Conditional Waiver for Rice 2013 Annual Monitoring Report

December 2013



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Prepared for

California Rice Commission

California Rice

Prepared by

CH2MHILL®

RWQCB Staff Review Version

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Prepared for

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CH2MHILL®

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Acronyms and Abbreviations

2008 Coalition MRP	CVRWQCB Order No. R5-2008-0005
µg/L	micrograms per liter
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
CAC	County Agricultural Commissioner
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	laboratory control spike
LCSD	laboratory control spike duplicate
MCL	maximum contaminant level
MDL	method detection limit
mg/L	milligrams per liter
MRL	method reporting limit
MRP	Monitoring and Reporting Program
MRP Order	Monitoring and Reporting Program Order No. R5-2003-0826
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
SWAMP	Surface Water Ambient Monitoring Program
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
USDA	U.S. Department of Agriculture

USEPA	U.S. Environmental Protection Agency
WET	whole effluent toxicity
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 2013 CWFR are specified in CVRWQCB Order No. R5-2010-0805 (CRC MRP) (Appendix A).

This report serves as the 2013 Annual Monitoring Report (AMR) for the CWFR effort, and describes CRC-conducted program activities for the 2013 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.

Kleinfelder was contracted by the CRC to collect water samples at specified sites to obtain data to characterize water quality. CH2M HILL 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 2013, an estimated 565,566 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).

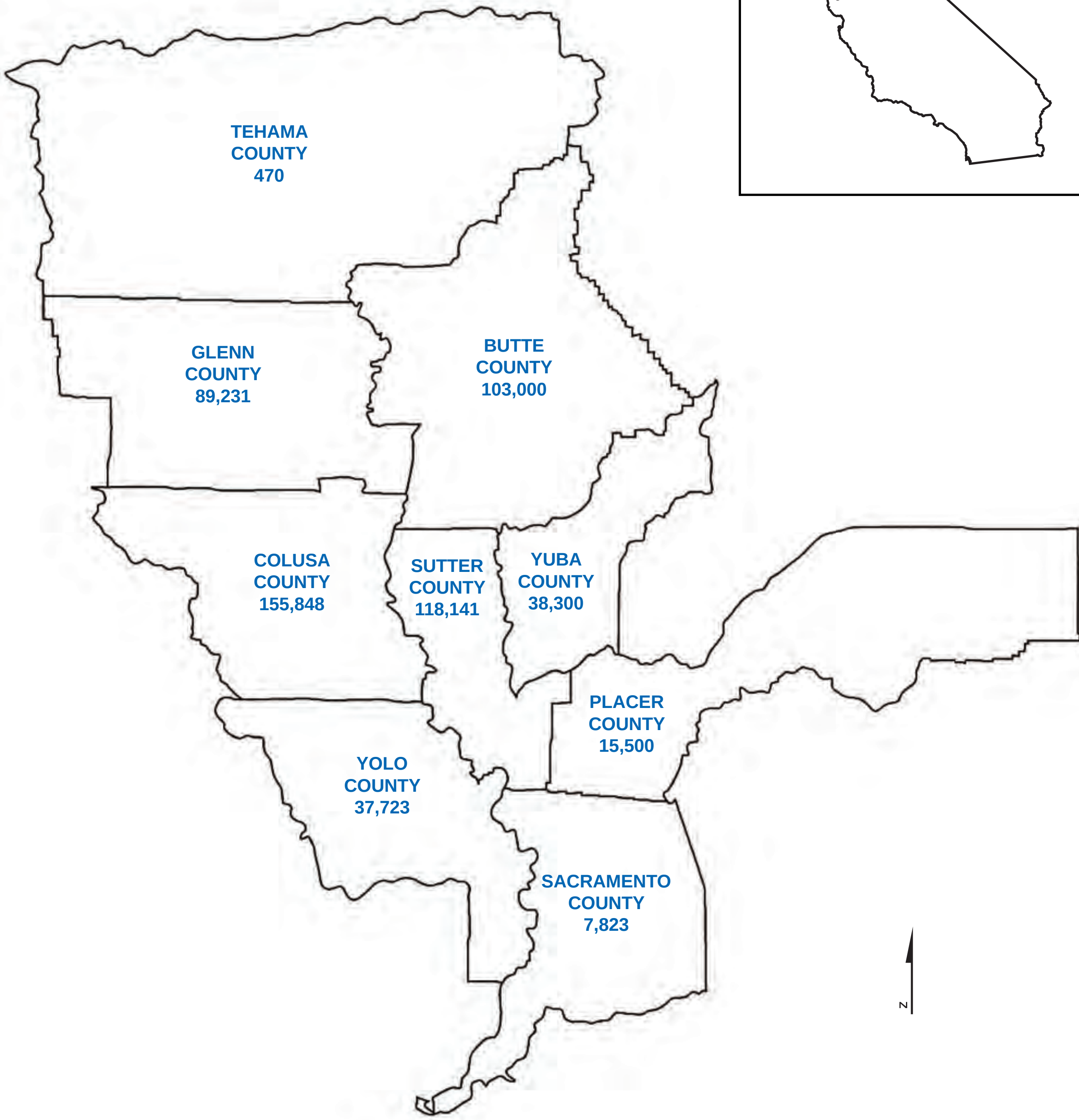
Rice Farming's Influence on Water Quality

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 2013 RPP AMR.

2013 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, 2013
CRC 2013 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 No. R5-2003-0826 (MRP Order).

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 2013 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 4
Sample site descriptions	Section 4
Location map of sampling sites and land use	Appendix B
Tabulated results of analyses	Section 5
Sampling and analytical methods used	Section 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 6
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 7
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

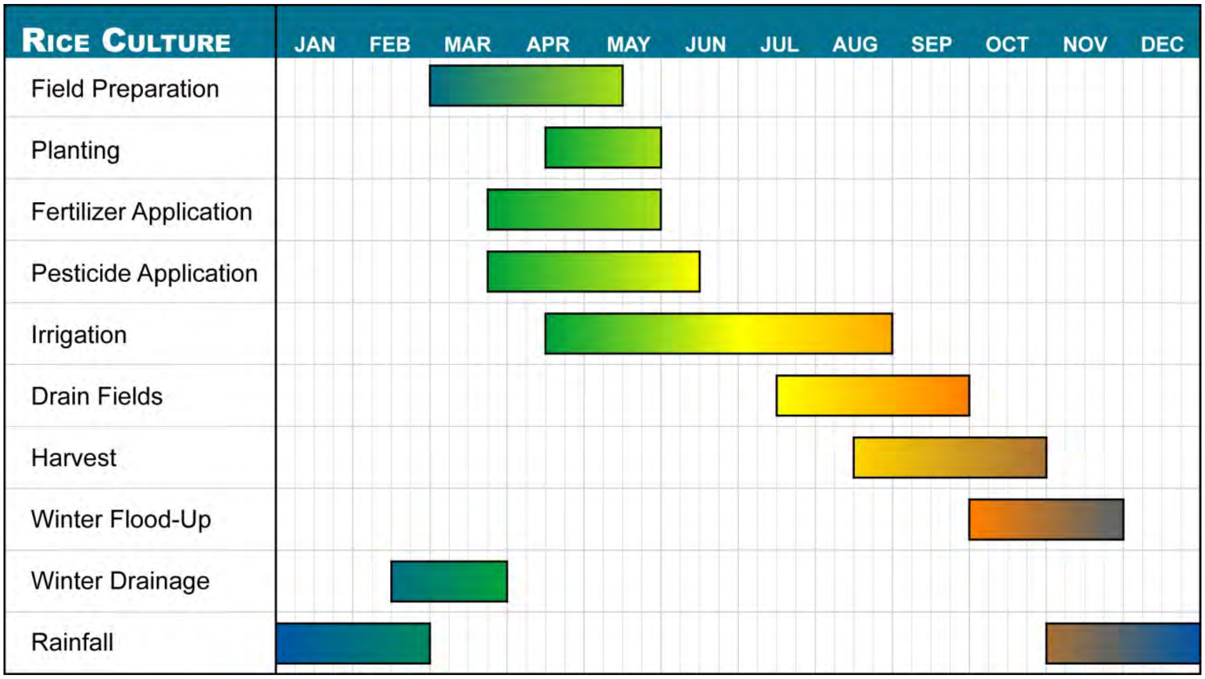
The rice water quality monitoring programs are based on a thorough understanding of how rice is grown in the Sacramento Valley, including key events such as irrigation, drainage, and runoff, and an understanding of when and how products such as pesticides and nutrients are applied. Hydrologic conditions during the year can also influence the timing of key events. This section describes the "typical" Sacramento Valley rice farming calendar and the 2013 rice growing season (including 2013 Sacramento River hydrology), and includes data on the materials applied to rice during the 2013 growing season.

Rice Farming in the Sacramento Valley

Most California rice is produced by direct seeding into standing water, and a continuous flood is maintained for most of the season. Limited acreage is drill 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. The 2013 rice farming year was relatively typical. Fields were planted in mid-April, and fall drainage occurred during August and September.

Flow data for the Sacramento River at Colusa were acquired from the California Department of Water Resources (DWR) California Data Exchange Center (CDEC), and precipitation data for a sensor in Colusa were obtained from the University of California Integrated Pest Management (UC IPM) California Weather Database. Data were collected for the period January 1, 2013, through October 31, 2013. Flow and precipitation data for January through October 2013 are shown in Figure 2-2, and minimum and maximum air temperatures are shown in Figure 2-3.

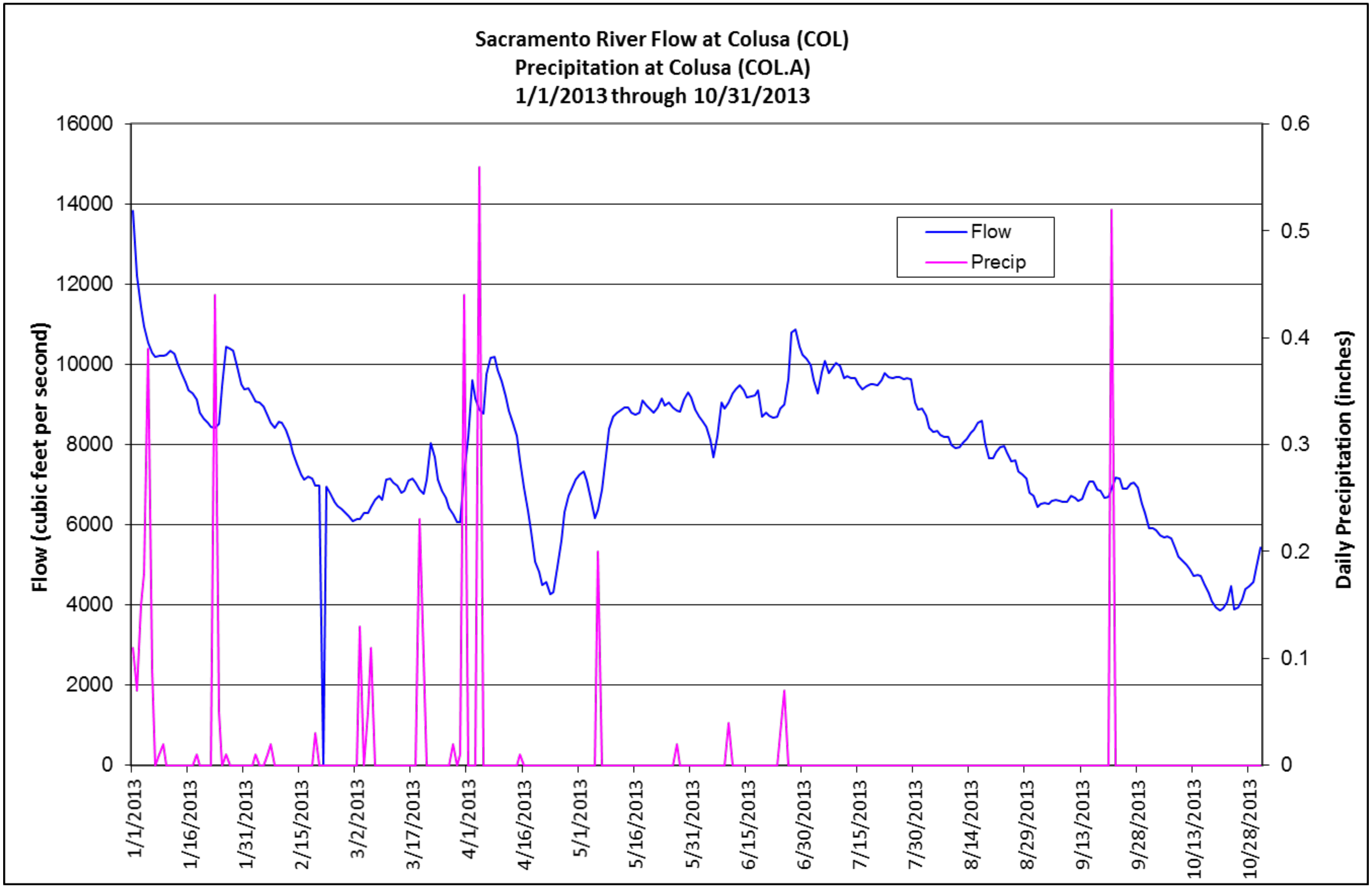


FIGURE 2-2
Flow and Precipitation Data, 2013

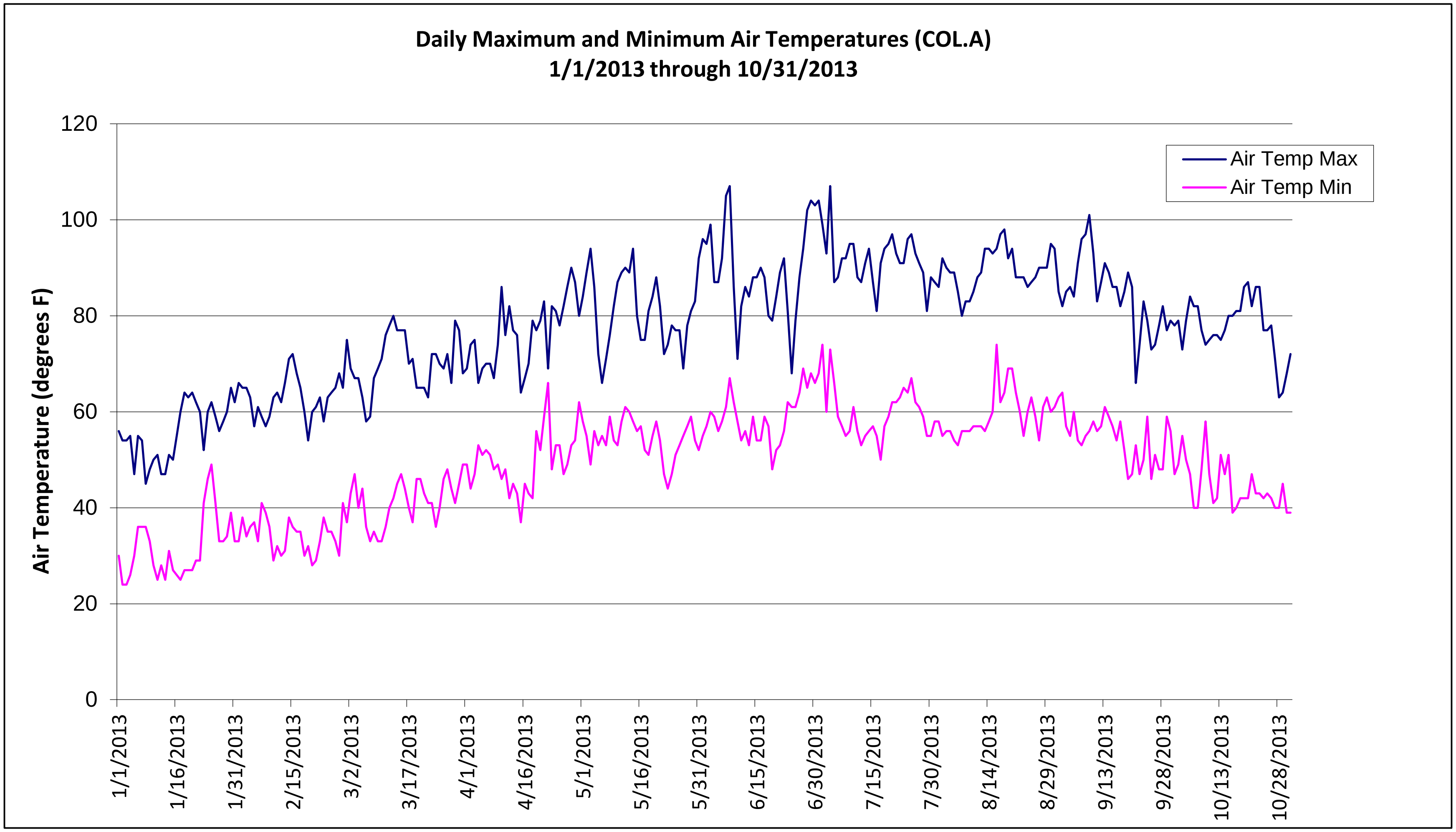


FIGURE 2-3
Daily Maximum and Minimum Air Temperatures, 2013

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 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, Tables 2-1 through 2-4 group pre-flood and germination into early season; tiller initiation and tillering are mid-season, and panicle initiation and flower are late season.

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

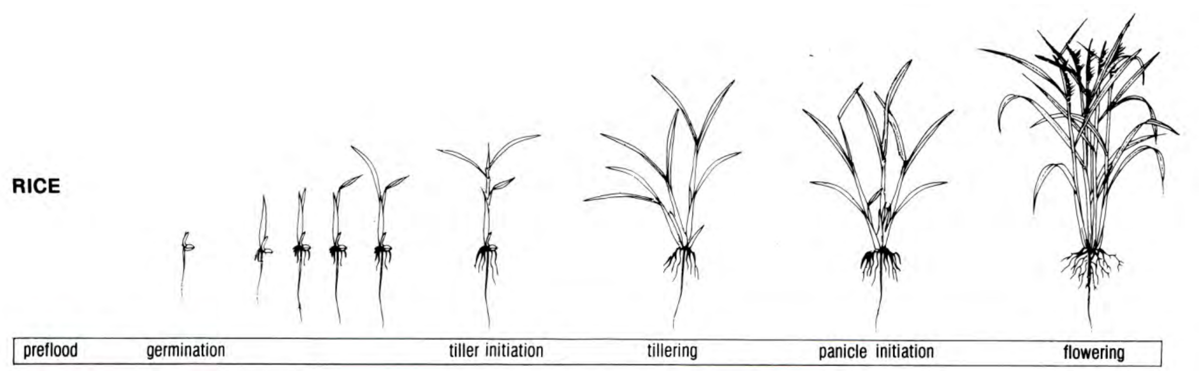


FIGURE 2-4
Rice Growth Stages

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 old
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 agricultural 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 DPR's 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 2013 were lambda cyhalothrin (+22,877 acres), propiconazole (+6,565 acres), trifloxystrobin (+4,388 acres), bispyribac-sodium (+15,556 acres), carfentrazone-ethyl (+378 acres), cyhalofop-butyl (+896 acres), and propanil (+46,750 acres). Thiobencarb is discussed separately in the RPP AMR.

The pesticides with acreage decreases in 2013 were diflubenzuron (-34 acres), (s)-cypermethrin (-8,305 acres), azoxystrobin (-22,002 acres), bensulfuron-methyl (-6,147 acres), clomazone (-21,230 acres), penoxsulam (-17,768 acres), and triclopyr TEA (-6,717 acres).

Treated acreage has a direct correlation to pounds of active ingredient applied. According to the preliminary CAC data, planted acreage in 2013 increased by 9,720 acres, or nearly 2 percent, from 556,316 acres (2012) to 566,036 acres.

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) 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 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 before flooding. Some N may

TABLE 2-5
Herbicides: Acres Treated, Sacramento Valley, 2013

	Acres Treated							
County	**Bensulfuron-methyl**	**Bispyribac-sodium**	**Carfentrazone-ethyl**	**Clomazone**	**Cyhalofop-butyl**	**Penoxsulam**	**Propanil**	**Triclopyr TEA**
Butte	17,580	24,424	3,570	60,104	12,202	22,114	82,468	68,296
Colusa	7,842	40,391	1,250	86,294	20,216	14,435	107,235	100,926
Glenn	2,017	3,154	1,142	36,040	2,692	6,237	65,126	3,301
Placer	1,795	2,237	681	4,597	787	4,345	8,072	7,228
Sacramento	0	320	0	1,704	2,411	1,425	6,276	5,819
Sutter	6,840	30,180	2,093	66,333	8,093	40,196	87,384	74,118
Tehama	0	0	155	160	0	155	175	175
Yolo	681	4,150	46	12,054	3,241	5,185	19,992	20,696
Yuba	10,510	8,691	1,253	25,083	1,990	13,530	34,833	24,400
Total acres	47,265	113,547	10,190	292,369	51,632	107,622	411,561	304,959

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

TABLE 2-6
Herbicides: Pounds Applied, Sacramento Valley, 2013

	Pounds Applied							
County	**Bensulfuron-methyl**	**Bispyribac-sodium**	**Carfentrazone-ethyl**	**Clomazone**	**Cyhalofop-butyl**	**Penoxsulam**	**Propanil**	**Triclopyr TEA**
Butte	1,059	857	470	25,020	4,123	796	423,011	11,228
Colusa	347	994	157	36,620	6,418	476	625,843	17,784
Glenn	153	113	209	16,271	869	223	350,541	504
Placer	162	94	101	1,530	233	161	40,489	1,824
Sacramento	0	11	0	626	2,382	51	32,403	1,207
Sutter	334	967	279	27,004	2,721	1,415	456,709	16,170
Tehama	0	0	29	56	0	6	1,063	24
Yolo	54	122	6	5,162	1,086	192	110,737	4,193
Yuba	385	211	244	9,879	646	490	178,515	4,670
Total pounds	2,494	3,369	1,495	122,168	18,478	3,810	2,219,311	57,604

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

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) is generally unnecessary in California.

Zinc (Zn) deficiency or "alkali disease" is common in alkaline soils and areas where topsoil has been removed. If Zn is used, the 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 deficiency is rare in California and can usually be corrected by lowering the soil pH.

TABLE 2-7
Insecticides: Acres Treated, Sacramento Valley, 2013

	Acres Treated		
County	**Diflubenzuron**	**(s)-Cypermethrin**	**Lambda Cyhalothrin**
Butte	157	467	31,776
Colusa	0	4,848	34,409
Glenn	0	3,360	10,734
Placer	259	707	6,640
Sacramento	0	84	3,082
Sutter	48	6,291	51,977
Tehama	0	0	0
Yolo	0	0	7,019
Yuba	0	4,182	16,903
Total acres	464	19,939	162,540

Notes:

No malathion usage was reported.

Data are preliminary and have not been audited or error checked by DPR. Official release is anticipated by the end of 2013 or start of 2014.

TABLE 2-8
Insecticides: Pounds Applied, Sacramento Valley, 2013

	Pounds Applied		
County	**Diflubenzuron**	**(s)-Cypermethrin**	**Lambda Cyhalothrin**
Butte	16	23	939
Colusa	0	227	975
Glenn	0	159	314
Placer	49	35	180
Sacramento	0	3	89
Sutter	10	252	1,670
Tehama	0	0	0
Yolo	0	0	215
Yuba	0	197	451
Total pounds	75	896	4,833

Notes:

No malathion usage was reported.

Data are preliminary and have not been audited or error checked by DPR. Official release is anticipated by the end of 2013 or start of 2014.

TABLE 2-9
Fungicides: Acres Treated, Sacramento Valley, 2013

	Acres Treated		
County	**Azoxystrobin**	**Propiconazole**	**Trifloxystrobin**
Butte	51,394	270	270
Colusa	72,991	8,842	8,454
Glenn	0	0	0
Placer	3,451	0	0
Sacramento	2,168	870	870
Sutter	36,086	10,183	10,183
Tehama	0	0	0
Yolo	8,449	4,852	4,852
Yuba	11,494	4,127	2,338
Total acres	186,033	29,144	26,967

Note: Data are preliminary and have not been audited or error checked by DPR. Official release is anticipated by the end of 2013 or start of 2014.

TABLE 2-10
Fungicides: Pounds Applied, Sacramento Valley, 2013

	Pounds Applied		
County	**Azoxystrobin**	**Propiconazole**	**Trifloxystrobin**
Butte	8,577	40	40
Colusa	12,655	1,207	1,153
Glenn	0	0	0
Placer	625	0	0
Sacramento	299	114	114
Sutter	6,425	1,427	1,427
Tehama	0	0	0
Yolo	1,508	606	606
Yuba	2,195	687	343
Total pounds	32,284	4,081	3,683

Note: Data are preliminary and have not been audited or error checked by DPR. Official release is anticipated by the end of 2013 or start of 2014.

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 2011 CRC MRPs were developed to be functionally equivalent to the 2008 Coalition MRP.

Monitoring requirements defined by the 2008 Coalition MRP incorporate 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 was to include an expanded suite of parameters and may include an expanded list of sites, including assessment sites and core sites. The purposes of the expanded suite was 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 propanil, which was 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.

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

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 assessment monitoring or other 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. These sites are described in more detail below. Photos 1 through 7 show the monitoring sites.

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.

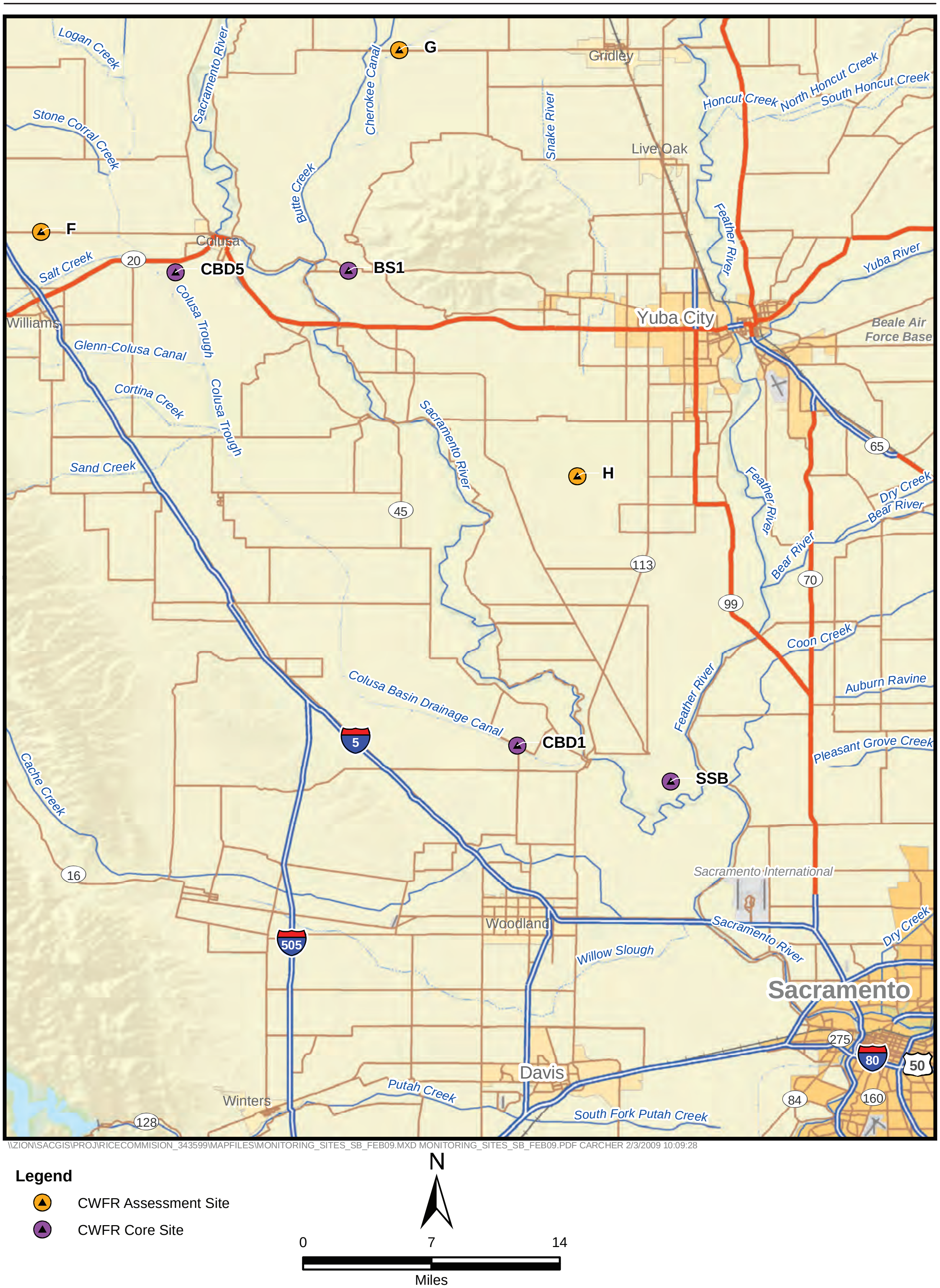


FIGURE 3-1
Monitoring Sites
CRC 2013 Annual Monitoring Report

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. Site F is monitored as an assessment site under the CWFR.

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. Site G is monitored as an assessment site under the CWFR.

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 under the CWFR.

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 that may contain constituents that affect water quality. 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 period with the greatest risk to water quality occurs during the peak pesticide application period from April through June. During this period 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 the water hold. 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 applications of fertilizers.

The monitoring calendar has been developed to focus sampling on the periods of risk to water quality. Monitoring is scheduled to provide 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 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 (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 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 2013 monitoring. The water grab samples were collected using a Kemmerer water sampler (either a stainless steel and Teflon model, or a clear acrylic and PVC 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 updated during the 2012 season (and continued in 2013) 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 also 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 CH2M HILL. CWFR 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

SECTION 4

2013 Monitoring

Monitoring is conducted under the CWFR according to the MRP. 2013 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, TDS, 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 2013.

TABLE 4-1
Monitoring Requirements, 2013

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 2013.

TABLE 4-2
2013 Sampling Calendar

Month	Sample Date	Field Parameters	TDS	TOC	Hardness
April	4/30/2013	✓	✓	✓	✓
May	5/28/2013	✓	✓	✓	✓
June	6/25/2013	✓	✓	✓	✓
July	7/30/2013	✓	✓	✓	✓
August	8/27/2013	✓	✓	✓	✓

General Physical Parameter Results – Field Parameters

The following field parameters were measured as part of the 2013 sampling effort: temperature, DO, pH, EC, turbidity, and flow.

Temperature Measurements

Figure 4-1 shows the 2013 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 77.7°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.

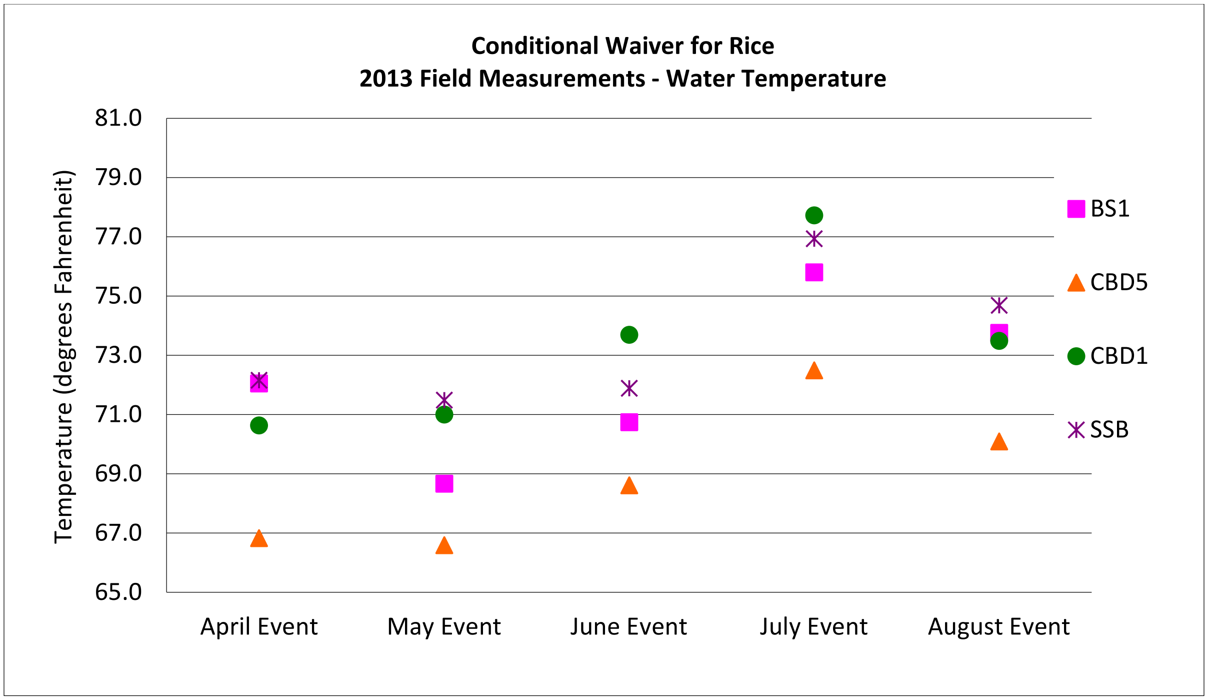


FIGURE 4-1
Water Temperature Measurements, 2013

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 includes 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 2013 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 includes 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.

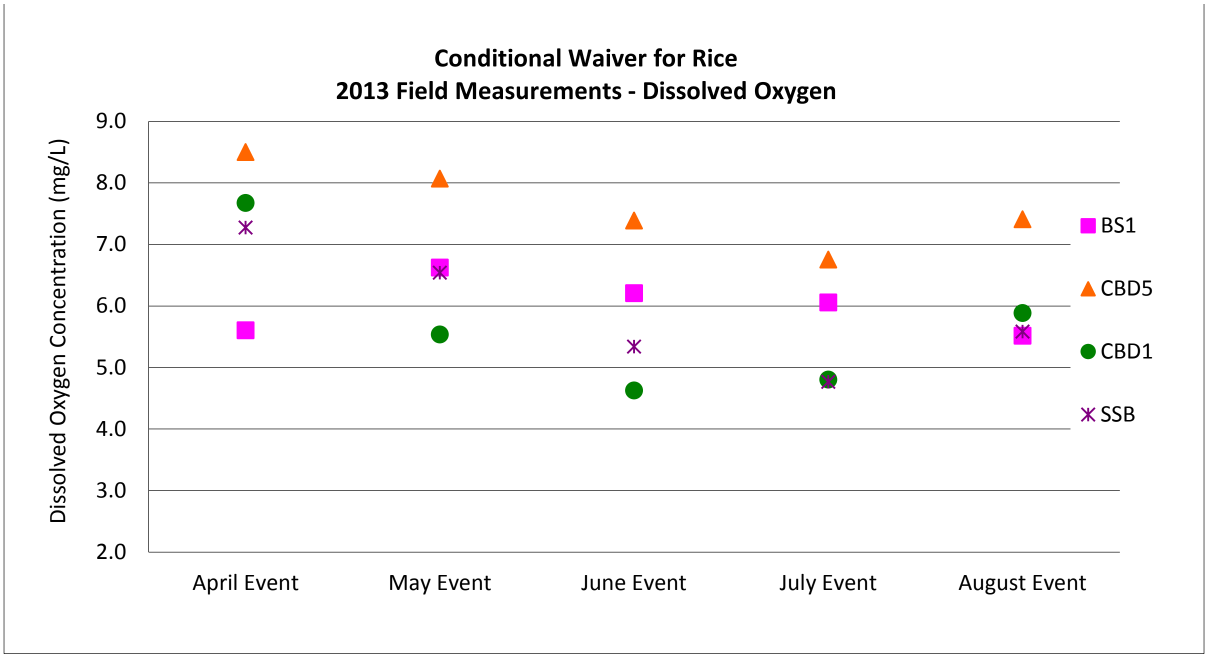


FIGURE 4-2
Dissolved Oxygen Field Measurements, 2013

TABLE 4-3
Field Temperature Measurements, 2013

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
April Event	4/30/2013	72.1	66.8	70.6	72.2	66.8	70.4	71.3	72.2	6.2	2.5	4
May Event	5/28/2013	68.7	66.6	71.0	71.5	66.6	69.4	69.8	71.5	5.1	2.3	4
June Event	6/25/2013	70.7	68.6	73.7	71.9	68.6	71.2	71.3	73.7	4.5	2.1	4
July Event	7/30/2013	75.8	72.5	77.7	76.9	72.5	75.7	76.4	77.7	5.3	2.3	4
August Event	8/27/2013	73.8	70.1	73.5	74.7	70.1	73.0	73.6	74.7	4.0	2.0	4
Site Low		68.7	66.6	70.6	71.5							
Site Mean		72.2	68.9	73.3	73.4							
Site Median		72.1	68.6	73.5	72.2							
Site High		75.8	72.5	77.7	76.9							
Site Variance		7.5	6.0	8.0	5.4							
Site Standard Deviation		2.7	2.4	2.8	2.3							
N		5	5	5	5							
Number of obs. Temp >68°F		5	3	5	5							
Number of obs. Temp <68°F		0	2	0	0							
Percent of obs. where Temp >68°F		100%	60%	100%	100%							
Percent of obs. where temp <68°F		0%	40%	0%	0%							

TABLE 4-4
Dissolved Oxygen Field Measurements, 2013

		Site Measurements (mg/L)				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
Sample Event	Sample Date	BS1	CBD5	CBD1	SSB													
April Event	4/30/2013	5.61	8.50	7.68	7.28	5.61	7.26	7.48	8.50	1.48	1.22	4	1	1	0	25%	25%	0%
May Event	5/28/2013	6.63	8.07	5.54	6.54	5.54	6.69	6.58	8.07	1.09	1.04	4	3	1	0	75%	25%	0%
June Event	6/25/2013	6.21	7.39	4.63	5.34	4.63	5.89	5.77	7.39	1.41	1.19	4	3	2	1	75%	50%	25%
July Event	7/30/2013	6.06	6.75	4.80	4.77	4.77	5.59	5.43	6.75	0.96	0.98	4	4	2	2	100%	50%	50%
August Event	8/27/2013	5.52	7.41	5.89	5.58	5.52	6.10	5.73	7.41	0.79	0.89	4	3	3	0	75%	75%	0%
Site Low		5.52	6.75	4.63	4.77													
Site Mean		6.00	7.62	5.70	5.90													
Site Median		6.06	7.41	5.54	5.58													
Site High		6.63	8.50	7.68	7.28													
Site Variance		0.21	0.46	1.48	1.00													
Site Standard Deviation		0.45	0.68	1.22	1.00													
N		5	5	5	5													
Number of obs. DO<7		5	1	4	4													
Number of obs. DO<6		2	0	4	3													
Number of obs. DO<5		0	0	2	1													
Percent of obs. DO<7		100%	20%	80%	80%													
Percent of obs. DO<6		40%	0%	80%	60%													
Percent of obs. DO<5		0%	0%	40%	20%													

DO values of less than 6 mg/L were observed at BS1, CBD1, and SSB (Table 4-4). These observations occurred in April (BS1 only), May (CBD1 only), June (both CBD1 and SSB), July (both CBD1 and SSB), and August (BS1, CBD1 and SSB). CBD1 had a DO reading of less than 5 mg/L at the June event and both CBD1 and SSB had DO readings of less than 5 mg/L at the July event. These results are consistent with prior observations at CBD1, which historically has had low DO throughout the summer months. Historically, SSB has not had low DO during the sampling season; however, low DO has been recorded during the last two monitoring seasons. BS1 has not had low DO since the 2010 monitoring season.

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.

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.

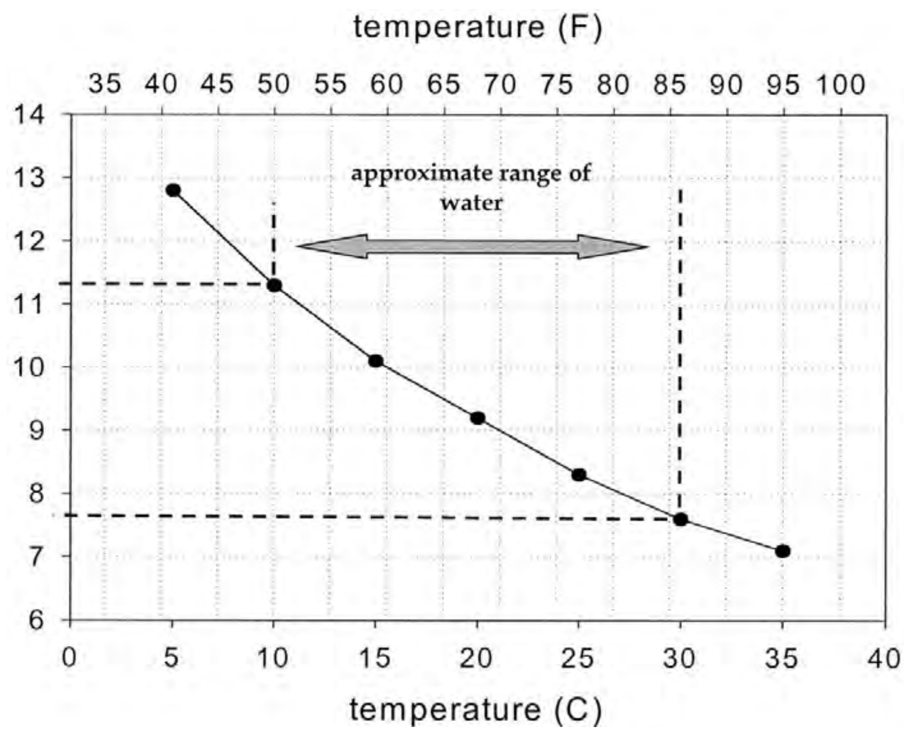


FIGURE 4-3
Oxygen Solubility as a Function of Temperature

pH Measurements

Figure 4-4 shows the 2013 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 includes an evaluation of the number of times the observed field pH was less than 6.5 or greater than 8.5 (WQOs). In 2013, no observations fell outside the 6.5 to 8.5 pH range.

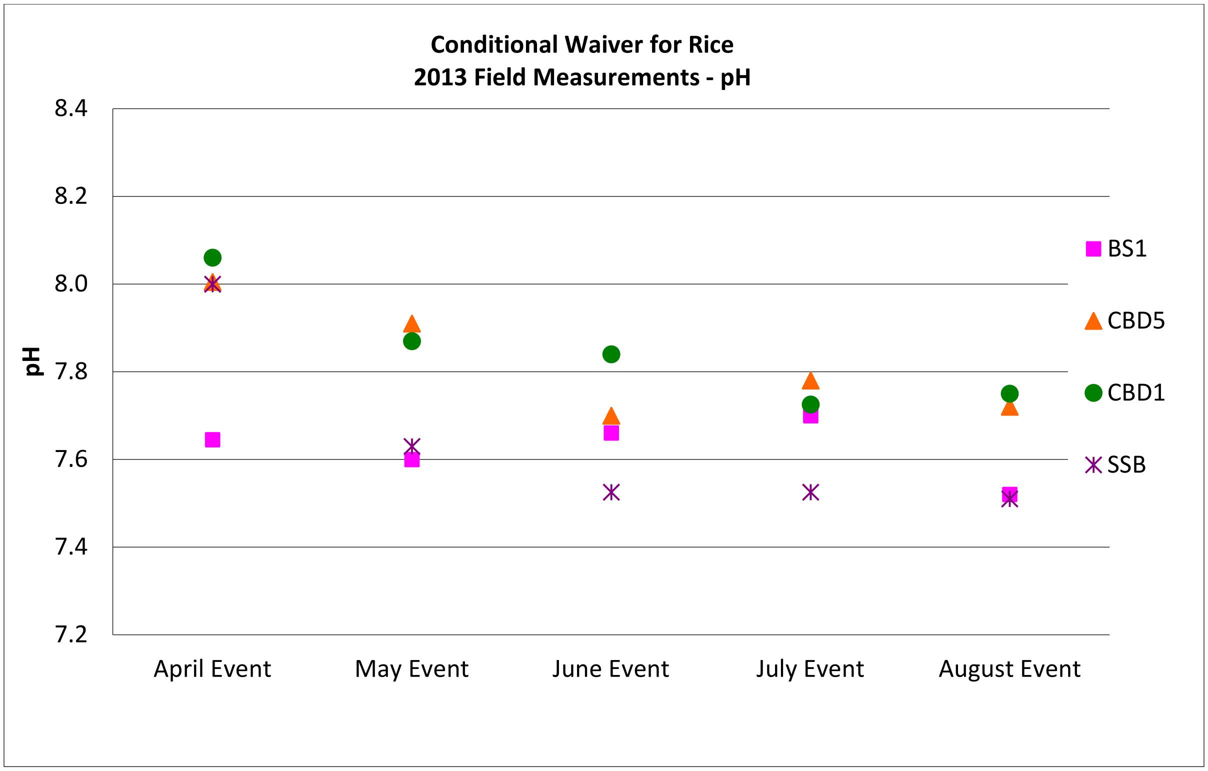


FIGURE 4-4
pH Field Measurements, 2013

TABLE 4-5
pH Field Measurements, 2013

Sample Event	Sample Date	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
		BS1	CBD5	CBD1	SSB											
April Event	4/30/2013	7.65	8.01	8.06	8.00	7.65	7.93	8.00	8.06	0.04	0.19	4	0	0	0%	0%
May Event	5/28/2013	7.60	7.91	7.87	7.63	7.60	7.75	7.75	7.91	0.03	0.16	4	0	0	0%	0%
June Event	6/25/2013	7.66	7.70	7.84	7.53	7.53	7.68	7.68	7.84	0.02	0.13	4	0	0	0%	0%
July Event	7/30/2013	7.70	7.78	7.73	7.53	7.53	7.68	7.71	7.78	0.01	0.11	4	0	0	0%	0%
August Event	8/27/2013	7.52	7.72	7.75	7.51	7.51	7.63	7.62	7.75	0.02	0.13	4	0	0	0%	0%
Site Low		7.52	7.70	7.73	7.51											
Site Mean		7.63	7.82	7.85	7.64											
Site Median		7.65	7.78	7.84	7.53											
Site High		7.70	8.01	8.06	8.00											
Site Variance		0.00	0.02	0.02	0.04											
Site Standard Deviation		0.07	0.13	0.13	0.21											
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 2013 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 includes an evaluation of the number of times the observed field EC exceeded 700 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.

One EC value of greater than 700 µmhos/cm was observed during the 2013 sampling season. This value was observed at CBD1 during the May event. All other samples had EC readings below 700 µmhos/cm.

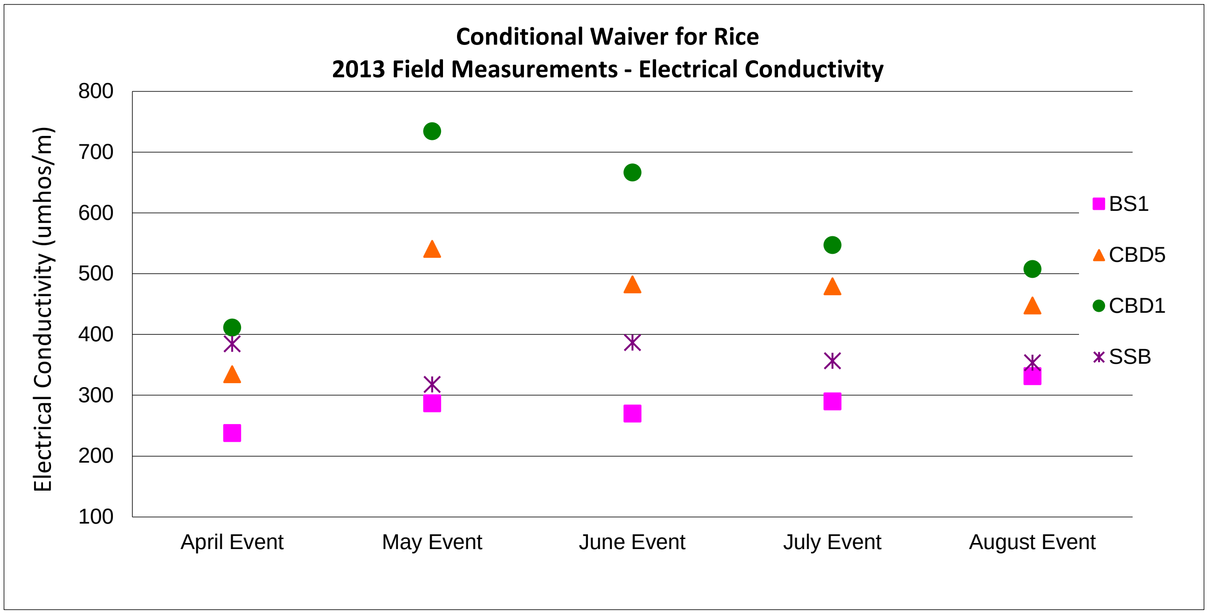


FIGURE 4-5
Electrical Conductivity Field Measurements, 2013

Turbidity

Figure 4-6 shows the 2013 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.

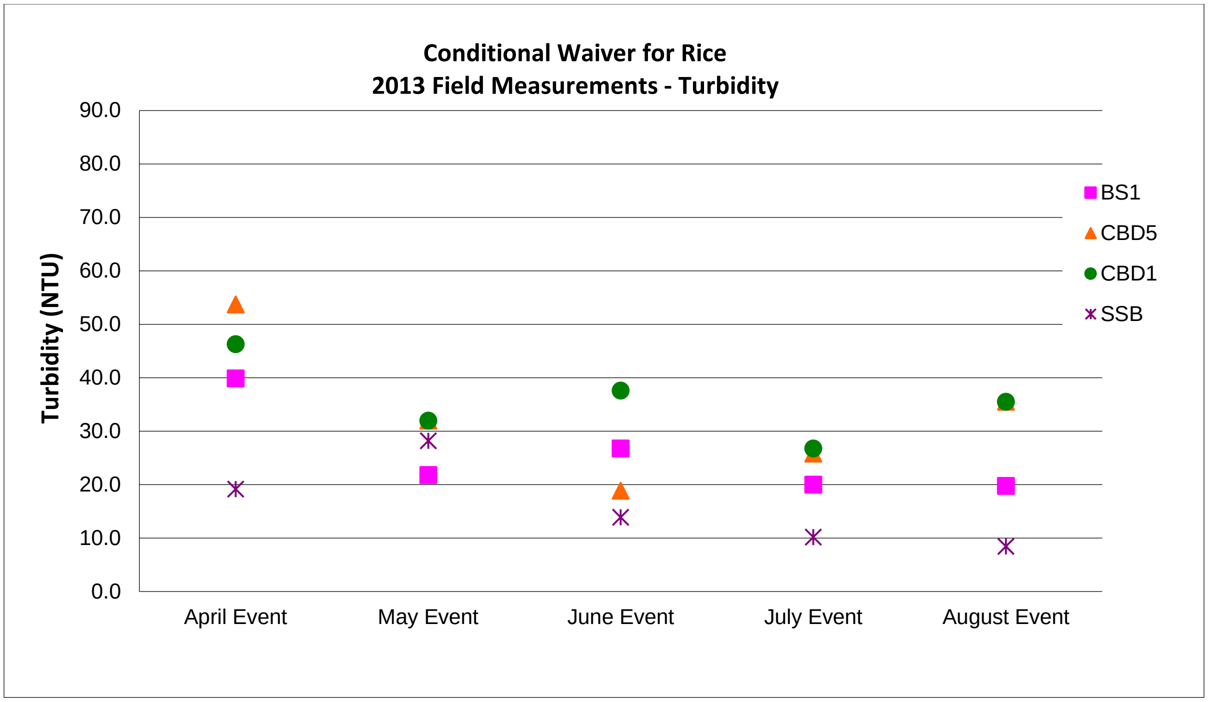


FIGURE 4-6
Turbidity Field Measurements, 2013

TABLE 4-6
Electrical Conductivity Field Measurements, 2013

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									
April Event	4/30/2013	238	335	412	385	238	343	360	412	5871	77	4	0	0%
May Event	5/28/2013	287	541	735	318	287	470	430	735	43953	210	4	1	25%
June Event	6/25/2013	270	483	667	387	270	452	435	667	28178	168	4	0	0%
July Event	7/30/2013	290	480	548	357	290	419	418	548	13552	116	4	0	0%
August Event	8/27/2013	332	448	508	354	332	411	401	508	6756	82	4	0	0%
Site Low		238	335	412	318									
Site Mean		283	457	574	360									
Site Median		287	480	548	357									
Site High		332	541	735	387									
Site Variance		1165	5801	16468	791									
Site Std. Deviation		34.1	76.2	128.3	28.1									
N		5	5	5	5									
Number of obs. EC>700		0	0	1	0									
Percent of obs. EC>700		0%	0%	20%	0%									

µS/cm = microSiemens per centimeter

TABLE 4-7
Turbidity Field Results, 2013

Sample Event	Sample Date	Turbidity (NTU) BS1	CBD5	CBD1	SSB	Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
April Event	4/30/2013	39.9	53.7	46.3	19.2	19.2	39.8	43.1	53.7	219.9	14.8	4
May Event	5/28/2013	21.8	32.0	32.0	28.2	21.8	28.5	30.1	32.0	23.2	4.8	4
June Event	6/25/2013	26.8	18.9	37.6	13.9	13.9	24.3	22.9	37.6	106.8	10.3	4
July Event	7/30/2013	20.0	25.8	26.8	10.2	10.2	20.7	22.9	26.8	58.0	7.6	4
August Event	8/27/2013	19.8	35.5	35.5	8.5	8.5	24.8	27.7	35.5	173.8	13.2	4
Site Low		19.8	18.9	26.8	8.5							
Site Mean		25.7	33.2	35.6	16.0							
Site Median		24.3	28.9	34.8	16.6							
Site High		39.9	53.7	46.3	28.2							
Site Variance		80.8	226.5	69.6	61.0							
Site Standard Deviation		9.0	15.0	8.3	7.8							
N		4	4	4	4							

Flow Measurements

Table 4-8 contains the estimation of flow from the flow measurements collected during the 2013 monitoring season. Field measurements were documented on field sheets contained in Appendix C-1.

TABLE 4-8
Flow Results, 2013

Sample Event	Sample Date	Estimated Flow (cubic feet per second)			
		BS1	CBD5	CBD1	SSB
April Event	4/30/2013	0	17.6	322	25.9
May Event	5/28/2013	46.6	668	111	144
June Event	6/25/2013	31.4	656	29.2	40.9
July Event	7/30/2013	37.8	678	521	125
August Event	8/27/2013	14.2	1424	1371	597

General Physical Parameter Results – Lab Parameters

Monitoring during 2013 included laboratory analysis of total dissolved solids (TDS), total organic carbon (TOC), and hardness.

TDS Measurements

TDS samples were collected in the field and analyzed in the lab. Figure 4-7 shows the 2013 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 2013 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.

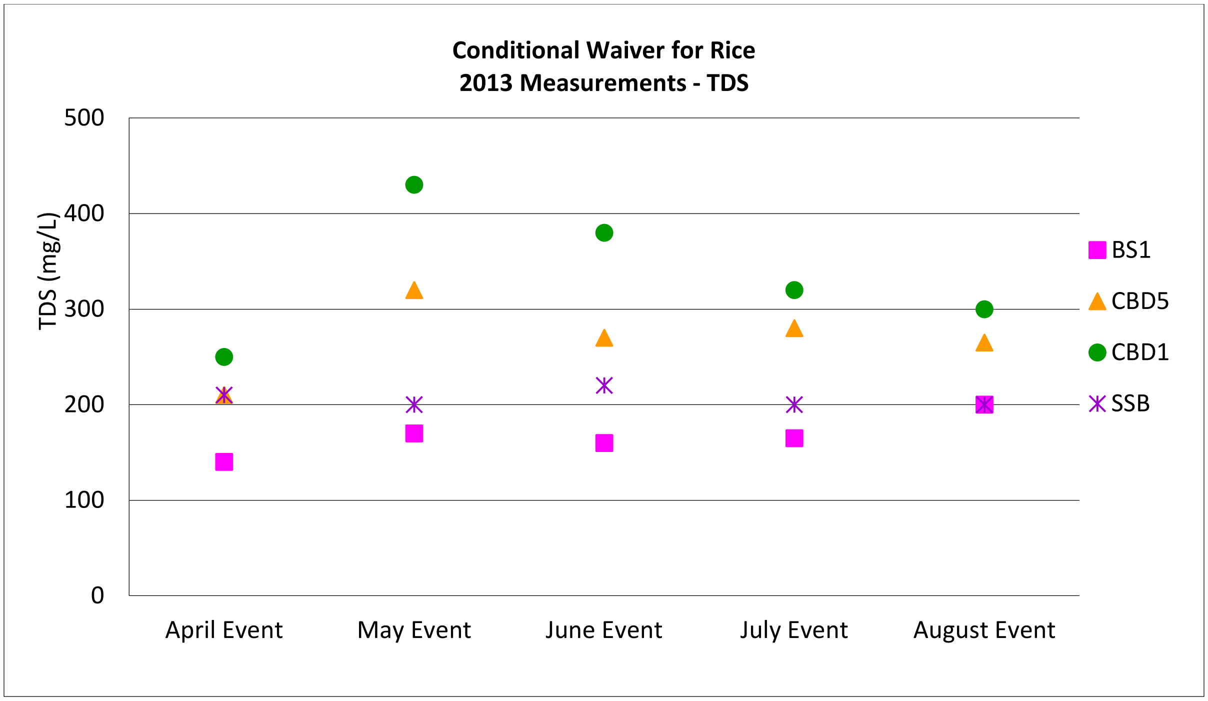


FIGURE 4-7
TDS Results, 2013

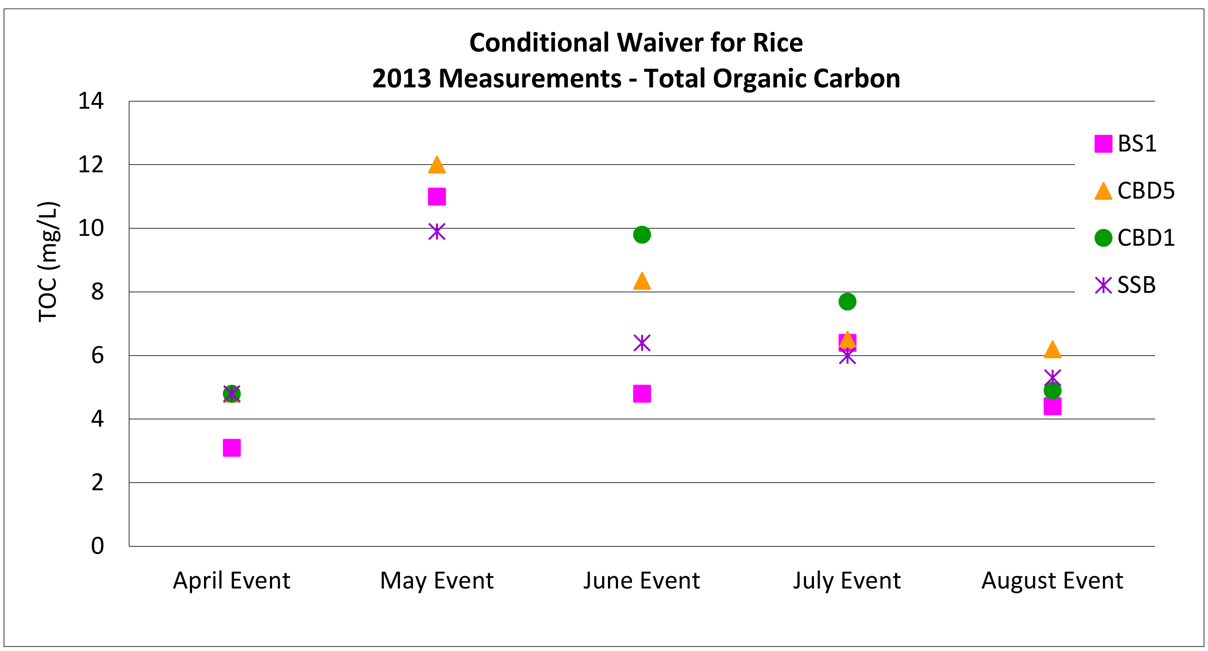


FIGURE 4-8
TOC Results, 2013

TABLE 4-9
TDS Lab Results, 2013

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
April Event	4/30/2013	140	210	250	210	140	203	210	250	2092	46	4
May Event	5/28/2013	170	320	430	200	170	280	260	430	14200	119	4
June Event	6/25/2013	160	270	380	220	160	258	245	380	8692	93	4
July Event	7/30/2013	165	280	320	200	165	241	240	320	5073	71	4
August Event	8/27/2013	200	265	300	200	200	241	233	300	2473	50	4
Site Low		140	210	250	200							
Site Mean		167	269	336	206							
Site Median		165	270	320	200							
Site High		200	320	430	220							
Site Variance		470	1555	4930	80							
Site Standard Deviation		21.7	39.4	70.2	8.9							
N		5	5	5	5							

TABLE 4-10
TOC Lab Results, 2013

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
April Event	4/30/2013	3.1	4.8	4.8	4.8	3.1	4.4	4.8	4.8	1	1	4
May Event	5/28/2013	11.0	12.0	14.5	9.9	9.9	11.9	11.5	14.5	4	2	4
June Event	6/25/2013	4.8	8.4	9.8	6.4	4.8	7.3	7.4	9.8	5	2	4
July Event	7/30/2013	6.4	6.5	7.7	6.0	6.0	6.7	6.5	7.7	1	1	4
August Event	8/27/2013	4.4	6.2	4.9	5.3	4.4	5.2	5.1	6.2	1	1	4
Site Low		3.1	4.8	4.8	4.8							
Site Mean		5.9	7.6	8.3	6.5							
Site Median		4.8	6.5	7.7	6.0							
Site High		11.0	12.0	14.5	9.9							
Site Variance		9	8	16	4							
Site Standard Deviation		3.06	2.78	4.03	2.01							
N		5	5	5	5							

Hardness Analysis

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

TABLE 4-11
Hardness Results, 2013

Sample Event	Sample Date	Hardness as $CaCO_3$ (mg/L)			
		BS1	CBD5	CBD1	SSB
April Event	4/30/2013	100	89	110	130
May Event	5/28/2013	150	130	170	120
June Event	6/25/2013	160	120	200	150
July Event	7/30/2013	160	120	170	130
August Event	8/27/2013	170	130	180	140

Summary of 2013 Exceedance Reports

Exceedance reports were issued after each monitoring event in 2013 (Appendix D). All exceedance reports were issued due to low DO. 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, 2013

Sample Event	Sample Date	Site with Exceedance and DO Reading (mg/L)			
		BS1	CBD5	CBD1	SSB
April Event	4/30/2013	5.57/5.64	ok	ok	ok
May Event	5/28/2013	6.42/6.83	ok	5.59/5.48	6.57/6.51
June Event	6/25/2013	6.18/6.23	ok	4.66/4.59	5.37/5.31
July Event	7/30/2013	6.13/5.98	6.77/6.73	4.84/4.76	4.82/4.71
August Event	8/27/2013	5.66/5.37	ok	6.05/5.72	5.76/5.40

Notes:
Two instruments are used for sampling; results shown as Instrument 1 / Instrument 2.
Blue indicates that the cold water quality standard (7.0 mg/L DO) was exceeded.
Red indicates that the warm water quality standard (5.0 mg/L DO) was exceeded.

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 a 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 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 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 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, and then evaluates the 2013 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 during the 2013 sampling: 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

LCSs 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:

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

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 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, 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 2013, 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, 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 percent recovery
- 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 and 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 2013 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, 2013

Sample Event	Sample Date	QA/QC Sample Type(s)
April Event	4/30/2013	None
May Event	5/28/2013	Field blank at CBD1 Field duplicate at CBD1
June Event	6/25/2013	Field blank at CBD5 Field duplicate at CBD5
July Event	7/30/2013	Field blank at BS1 Field duplicate at BS1
August Event	8/27/2013	Field blanks at CBD5 and SSB Field duplicates at CBD5 and 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 is expected (Table 5-3).

TABLE 5-2
Field Blank Results, 2013

		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	CBD1	ND	ND	ND
June Event	CBD5	0.57j	0.71j	ND
July Event	BS1	ND	ND	ND
August Event	CBD5	ND	ND	ND
	SSB	0.24j	0.82j	ND

Notes:

ND = non-detect above the MRL

j = result is below the MRL

TABLE 5-3
Field Duplicate Results, 2013

	Analyte								
Sample Event	**Total Hardness (MRL = 1.0 mg/L)**			**TOC (MRL = 1.0 mg/L)**			**TDS (MRL = 10 mg/L)**		
	Primary	**Secondary**	**RPD %**	**Primary**	**Secondary**	**RPD %**	**Primary**	**Secondary**	**RPD %**
May Event	180	160	12	15	14	6.9	430	430	0
June Event	160	160	0	8.3	8.4	1.2	260	280	7
July Event	120	120	0	6.4	6.4	0	170	160	6
August Event									
CBD5	170	170	0	5.7	6.7	16	260	270	4
SSB	140	140	0	4.8	5.8	19	190	210	10

Notes: RPD limit is 25%

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) for these analytes (Table 5-4).

TABLE 5-4
Method Blank Results, 2013

Sample Event	Analyte		
	Total Hardness (MRL = 1.0 mg/L)	**TOC (MRL = 1.0 mg/L)**	**TDS (MRL = 10 mg/L)**
April Event	ND	ND	ND
May Event	ND	ND	ND
June Event	ND	ND	ND
July Event	ND	ND	ND
August 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 QAPP limits, however two samples were outside of the limits in 2013. In both cases, the QC sample batch was accepted because the LCS recoveries were within range. Because of this, no corrective actions were taken. The MS/MSD samples identified as out of range included total hardness from the May and June events (both above the QAPP limit/over-recovered).

TABLE 5-5
Laboratory MS/MSD Samples, 2013

Sample Event	Analyte	Spike Level (mg/L)	Matrix Result (mg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
April Event	TOC	10.0	4.77	108	110	80–120	1	25
	Total Hardness	66.4	120	111	NA	80–120	NA	25
May Event	TOC	50.0	12.2	104	109	80–120	3	25
	Total Hardness	66.4	197	114	**121**	80–120	1	25
June Event	TOC	10.0	ND	108	107	80–120	0.7	25
	Total Hardness	66.4	NA	**175**	NA	80–120	NA	25
		66.4	45.1	104	NA	80–120	NA	25

TABLE 5-5
Laboratory MS/MSD Samples, 2013

Sample Event	Analyte	Spike Level (mg/L)	Matrix Result (mg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
July Event	TOC	10.0	6.36	92	90	80–120	1	25
	Total Hardness	66.4	122	92	89	80–120	1	25
	TDS	300	165	85	88	80–120	2	25
August Event	TOC	10.0	5.70	103	105	80–120	0.8	25
		10.0	4.79	105	101	80–120	3	25
	Total Hardness	66.4	166	111	108	80–120	0.8	25
		66.4	139	108	111	80–120	1	25
	TDS	300	263	86	87	80–120	0.2	25
		300	188	89	95	80–120	4	25

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

LCS/LCSD Samples

LCS samples were prepared and analyzed for each sampling event. The recoveries and RPD percentages for most 2013 samples were within the QAPP limits (Table 5-6). One sample was outside of the limits: the TOC spike from April, which had a recovery below the QAPP limit.

TABLE 5-6
LCS, 2013

Sample Event	Analyte	Spike Level (mg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
April Event	TOC	10.0	**79**	84	80–120	6	25
	Total Hardness	66.4	100	NA	80–120	NA	25
May Event	TOC	10.0	96	99	80–120	3	25
	Total Hardness	66.4	110	NA	80–120	NA	25
June Event	TOC	10.0	102	98	80–120	4	25
	Total Hardness	66.4	102	NA	80–120	NA	25
July Event	TOC	10.0	118	120	80–120	2	25
	Total Hardness	66.4	103	96	80–120	7	25
	TDS	300	86	82	80–120	5	25

TABLE 5-6
LCS, 2013

Sample Event	Analyte	Spike Level (mg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
August Event	TOC	10.0	96	95	80–120	0.3	25
	Total Hardness	66.4	109	109	80–120	0.1	25
	TDS	300	87	87	80–120	0.4	25

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

Analysis of Precision

Field duplicate samples were collected during the May, June, July, and August events and 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 2013 season. All the sample sets had acceptable RPD limits for all analytes. MS/MSD results and RPD values are presented in Table 5-5.

LCS samples were prepared and analyzed for every sampling event during the 2013 season. The RPD percentages for all samples were within the acceptable limits. LCS 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 2013 season. The majority of the MS/MSD results were within the QAPP recovery limits (Table 5-5). Two samples had analyte recoveries outside the limits: the duplicate hardness sample from the May event, and the primary hardness sample from the June event. Both samples had recoveries above the QAPP limit. In each case, the QC sample batch was accepted because the LCS recoveries were within range.

LCS samples were prepared and analyzed for every sampling event during the 2013 season. The majority of the LCS results were within the QAPP recovery limits (Table 5-6). The one exception was the primary TOC sample from the April event, which was below QAPP limits. This sample batch was accepted because the MS/MSD recoveries and RPDs were within range.

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 2013, 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 2013, 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 only a handful of QA/QC samples missing. After receipt and review of the CVRWQCB staff review of the 2012 AMR (highlighting the missing QA/QC data), the lab was notified that these samples were required. Therefore, complete QA/QC samples were not included in the April, May, and June event results, but are included with the subsequent event results (July and August).

Lab QC data missing from the April, May, and June events include the following:

- April: LCS/LCSD and MS/MSD samples from TDS, and LCSD and MSD samples from hardness.
- May: LCS/LCSD and MS/MSD samples from TDS, and LCSD samples from hardness.
- June: LCS/LCSD and MS/MSD samples from TDS, and LCSD and MSD samples from hardness.

A few lab QC samples had results out of acceptable ranges (as discussed in previous sections). These included the following:

- April: LCS from TOC, low recovery (batch accepted based on acceptable MS/MSD recovery).
- June: MS from hardness, high recovery (batch accepted based on acceptable LCS recovery; in addition a second MS sample had acceptable results).

A calculation of laboratory completeness based on the QC samples (Table 5-7) yields a result of 84 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, 2013

		Number of QC Samples		
Sample Event	**Analyte**	**Acceptable QC**	**Unacceptable/ Incomplete**	**% Completeness**
April Event	TOC	4	1	
	Total Hardness	3	2	
	TDS	1	4	53.3
May Event	TOC	5	0	
	Total Hardness	4	1	
	TDS	1	4	66.6

TABLE 5-7
Laboratory Completeness, 2013

Sample Event	Analyte	Number of QC Samples: Acceptable QC	Number of QC Samples: Unacceptable/ Incomplete	% Completeness
June Event	TOC	5	0	
	Total Hardness	3	2	
	TDS	1	4	60
July Event	TOC	5	0	
	Total Hardness	5	0	
	TDS	5	0	100
August Event	TOC	7	0	
	Total Hardness	7	0	
	TDS	7	0	140
Overall laboratory completeness		63 (75 required)	18	84

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.
- MS/MSD samples had RPD values within QAPP limits. Two events had analyte recoveries outside QAPP limits; total hardness from the May and June events (both above the QAPP limit/over-recovered).
- LCS samples had RPD values within QAPP limits. One sample was outside of the QAPP recovery limits: the TOC spike from the April event, which had a recovery just below the QAPP limit.
- 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 2013 CWFR are specified in an extension of MRP Order R5-2010-0805 dated 19 Dec 2012.

CWFR monitoring included field assessment of field parameters, including temperature, DO, pH, and EC. Lab analyses were conducted as required for TDS, TOC, and 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 77.7°F.
- **DO:** DO results were lower than in previous years. DO generally trended above the 6 mg/L warm water standard, with a few exceptions. Low DO (less than the warm WQO of 5 mg/L) was observed during the June event at site CBD1, and during the July event at sites CBD1 and SSB. There were several observations outside of the 6.5 to 8.5 mg/L WQO range during 2013: BS1 at the April event; CBD1 at the May event; BS1, CBD1, and SSB at the June event; BS1, CBD1, and SSB at the July event; and BS1, CBD1, and SSB at the August event. CBD5 is the only site that did not drop below 6.5 mg/L during the monitoring season.
- **pH:** No observations were made outside of the 6.5 to 8.5 pH range during the 2013 monitoring season.
- **EC:** One sample had an EC value of greater than 700 µmhos/cm, the CBD1 sample from the May event. All other samples had EC readings below the 700 µmhos/cm threshold for reporting during the 2013 monitoring season.
- **TDS:** TDS samples were collected at all events. TDS was generally highest in May. The maximum observed TDS was 430 mg/L, at CBD1 in May.
- **TOC:** TOC samples were collected at all events. TOC was generally lowest in April and highest in May and June. The maximum observed TOC value was 14.5 mg/L at CBD1 during the May event. All of the samples outside of May and June had TOC values of less than 8.0 mg/L.

Assessment of the 2013 CWFR Program

This year represents the ninth full year of the CWFR program. The key successes and challenges faced during 2013 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, electrical conductivity, and flow) and lab parameters (TOC, TDS, and 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 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 2013, 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, 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 2014

- 2014 monitoring will mirror 2013 monitoring, with a more aggressive monitoring plan scheduled for 2015. Lessons learned in 2013 will ensure that 2014 is a successful monitoring year.

SECTION 7

References

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