their fields in the winter (when no rice is present) to degrade the straw. Rice farming requires flooded field conditions that contribute to favorable habitat conditions. More than 230 species of wildlife and millions of migratory waterfowl thrive in California rice fields. In 2003, California rice lands were designated as shorebird habitat of international significance by the Manomet Center for Conservation Sciences in partnership with the Western Hemisphere Shorebird Reserve Network.

In 2014, an estimated 462,000 acres of rice were planted in the nine rice-growing counties of the Sacramento Valley, as reported by the CACs. The CAC acreage numbers are preliminary and usually higher than actual planted acres because of accounting through pesticide applications; multiple applications on single acres can result in double counting of acreage under the CAC method. Figure 1-1 shows the distribution of acreage within the Sacramento Valley (as reported by the CACs).

Rice Farming's Influence on Water Quality

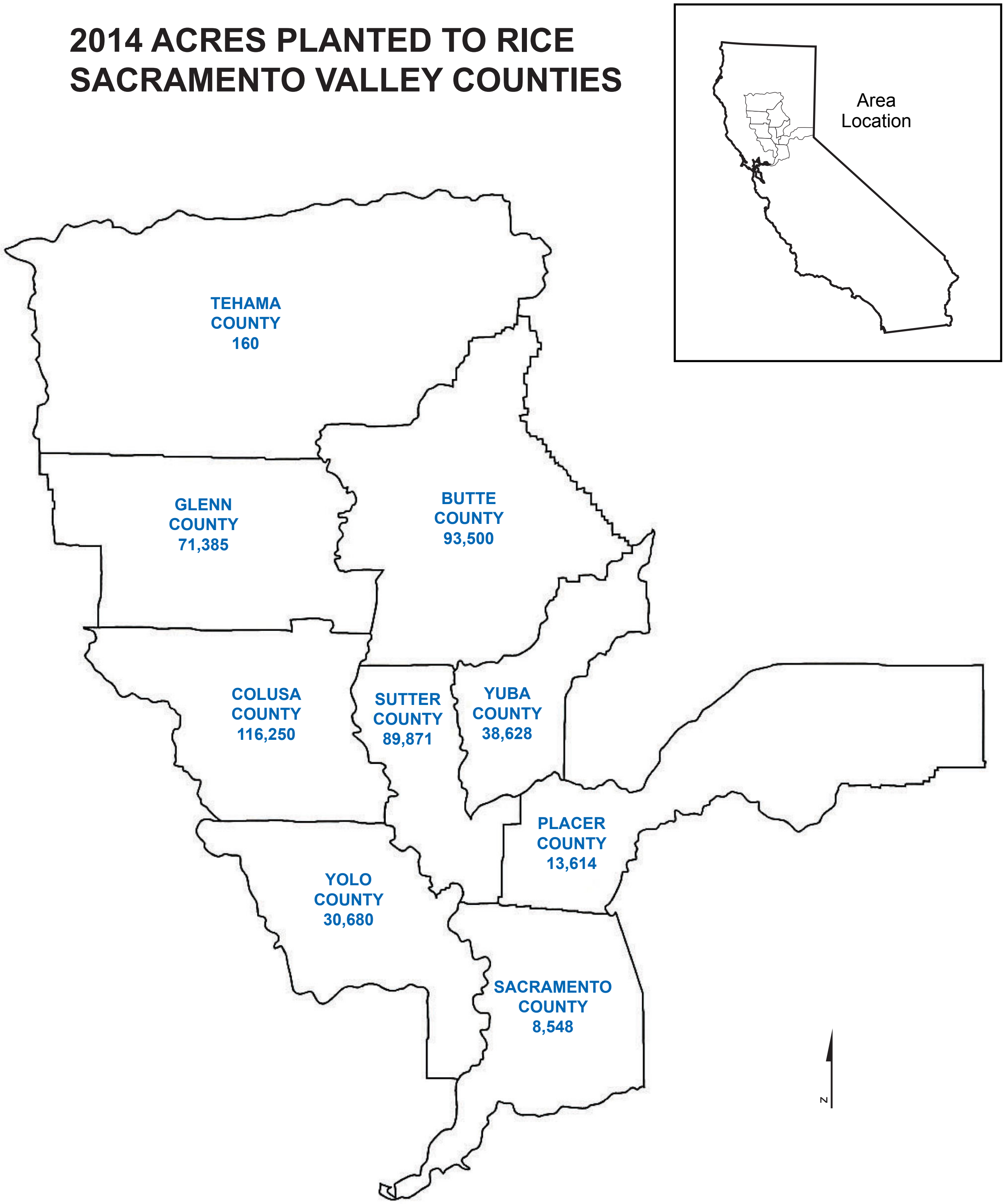
Because rice is farmed in standing water, the importance of good farming practices to water quality is evident. However, water quality problems associated with other crops and locales (such as soil erosion and sediment transport, saline drainage waters, and high concentrations of trace elements in subsurface drainage) are typically not problems associated with rice drainage. The generally slow rate of flow through rice fields and the controlled rate of water release tend to minimize significant soil erosion. With regard to salinity, much of the water used to irrigate rice fields initially has a low salt concentration, and there is little possibility for salt accumulation in a continuously flooded system, so salt concentration in return flows is usually relatively low.

History of Rice Water Quality Efforts

The CRC has undertaken water quality management activities since the 1980s. The efforts began under the Rice Pesticides Program (RPP) and, beginning in 2004, included efforts under the

CWFR. A description of the historical context of rice water quality management efforts under the CWFR follows. Historical information on the RPP can be found in the 2014 RPP AMR.

2014 ACRES PLANTED TO RICE SACRAMENTO VALLEY COUNTIES



Note: Acreage totals based on preliminary data provided by the County Agricultural Commissioners

FIGURE 1-1
Sacramento Valley Rice Acres, 2014
CRC 2014 Annual Monitoring Report

The CRC was granted an NOA to serve as a watershed coalition group under the CVRWQCB Resolution R5-2003-0105, *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands within the Central Valley* (referred to as the Irrigated Lands Conditional Waiver) and Monitoring and Reporting Program Order (MRP Order) No. R5-2003-0826.

In October 2004, the CRC submitted a technical report, *Basis for Water Quality Monitoring Program: Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands for Rice* (*CWFR*), to the CVRWQCB. The report served as the basis for the CVRWQCB's rice-specific MRP. The report presented mapping information, including subwatersheds and drainages, rice acreage, and hydrography (lakes, reservoirs, rivers, creeks, canals, and drains); an overview of rice cultural practices; information on the use of and a review of historical data for pesticides and nutrients; a discussion of other potential constituents of concern; a proposed future rice-specific sampling program, including sample locations, sample parameters, and sample timing; and a discussion of the framework for future program review. The geographic and historical data were analyzed and employed to select appropriate water quality monitoring sites. Specifically, the report included information on the study area, rice pesticide use and water quality data, nutrient use and water quality data, copper use and water quality data, proposed future sampling, and a framework for program review and update.

Since 2004, the CVRWQCB has issued additional monitoring and reporting requirements, which have been refined based on water quality results and evolving requirements of the Irrigated Lands Regulatory Program.

The current monitoring and reporting requirements for the CWFR are specified in MRP Order R5-2010-0805, which was extended to cover the 2014 monitoring season.

AMR Requirements

The AMR for the CWFR program is to be submitted by December 31 each year. The AMR is to include the following:

1. Title page
2. Table of contents
3. Description of the watershed
4. Monitoring objectives
5. Sample site descriptions
6. Location map of sampling sites and land use
7. Tabulated results of analyses
8. Sampling and analytical methods used
9. Copies of chains of custody
10. Associated laboratory and field quality control sample results

11. Summary of precision and accuracy
12. Pesticide use information
13. Data interpretation, including an assessment of data quality objectives
14. Summary of management practices used
15. Actions taken to address water quality impacts identified, including but not limited to revised or additional management practices to be implemented
16. Communication reports
17. Conclusions and recommendations

Table 1-1 shows the location of the required information within this report.

TABLE 1-1
Location of Required AMR Information in this Report

Required Information	Location in this Report
Table of contents	Page iii
Description of the watershed	Section 2
Monitoring objectives	Section 3
Sample site descriptions	Section 3
Location map of sampling sites and land use	Appendix B
Tabulated results of analyses	Section 4
Sampling and analytical methods used	Sections 3 and 4
Copies of chains of custody	Appendix C-1
Associated laboratory and field quality control sample results	Appendix C-2
Summary of precision and accuracy	Section 5
Pesticide use information	Section 2
Data interpretation, including an assessment of data quality objectives	Section 5
Summary of management practices used	Section 3
Actions taken to address water quality impacts identified, including but not limited to revised or additional management practices to be implemented	Section 3
Communication reports	The information herein supersedes the communication reports.
Conclusions and recommendations	Section 6
Field documentation	Appendix C
Laboratory original data	Appendix C
Summary of field conditions, including a description of the weather, rainfall, stream flow, color of the water, odor, and other relevant information that can help in data interpretation	Section 2 and field sheets (Appendix C)

SECTION 2

Growing Season, Hydrology, and Applied Materials

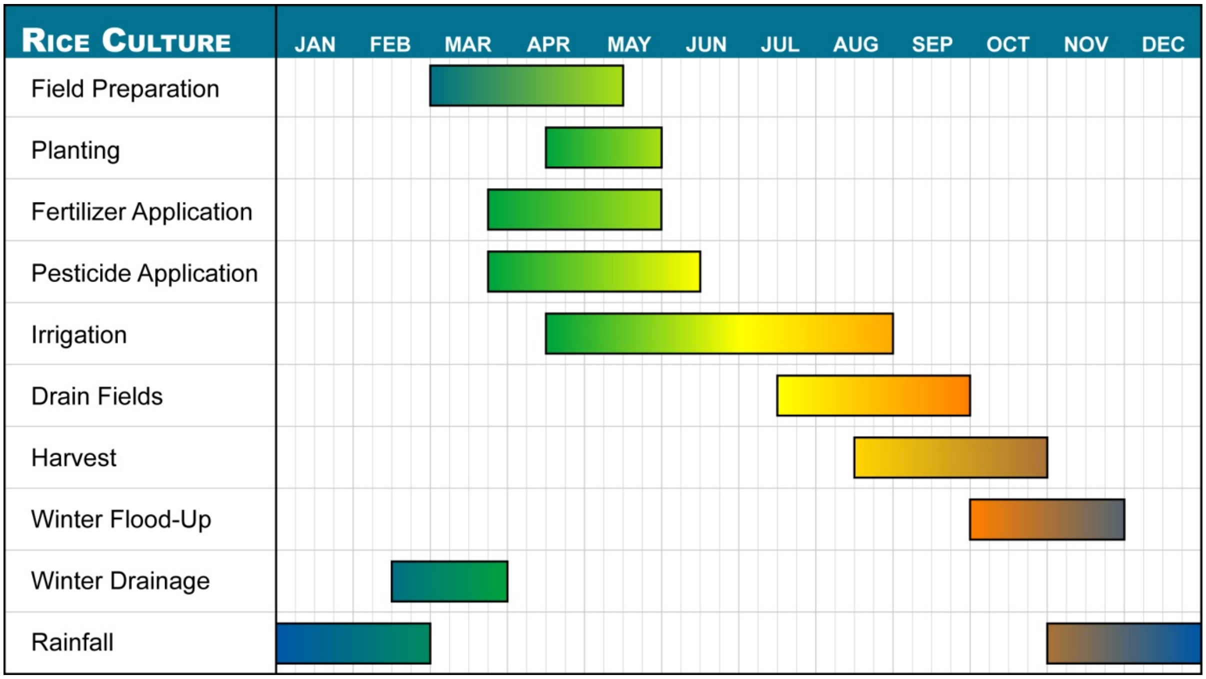
The rice water quality monitoring programs are based on a thorough understanding of how rice is grown in the Sacramento Valley, including key events such as irrigation, drainage, and runoff, and an understanding of when and how products such as pesticides and nutrients are applied. Hydrologic conditions during the year can also influence the timing of key events. This section describes the "typical" Sacramento Valley rice farming calendar and the 2014 rice growing season (including 2014 Sacramento River hydrology), and includes data on the materials applied to rice during the 2014 growing season.

Rice Farming in the Sacramento Valley

Most California rice is produced by direct seeding into standing water with a continuous flood maintained for most of the season. Limited acreage is drill or dry seeded (planted with ground equipment), which also uses permanent flood after stand establishment. The rice farming cycle includes these key events:

- Field preparation
- Planting
- Fertilizer application
- Pesticide application
- Irrigation
- Drainage
- Harvest
- Winter flood-up
- Winter drainage

Figure 2-1 illustrates the typical timeline for these key events.



Source: University of California Cooperative Extension and grower input

FIGURE 2-1
Key Events in a Typical Rice Year

Hydrology

Seasonal rainfall and weather conditions influence rice planting and rice pesticide application. Fields were planted later than typical in 2014 due to the delay of water allocations resulting from severe drought conditions. Field planting typically begins in mid-April through the end of May, with draining in August and September; in 2014, most field planting began in May, with draining in September and October. The 2014 harvest extended into mid-November.

Flow data for the Sacramento River at Colusa (station COL) were acquired from the California Department of Water Resources (DWR) California Data Exchange Center (CDEC), and precipitation and air temperature data for a sensor in Colusa (COL.A) were obtained from the University of California Integrated Pest Management (UC IPM) California Weather Database. Data were collected for the period January 1, 2014, through October 23, 2014. Flow and precipitation data for that time period are shown in Figure 2-2, and minimum and maximum air temperatures are shown in Figure 2-3.

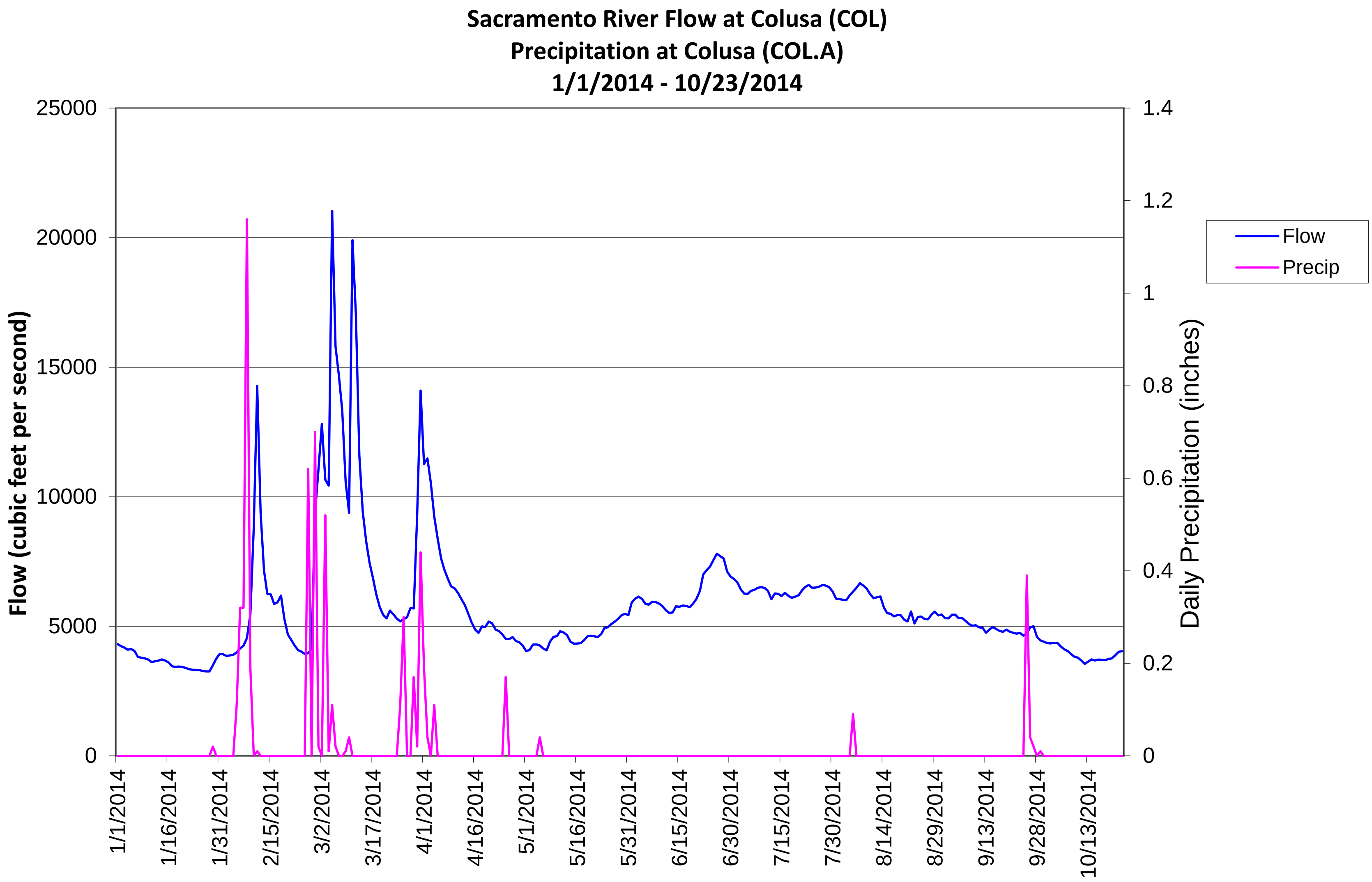


FIGURE 2-2
Flow and Precipitation Data, 2014

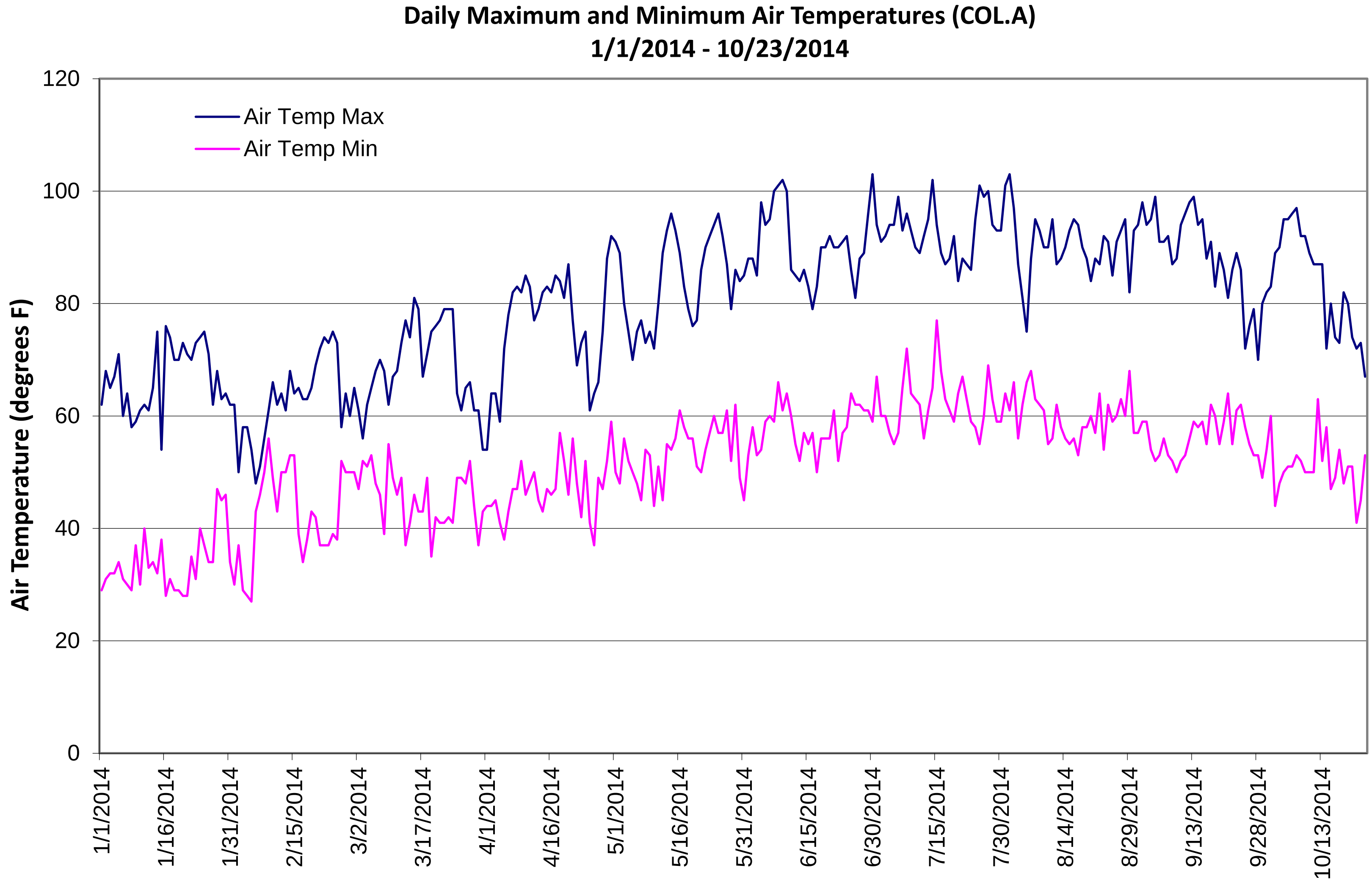


FIGURE 2-3
Daily Maximum and Minimum Air Temperatures, 2014

Rice Growth Stages and Pesticide Application Timing

Management practices are a key component of the rice water quality programs and were initially developed to increase efficacy and ultimately to protect water quality. The cornerstone of rice management practices is a thorough understanding of the rice-farming calendar, including the application methods and timing of pesticide use.

Figure 2-4 depicts the rice growth stages, and Tables 2-1 through 2-4 show the season or timing of pesticide applications to rice, including herbicide applications, tank mix combinations, insecticide applications, and sequential herbicide applications. A “sequential application” is the application of an herbicide followed by another herbicide with a different mode of action. Sequential applications are used to achieve better coverage and efficacy for weed control. The second application usually occurs in the next growth stage of the rice plant. For example, clomazone is applied at germination. A sequential application of bispyribac-sodium is applied at tiller initiation.

Rice pesticide applications are timed for specific growth stages of the rice plant. To simplify the rice growth schedule presentation, Tables 2-1 through 2-4 group pre-flood and germination into early season, tiller initiation and tillering into mid-season, and panicle initiation and flower into late season.

This calendar of applications provides information that is useful for understanding potential water quality concerns relative to particular times during the year.

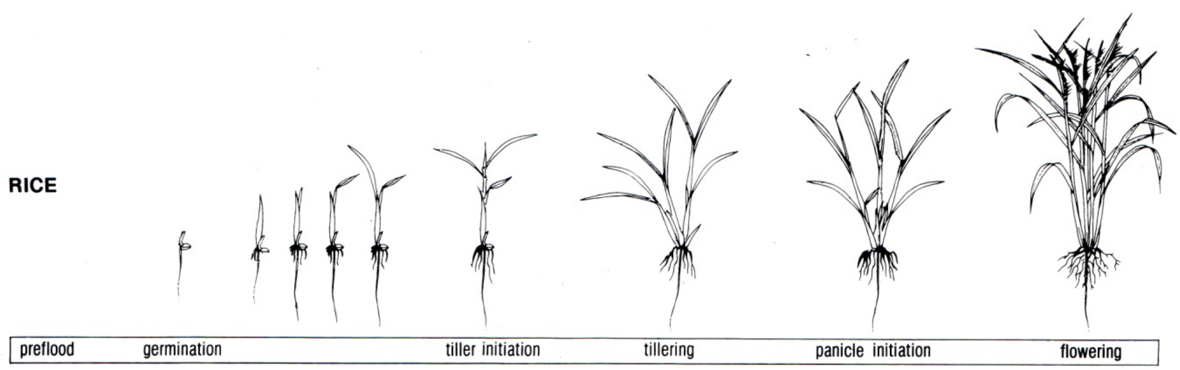


FIGURE 2-4
Rice Growth Stages

TABLE 2-1
Timing of Specific Rice Herbicide Applications

<table>
<tr><th colspan="2">Early Season
(March–April)</th><th colspan="2">Mid Season
(May–June)</th><th colspan="2">Late Season
(June–July)</th></tr>
<tr><th>Pre-Flood</th><th>Germination</th><th>Tiller Initiation</th><th>Tillering</th><th>Panicle Initiation</th><th>Flowering</th></tr>
<tr><td></td><td>Bensulfuron-methyl
Permanent flood</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>Bensulfuron-methyl
Pinpoint flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>Bispyribac-sodium
Pinpoint flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Carfentrazone-ethyl
Permanent flood
5-day static; 30-day release</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Clomazone
Permanent flood
14-day water hold</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl
Pinpoint flood
7-day water hold</td><td></td><td></td></tr>
<tr><td></td><td></td><td>Propanil
Pinpoint flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Thiobencarb (Bolero and Abolish)
Permanent flood
30-day maximum water hold</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Triclopyr TEA
Pinpoint flood
20-day water hold</td><td></td><td></td></tr>
</table>

TABLE 2-2
Examples of the Timing of Herbicide Tank Mix Combinations as Provided by Dr. Albert Fischer, UC Davis

Early Season (March–April)		**Mid Season (May–June)**		**Late Season (June–July)**	
Pre-Flood	**Germination**	**Tiller Initiation**	**Tillering**	**Panicle Initiation**	**Flowering**
		Bispyribac-sodium/Thiobencarb (Abolish) Pinpoint flood 30-day water hold **Propanil/Thiobencarb** (Abolish) Permanent flood 30-day water hold			

TABLE 2-3
Timing of Specific Rice Insecticide Applications

Early Season (March–April)		**Mid Season (May–June)**		**Late Season (June–July)**	
Pre-Flood	**Germination**	**Tiller Initiation**	**Tillering**	**Panicle Initiation**	**Flowering**
	Lambda cyhalothrin Border treatment 7-day water hold **(s)-cypermethrin** Border treatment 7-day water hold				**Lambda cyhalothrin** Border treatment 7-day water hold **(s)-cypermethrin** Border treatment 7-day water hold

TABLE 2-4
Timing of Sequential Rice Herbicide Applications

<table>
<tr><th colspan="2">Early Season
(March-April)</th><th colspan="2">Mid Season
(May–June)</th><th colspan="2">Late Season
(June–July)</th></tr>
<tr><th>Pre-Flood</th><th>Germination</th><th>Tiller Initiation</th><th>Tillering</th><th>Panicle Initiation</th><th>Flowering</th></tr>
<tr><td></td><td colspan="2">Bispyribac-sodium, Thiobencarb (Bolero)
30-day water hold
Permanent Flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Bispyribac-sodium, Propanil
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Clomazone, Bensulfuron-methyl
14-day water hold
Permanent flood</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Clomazone, Bispyribac-sodium
14-day water hold
Permanent flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Clomazone, Carfentrazone-ethyl
up to 30-day water hold
Permanent flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Clomazone, Propanil
14-day water hold
Permanent flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Clomazone, Propanil/Triclopyr TEA
20-day water hold</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl, Bensulfuron-methyl
7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl, Bispyribac-sodium
7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Cyhalofop-butyl, Propanil
7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Propanil, Cyhalofop-butyl
7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Carfentrazone-ethyl, Cyhalofop-butyl
30-day water hold, 7-day water hold
Pinpoint flood</td><td></td><td></td></tr>
</table>

Applied Materials

The DPR regulates the agricultural sales and use of pesticides in California. Growers, pesticide applicators, pest control advisors, and pest control operators report pesticide use to the CACs, and these data are included in the DPR Pesticide Use Report (PUR). DPR provides the CRC with early review/draft PUR data and enforcement data for inclusion in the CRC's annual report. Data presented in the following discussions of pesticide use and nutrient application are for the Sacramento Valley rice-growing counties.

Pesticide Use

The CACs report preliminary pesticide use information to DPR. All pesticide use numbers reported herein are preliminary and have not been audited or quality control checked by DPR.

The CWFR pesticides with overall acreage increases in 2014 were: clothianidin (+97 acres; new rice insecticide), azoxystrobin (+30,544 acres), bispyribac-sodium (+757 acres), carfentrazone-ethyl (+15,391 acres), and penoxsulam (+14,991 acres). Thiobencarb and malathion are discussed separately in the RPP AMR.

The pesticides with acreage decreases in 2014 were: diflubenzuron (-19 acres), (s)-cypermethrin (-5,507 acres), lambda cyhalothrin (-17,734 acres), propiconazole (-5,370 acres), trifloxystrobin (-4,093 acres), bensulfuron-methyl (-1,375 acres), clomazone (-43,837 acres), cyhalofop-butyl (-14,939 acres), propanil (-89,573 acres), and triclopyr TEA (-24,102 acres).

Treated acreage has a direct correlation to pounds of active ingredient applied. According to the preliminary CAC data, planted acreage in 2014 decreased by 93,400 acres, or nearly 16.8 percent, from 566,036 acres (2013) to 462,636 acres. Much of this decrease is due to the delay of water allocations resulting from severe drought conditions. Pesticide use also changed in 2014 due to the drought conditions. Some irrigation districts had no spill prohibitions until July 1st, making the longer held pesticides an attractive option. In addition, pesticide resistance issues resulted in alternative pesticides being used.

Tables 2-5 and 2-6 show the preliminary Sacramento Valley rice herbicide data, including acres treated and pounds applied, respectively. Tables 2-7 and 2-8 show the preliminary Sacramento Valley rice insecticide data, including acres treated and pounds applied, respectively. Tables 2-9 and 2-10 show the preliminary Sacramento Valley rice fungicide data, including acres treated and pounds applied, respectively.

Nutrient Use

Like most other farmland, rice acreage is fertilized annually. Fertilizer suppliers are the best source of information regarding the rates of fertilizer application. Suppliers were consulted to determine the range of fertilizer rates commonly applied to rice in the Sacramento Valley. The information obtained from the suppliers is summarized in Table 2-11. The table shows that fertilizer may be applied to rice before planting (granular starter, aqua ammonia, zinc [Zn]) and later in the season (topdressing). The totals for the high and low ends of the reported range are shown for each element in the lower section of Table 2-11.

Nitrogen (N) is essential for all commercial rice production in California. The general application rate is 120 to 150 pounds per acre. Specific N requirements vary with soil type, variety, cropping history, planting date, herbicide used, and the kind and amount of crop residue incorporated during seedbed preparation. Winter flooding for straw decomposition and waterfowl management has greatly reduced N use in some rice fields. Most N is applied preplant and either soil-incorporated or injected 2 to 4 inches into the soil before flooding. Some N may be topdressed mid-season (panicle differentiation) to correct deficiencies and maintain plant growth and yield.

Phosphorus (P) is applied at a rate of 18 to 26 pounds per acre and is incorporated into the seedbed before flooding. Most rice fields are above a critical need for P and do not require repeated use of this fertilizer. Phosphate fertilizer also may be topdressed when a deficiency occurs, usually in the early seedling stage.

Potassium (K) addition is generally unnecessary in California.

Zinc deficiency or “alkali disease” is common in alkaline soils and areas where topsoil has been removed. If Zn is used, the application rate is 2 to 16 pounds per acre at preflood, and it is not incorporated into the soil. Zinc deficiencies most commonly occur in cool weather during stand establishment (early season).

Iron (Fe) deficiency is rare in California and can usually be corrected by lowering the soil pH.

TABLE 2-5
Herbicides: Acres Treated, Sacramento Valley, 2014

	Acres Treated							
County	**Bensulfuron-methyl**	**Bispyribac-sodium**	**Carfentrazone-ethyl**	**Clomazone**	**Cyhalofop-butyl**	**Penoxsulam**	**Propanil**	**Triclopyr TEA**
Butte	10,209	20,779	6,446	53,700	5,594	31,735	64,648	52,850
Colusa	9,161	31,079	6,259	61,949	8,056	12,754	70,934	71,586
Glenn	7,557	19,661	6,240	40,665	4,176	11,993	52,867	47,427
Placer	587	1,753	1,060	3,756	1,841	4,896	9,827	8,859
Sacramento	492	397	0	2,693	1,695	2,234	6,332	5,091
Sutter	8,446	28,737	2,191	48,955	9,174	36,816	74,758	65,324
Tehama	120	0	0	120	0	0	120	120
Yolo	3,013	2,079	1,630	9,499	2,537	3,503	14,596	14,243
Yuba	6,305	9,819	1,755	27,195	3,620	18,682	27,906	15,357
Total acres	45,890	114,304	25,581	248,532	36,693	122,613	321,988	280,857

Note: Data are preliminary and have not been audited or error checked by DPR.

TABLE 2-6
Herbicides: Pounds Applied, Sacramento Valley, 2014

County	Pounds Applied							
	Bensulfuron-methyl	**Bispyribac-sodium**	**Carfentrazone-ethyl**	**Clomazone**	**Cyhalofop-butyl**	**Penoxsulam**	**Propanil**	**Triclopyr TEA**
Butte	559	640	726	20,668	2,217	1,146	339,793	8,559
Colusa	386	819	834	25,512	2,562	432	403,453	13,295
Glenn	409	724	1017	17,877	1,420	387	328,697	8,572
Placer	27	63	126	1,184	577	169	54,114	2,035
Sacramento	18	14	0	946	588	71	33,187	1,007
Sutter	383	801	293	19,125	3,152	1,296	392,294	16,094
Tehama	6	0	0	40	0	0	720	16
Yolo	120	62	163	4,455	871	125	79,430	2,764
Yuba	264	263	328	10,322	1,126	656	143,082	3,312
Total pounds	2,172	3,386	3,487	100,129	12,513	4,282	1,774,770	55,654

Note: Data are preliminary and have not been audited or error checked by DPR.

TABLE 2-7
Insecticides: Acres Treated, Sacramento Valley, 2014

	Acres Treated			
County	**Diflubenzuron**	**Clothianidin**	**(s)-Cypermethrin**	**Lambda Cyhalothrin**
Butte	138	51	368	27,121
Colusa	0	46	3,728	28,358
Glenn	0	0	5,839	18,545
Placer	259	0	0	7,079
Sacramento	0	0	0	1,750
Sutter	48	0	3,009	36,778
Tehama	0	0	0	0
Yolo	0	0	0	6,101
Yuba	0	0	1,488	19,074
Total acres	445	97	14,432	144,806

Note: Data are preliminary and have not been audited or error checked by DPR.

TABLE 2-8
Insecticides: Pounds Applied, Sacramento Valley, 2014

	Pounds Applied			
County	**Diflubenzuron**	**Clothianidin**	**(s)-Cypermethrin**	**Lambda Cyhalothrin**
Butte	14	4	16	771
Colusa	0	3	166	985
Glenn	0	0	282	562
Placer	49	0	0	169
Sacramento	0	0	0	53
Sutter	9	0	136	1,055
Tehama	0	0	0	0
Yolo	0	0	0	199
Yuba	0	0	67	513
Total pounds	72	7	667	4,307

Note: Data are preliminary and have not been audited or error checked by DPR.

TABLE 2-9
Fungicides: Acres Treated, Sacramento Valley, 2014

	Acres Treated		
County	**Azoxystrobin**	**Propiconazole**	**Trifloxystrobin**
Butte	63,420	30	0
Colusa	43,574	5,599	5,342
Glenn	54,633	577	179
Placer	5,439	0	0
Sacramento	1,605	830	830
Sutter	29,353	10,467	10,252
Tehama	0	0	0
Yolo	5,612	4,168	4,168
Yuba	12,941	2,103	2,103
Total acres	216,577	23,774	22,874

Note: Data are preliminary and have not been audited or error checked by DPR.

TABLE 2-10
Fungicides: Pounds Applied, Sacramento Valley, 2014

	Pounds Applied		
County	**Azoxystrobin**	**Propiconazole**	**Trifloxystrobin**
Butte	10,481	5	0
Colusa	7,484	798	757
Glenn	9,590	93	26
Placer	923	0	0
Sacramento	212	122	122
Sutter	6,047	2,202	1,528
Tehama	0	0	0
Yolo	1,026	516	516
Yuba	2,497	309	309
Total pounds	38,260	4,045	3,258

Note: Data are preliminary and have not been audited or error checked by DPR.

TABLE 2-11
Range of Fertilizer Components Applied to Rice

	Pounds per Acre		
Material/Element	**Low**	**High**	**Form and Method**
N	80	120	Injected aqua
16-20	150	200	
N	24	32	Solid 16-20-0-13 starter
P	30	40	Solid 16-20-0-13 starter
K	0	0	Solid 16-20-0-13 starter
S	19.5	26	Solid 16-20-0-13 starter
Zn	1	5	Metallic
NH_4SO_4	0	200	
N	0	42	Topdressed
S	0	49	Topdressed
Total for all application methods			
N	104	194	
P	30	40	
K	0	0	
S	20	75	
Zn*	1	5	

*Seldom applied

SECTION 3

Monitoring and Reporting Requirements

This section provides an overview of the monitoring and reporting requirements of the CRC MRP, including the overall purpose and objectives; monitoring periods, sites, and constituents; program administration; sampling procedures; and analytical labs and methods used to assess water quality.

Monitoring Purpose and Objectives

The purpose of the CRC MRP is to monitor the discharge of wastes in irrigation return flows and stormwater from irrigated rice lands. These objectives are consistent with the State's Nonpoint Source (NPS) Policy and include the following:

- Determine whether the discharge of waste from irrigated lands within the Coalition Group boundaries causes or contributes to exceedances of applicable water quality standards or causes nuisance.
- Provide information about the Coalition Group area characteristics, including but not limited to land use, crops grown, and chemicals used.
- Monitor the effectiveness of management practices implemented to address exceedances of applicable water quality standards.
- Determine which management practices are most effective in reducing wastes discharged to surface waters from irrigated lands.
- Specify details about monitoring periods, parameters, protocols, and quality assurance.
- Support the development and implementation of the CWFR.
- Verify the adequacy and effectiveness of the CWFR's conditions.
- Evaluate the Coalition Group's compliance with the terms and conditions of the CWFR.

Overview of Requirements

In January 2008, the CVRWQCB adopted Order No. R5-2008-0005 (2008 Coalition MRP), which required Coalition Groups to revise their MRP plans to incorporate refined approaches to implementation of the Irrigated Lands Regulatory Program. The 2009 through 2014 CRC MRPs were developed to be functionally equivalent to the 2008 Coalition MRP.

Consistent with the approach outlined in the MRP, the CRC's approach for its monitoring program includes three types of monitoring:

- Core monitoring to track trends
- Assessment monitoring to determine the condition of a water body
- Special project monitoring for source identification and other problem solving

Monitoring requirements defined by the 2008 Coalition MRP incorporated a 3-year cycle of assessment monitoring and core monitoring. Core monitoring was conducted at a subset of core sites considered representative of the Coalition Group's area, and for a reduced set of parameters. Assessment monitoring included an expanded suite of parameters and an expanded list of sites, including assessment sites and core sites. The purposes of the expanded suite were to confirm that core monitoring continues to adequately characterize water quality conditions or identify changed conditions and to provide the technical basis for use of core sites. CWFR assessment monitoring was conducted in 2009. Monitoring results for core and assessment sites in 2009 did not show any constituents of concern other than one exceedance of the propanil trigger, which the CRC voluntarily addressed by special monitoring.

In addition to core and assessment monitoring, special project monitoring can be implemented. Special project monitoring includes specific targeted studies that are incorporated into the MRP plan to implement a total maximum daily load (TMDL), implement a Management Plan that results from exceedances, or implement other types of focused investigation that may assist in addressing data gaps or other technical evaluations.

Core Monitoring

Core monitoring sites and constituents are used to measure trends at the selected representative sites over extended periods of time. The core monitoring component of the monitoring strategy was designed to:

- Focus on a diversity of monitoring sites across the Coalition Group's area (hydrology, size, and flow).
- Include sites that, through environmental and assessment monitoring, or other data/information, have been shown to be characteristic of key crop types, topography, and hydrology within the Coalition Group's boundaries.
- Provide scientific rationale for the site selection process based on the assessment monitoring, existing monitoring projects, or historical information.
- Discuss the criteria for the selection of each monitoring site.
- Propose the approach, including schedule, to sampling core monitoring sites.
- Include water bodies that carry agricultural drainage, are dominated by agricultural drainage, or are otherwise affected by other irrigated agriculture activities.
- Have management practice information provided to establish relationships (status and trends) with water quality monitoring information.
- In conjunction with assessment monitoring, demonstrate the effectiveness of management practices and implement new management practices as needed.
- Use data generated from the core monitoring sites to establish trend information about the effectiveness of the Coalition Group's efforts to reduce or eliminate the impact of irrigated agriculture on surface waters.

Assessment Monitoring

Assessment monitoring is used to provide supporting data for sites that a Coalition Group selects as core monitoring sites for trends. Supporting data also may allow consideration for the use of some monitoring sites to be representative of other locations within the CRC study area.

The 2008 Coalition MRP describes the technical requirements of the proposed assessment monitoring. These requirements include:

- Focus on a diversity of monitoring sites across the Coalition Group's area (hydrology, size, and flow).
- Evaluate different types of water bodies for assessment.
- Include a sufficient number of sampling sites to assess the entire Coalition Group area and all drainages.
- Propose the approach, including schedule, to sampling assessment monitoring sites.
- Include sampling sites in areas of known water quality impairments, even if they are not currently identified on the Clean Water Act (CWA) 303(d) listing.
- Include sampling sites that are compliance monitoring sites for TMDLs, where implementation is conducted by the Coalition Group.
- Provide scientific rationale for the site selection process based on historical and/or ongoing monitoring, drainage size, crop types and distribution, and topography and land use.
- Discuss the criteria for the selection of each monitoring site.
- Conduct the initial focus of monitoring on water bodies that carry agricultural drainage or are dominated by agricultural drainage.
- Identify priorities with respect to work on specific watersheds, subwatersheds, and water quality parameters.
- In conjunction with core monitoring for trends and special projects focused on specific problems, demonstrate the effectiveness of management practices, and identify locations for implementation of new management practices, as needed.
- Include the requirements provided in Parts I through III of the 2008 Coalition MRP.

Special Project Monitoring

Special project monitoring includes specific targeted studies that are incorporated into the MRP to implement a TMDL or to implement a Management Plan that results from exceedances. Management Plans are required when more than one exceedance of the same constituent occurs at a given site within a period of 3 years. Special project monitoring was last implemented in 2011 with the Algae Management Plan and Propanil Monitoring Plan.

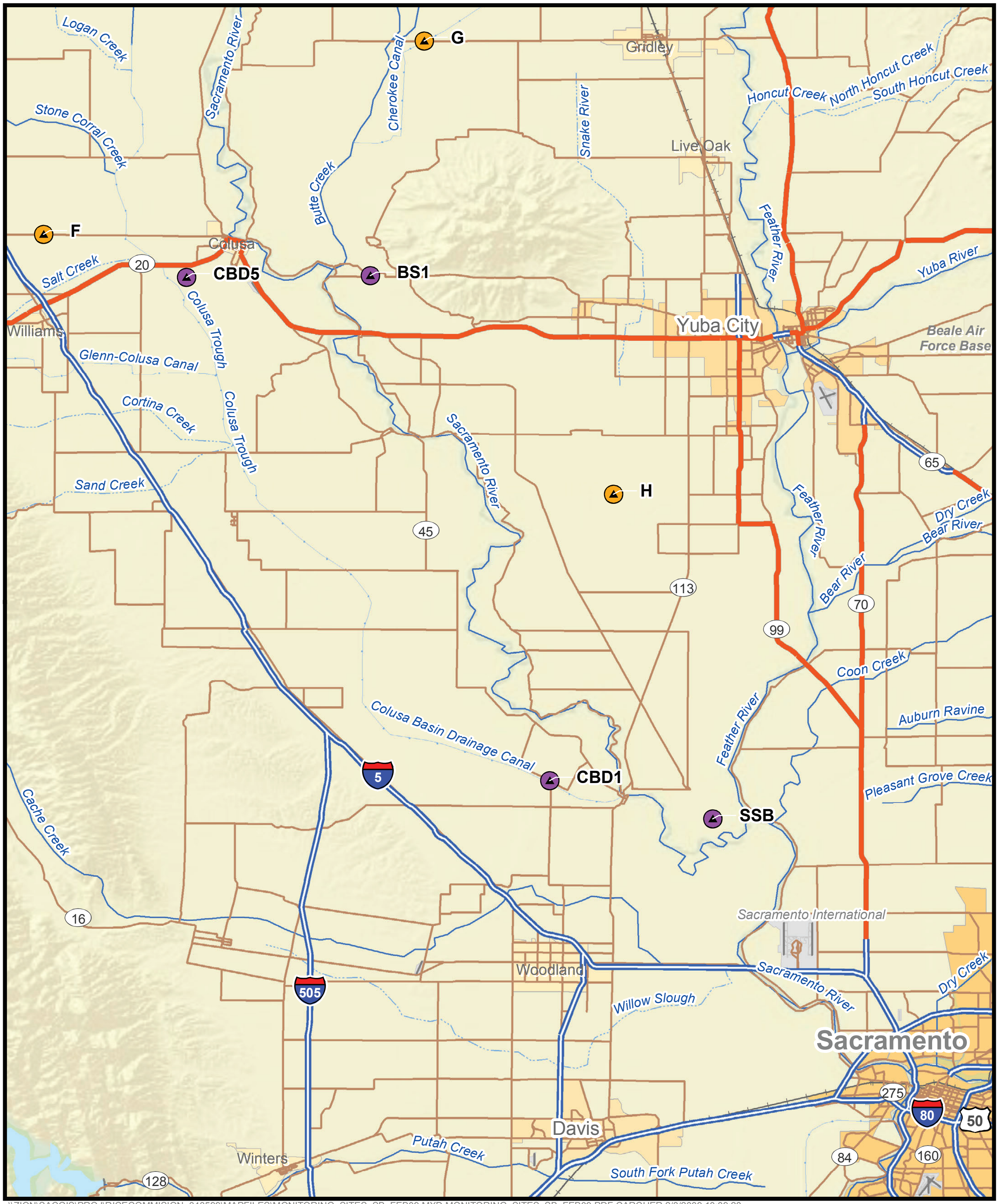
Monitoring Sites Descriptions

Monitoring under the CWFR is conducted at core and assessment sites, as listed in Table 3-1. Figure 3-1 shows the locations of the CWFR assessment and core monitoring sites, and Appendix B shows more detailed sampling site maps. These sites are described in more detail below. Photos 1 through 7 show the monitoring sites, and Appendix B includes detailed maps of each site.

TABLE 3-1
CWFR Monitoring Sites

Site Code	Site Name	Latitude	Longitude	Estimated Rice Area Captured by Station (acres)	Site Type
CBD1	Colusa Basin Drain above Knights Landing	38.81172	-121.77419	171,165	Core
CBD5	Colusa Basin Drain #5	39.18648	-122.05133	156,000	Core
BS1	Butte Slough at Lower Pass Road	39.18721	-121.90920	183,617	Core
SSB	Sacramento Slough Bridge near Karnak	38.78513	-121.65400	24,549	Core
F	Lurline Creek; upstream site of CBD5	39.21838	-122.15113	--	Assessment
G	Cherokee Canal; upstream site for BS1	39.36216	-121.86802	--	Assessment
H	Obanion Outfall at DWR Pumping Plant on Obanion Road	39.02536	-121.72801	--	Assessment

Note: Coordinates are NAD83 datum.



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Legend

- CWFR Assessment Site
- CWFR Core Site

N

0 7 14

Miles

FIGURE 3-1
CWFR Assessment and Core Monitoring Sites
CRC 2014 Annual Monitoring Report

CH2MHILL

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CBD1

CBD1 is located on the Colusa Basin Drain. Water samples at CBD1 were collected from the middle of the bridge along Road 99E as it crosses Colusa Basin Drainage Canal near Road 108 west of Knights Landing.

PHOTO 1
CBD1: Colusa Basin Drain #1

CBD5

CBD5 is located on the Colusa Basin Drain within the Colusa National Wildlife Refuge. Water samples at CBD5 were collected from the middle of the second bridge at the Colusa National Wildlife Refuge south of Highway 20.

PHOTO 2
CBD5: Colusa Basin Drain #5

BS1

BS1 is located on Butte Slough. Water samples at BS1 were collected from the middle of the bridge along Lower Pass Road, which crosses Butte Sough northeast of Meridian, California. In 1995 and 1996, samples were collected at the west end of the washed out bridge. Sampling at the new bridge site started in 1997.

PHOTO 3
BS1: Butte Slough #1

SSB

The RPP historically monitored Sacramento Slough at a location known as Sacramento Slough 1 (SS1), which was located at the DWR gauging station downstream of the Karnak pumps. Beginning in 2006, the monitoring site for Sacramento Slough was moved slightly upstream to a location named Sacramento Slough Bridge (SSB) to provide improved safety for field technicians accessing the site.

PHOTO 4
SSB: Sacramento Slough Bridge

F

Site F is located on Lurline Creek. Water samples on Site F were collected from the middle of the bridge located along Lurline Avenue between San Jose Road and Two Mile Road, northwest of Colusa, east of Interstate 5. This site serves as the upstream assessment site for core site CBD5.

PHOTO 5
F: Lurline Creek

G

Site G is located on Cherokee Canal. Water samples on Site G were collected from the middle of the bridge located along Colusa Highway, west of Hatch Road and east of Gridley Road and Butte Creek. This site serves as the upstream assessment site for core Site BS1.

PHOTO 6
G: Cherokee Canal

H

Site H is located at the Obanion Outfall at DWR pumping plant (DWR PP) on Obanion Road. Water samples on Site H were collected from the middle of the bridge along Obanion Road west of Boulton Road and immediately east of the Sutter Bypass levee. Site H is monitored as an assessment site.

PHOTO 7
H: Obanion Outfall

Monitoring Schedule Approach

The monitoring schedules for CWFR sampling are based on the timing and frequency of discharge from rice fields with constituents specific to the crop. The current monitoring periods for the CWFR were developed based on the understanding of the rice growing season and analysis of historical data, including data collected since 2004 under the CWFR.

The peak rice-pesticide application period is from April through June. During this period and into July, water may be released from the field. From mid-July to mid-August, water is held on rice fields to protect grain development. A top-dressing of nutrients may be added during July. Rice drainage season, when the rice fields are drained prior to harvest, typically occurs from mid-August through September. After harvest, rice fields are generally flooded to decompose rice straw and to provide waterfowl habitat. No application of fertilizers or pesticides occurs on rice fields during the winter until the fields are drained in mid-February or March. Field preparation for the next season may include pre-plant applications of fertilizers.

The monitoring calendar has been developed to focus sampling to match the rice growing season and the periods of peak pesticide application. Therefore, the monitoring schedule provides for water quality assessment during the peak rice-pesticide application period. A typical monitoring calendar is established in the CRC MRP, but annual weather conditions and other factors may affect planting and pesticide application; therefore, the actual start date of monitoring is established annually to ensure that sampling activities bracket the actual pesticide use season.

Administration and Execution

The CRC contracted with Kleinfelder to collect water samples and coordinate with the laboratories. Kleinfelder was the primary contact for all laboratory services. Following each monitoring event, field data sheets, chain-of-custody (COC) forms, and calibration logs were scanned and e-mailed to CH2M HILL. After analysis, the labs submitted data to Kleinfelder, which then forwarded the data to CH2M HILL for review and analysis.

Sampling Procedures

Sampling was conducted pursuant to the procedures described in the CRC's Quality Assurance Project Plan (CH2M HILL, 2010) unless otherwise noted.

Field Measurements

Field water quality parameters were measured prior to sample collection at each site, and flow was measured after samples were collected. At each site, a water quality sheet was completed; this documented the surface water level, width of the waterway, sample depth at the middle of the water column, total depth to sediment, general weather observations, time arrived on site, and field water quality measurements. Unless otherwise noted, field measurements were taken at a depth equal to approximately half the water column.

Flow

Flow measurements are taken at 10 cross-sections at each site. The wetted width of the water body was measured, recorded, and divided by 10 to determine the width of each cross-section. The midpoint of each cross-section was calculated by dividing the cross-section width in half. Velocity was measured at the midpoint of each cross-section at 0.2 and 0.8 of the total depth from the water surface, and then averaged. Flow was then calculated using the following equation:

$$Q = \sum_{n=1}^{10} W_n D_n V_n$$

Where:

Q	=	estimated flow at the site (cubic feet per second [cfs])
W	=	section width (feet)
D	=	depth of measurement (feet)
V	=	velocity (feet per second)

Electrical Conductivity, Dissolved Oxygen, Temperature, and pH

Electrical conductivity (EC), dissolved oxygen (DO), temperature, and pH measurements are taken for the CWFR monitoring programs. These parameters were measured in the field using a multiprobe instrument that was lowered directly into the water column. The meter was allowed to equilibrate for at least 90 seconds before data were recorded. The meter was calibrated at the beginning of the sampling day. Calibration logs for the CWFR monitoring events are included in Appendix C-1.

Turbidity

Turbidity was measured in the field using a La Motte 2020e turbidity meter.

Grab Samples

A qualified and trained crew of Kleinfelder technicians collected the grab samples for the 2014 monitoring. The water grab samples were collected using a Kemmerer water sampler (stainless steel and Teflon model; approximately 1.5-liter volume) at a depth equal to one-half the water column. The Kemmerer was emptied into a stainless steel container and the process repeated until the appropriate volume of water was acquired to split into the required number of samples. This process allowed for homogenization as additional sample volume was added to the container. Certified sample containers were filled with the composite sample using disposable Tygon tubing connected to a peristaltic pump. This sampling methodology was designed as a health and safety measure for the sampler and was designed to minimize fatigue to the sampler's lower back.

Non-disposable equipment used in sample collection was decontaminated after each use by rinsing thoroughly with distilled water. The sample equipment was rinsed at each site with water from the middle of the water column before sample collection. Clean sampling equipment was not allowed to touch the ground, and field personnel wore clean, disposable gloves. New, clean sample bottles and jars were provided by the analytical laboratories or purchased from a supply company.

Sample containers were labeled at the time of sample collection with a unique sample ID number. The label contained the following information:

- Sample ID
- Sample location
- Date and time of sample collection
- Kleinfelder project number
- Sampling technician identification

Samples were held on wet or blue ice at 4°C until delivered to the laboratory for analysis.

Sample Custody and Documentation

Custody of samples was maintained and documented from the time of sample collection to completion of analysis. Each sample was considered to be in the sampler's custody, and the sampler was responsible for the care and custody of the samples until they were delivered to the laboratory. Field data sheets and copies of COC forms were maintained in the project file for samples collected during each event.

A COC form, sample labels, and field documentation were crosschecked to verify sample identification, type of analyses, sample volume, and number and type of containers.

Field data sheets, COC forms, and calibration forms were scanned by Kleinfelder and submitted to the CRC and CH2M HILL. COC forms are included in Appendix C-1.

Sample Delivery and Analysis

After each sampling event, Kleinfelder submitted the samples under COC to the laboratories for analyses. Sample shipments were accompanied by the original COC form, which identified contents, and were transported to the lab within the sample holding time. The laboratories performing the analyses and the methods they used are listed in Table 3-2.

TABLE 3-2
Analytical Laboratories and Methods

Laboratory	Analytes	Analytical Method(s) Standard Operating Procedures
California Laboratory Services (CLS) 3249 Fitzgerald Road Rancho Cordova, CA 95742	Total hardness as calcium carbonate ($CaCO_3$)	SM2340B
	TDS	SM2540C
	TOC	SM5310B

Notes:
TDS = total dissolved solids
TOC = total organic carbon

SECTION 4

2014 Monitoring

Monitoring is conducted under the CWFR according to the MRP. 2014 monitoring requirements included only the four core sites: CBD5, BS1, CBD1, and SSB. Monitoring included a monthly measurement of general physical parameters: temperature, DO, pH, EC, total dissolved solids (TDS), total organic carbon (TOC), total hardness, turbidity, and flow.

Required Constituents

The MRP specifies the constituents for which monitoring and laboratory analyses are to be conducted. Table 4-1 presents the required constituents and sampling frequency during 2014.

TABLE 4-1
Monitoring Requirements, 2014

Constituent	Units	Sample Type	Irrigation Season Sampling Frequency (May to August)
Flow	cfs	Field*	Monthly
pH	pH units	Field	Monthly
Electrical conductivity	µmhos/cm	Field	Monthly
Dissolved oxygen	mg/L	Field	Monthly
Temperature	degrees C	Field	Monthly
Turbidity	NTUs	Field	Monthly
Total organic carbon (TOC)	mg/L	Grab	Monthly
Total dissolved solids (TDS)	mg/L	Grab	Monthly
Hardness	mg/L	Grab	Monthly

Notes:
*Flow may also be obtained from DWR monitoring stations, where available.
µmhos/cm = micromhos per centimeter
cfs = cubic feet per second
mg/L = milligrams per liter
NTU = nephelometric turbidity unit

Sampling Schedule

The MRP specifies the general calendar for monitoring. Based on an understanding of the rice-growing season, a general rice-specific monitoring calendar was developed to sample the April through August “irrigation season.” Table 4-2 lists regularly scheduled monitoring; no resampling was required in 2014.

TABLE 4-2
2014 Sampling Calendar

Sample Event	Sample Date	Field Parameters	TDS	TOC	Hardness
May Event	5/20/2014	✓	✓	✓	✓
June Event	6/17/2014	✓	✓	✓	✓
July Event	7/15/2014	✓	✓	✓	✓
August Event	8/19/2014	✓	✓	✓	✓
September Event	9/16/2014	✓	✓	✓	✓

General Physical Parameter Results – Field Parameters

The following field parameters were measured as part of the 2014 sampling effort: temperature, DO, pH, EC, turbidity, and flow.

Temperature Measurements

Figure 4-1 shows the 2014 field temperature results. Temperatures in water bodies are typically lowest in the winter and highest in the summer. Peak water temperatures were observed during the July event, with a high of 83.0°F. As seen in previous years, water temperature in these water bodies generally track with ambient air temperature. During peak temperatures, these drain sites would not provide habitat for coldwater fisheries, although they may provide coldwater habitat during other times of the year.

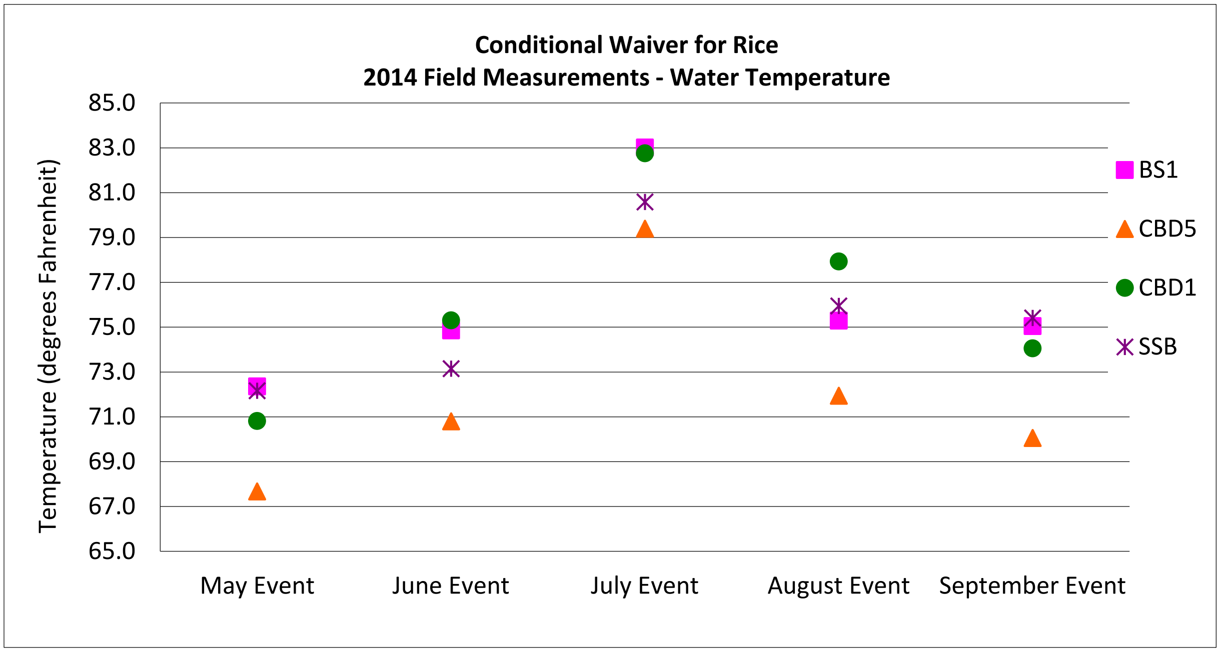

FIGURE 4-1
Water Temperature Measurements, 2014

Table 4-3 presents temperature results and summary information, including site minimum, maximum, mean, and median observed temperatures, as well as event minimum, maximum, mean, and median observed temperatures. Table 4-3 also presents an evaluation of the number of times the observed field temperature exceeded 68°F, which is the *Water Quality Control Plan for the Sacramento and San Joaquin River Basins* (Basin Plan) water quality objective (WQO) for the lower Sacramento River.

DO Measurements

Figure 4-2 shows the 2014 DO measurements. Table 4-4 presents DO results and basic summary information, including site minimum, maximum, mean, and median observed DO, as well as event minimum, maximum, mean, and median observed DO. Table 4-4 also presents an evaluation of the number of times the observed field DO values were less than 5 milligrams per liter (mg/L), 6 mg/L, and 7 mg/L.

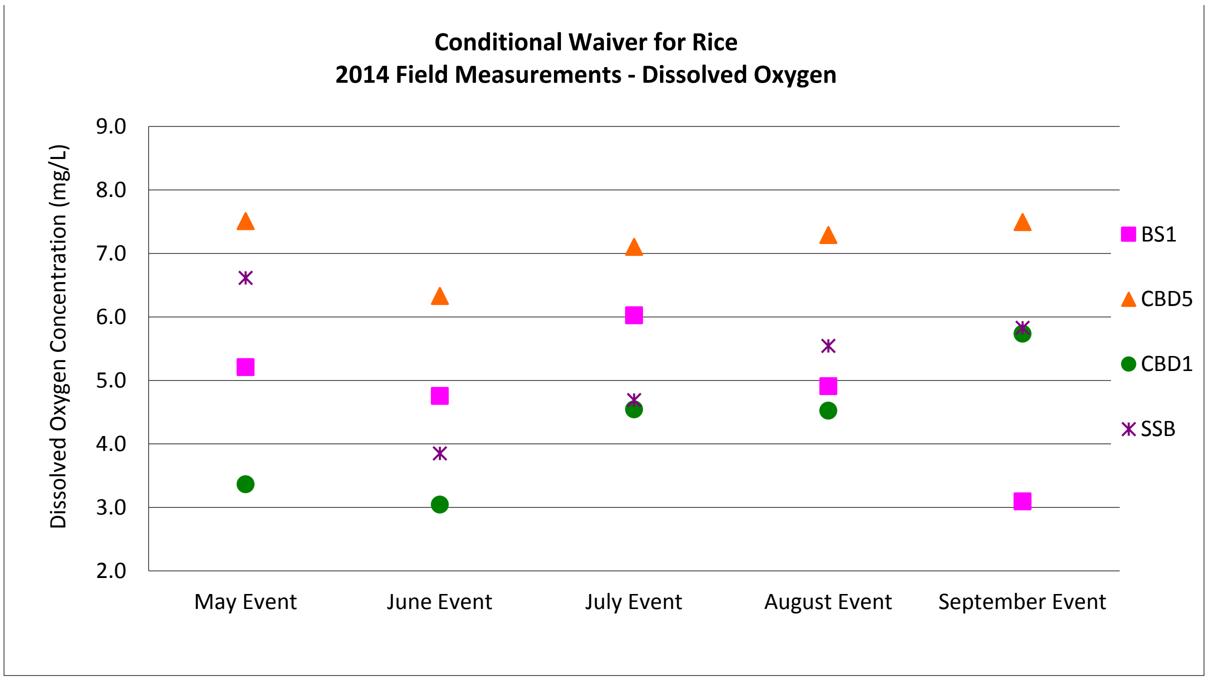

FIGURE 4-2
Dissolved Oxygen Field Measurements, 2014

TABLE 4-3
Field Temperature Measurements, 2014

Sample Event	Sample Date	Site Measurements (°F) BS1	CBD5	CBD1	SSB	Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
May Event	5/20/2014	72.4	67.7	70.8	72.2	67.7	70.8	71.5	72.4	4.7	2.2	4
June Event	6/17/2014	74.9	70.8	75.3	73.1	70.8	73.5	74.0	75.3	4.2	2.0	4
July Event	7/15/2014	83.0	79.4	82.8	80.6	79.4	81.4	81.7	83.0	3.0	1.7	4
August Event	8/19/2014	75.3	71.9	77.9	75.9	71.9	75.3	75.6	77.9	6.2	2.5	4
September Event	9/16/2014	75.0	70.1	74.1	75.4	70.1	73.6	74.6	75.4	6.0	2.5	4
Site Low		72.4	67.7	70.8	72.2							
Site Mean		76.1	72.0	76.2	75.5							
Site Median		75.0	70.8	75.3	75.4							
Site High		83.0	79.4	82.8	80.6							
Site Variance		16.3	19.6	20.1	10.7							
Site Standard Deviation		4.0	4.4	4.5	3.3							
N		5	5	5	5							
Number of obs. Temp >68°F		5	4	5	5							
Number of obs. Temp <68°F		0	1	0	0							
Percent of obs. where Temp >68°F		100%	80%	100%	100%							
Percent of obs. where temp <68°F		0%	20%	0%	0%							

TABLE 4-4
Dissolved Oxygen Field Measurements, 2014

Sample Event	Sample Date	Site Measurements (mg/L) BS1	CBD5	CBD1	SSB	Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N	Number of obs. DO<7	Number of obs. DO<6	Number of obs. DO<5	Percent of obs. DO<7	Percent of obs. DO<6	Percent of obs. DO<5
May Event	5/20/2014	5.21	7.51	3.37	6.62	3.37	5.68	5.91	7.51	3.27	1.81	4	3	2	1	75%	50%	25%
June Event	6/17/2014	4.76	6.33	3.05	3.85	3.05	4.50	4.30	6.33	1.98	1.41	4	4	3	3	100%	75%	75%
July Event	7/15/2014	6.03	7.11	4.55	4.69	4.55	5.59	5.36	7.11	1.46	1.21	4	3	2	2	75%	50%	50%
August Event	8/19/2014	4.91	7.29	4.53	5.55	4.53	5.57	5.23	7.29	1.50	1.22	4	3	3	2	75%	75%	50%
September Event	9/16/2014	3.10	7.50	5.74	5.83	3.10	5.54	5.78	7.50	3.31	1.82	4	3	3	1	75%	75%	25%
Site Low		3.10	6.33	3.05	3.85													
Site Mean		4.80	7.15	4.24	5.31													
Site Median		4.91	7.29	4.53	5.55													
Site High		6.03	7.51	5.74	6.62													
Site Variance		1.15	0.24	1.15	1.14													
Site Standard Deviation		1.07	0.49	1.07	1.07													
N		5	5	5	5													
Number of obs. DO<7		5	1	5	5													
Number of obs. DO<6		4	0	5	4													
Number of obs. DO<5		3	0	4	2													
Percent of obs. DO<7		100%	20%	100%	100%													
Percent of obs. DO<6		80%	0%	100%	80%													
Percent of obs. DO<5		60%	0%	80%	40%													

DO values of less than 6 mg/L were observed at BS1, CBD1, and SSB (Table 4-4). These observations occurred in May (BS1 and CBD1), June (BS1, CBD1, and SSB), July (CBD1 and SSB), August (BS1, CBD1, and SSB), and September (BS1, CBD1 and SSB). DO readings of less than 5 mg/L were observed at every site except for CBD5. June had the most readings less than 5 mg/L (sites BS1, CBD1, and SSB were all less than 5 mg/L), and two sites had DO readings of less than 5 mg/L at the July and August events. These results are consistent with prior observations, with low DO throughout the summer months.

Factors that may contribute to low DO include in-stream biological oxygen demand from high organic loads and productive algal communities (resulting from available nutrients) and the diurnal oxygen depletion resulting from nighttime algae uptake and/or uniform channel character that limits natural aeration. In addition, drought conditions cause shallower water volumes, leading to higher in-stream water temperatures.

Warm water temperatures also can contribute to low DO values. As temperature increases, oxygen solubility decreases and approaches the WQO of 7 mg/L DO. This means that biological activity (such as microorganisms breaking down detritus or other organic matter) can easily consume enough oxygen to depress DO below the WQO, particularly under warmer conditions. Figure 4-3 shows oxygen solubility as a function of temperature. Oxygen solubilities on the graph are approximate because additional factors, such as salinity, influence oxygen solubility.

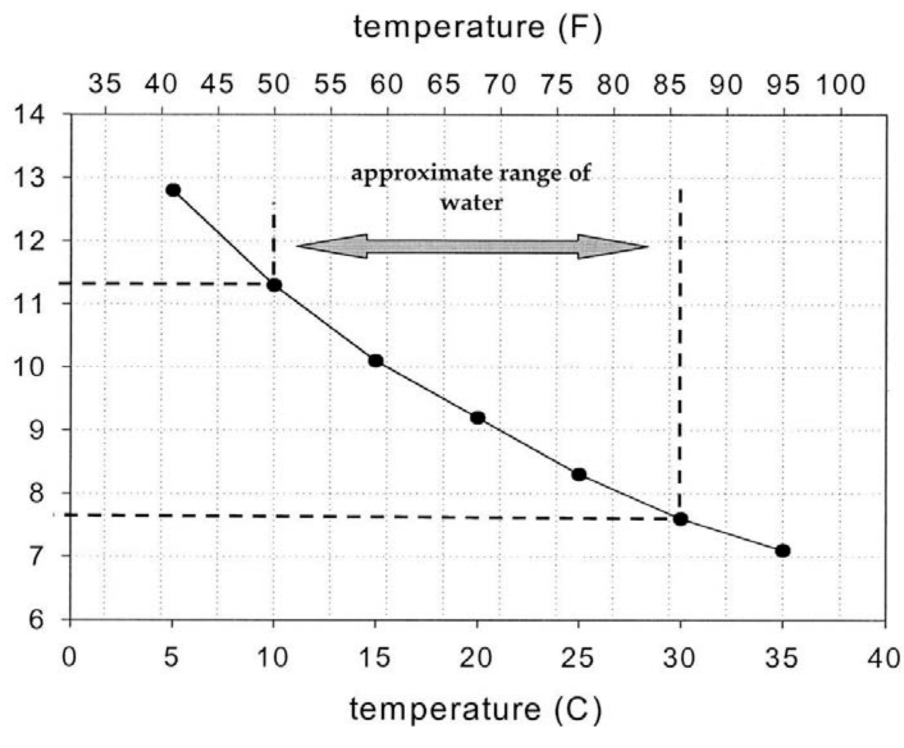

FIGURE 4-3
Oxygen Solubility as a Function of Temperature

pH Measurements

Figure 4-4 shows the 2014 pH measurements. Table 4-5 presents pH results and basic summary information, including site minimum, maximum, mean, and median observed pH, as well as event minimum, maximum, mean, and median observed pH. Table 4-5 also presents an evaluation of the number of times the observed field pH was less than 6.5 or greater than 8.5 (WQOs). In 2014, no observations fell outside the 6.5 to 8.5 pH range.

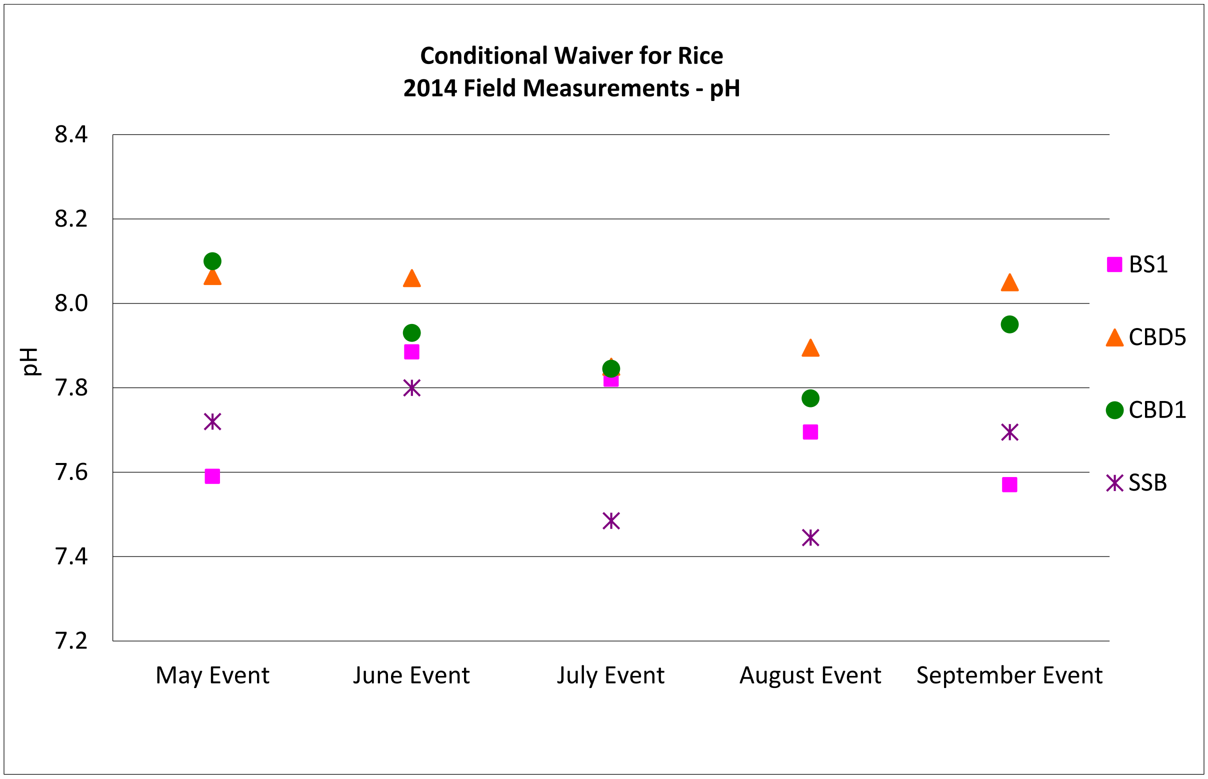

FIGURE 4-4
pH Field Measurements, 2014

TABLE 4-5
pH Field Measurements, 2014

	Sample	pH				Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N	Number of obs. pH<6.5	Number of obs. pH>8.5	Percent of obs. pH<6.5	Percent of obs. pH>8.5
Sample Event	Date	BS1	CBD5	CBD1	SSB											
May Event	5/20/2014	7.59	8.07	8.10	7.72	7.59	7.87	7.89	8.10	0.06	0.25	4	0	0	0%	0%
June Event	6/17/2014	7.89	8.06	7.93	7.80	7.80	7.92	7.91	8.06	0.01	0.11	4	0	0	0%	0%
July Event	7/15/2014	7.82	7.85	7.85	7.49	7.49	7.75	7.83	7.85	0.03	0.18	4	0	0	0%	0%
August Event	8/19/2014	7.70	7.90	7.78	7.45	7.45	7.70	7.74	7.90	0.04	0.19	4	0	0	0%	0%
September Event	9/16/2014	7.57	8.05	7.95	7.70	7.57	7.82	7.82	8.05	0.05	0.22	4	0	0	0%	0%
Site Low		7.57	7.85	7.78	7.45											
Site Mean		7.71	7.98	7.92	7.63											
Site Median		7.70	8.05	7.93	7.70											
Site High		7.89	8.07	8.10	7.80											
Site Variance		0.02	0.01	0.02	0.02											
Site Standard Deviation		0.14	0.10	0.12	0.16											
N		5	5	5	5											
Number of obs. pH<6.5		0	0	0	0											
Number of obs. pH>8.5		0	0	0	0											
Percent of obs. pH<6.5		0%	0%	0%	0%											
Percent of obs. pH>8.5		0%	0%	0%	0%											

Electrical Conductivity Measurements

Figure 4-5 shows the 2014 EC measurements. Table 4-6 presents EC results and basic summary information, including site minimum, maximum, mean, and median observed EC, as well as event minimum, maximum, mean, and median observed EC. Table 4-6 also presents an evaluation of the number of times the observed field EC exceeded 700 micromhos per centimeter (µmhos/cm), which has been cited by CVRWQCB as a threshold for reporting. This threshold is based on the citation in Recommended Numerical Limits to Translate Water Quality Objectives (CVRWQCB, 2004) and is an agricultural water quality value (Ayers and Westcot, 1985). Inclusion of this reference value is for screening purposes only and does not imply that the CRC recognizes this value as an adopted salinity WQO.

Three EC values of greater than 700 µmhos/cm were observed during the 2014 sampling season, all at CBD1 (May, June, and July events). All other samples had EC readings below 700 µmhos/cm.

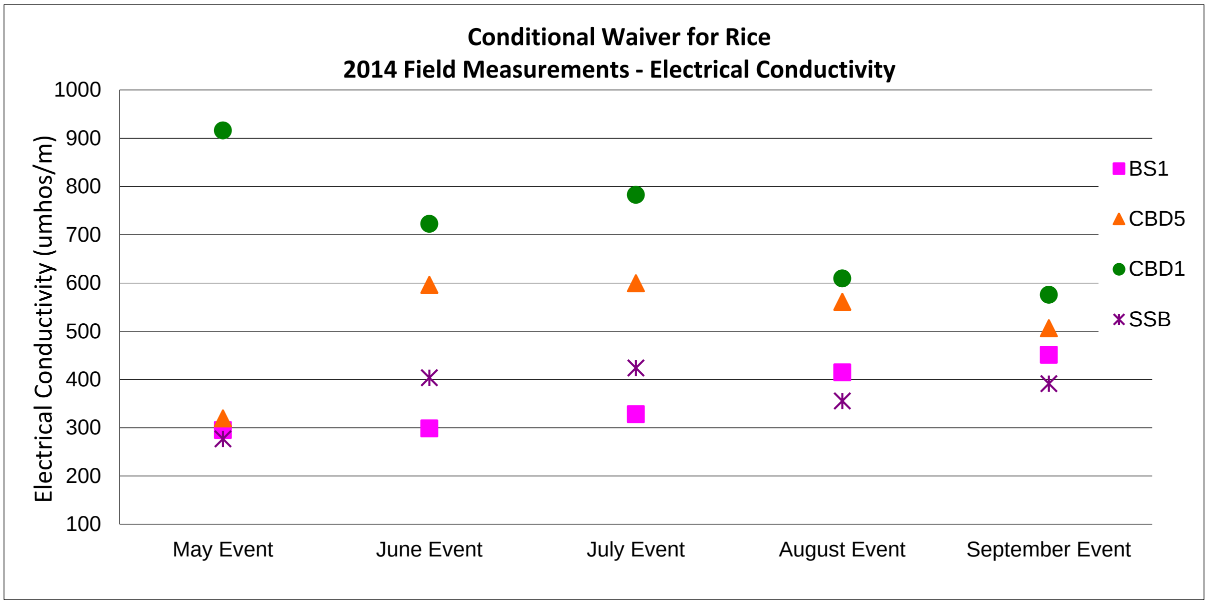

FIGURE 4-5
Electrical Conductivity Field Measurements, 2014

Turbidity

Figure 4-6 shows the 2014 turbidity measurements. Table 4-7 presents turbidity results and basic summary information, including site minimum, maximum, mean, and median observed turbidity, as well as event minimum, maximum, mean, and median observed turbidity.

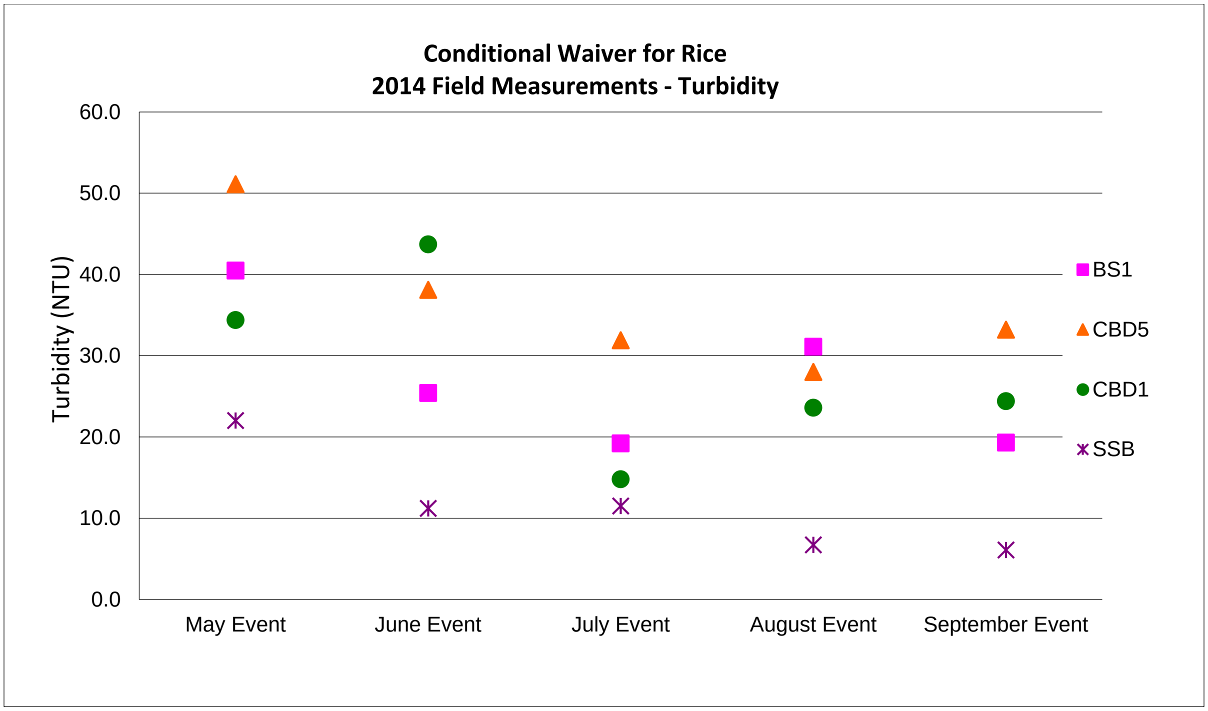

FIGURE 4-6
Turbidity Field Measurements, 2014

TABLE 4-6
Electrical Conductivity Field Measurements, 2014

Sample Event	Sample Date	Electrical Conductivity (µS/cm)				Event Low	Event Mean	Event Median	Event High	Event Variance	Event Std. Deviation	N	Number of obs. EC>700	Percent of obs. EC>700
		BS1	CBD5	CBD1	SSB									
May Event	5/20/2014	295	320	916	277	277	452	307	916	96042	310	4	1	25%
June Event	6/17/2014	299	596	723	404	299	505	500	723	36177	190	4	1	25%
July Event	7/15/2014	328	600	783	424	328	534	512	783	40193	200	4	1	25%
August Event	8/19/2014	415	561	610	356	356	485	488	610	14339	120	4	0	0%
September Event	9/16/2014	451	506	576	392	392	481	479	576	6155	78	4	0	0%
Site Low		295	320	576	277									
Site Mean		357	516	721	370									
Site Median		328	561	723	392									
Site High		451	600	916	424									
Site Variance		5062	13527	18853	3340									
Site Std. Deviation		71.1	116.3	137.3	57.8									
N		5	5	5	5									
Number of obs. EC>700		0	0	3	0									
Percent of obs. EC>700		0%	0%	60%	0%									

µS/cm = microSiemens per centimeter

TABLE 4-7
Turbidity Field Results, 2014

Sample Event	Sample Date	Turbidity (NTU) BS1	CBD5	CBD1	SSB	Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
May Event	5/20/2014	40.5	51.1	34.4	22.0	22.0	37.0	37.4	51.1	147.4	12.1	4
June Event	6/17/2014	25.4	38.1	43.7	11.2	11.2	29.6	31.8	43.7	209.1	14.5	4
July Event	7/15/2014	19.2	31.9	14.8	11.5	11.5	19.4	17.0	31.9	80.0	8.9	4
August Event	8/19/2014	31.1	28.0	23.6	6.7	6.7	22.4	25.8	31.1	118.2	10.9	4
September Event	9/16/2014	19.3	33.2	24.4	6.1	6.1	20.7	21.9	33.2	128.5	11.3	4
Site Low		19.2	28.0	14.8	6.1							
Site Mean		27.1	36.5	28.2	11.5							
Site Median		25.4	33.2	24.4	11.2							
Site High		40.5	51.1	43.7	22.0							
Site Variance		80.2	80.0	123.4	40.7							
Site Standard Deviation		9.0	8.9	11.1	6.4							
N		5	5	5	5							

Flow Measurements

Table 4-8 contains the estimation of flow from the flow measurements collected during the 2014 monitoring season. Field measurements were documented on field sheets contained in Appendix C-1.

TABLE 4-8
Flow Results, 2014

Sample Event	Sample Date	Estimated Flow (cfs)			
		BS1	CBD5	CBD1	SSB
May Event	5/20/2014	30.3	88.1	6.7	423
June Event	6/17/2014	1.8	298	4.8	35.2
July Event	7/15/2014	0	155	7.5	19.8
August Event	8/19/2014	0	373	29.7	188
September Event	9/16/2014	0	485	86.6	211

Notes:
cfs= cubic feet per second

General Physical Parameter Results – Lab Parameters

Monitoring during 2014 included laboratory analysis of TDS, total TOC, and hardness.

TDS Measurements

TDS samples were collected in the field and analyzed in the lab. Figure 4-7 shows the 2014 TDS results. Table 4-9 presents TDS results and basic summary information, including site minimum, maximum, mean, and median observed TDS, as well as event minimum, maximum, mean, and median observed TDS.

TOC Measurements

TOC samples were collected in the field and analyzed in the lab. Figure 4-8 shows the 2014 TOC results. Table 4-10 presents TOC results and basic summary information, including site minimum, maximum, mean, and median observed TOC, as well as event minimum, maximum, mean, and median observed TOC.

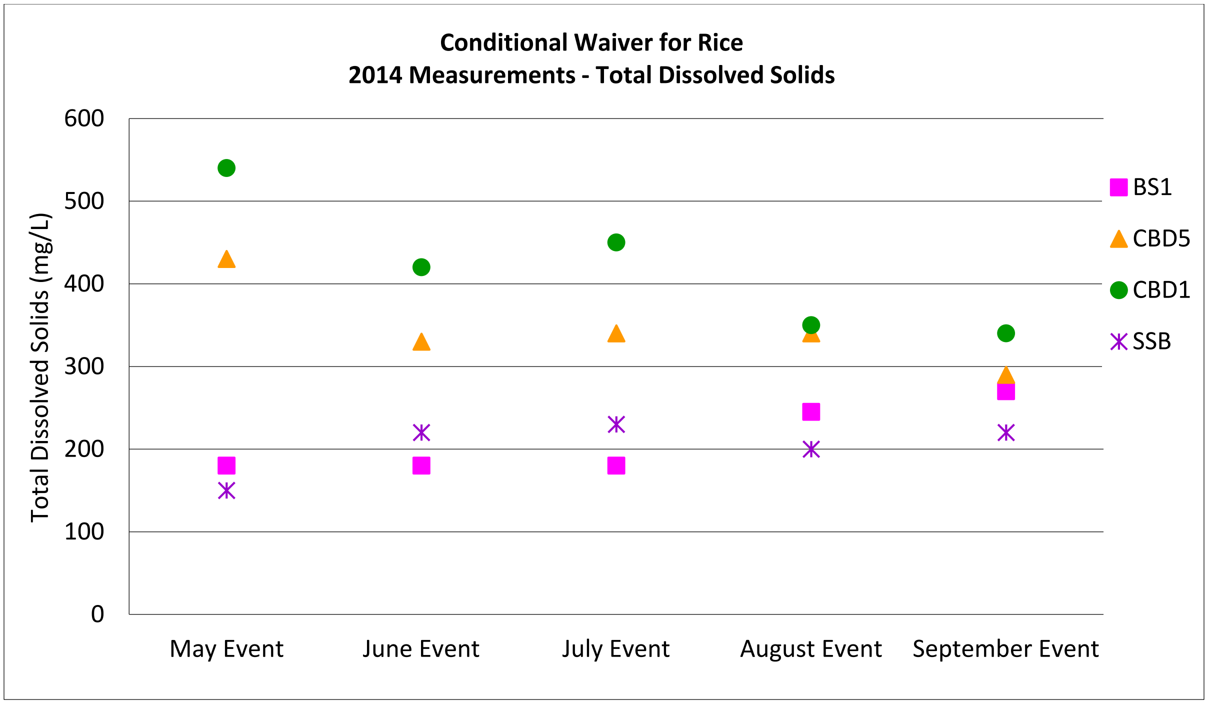

FIGURE 4-7
TDS Results, 2014

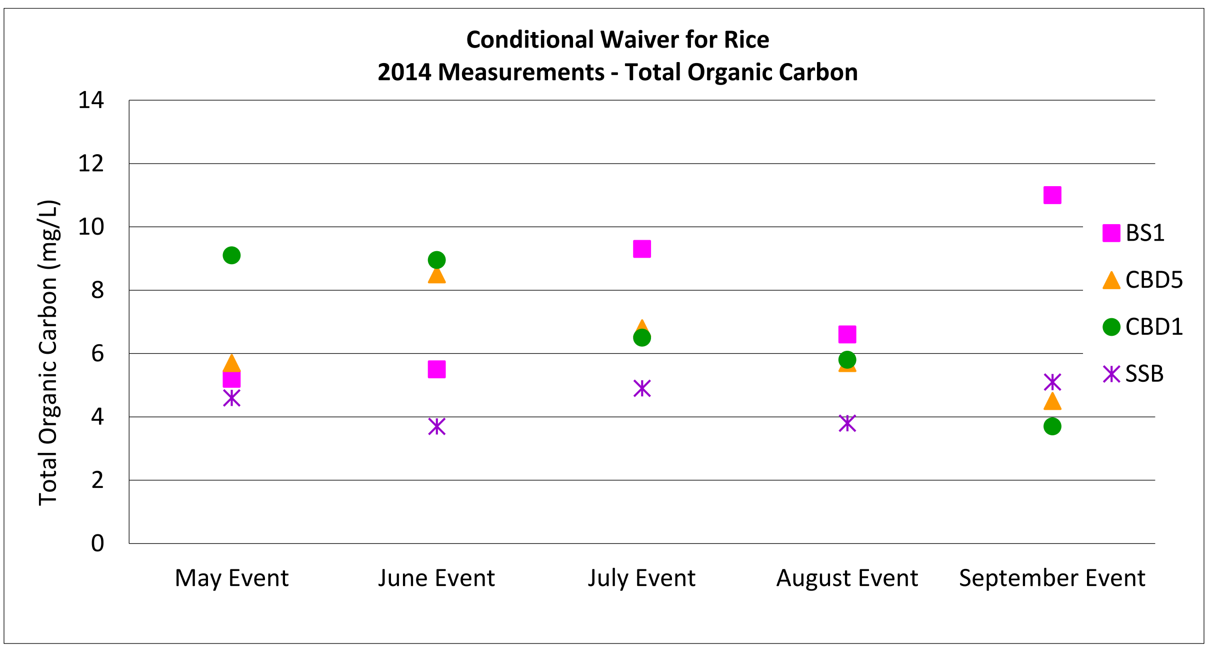

FIGURE 4-8
TOC Results, 2014

TABLE 4-9
TDS Lab Results, 2014

Sample Event	Sample Date	TDS (mg/L) BS1	CBD5	CBD1	SSB	Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
May Event	5/20/2014	180	430	540	150	150	325	305	540	36300	191	4
June Event	6/17/2014	180	330	420	220	180	288	275	420	11825	109	4
July Event	7/15/2014	180	340	450	230	180	300	285	450	14467	120	4
August Event	8/19/2014	245	340	350	200	200	284	293	350	5356	73	4
September Event	9/16/2014	270	290	340	220	220	280	280	340	2467	50	4
Site Low		180	290	340	150							
Site Mean		211	346	420	204							
Site Median		180	340	420	220							
Site High		270	430	540	230							
Site Variance		1880	2630	6650	1030							
Site Standard Deviation		43.4	51.3	81.5	32.1							
N		5	5	5	5							

TABLE 4-10
TOC Lab Results, 2014

Sample Event	Sample Date	TOC (mg/L) BS1	CBD5	CBD1	SSB	Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
May Event	5/20/2014	5.2	5.7	9.1	4.6	4.6	6.2	5.5	9.1	4	2	4
June Event	6/17/2014	5.5	8.5	9.0	3.7	3.7	6.7	7.0	9.0	6	2	4
July Event	7/15/2014	9.3	6.8	6.5	4.9	4.9	6.9	6.7	9.3	3	2	4
August Event	8/19/2014	6.6	5.7	5.8	3.8	3.8	5.5	5.8	6.6	1	1	4
September Event	9/16/2014	11.0	4.5	3.7	5.1	3.7	6.1	4.8	11.0	11	3	4
Site Low		5.2	4.5	3.7	3.7							
Site Mean		7.5	6.2	6.8	4.4							
Site Median		6.6	5.7	6.5	4.6							
Site High		11.0	8.5	9.1	5.1							
Site Variance		6	2	5	0							
Site Standard Deviation		2.53	1.50	2.27	0.64							
N		5	5	5	5							

Total Hardness Analysis

Samples were collected in the field and analyzed in the lab for total hardness using EPA Method 200.7 and calculation SM2340B. Results are shown in Table 4-11.

TABLE 4-11
Total Hardness Results, 2014

Sample Event	Sample Date	Total Hardness as $CaCO_3$ (mg/L)			
		BS1	CBD5	CBD1	SSB
May Event	5/20/2014	130	180	230	110
June Event	6/17/2014	130	170	190	150
July Event	7/15/2014	150	195	230	160
August Event	8/19/2014	150	200	200	130
September Event	9/16/2014	160	160	170	140

Summary of 2014 Exceedance Reports

Exceedance reports are required after each event if a parameter exceeds water quality standards. For DO, the COLD (cold water habitat) beneficial use standard is 7.0 mg/L DO, and the WARM (warm water habitat) standard is 5.0 mg/L DO. For EC, the threshold for reporting is 700 µmhos/cm.

Exceedance reports were issued after each monitoring event in 2014 (Appendix D). Low DO was experienced at each event, and high EC was experienced at one site for three events. Low DO persisted at three of the four sites throughout the monitoring season (Table 4-12). This is typical of these sites, which experience low DO as water temperatures rise.

TABLE 4-12
Exceedance Reports Issued, 2014

Sample Event	Sample Date	Site with Exceedance and Reading			
		BS1	CBD5	CBD1	SSB
Dissolved Oxygen (mg/L)					
May Event	5/20/2014	**5.26 / 5.16**	ok	**3.41 / 3.32**	**6.60 / 6.63**
June Event*	6/17/2014	**5.90**	**6.89**	**4.71**	**5.92**
July Event	7/15/2014	**6.05 / 6.00**	ok	**3.70 / 5.39**	**4.80 / 4.58**
August Event	8/19/2014	**5.03 / 4.79**	ok	**4.57 / 4.48**	**5.53 / 5.56**
September Event	9/16/2014	**3.06 / 3.13**	ok	**5.59 / 5.88**	**5.67 / 5.99**
Electrical Conductivity (µmhos/cm)					
May Event	5/20/2014	ok	ok	**914 / 918**	ok
June Event*	6/17/2014	ok	ok	**723 / 722**	ok

TABLE 4-12
Exceedance Reports Issued, 2014

Sample Event	Sample Date	Site with Exceedance and Reading			
		BS1	**CBD5**	**CBD1**	**SSB**
July Event	7/15/2014	ok	ok	**782 / 783**	ok
August Event	8/19/2014	ok	ok	ok	ok
September Event	9/16/2014	ok	ok	ok	ok

Notes:
Two instruments are used for sampling; results shown as Instrument 1 / Instrument 2.
Blue DO result indicates that the cold water quality standard (7.0 mg/L DO) was exceeded.
Red DO result indicates that the warm water quality standard (5.0 mg/L DO) was exceeded.
Bolded EC result indicates that the EC threshold for reporting (700 µmhos/cm) was exceeded.
*Only one instrument measured DO correctly during this sampling event.

SECTION 5

Review of Quality Assurance/Quality Control

The validity of water quality monitoring results relies on defining and rigorously following a Quality Assurance/Quality Control (QA/QC) Program. QA/QC requirements are specified in a Monitoring Quality Assurance Project Plan (QAPP), and the laboratory QA/QC requirements are specified in QA/QC plans for each lab.

QA/QC requirements for the CWFR sampling are specified in the CRC QAPP submitted December 2010 (CH2M HILL, 2010). Project schedules (sampling dates, parameters, and sites) specified for each program are revised at the beginning of each monitoring year based on actual weather conditions and grower schedules. The CRC QAPP was prepared in accordance with Attachment C (Quality Assurance Project Plan Guidelines for California Rice Commission) of the Monitoring and Reporting Program under Order No. R5-2010-0805.

The CRC QAPP specifies several types of QA/QC samples, including:

- Field QA/QC samples
  - Field blanks
  - Field duplicates
- Lab QA/QC samples
  - Method blanks
  - Matrix spikes and matrix spike duplicates (MS/MSDs)
  - Laboratory control spikes and spike duplicates (LCS/LCSDs)

The CRC QAPP also specifies numeric QA/QC objectives for precision, accuracy, representativeness, comparability, and completeness.

This section describes the QA/QC samples and their purposes, presents the quality assurance objectives (QAO), and then evaluates the 2014 CWFR QA/QC results against the objectives.

Internal QC

Internal QC is achieved by collecting and analyzing a series of duplicate, blank, spike, and spike duplicate samples to confirm that analytical results are within the specified QC objectives. The QC sample results are used to qualify precision and accuracy, and to identify any problem or limitation in the associated sample results. The internal QC components of a sampling and analysis program ensure that data of known quality are produced and documented.

Field QA/QC Samples

Field QA/QC samples are used to assess the influence of sampling procedures and equipment used in sampling. The results from these samples are examined to ensure that field procedures yield acceptable results. Two types of field quality control samples were used to determine field accuracy: field blanks and field duplicates.

Field Blanks

A field blank is a bottle of reagent water that is exposed to sampling conditions, returned to the laboratory, and treated as an environmental sample. This blank is used to provide information about contaminants that may be introduced during sample collection, storage, and transport.

Field Duplicates

Field duplicates, or split samples, consist of an additional bottle of sample collected at a randomly selected sample location. The results from the duplicate sample are compared to the results from the primary sample; if the relative percent difference (RPD) between the samples is greater than 35 percent, a thorough evaluation of the samples will be performed to determine whether to take corrective action (to either report the data or resample). Duplicate samples provide precision information for the entire measurement system, including sample acquisition, homogeneity, handling, shipping, storage, laboratory sample preparation, and laboratory analysis.

Laboratory QA/QC Samples

Laboratory QA/QC samples are prepared to ensure that the required level of laboratory accuracy is being achieved. Three types of quality control samples were used to determine laboratory accuracy: method blanks, MS/MSDs, and LCS/LCSDs.

Method Blanks

Method blanks consist of deionized water that is run through all of the same steps as the environmental samples at the lab. These samples are used to determine the existence of any laboratory sources of contamination.

Matrix Spikes and Matrix Spike Duplicates

MS/MSD samples are collected at the same time as the environmental samples and are spiked at the laboratory with known concentrations of the analyte(s) to be measured. These samples are used to evaluate the effect a particular sample matrix has on the accuracy of the measurement. The MSD sample serves as another check of accuracy and allows calculation of the analysis method’s precision. The difference in the measured concentrations of the original sample and the spiked sample is compared with the spike concentration, and a percent recovery (the concentration that the laboratory measures divided by the known concentration of a spiked sample multiplied by 100) of the spiked concentration is reported.

Laboratory Control Spikes and Spike Duplicates

LCS/LCSD samples consist of known concentrations of a constituent in distilled water. The measured concentrations are compared with the spike concentration, and a percent recovery can be determined. Results are acceptable if the percent recovery falls within a predetermined range.

Quality Assurance Objectives

QAOs are the detailed QC specifications for precision, accuracy, representativeness, comparability, and completeness. QAOs are used as comparison criteria during data quality review to evaluate whether the minimum requirements have been met and the data can be used as planned. The basis for assessing each element of data quality for this project is discussed in the following subsections.

Precision

Precision is a measure of the reproducibility of analyses under a given set of conditions. Precision is assessed by replicate measurements of field and laboratory duplicate samples. The routine comparison of precision is measured by the RPD between duplicate sample measurements. The overall precision of a sampling event is determined by a sampling component and an analytical component.

The following formula determines the RPD between two samples:

$$RPD = \frac{|D1 - D2|}{(D1 + D2)/2} x100$$

Where:

RPD	=	relative percent difference
D1	=	first sample value
D2	=	second sample value (duplicate)

The maximum acceptable RPD for all duplicates, MS/MSD, and LS/LSD samples is 25 percent.

Accuracy

Accuracy is a determination of how close the measurement is to the true value. Accuracy can be assessed using the MS/MSD, LCS/LCSD, calibration standard, and spiked environmental samples. The accuracy of the data submitted for this project will be assessed in the following manner: The percent recovery of LCS/LCSD, MS/MSD, and spiked surrogates will be calculated and evaluated against established laboratory recovery limits. Acceptable percent recovery for this project depends on sample type.

For the constituents measured in 2014, the acceptable recovery was 80 to 120 percent.

Laboratory method blanks will be tested to determine levels of target compounds. If a target compound is found above the method detection limit (MDL) in the method blank corresponding to a batch of samples, and the same target compound is found in a sample, then the data will not be background subtracted but will be flagged to indicate the result in the blank.

Accuracy is presented as percent recovery. Because accuracy is often evaluated from spiked samples, laboratories commonly report accuracy using this formula:

$$\% \text{ Recovery} = R / S * 100$$

Where:

S	=	spiked concentration
R	=	reported concentration

The laboratories monitor accuracy by reviewing MS/MSD, LCS/LCSD, calibration standard, and surrogate spike recovery results.

Representativeness

Representativeness refers to the degree to which sample data accurately and precisely describe the characteristics of a population of samples, parameter variations at a sampling point, or environmental conditions. Representativeness is a qualitative parameter that is primarily concerned with the proper design of the sampling program or of the subsampling of a given sample. Representativeness will be assessed by the use of duplicate field and laboratory samples because they provide information pertaining to both precision and representativeness.

Samples that are not properly preserved or are analyzed beyond acceptable holding times will not be considered to provide representative data. Also, detection limits above applicable maximum contaminant levels (MCLs) or screening criteria will not be considered representative.

Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data should be comparable for similar samples collected under like conditions. This goal is achieved through the use of standard techniques to collect and analyze representative samples and reporting analytical results with appropriate units.

Comparability is limited by other analytical control parameters; therefore, only when precision and accuracy are known can data sets be compared with confidence. Using standard operating procedures (SOPs) promotes comparability.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount as expected to be obtained under normal conditions. To be considered complete, the data set must contain all analytical results and data specified for the project. Additionally, all data are compared to project requirements to ensure that specifications are met. Completeness is evaluated by comparing the project objectives to the quality and quantity of the data collected to assess whether any deficiencies exist. Missing data can result from any number of circumstances, ranging from sample acquisition and accessibility problems to sample breakage and rejection of analytical data because of quality control deficiencies. Completeness is quantitatively assessed as the percent of controlled QC parameters that are within limits. Percent completeness for each set of samples for each individual method can be calculated as follows:

$$Completeness = \frac{\text{valid data obtained}}{\text{total data analyzed}} \times 100\%$$

Where:

Valid data are defined as those data points that are not qualified as rejected.

The requirement for completeness is 90 percent for each individual analytical method for all QC parameters except holding times.

These QC parameters include:

- Initial calibration
- Continuing calibrations
- LCS/LCSD
- MS/MSD
- Field duplicate RPDs
- Surrogate percent recoveries

The requirement for holding times is 100 percent. Any deviations are reported in the report narrative.

QA/QC Sample Results and Analysis

One "QC set" is required for each analytical method batch per sampling event. The minimum required samples for chemical analysis include:

- Field blank
- Field duplicate
- MS/MSD
- LCS/LCSD
- Laboratory blank
- Laboratory duplicate (MS/MSD or LCS/LCSD pair may serve this function).

Field duplicates and field blanks are not required for events where only general parameters are collected.

Field QA/QC Samples

Field CWFR QA/QC samples collected during 2014 sampling events included field blanks and field duplicates. The dates, events, and sites of these samples are shown in Table 5-1. Results for field QA/QC samples are provided below.

TABLE 5-1
Field QA/QC Samples, 2014

Sample Event	Sample Date	QA/QC Sample Type(s)
May Event	5/20/2014	Field blank at SSB Field duplicate at SSB
June Event	6/17/2014	Field blank at CBD1 Field duplicate at CBD1
July Event	7/15/2014	Field blank at CBD5 Field duplicate at CBD5
August Event	8/19/2014	Field blank at BS1 Field duplicate at BS1
September Event	9/16/2014	Field blank at SSB Field duplicate at SSB

Field Blanks

Field blank samples were collected and analyzed for the same constituents as the environmental samples. The results for the field blanks were below the method reporting limits (MRLs) for all analytes (Table 5-2).

Field Duplicates

Field duplicate samples were collected and analyzed for the same constituents as the primary environmental samples. Results between primary and duplicate samples were similar, as expected (Table 5-3).

TABLE 5-2
Field Blank Results, 2014

		Analyte		
Sample Event	**Sample Location**	**Total Hardness (MRL = 1.0 mg/L)**	**Total Organic Carbon (MRL = 1.0 mg/L)**	**TDS (MRL = 10 mg/L)**
May Event	SSB	0.34j	ND	ND
June Event	CBD1	ND	ND	ND*
July Event	CBD5	ND	0.71j	ND
August Event	BS1	ND	ND	ND
September Event	SSB	ND	ND	ND

Notes:
ND = non-detect above the MRL
j = result is below the MRL
* = QC percent recovery for the June Event TDS QA/QC samples was low. Samples were re-analyzed with results matching the original data.

TABLE 5-3
Field Duplicate Results, 2014

	Analyte								
Sample Event	**Total Hardness (MRL = 1.0 mg/L)**			**TOC (MRL = 1.0 mg/L)**			**TDS (MRL = 10 mg/L)**		
	Primary	**Duplicate**	**RPD (%)**	**Primary**	**Duplicate**	**RPD (%)**	**Primary**	**Duplicate**	**RPD (%)**
May Event (SSB)	110	110	0	4.9	4.3	13.0	150	150	0
June Event (CBD1)	190	190	0	8.9	9.0	1.1	430*	410*	4.8
July Event (CBD5)	200	190	5.1	6.7	6.9	2.9	340	340	0
August Event (BS1)	150	150	0	7.0	6.2	12.1	250	240	4.1
September Event (SSB)	140	140	0	5.4	4.8	11.8	220	220	0

Notes:
RPD limit is 25%
* = QC percent recovery for the June Event TDS QA/QC samples was low. Samples were re-analyzed with results matching the original data.

Laboratory QA/QC Samples

The laboratory QA/QC samples included method blanks, laboratory duplicates, matrix spikes, and lab control spikes; the results for each follow.

Method Blanks

Method blank samples were prepared by the laboratory and tested for the same analytes as the environmental samples. The results of all the method blank samples were below the MRL (non-detect [ND]) for these analytes (Table 5-4).

TABLE 5-4
Method Blank Results, 2014

	Analyte		
Sample Event	**Total Hardness (MRL = 1.0 mg/L)**	**TOC (MRL = 1.0 mg/L)**	**TDS (MRL = 10 mg/L)**
May Event	ND	ND	ND
June Event	ND	ND	ND
July Event	ND	ND	ND
August Event	ND	ND	ND
September Event	ND	ND	ND

Notes:
ND = non-detect above the MRL

MS/MSD Samples

MS and MSD samples were prepared and analyzed for each sampling event (Table 5-5). The majority of the MS/MSD samples were within the CRC QAPP limits, however a couple of samples had recoveries outside of the limits in 2014. In all cases, the QC sample batch was accepted because the LCS/LCSD recoveries or duplicate QC samples were within range. Because of this, no corrective actions were taken. The out-of-range samples included: TDS recoveries from May and June (both below the limit/under-recovered), and total hardness recoveries from August and September (both above the CRC QAPP limit/over-recovered).

TABLE 5-5
Laboratory MS/MSD Samples, 2014

Sample Event	Analyte	Spike Level (mg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
May Event	TDS	300	**74**	88	80–120	10	25
	TOC	10.0	117	118	80–120	0.4	25
	Total Hardness	66.4	95	85	80–120	3	25
June Event	TDS	300	**72**	**72**	80–120	0.2	25
	TOC	10.0	115	112	80–120	1	25
	Total Hardness	66.4	82	80	80–120	0.6	25

TABLE 5-5
Laboratory MS/MSD Samples, 2014

Sample Event	Analyte	Spike Level (mg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
July Event	TDS	500	97	97	80–120	0.4	25
	TOC	10.0	83	90	80–120	4	25
	Total Hardness	33.1	82	90	80–120	1	25
August Event	TDS	500	81	85	80–120	3	25
	TOC	10.0	95	110	80–120	10	25
	Total Hardness	33.1	119	**122**	80–120	0.6	25
September Event	TDS	500	86	86	80–120	0	25
	TOC	10.0	95	84	80–120	7	25
	Total Hardness 1	33.1	108	105	80–120	1	25
	Total Hardness 2	33.1	**495**	80	80–120	**58**	25

Notes:
ND = non-detect
NA = not applicable
Bold values are outside of recovery limits.

LCS/LCSD Samples

LCS and LCSD samples were prepared and analyzed for each sampling event. The recoveries and RPD percentages for all 2014 samples were within the CRC QAPP limits (Table 5-6).

TABLE 5-6
Laboratory LCS/LCSD Samples, 2014

Sample Event	Analyte	Spike Level (mg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
May Event	TDS	300	103	99	80–120	4	25
	TOC	10.0	81	90	80–120	11	25
	Total Hardness	66.4	95	96	80–120	1	25
June Event	TDS	300	88	84	80–120	5	25
	TOC	10.0	89	81	80–120	9	25
	Total Hardness	66.4	91	92	80–120	1	25
July Event	TDS	500	100	101	80–120	1	25
	TOC	10.0	95	100	80–120	5	25
	Total Hardness	33.1	104	103	80–120	1	25

TABLE 5-6
Laboratory LCS/LCSD Samples, 2014

Sample Event	Analyte	Spike Level (mg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
August Event	TDS	500	83	89	80–120	6	25
	TOC	10.0	94	106	80–120	13	25
	Total Hardness	33.1	108	107	80–120	1	25
September Event	TDS	500	91	96	80–120	6	25
	TOC	10.0	90	102	80–120	12	25
	Total Hardness	33.1	98	97	80–120	1	25

Notes:
NA = not applicable
Bold values are outside of recovery limits.

Analysis of Precision

Field duplicate samples were collected during each sampling event, and were analyzed for each primary analyte. Duplicate results were found to be consistent with the original matrix results. Field duplicate results are presented in Table 5-3.

MS/MSD sample sets were prepared and analyzed for every sampling event during the 2014 season. All the sample sets had acceptable RPD limits for all analytes, with the exception of a duplicate MS/MSD sample from the September event. MS/MSD results and RPD values are presented in Table 5-5.

LCS/LCSD samples were prepared and analyzed for every sampling event during the 2014 season. The RPD percentages for all samples were within the acceptable limits. LCS/LCSD results and RPD values are presented in Table 5-6.

Analysis of Accuracy

Field blank samples were utilized during each sampling event, and were analyzed for each primary analyte. All field blank samples were found to have detectable analyte levels below the MRLs. Field blank results are presented in Table 5-2.

Method blank samples were run with every batch of analytical samples. All method blank samples were found to have analyte levels below the MRLs. Method blank results are presented in Table 5-4.

MS and MSD samples were prepared and analyzed for every sampling event during the 2014 season. The majority of the MS/MSD results were within the CRC QAPP recovery limits (Table 5-5). Five samples had analyte recoveries outside the limits: the primary TDS samples from the May event (below the CRC QAPP limit), the primary and secondary TDS samples from the June event (both below the limit), the secondary total hardness sample from the August event (above the limit), and a duplicate primary total hardness sample from the September event (above the limit). In each case, the QC sample batch was accepted because the LCS/LCSD recoveries were within range.

LCS/LCSD samples were prepared and analyzed for every sampling event during the 2014 season. All of the LCS/LCSD results were within the CRC QAPP recovery limits (Table 5-6).

Analysis of Completeness

Field and transport completeness refers to the complete event process of all field activities and successful transport of samples to the receiving agencies. In 2014, all field and transport activities were successful; therefore, field completeness was greater than 90 percent.

Laboratory completeness refers to the complete event process, from sample reception to analysis, at the laboratory. In 2014, all samples were transported and received by the lab under COC (Appendix C-1), all storage times were met, and in-house preservation methods were correctly applied. Extraction and analysis of samples were completed successfully, with no missing QA/QC samples. A few lab QC samples had results out of acceptable ranges (as discussed in previous sections). These included the following:

- May: MS from TDS (batch accepted based on acceptable LCS/LCSD recovery).
- June: MS and MSD from TDS (batch accepted based on acceptable LCS/LCSD recovery).
- August: MSD from total hardness (batch accepted based on acceptable LCS/LCSD recovery).
- September: MS from total hardness (batch accepted based on acceptable LCS/LCSD recovery; in addition the primary MS sample had acceptable results).

A calculation of laboratory completeness based on the QC samples (Table 5-7) yields a result of 94.7 percent. This coupled with the acceptable COC process, storage times, in-house sample preservation, and extraction and analysis of samples yields total laboratory completeness of greater than 90 percent.

TABLE 5-7
Laboratory Completeness, 2014

		Number of QC Samples		
Sample Event	**Analyte**	**Acceptable QC**	**Unacceptable/ Incomplete**	**% Completeness**
May Event	TOC	5	0	
	Total Hardness	5	0	
	TDS	4	1	93.3
June Event	TOC	5	0	
	Total Hardness	5	0	
	TDS	4	1	93.3
July Event	TOC	5	0	
	Total Hardness	5	0	
	TDS	5	0	100
August Event	TOC	5	0	
	Total Hardness	4	1	
	TDS	5	0	93.3

TABLE 5-7
Laboratory Completeness, 2014

		Number of QC Samples		
Sample Event	**Analyte**	**Acceptable QC**	**Unacceptable/ Incomplete**	**% Completeness**
September Event	TOC	5	0	
	Total Hardness	5	1	
	TDS	5	0	93.8
Overall laboratory completeness		72	4	94.7

Analysis Summary

The following summarizes the results of the QA/QC analysis performed on the CWFR data:

- Field blank samples all had analyte levels below the MRLs.
- Field duplicate sample results were consistent with primary sample results.
- Method blank samples had results below the MRLs for all analytes.
- The majority of the MS/MSD samples had RPD values within CRC QAPP limits, with the exception of one total hardness sample form the September event. Four events had analyte recoveries outside CRC QAPP limits; TDS from the May and June events (both under the limit/under-recovered), and total hardness from the August and September events (both above the CRC QAPP limit/over-recovered).
- LCS/LCSD samples had RPD values within CRC QAPP limits. All sample recoveries fell within the CRC QAPP recovery limits.
- Field and laboratory completeness were calculated and determined to be greater than 90 percent.

Chains of Custody

COC forms documented sample possession from the time of field sampling until the time of laboratory analysis. A COC form was completed after sample collection at each sample event and prior to sample shipment or release. The COC record forms were completed with indelible ink. Unused portions of the form were crossed out and initialed by the sampler. The COC form, sample labels, and field documentation were crosschecked to verify sample identification, type of analyses, sample volume, and number and type of containers.

COC forms for the CWFR monitoring program are included in Appendix C-1.

SECTION 6

Summary and Recommendations

The CRC implemented water quality monitoring and reporting activities in compliance with MRP Order R5-2010-0805 issued under the CVRWQCB's Irrigated Lands Conditional Waiver. The monitoring and reporting requirements for the 2014 CWFR are specified in an extension of MRP Order R5-2010-0805 dated 6 Sept 2013.

CWFR monitoring included field assessment of field parameters, including temperature, DO, pH, and EC. Lab analyses were conducted as required for TDS, TOC, and total hardness. The following summarizes the CWFR water quality results:

- **Temperature:** Temperature results indicate warm water conditions during the monitoring season. Core site temperatures were consistent with results observed in previous years. Water temperatures track with observed air temperatures. Peak temperatures were observed during the July monitoring event, with a high of 83.0°F.
- **DO:** DO results were again slightly lower than in previous years. This was the first season that DO generally trended BELOW the 6 mg/L warm water standard, with the exception of CBD5; all readings were above the 6 mg/L standard). Low DO (less than the warm WQO of 5 mg/L) was observed during the May event at CBD1; during the June event at BS1, CBD1, and SSB; during the July event at CBD1 and SSB; during the August event at BS1 and CBD1; and during the September event at BS1. Nearly all observations were outside of the 6.5 to 8.5 mg/L WQO range during 2014. CBD5 had the best season-wide DO observations, only dropping below 6.5 mg/L once, during the June event (6.33 mg/L).
- **pH:** No observations were made outside of the 6.5 to 8.5 pH range during the 2014 monitoring season.
- **EC:** Three samples had EC values of greater than 700 µmhos/cm during 2014 sampling. All three were at CBD1, and included the May, June, and July events. All other samples had EC readings below the 700 µmhos/cm threshold for reporting during the 2014 monitoring season.
- **TDS:** TDS samples were collected at all events. TDS was highest in May for CBD1 and CBD5, highest in July for SSB, and highest in September for BS1. The maximum observed TDS was 540 mg/L, at CBD1 in May.
- **TOC:** TOC samples were collected at all events. TOC was generally lowest in August and highest in June and July during 2014. The maximum observed TOC value was 11.0 mg/L at BS1 during the September event.

Assessment of the 2014 CWFR Program

This year represents the tenth full year of the CWFR program. The key successes and challenges faced during 2014 program implementation are summarized as follows:

- Monitoring and assessment were conducted in accordance with the requirements of the MRP. Sampling included core site analysis for field parameters (temperature, DO, pH, EC, and flow) and lab parameters (TOC, TDS, and total hardness).
- The CRC implemented a California Environmental Data Exchange Network (CEDEN)-compliant electronic data submittal system, including laboratory prepared CEDEN-compliant Electronic Data Reports for chemistry analyses.
- Review of field and laboratory QA/QC samples indicates substantial achievement of quality objectives.
  - All field blank samples were found to have analyte levels below the MRLs. Field duplicate sample results were consistent with primary sample results.
  - Laboratory QA/QC substantially achieved data quality objectives. Method blanks achieved data quality objectives, with all results non-detect, as expected. Although a few of the MS/MSD and LCS/LCSD samples were outside of data quality objectives, most samples had recoveries and RPD values within the target range.
- Core monitoring sites for trend monitoring of rice water quality impacts continue to be appropriate because of the uniformity of rice farming practices across the valley. Rice water management and rice water quality management practices are relatively consistent throughout the valley: The same sets of field preparation, irrigation, and harvest practices are available to growers. Additionally, the water hold requirements apply to all rice growers, leaving little variation in the methods of rice farming from the various drainage areas.
- Implementation of management practices continued in 2014, including water hold requirements; education and outreach (newsletters and grower meetings); stakeholder involvement with enforcement activities; and coordination with the University of California Cooperative Extension, University of California (UC) Davis, and the Rice Research Board. Additionally, the CRC has the ability to directly contact each of its members and is committed to using its outreach capabilities to address water quality concerns when they are identified.
- The CRC continues to be engaged in the CVRWQCB's efforts to refine the Irrigated Lands Regulatory Program through its regular consultation with CVRWQCB staff and through its development of technical documentation in support of the Long-Term Irrigated Lands Program, and participation in the CVRWQCB's Technical Issues Committee, CV-SALTS Salinity Coalition, Central Valley Pesticide Total Maximum Daily Load and Basin Plan Amendment, and Drinking Water Policy Workgroup.

Recommendations for 2015

The adoption by the Central Valley Regional Water Quality Control Board of the new Rice Waste Discharge Requirements (Rice WDR) under the Long-Term Irrigated lands Regulatory Program replaces the CWFR starting with the 2015 growing season.

Therefore, 2015 monitoring will occur under a new program, the Rice WDR Order, with requirements specifically developed for Sacramento Valley rice growers (Order No. R5-

2014-0032; adopted 27 March 2014). Through this new program, surface water monitoring will be expanded, and groundwater monitoring will be added. Lessons learned from the CWFR program will be applied to ensure monitoring under the new Rice WDR goes smoothly and successfully and to ensure the continuity of data sampling for adequate trend monitoring analysis.

In addition, new reporting requirements for growers include completing Farm Evaluations and, Nitrogen Management Plans for compliance with the Rice WDR.

SECTION 7

References

Ayers, R. S. and D. W. Wescot. 1985. Water Quality for Agriculture. Food and Agriculture Organization of the United Nations—Irrigation and Drainage Paper No. 29, Rev. 1. Rome.

CVRWQCB (Central Valley Regional Water Quality Control Board). 2004. Recommended Numerical Limits to Translate Water Quality Objectives.

CH2M HILL. 2010. Quality Assurance Project Plan for the California Rice Commission Water Quality Programs, Rice Pesticides Program (RPP), Conditional Waiver for Rice (CWFR), and Algae Management Plan (AMP). QAPP Revision Number: Version 2.0 FINAL. Sacramento, CA.

APPENDIX H: ONLINE RESOURCES

Hosted by the State Water Resources Control Board

SWAMP Quality Assurance Management Plan:
http://www.waterboards.ca.gov/swamp/qamp.html
This QAMP and associated appendices in Adobe PDF and Microsoft Word formats

SWAMP Quality Assurance Project Plan Template:
http://www.waterboards.ca.gov/swamp/docs/swampqapp_template032404.doc
Template for SWAMP-comparable QAPP creation

SWAMP Quality Assurance and Quality Control:
http://www.waterboards.ca.gov/swamp/qapp.html
SWAMP quality assurance homepage and links

Hosted by the Moss Landing Marine Laboratories

SWAMP Standard Operating Procedures:
http://mpsl.mlml.calstate.edu/swsops.htm
SWAMP data management and quality assurance SOPs

SWAMP Quality Assurance Comparability:
http://mpsl.mlml.calstate.edu/swqacompare.htm
Guidelines and links pertaining to SWAMP quality assurance comparability

SWAMP Data Management Comparability:
http://mpsl.mlml.calstate.edu/swdbcompare.htm
Guidelines and links pertaining to SWAMP data management comparability