RWQCB Staff Review Version

Conditional Waiver for Rice (CWFR) 2012 Annual Monitoring Report

Prepared for

California Rice Commission

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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
CTR	California Toxics Rule
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
LT-ILRP	Long-Term Irrigated Lands Regulatory Program
MAI	McCampbell Analytical, Inc.
MCL	maximum contaminant level
MDL	method detection limit
mg/kg	milligrams per kilogram
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
ng/g	nanogram(s) per gram
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
SSB	Sacramento Slough Bridge

SWAMP	Surface Water Ambient Monitoring Program
TDS	total dissolved solids
TIE	toxicity identification evaluation
TKN	total Kjeldahl nitrogen
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 2012 CWFR are specified in CVRWQCB Order No. R5-2010-0805 (CRC MRP).

This report serves as the 2012 Annual Monitoring Report (AMR) for the CWFR effort, and describes CRC-conducted program activities for the 2012 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.

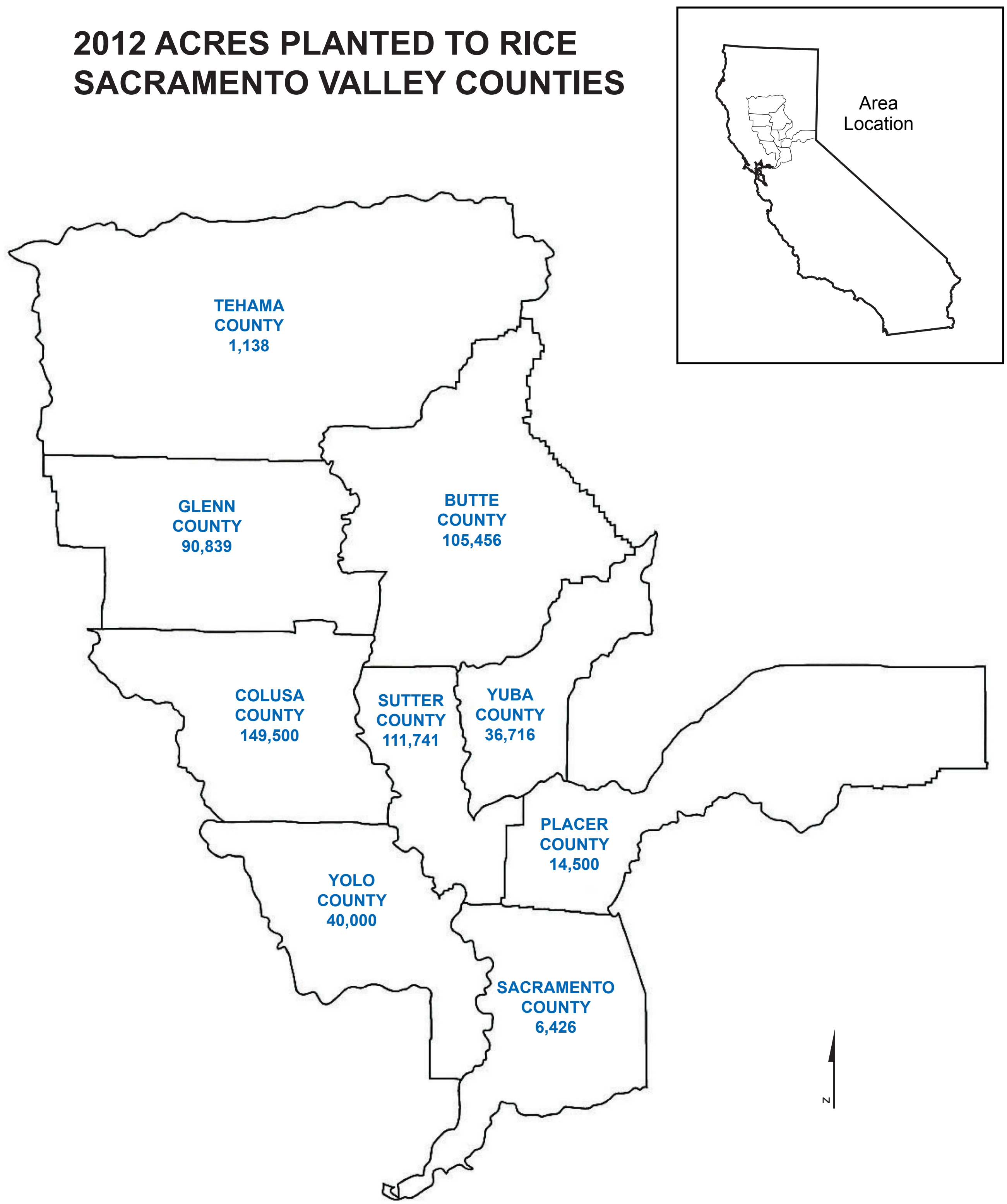
In 2012, an estimated 556,316 acres of rice (as reported by the CACs) were planted in the nine rice-growing counties of the Sacramento Valley. The CAC acreage numbers are usually higher than actual planted acres because of accounting through pesticide applications; multiple applications on single acres 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 2012 RPP AMR.



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

FIGURE 1-1
Sacramento Valley Rice Acres, 2012
CRC 2012 Annual Monitoring Report

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Conditional Waiver of Waste Discharge Requirements for Rice

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* (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 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 the CRC MRP, under Resolution No. R5-2006-0053 as amended by R5-2006-0077.

AMR Requirements

The AMR for the CWFR program is to be submitted by December 31 of 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 A
Tabulated results of analyses	Section 5
Sampling and analytical methods used	Section 4
Copies of chains of custody	Appendixes B and C
Associated laboratory and field quality control sample results	Appendixes B and C
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 B
Laboratory original data	Appendix B
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 B)

SECTION 2

Growing Season, Hydrology, and Applied Materials

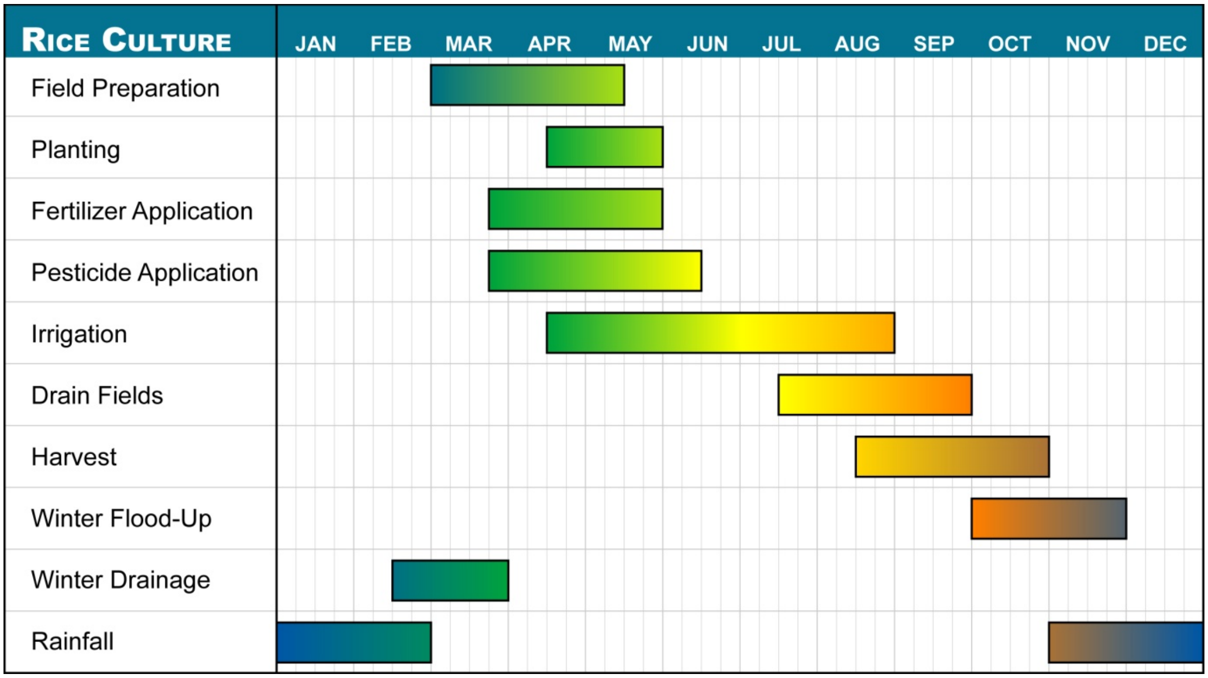
The rice water quality monitoring programs are based on a thorough understanding of how rice is grown in the Sacramento Valley, including key events such as irrigation, drainage, and runoff, and an understanding of when and how products such as pesticides and nutrients are applied. Hydrologic conditions during the year can also influence the timing of key events. This section describes the "typical" Sacramento Valley rice farming calendar and the 2012 rice growing season (including 2012 Sacramento River hydrology), and includes data on the materials applied to rice during the 2012 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. Key events in the rice farming cycle are:

- 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 2012 rice farming year was atypical, with rains and unseasonably cooler weather. Heavy rains extended into April, resulting in delayed field preparation and planting. As a result, peak pesticide use shifted to late May, early June. After planting, rice growth and development was delayed by the cooler weather, and as a result, harvest was delayed until mid-October and extended until mid-to-late-November.

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, 2012, through October 31, 2012. Flow and precipitation data for January through October 2012 are shown in Figure 2-2, and minimum and maximum air temperatures are shown in Figure 2-3.

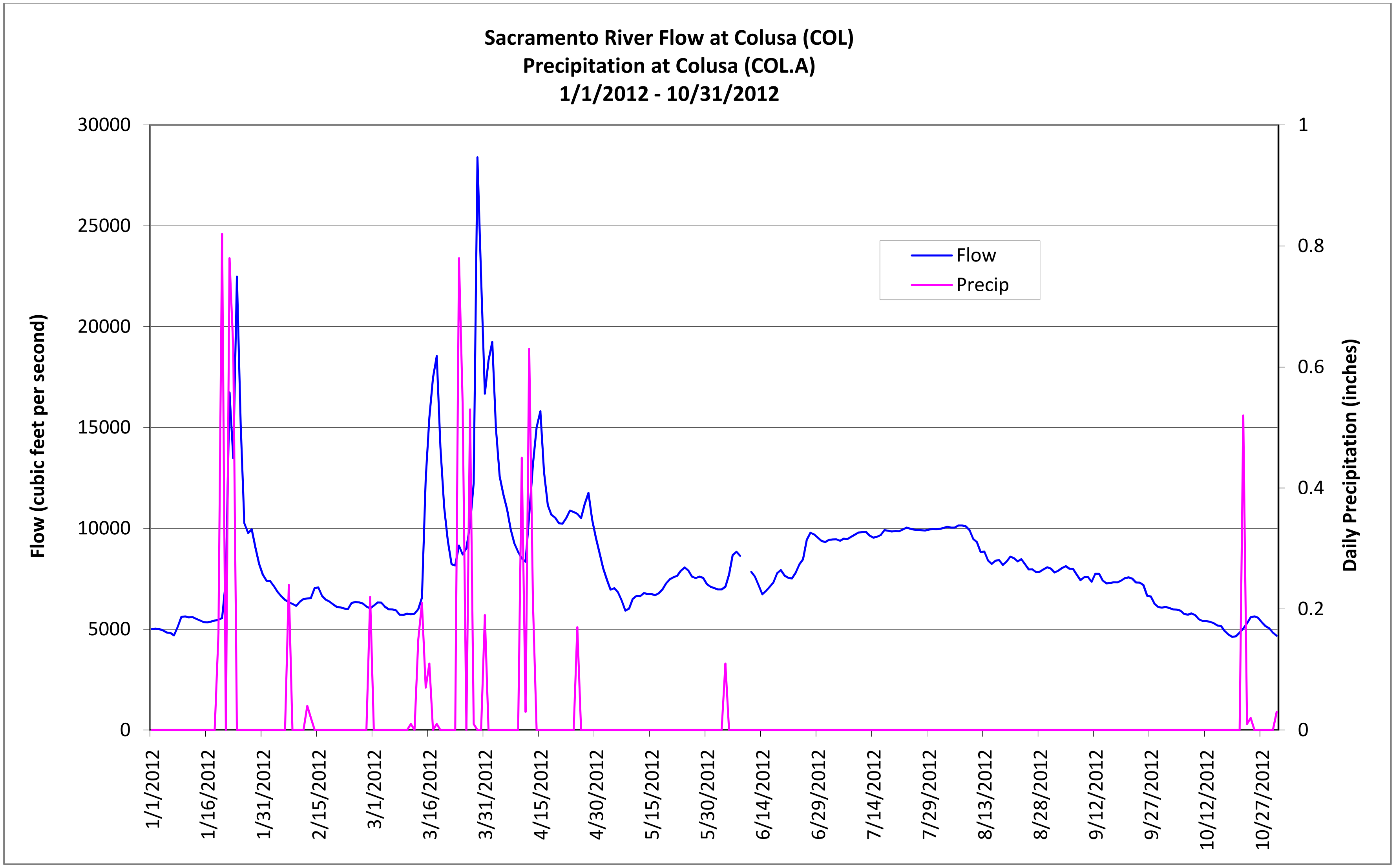


FIGURE 2-2
Flow and Precipitation Data, 2012

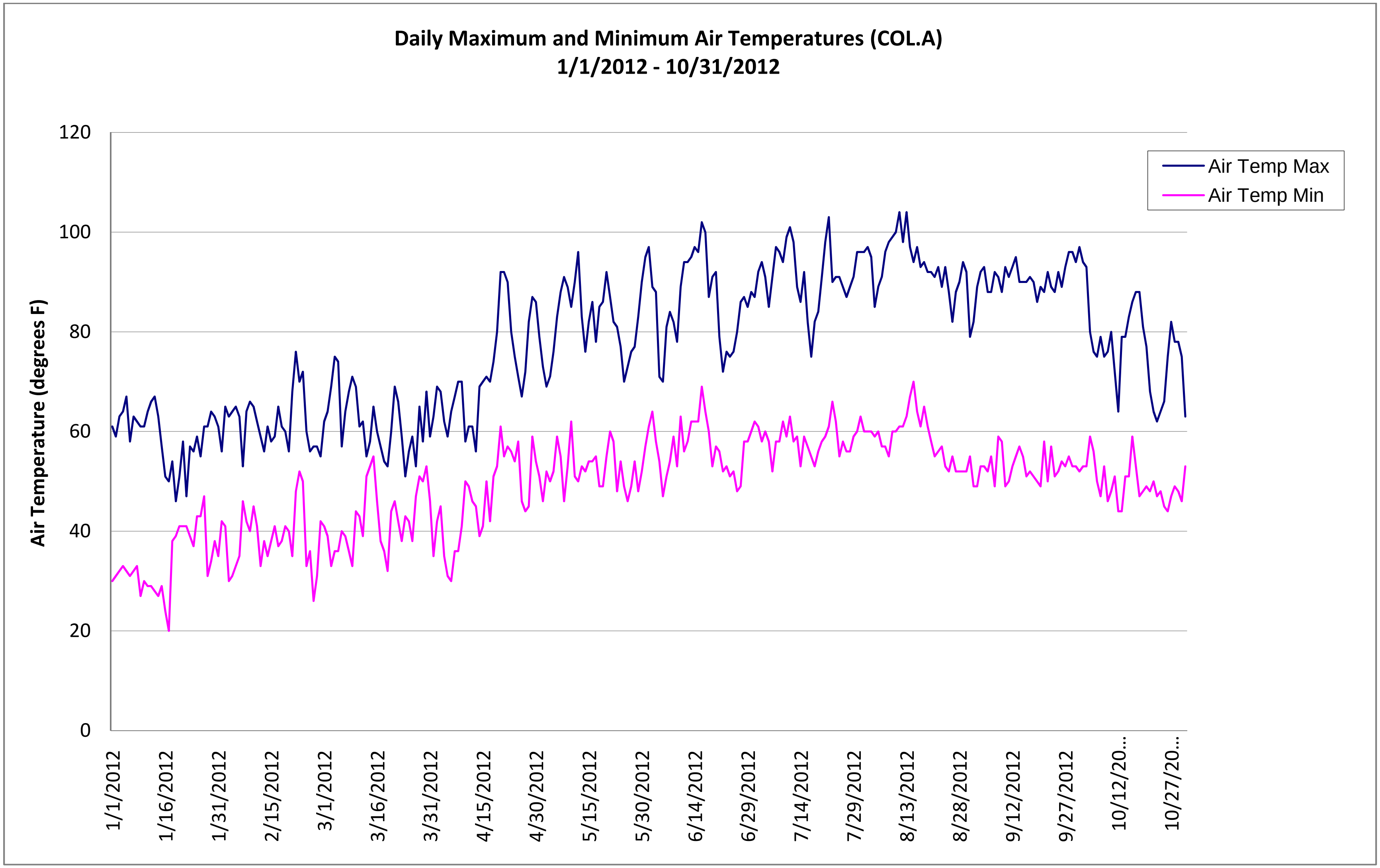


FIGURE 2-3
Daily Maximum and Minimum Air Temperatures, 2012

Applied Materials

Agricultural use of pesticides in California is regulated by DPR. Growers, pesticide applicators, pest control advisors, and pest control operators report pesticide use to 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 2012 were (s)-cypermethrin (+8,387 acres), lambda cyhalothrin (+45,016 acres), propiconazole (+2,790 acres), trifloxystrobin (+2,790 acres), bispyribac-sodium (+14,306 acres), carfentrazone-ethyl (+4,784 acres), clomazone (+141,468 acres), and penoxsulam (+8,944 acres). Thiobencarb is reported separately in the RPP AMR.

The pesticides with acreage decreases in 2012 were diflubenzuron (-668 acres), malathion (-145 acres), azoxystrobin (-26,956 acres), bensulfuron-methyl (-1,301 acres), cyhalofop-butyl (-15, 097 acres), propanil (-39,218 acres), and triclopyr TEA (-29,498 acres).

Treated acreage has a direct correlation to pounds of active ingredient applied. According to the preliminary CAC data, planted acreage in 2012 decreased by 22,965 acres, or nearly 4 percent from 579,281 acres (2011) to 556,316 acres (2012). The treated acreage is an indicator of the challenges rice farmers face with atypical weather conditions.

Tables 2-1 and 2-2 show the preliminary Sacramento Valley rice herbicide data, including acres treated and pounds applied, respectively. Tables 2-3 and 2-4 show the preliminary Sacramento Valley rice insecticide data, including acres treated and pounds applied, respectively. Tables 2-5 and 2-6 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 2-7. 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 2-7.

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

TABLE 2-1
Herbicides: Acres Treated, Sacramento Valley, 2012

County	Acres Treated							
	Bensulfuron-methyl	**Bispyribac-sodium**	**Carfentrazone-ethyl**	**Clomazone**	**Cyhalofop-butyl**	**Penoxsulam**	**Propanil**	**Triclopyr TEA**
Butte	18,866	18,749	2,641	57,691	5,846	20,821	70,584	50,398
Colusa	10,795	30,527	1,570	77,292	19,069	16,239	95,613	94,072
Glenn	5,833	14,178	855	52,707	6,093	10,575	38,240	33,995
Placer	1,220	654	0	6,720	1,232	3,708	11,961	10,659
Sacramento	0	464	0	1,298	2,378	1,309	6,063	3,329
Sutter	9,630	22,280	2,424	78,292	7,560	51,485	90,060	75,089
Tehama	526	0	0	140	526	526	0	0
Yolo	1,119	2,902	0	12,260	5,546	7,910	28,337	28,535
Yuba	5,423	8,237	2,322	27,199	2,486	12,817	23,953	15,599
Total acres	53,412	97,991	9,812	313,599	50,736	125,390	364,811	311,676

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

TABLE 2-2
Herbicides: Pounds Applied, Sacramento Valley, 2012

County	Pounds Applied							
	Bensulfuron-methyl	**Bispyribac-sodium**	**Carfentrazone-ethyl**	**Clomazone**	**Cyhalofop-butyl**	**Penoxsulam**	**Propanil**	**Triclopyr TEA**
Butte	888	591	349	24,498	1,943	746	349,918	7,548
Colusa	526	738	82	31,601	5,834	519	529,107	15,924
Glenn	307	466	160	25,593	2,046	364	212,685	6,037
Placer	48	20	0	2,354	375	135	55,938	1,917
Sacramento	0	11	0	405	1,113	47	31,108	629
Sutter	462	620	364	29,522	2,435	1,777	453,623	13,913
Tehama	20	0	0	56	181	23	0	0
Yolo	54	90	0	5,117	1,821	294	150,586	5,248
Yuba	268	223	437	10,684	813	441	120,528	2,769
Total pounds	2,573	2,759	1,392	129,830	16,561	4,346	1,903,453	53,985

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

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 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 2-3
Insecticides: Acres Treated, Sacramento Valley, 2012

	Acres Treated		
County	**Diflubenzuron**	**(s)-Cypermethrin**	**Lambda Cyhalothrin**
Butte	236	1,981	23,722
Colusa	0	7,020	25,877
Glenn	129	7,879	14,253
Placer	133	380	7,577
Sacramento	0	0	3,606
Sutter	0	7,146	43,233
Tehama	0	326	0
Yolo	0	774	7,228
Yuba	0	2,738	14,166
Total acres	498	28,244	139,663

Note:

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 2012 – start of 2013.

TABLE 2-4
Insecticides: Pounds Applied, Sacramento Valley, 2012

County	Pounds Applied		
	Diflubenzuron	(s)-Cypermethrin	Lambda Cyhalothrin
Butte	37	95	688
Colusa	0	303	821
Glenn	12	377	466
Placer	26	16	213
Sacramento	0	0	110
Sutter	0	309	1,372
Tehama	0	15	0
Yolo	0	26	230
Yuba	0	122	400
Total pounds	**75**	**1,263**	**4,300**

Note:

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 2012 – start of 2013.

TABLE 2-5
Fungicides: Acres Treated, Sacramento Valley, 2012

County	Acres Treated		
	Azoxystrobin	Propiconazole*	Trifloxystrobin*
Butte	69,506	0	0
Colusa	78,085	6,288	6,288
Glenn	3,329	0	0
Placer	4,422	0	0
Sacramento	1,522	739	739
Sutter	35,052	8,953	8,953
Tehama	0	0	0
Yolo	8,125	4,081	4,081
Yuba	7,994	2,518	2,518
Total acres	**208,035**	**22,579**	**22,579**

Note: Data are preliminary and have not been audited or error checked by DPR. Official release is anticipated by the end of 2012 – start of 2013.

TABLE 2-6
Fungicides: Pounds Applied, Sacramento Valley, 2012

	Pounds Applied		
County	**Azoxystrobin**	**Propiconazole***	**Trifloxystrobin***
Butte	11,774	0	0
Colusa	13,304	576	576
Glenn	599	0	0
Placer	800	0	0
Sacramento	200	108	108
Sutter	6,275	1,301	1,301
Tehama	0	0	0
Yolo	1,781	468	468
Yuba	1,549	372	372
Total pounds	36,282	2,825	2,825

Note: Data are preliminary and have not been audited or error checked by DPR. Official release is anticipated by the end of 2012 – start of 2013.

TABLE 2-7
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

Management Practices

Management practices are a key component of the rice water quality programs. Management practices were 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.

Management practices include field-level management of rice pesticides and discharges, CAC enforcement programs, grower education efforts, and communication programs. This section includes the pesticide use calendar, general information on rice water quality management practices, and specific 2012 enforcement data.

Pesticide Use Calendar

Figure 3-1 depicts the rice growth stages and 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 3-1 through 3-4 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.

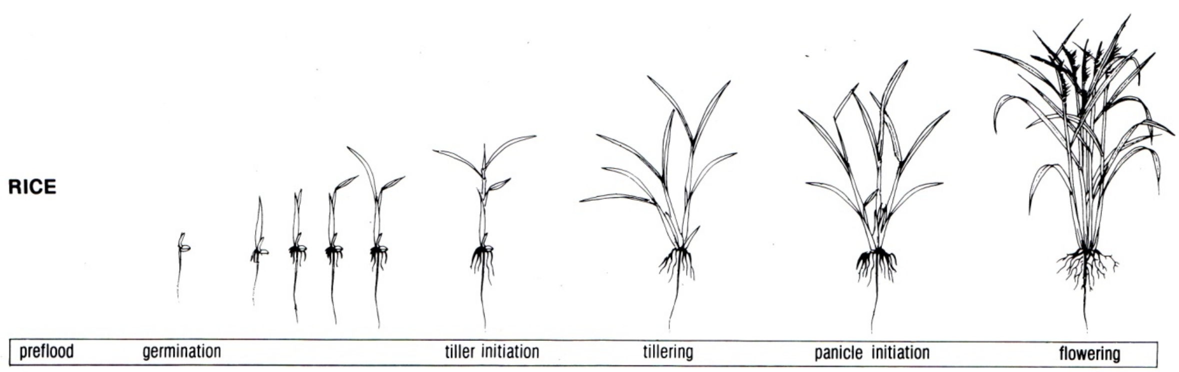


FIGURE 3-1
Rice Growth Stages

TABLE 3-1
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 3-2
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 3-3
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 3-4
Timing of Sequential Rice Herbicide Applications

Early Season (March-April)		**Mid Season (May–June)**		**Late Season (June–July)**	
Pre-Flood	**Germination**	**Tiller Initiation**	**Tillering**	**Panicle Initiation**	**Flowering**
	Bispyribac-sodium, Thiobencarb (Bolero) 30-day water hold Permanent Flood				
		Bispyribac-sodium, Propanil Pinpoint flood			
	Clomazone, Bensulfuron-methyl 14-day water old Permanent flood				
	Clomazone, Bispyribac-sodium 14-day water hold Permanent flood				
	Clomazone, Carfentrazone-ethyl up to 30-day water hold Permanent flood				
	Clomazone, Propanil 14-day water hold Permanent flood				
	Clomazone, Propanil/Triclopyr TEA 20-day water hold				
		Cyhalofop-butyl, Bensulfuron-methyl 7-day water hold Pinpoint flood			
		Cyhalofop-butyl, Bispyribac-sodium 7-day water hold Pinpoint flood			
		Cyhalofop-butyl, Propanil 7-day water hold Pinpoint flood			
		Propanil, Cyhalofop-butyl 7-day water hold Pinpoint flood			
	Carfentrazone-ethyl, Cyhalofop-butyl 30-day water hold, 7-day water hold Pinpoint flood				

SECTION 4

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.

2012 Monitoring

Sites CBD1, CBD5, BS1, and SSB rotated from core to assessment monitoring requirements in 2012 (the third year of the MRP Order). Additional monitoring of nutrients and pesticides was added to the requirements for this season. In addition, 2012 was a toxicity monitoring year, so toxicity monitoring was required at all events, and a sediment toxicity monitoring event was required in September. No special project monitoring was required in 2012. Monitoring requirements for the 2012 monitoring season are detailed in Table 4-1.

TABLE 4-1
Monitoring Sites, Frequency, Schedule, and Parameters as Required by the MRP

Parameter	2012 Requirements
Monitoring Sites	Primary sites: CBD5, BS1, CBD1, and SSB
Constituents	General parameters, pesticides, aquatic toxicity, sediment toxicity, nutrients, dissolved

TABLE 4-1
Monitoring Sites, Frequency, Schedule, and Parameters as Required by the MRP

Parameter	2012 Requirements
Required	copper
Monitoring Period	General parameters, pesticides[1], aquatic toxicity[2]: April to August Dissolved copper: April and May Nutrients: July and August Sediment toxicity[3] and TOC: September
Frequency	Monthly

[1] Pesticides selected for monitoring in 2012 included clomazone and triclopyr.

[2] Water column toxicity testing with *Selenastrum capricornutum, Ceriodaphnia dubia, and Pimelas promelas*

[3] Sediment toxicity testing with *Hyalella azteca.*

Monitoring Sites

Monitoring under the CWFR is conducted at core and assessment sites, as listed in Table 4-2. (Core sites were included in 2012 monitoring requirements. Assessment sites are listed in the table for consistency with past and future reports.) Figure 4-1 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 4-2
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	38.81255	-121.775	171,165	Core
CBD5	Colusa Basin Drain #5	39.18648	-122.045	156,000	Core
BS1	Butte Slough at Lower Pass Road	39.18763	-121.908	183,617	Core
SSB	Sacramento Slough Bridge near Karnak	38.7842	-121.654	24,549	Core
F	Lurline Creek; upstream site of CBD5	39.21838	-122.151	--	Assessment
G	Cherokee Canal; upstream site for BS1	39.362	-121.868	--	Assessment
H	Obanion Outfall at DWR Pumping Plant on Obanion Road	39.02536	-121.728	--	Assessment

Note: LAT/LON coordinates are NAD83 datum.

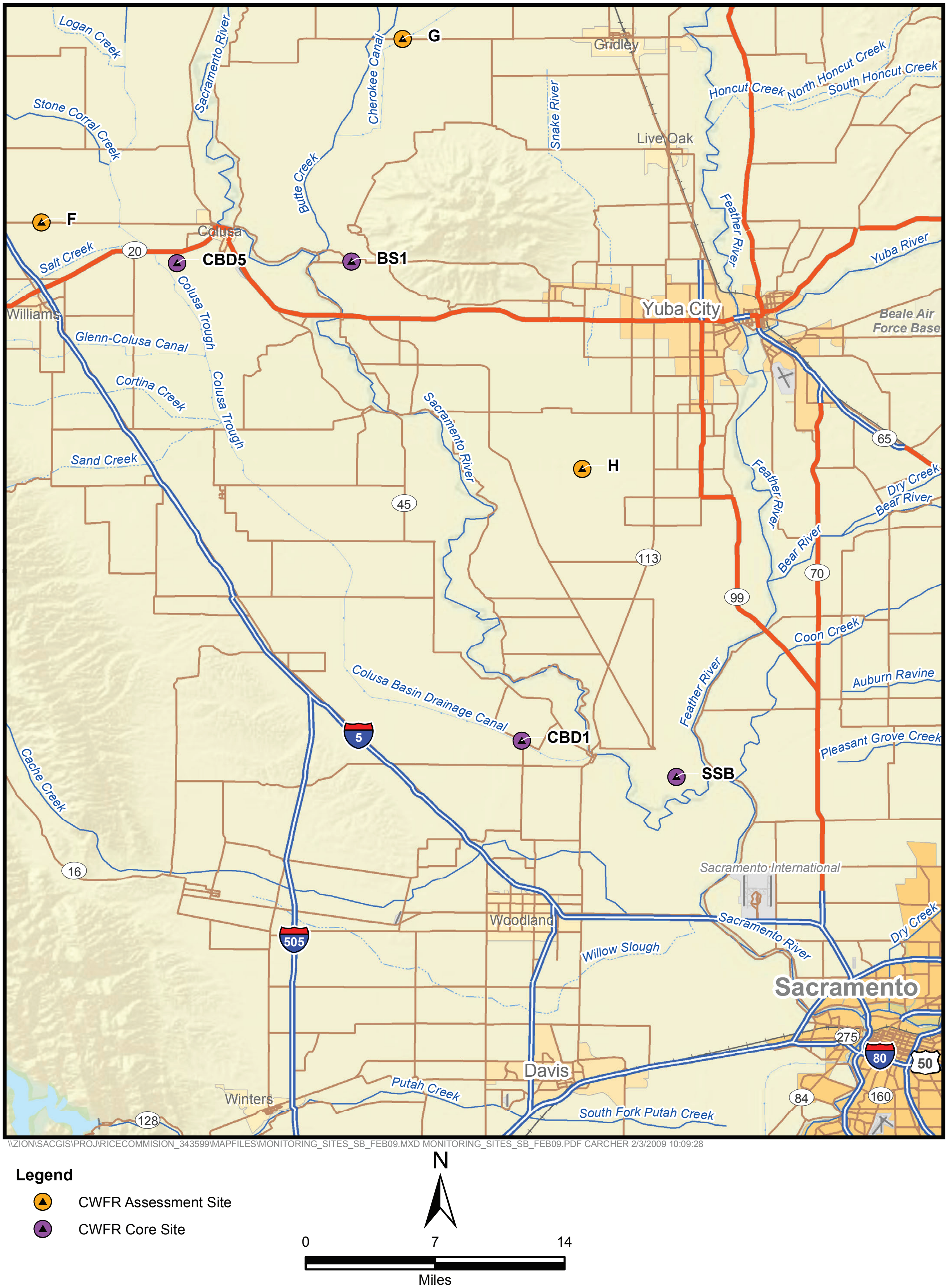


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FIGURE 4-1
Monitoring Sites
CRC 2012 Annual Monitoring Report

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

Schedule and Constituents

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, and therefore the actual start-date of monitoring is established annually to ensure that sampling brackets the actual pesticide use season. In 2012, the April monitoring event was canceled due to atypical weather that delayed planting.

Monitoring Constituents

The MRP specifies the constituents for which monitoring and laboratory analyses are to be conducted. Table 4-3 presents the required constituents and sampling frequency during 2012.

TABLE 4-3
Monitoring Requirements, 2012

Constituent	Units	Sample Type	Irrigation Season Sampling Frequency (May to August)
Flow	cfs	Field[a]	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 dissolved solids (TDS)	mg/L	Grab	Monthly
Total organic carbon (TOC)	mg/L	Grab	Monthly

TABLE 4-3
Monitoring Requirements, 2012

Constituent	Units	Sample Type	Irrigation Season Sampling Frequency (May to August)
Hardness	mg/L	Grab	May and June events
Dissolved copper	µg/L	Grab	May and June events
Nutrients	µg/L and mg/L	Grab	July and August events
Pesticides	µg/L	Grab	Monthly
Aquatic toxicity[b]	% survival / % growth[b]	Grab	Monthly
Sediment toxicity[c]	% survival	Grab	September event
Sediment pesticides	ng/g	Grab	September event as needed; see note c
Sediment TOC	mg/kg	Grab	September event

Notes:
[a] Flow may also be obtained from DWR monitoring stations, where available.
[b] Acute toxicity testing shall be conducted using the invertebrate, *Ceriodaphnia dubia*, and the larval fathead minnow, *Pimephales promelas*, according to standard U.S. Environmental Protection Administration (USEPA) acute toxicity test methods. In addition, to identify toxicity caused by herbicides, 96-hour toxicity tests with the green algae S*elanastrum capricornutum* shall be conducted.
[c] Sediment samples that show statistically significant toxicity to *Hyalella azteca* at the end of an acceptable test, and that exhibit ≥ 20% reduction in organism survival as compared to the control, require pesticide analysis of the same sample to determine the possible cause of toxicity. The sample is to be analyzed for lambda cyhalothrin and s-cypermethrin.

µg/L = micrograms per liter
µmhos/cm = micromhos per centimeter
cfs = cubic feet per second
mg/L = milligrams per liter
NTU = nephelometric turbidity unit
ng/g = nanogram(s) per gram
mg/kg = milligrams per kilogram

2012 Monitoring Calendar

Rice planting was delayed in 2012 because of atypical weather conditions. As a result, the typical April monitoring event was delayed, as sampling at this time would not have characterized pesticide use periods. The first monitoring event was delayed to May to better coincide with the use season. This decision was made in consultation with the CACs, rice growers, Pest Control Advisers, Farm Advisers, and CVRWQCB staff.

Monitoring was conducted May through August, with a September sediment sampling event. The first sample date was May 8, and sampling concluded on September 19. Dissolved copper, which is specified in the MRP for monitoring in April and May, was sampled in May and June to provide for sampling during the copper use period.

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, provided in Table 4-3, 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 B-1.

Turbidity

Turbidity was measured in the field using a turbidity meter.

Grab Samples

A qualified and trained crew of Kleinfelder technicians collected the grab samples for the 2012 monitoring. The water grab samples were collected using a Kemmerer water sampler (either stainless steel and Teflon model or 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 changed in 2012 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 B-1.

Sample Delivery and Analysis

After each sampling event, Kleinfelder submitted the samples under COC to the laboratories. Sample shipments were accompanied by the original COC form, which identified contents. Samples were transported after sample collection to the lab for analysis within the sample holding time. The laboratories performing the analyses and the methods used are listed in Table 4-4.

TABLE 4-4
Analytical Laboratories and Methods

Laboratory	Analytes	Analytical Method(s) Standard Operating Procedures	Notes
California Laboratory Services (CLS) 3249 Fitzgerald Road Rancho Cordova, CA 95742	Total Hardness as Calcium Carbonate ($CaCO_3$)	SM2340B	
	Dissolved Copper	EPA 200.8	
	Total Dissolved Solids (TDS)	SM 2540C	
	Total Organic Carbon (TOC)	SM5310B	
	Clomazone	EPA 8141A	
	Triclopyr TEA	EPA 8151A	
	Un-ionized Ammonia as N	SM4500-NH3F	
	Ammonia as N	SM4500-NH3C	
	Nitrate/Nitrite as N	EPA 300.0	
	Total Phosphorus as P	SM4500-P E	
	Total Kjeldahl Nitrogen (TKN)	SM4500-NH3C	
	Dissolved Orthophosphate as PO_4	SM4500-P E	
McCampbell Analytical 1534 Willow Pass Rd., Pittsburg, CA 94565	Sediment TOC	E9060 Am	McCampbell Analytical is a subcontractor to CLS
AQUA-Science 630 Cantrill Dr. Davis, CA 95618	Fathead minnow acute bioassay	Acute 96-Hour Percent Survival Static non-renewal, static renewal, or LC50 Test (USEPA 821-R-02-012; 5th ed.) SOP #503.3	AQUA-Science performed all aquatic toxicity tests with the exception of the sediment toxicity tests
	C. dubia acute bioassay	Acute 96-Hour Percent Survival Static non-renewal, static renewal, or LC50 Test (USEPA 821-R-02-012; 5th ed.) SOP #503.3	
	Algae chronic bioassay	Chronic Freshwater Algae (S*elanastrum capricornutum)* Static non-renewal Growth Test (USEPA 821-R-02-013; 4th ed.) SOP #510. NO EDTA.	

TABLE 4-4
Analytical Laboratories and Methods

Laboratory	Analytes	Analytical Method(s) Standard Operating Procedures	Notes
Nautilus Environmental San Diego Bioassay Laboratory 4340 Vandever Ave. San Diego, CA 92120	Sediment toxicity – *Hyalella azteca* 10-day bioassay	10-Day Freshwater Sediment Invertebrate (*Hyalella azteca*) Survival Test (based on USEPA 823-B-98-004; USEPA 600-R-99-064). SOP #518	Nautilus Environmental is a subcontractor to AQUA-Science

SOP = standard operating procedure

SECTION 5

2012 Monitoring

Monitoring is conducted under the CWFR according to the MRP. Monitoring at the four core sites included:

- measurement of general physical parameters (temperature, DO, pH, EC, total dissolved solids [TDS], total organic carbon [TOC], turbidity, and flow)
- measurement of dissolved copper and hardness (May and June events only)
- measurement of nutrients (July and August events only)
- analysis of aquatic toxicity
- monitoring of specific pesticides
- measurement of sediment toxicity and sediment TOC (September event only)

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." In 2012, sampling began in May because of late rains that delayed planting and therefore associated application of pesticides and fertilizers. Table 5-1 lists regularly scheduled monitoring; no resampling was required in 2012.

General Physical Parameter Results – Field Parameters

The following field parameters were measured as part of the 2012 sampling effort: temperature, DO, pH, EC, turbidity, and flow.

TABLE 5-1
2012 Sampling Calendar

Month	Sample Date	Field	TDS & TOC	Dissolved Copper & Hardness	Aquatic Toxicity	Pesticides	Nutrients	Sediment Toxicity & TOC
May	5/08/2012	✓	✓	✓	✓	✓	NR	NR
June	6/12/2012	✓	✓	✓	✓	✓	NR	NR
July	7/17/2012	✓	✓	NR	✓	✓	✓	NR
August	8/21/2012	✓	✓	NR	✓	✓	✓	NR
Sept	9/18/2012	NR	NR	NR	NR	NR	NR	✓

Notes:

NR = not required by the MRP

Pesticides monitored in 2012 included clomazone and triclopyr.

Nutrients monitored in 2012 included TKN, nitrate+nitrite as N, total ammonia, unionized ammonia, total phosphorus as P, and soluble orthophosphate.

Temperature Measurements

Temperature measurements were taken during field sampling using a multiprobe instrument. Figure 5-1 shows the 2012 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 June Event, with a high of 78.3°F. As seen in previous years, water temperature in these water bodies essentially tracks 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.

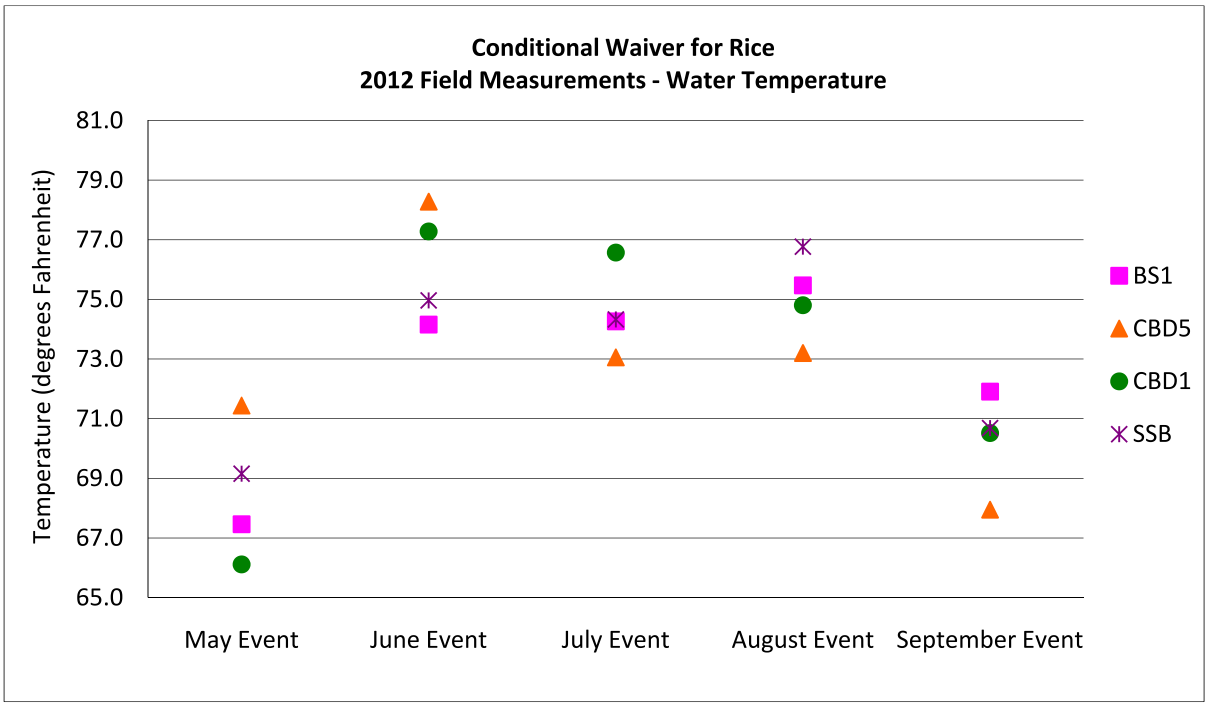


FIGURE 5-1
Field Temperature Measurements, 2012

Table 5-2 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 5-2 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

The multiprobe instrument was used to take field DO measurements. Figure 5-2 shows the 2012 DO measurements. Table 5-3 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 5-3 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.

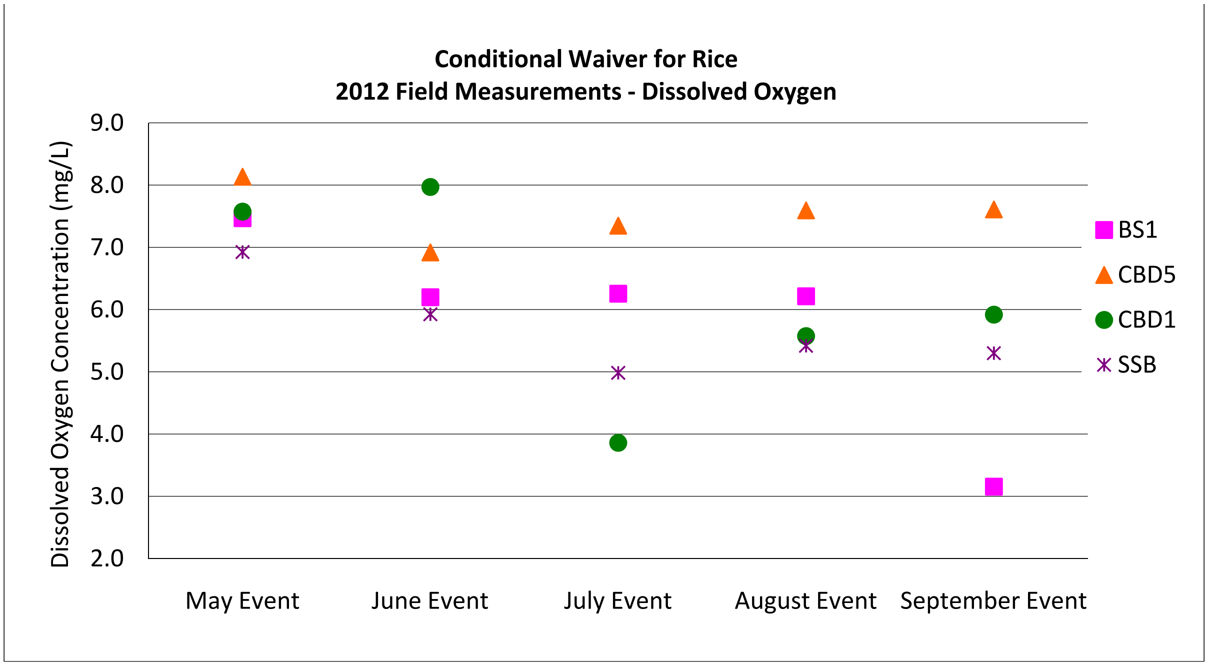


FIGURE 5-2
Dissolved Oxygen Field Measurements, 2012

TABLE 5-2
Field Temperature Measurements, 2012

Sample Event	Sample Date	Temperature (°F) BS1	CBD5	CBD1	SSB	Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
May Event	5/8/2012	67.5	71.4	66.1	69.2	66.1	68.5	68.3	71.4	5.3	2.3	4
June Event	6/12/2012	74.2	78.3	77.3	75.0	74.2	76.2	76.1	78.3	3.7	1.9	4
July Event	7/17/2012	74.3	73.1	76.6	74.3	73.1	74.6	74.3	76.6	2.1	1.5	4
August Event	8/21/2012	75.5	73.2	74.8	76.8	73.2	75.1	75.1	76.8	2.2	1.5	4
September Event	9/18/2012	71.9	67.9	70.5	70.7	67.9	70.3	70.6	71.9	2.8	1.7	4
Site Low		67.5	71.4	66.1	69.2							
Site Mean		72.7	74.0	73.7	73.8							
Site Median		74.2	73.1	75.7	74.6							
Site High		75.5	78.3	77.3	76.8							
Site Variance		10.1	8.8	26.6	10.7							
Site Standard Deviation		3.2	3.0	5.2	3.3							
N		5	5	5	5							
Number of obs. Temp >68°F		4	4	4	5							
Number of obs. Temp <68°F		1	0	1	0							
Percent of obs. where Temp >68°F		80%	80%	80%	100%							
Percent of obs. where temp <68°F		20%	20%	20%	0%							

TABLE 5-3
Dissolved Oxygen Field Measurements, 2012

		Dissolved Oxygen Concentration (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**													
May Event	5/8/2012	7.47	8.14	7.58	6.93	6.93	7.53	7.52	8.14	0.25	0.50	4	1	0	0	25%	0%	0%
June Event	6/12/2012	6.20	6.92	7.97	5.93	5.93	6.75	6.56	7.97	0.83	0.91	4	3	1	0	75%	25%	0%
July Event	7/17/2012	6.26	7.35	3.86	4.99	3.86	5.61	5.62	7.35	2.30	1.52	4	3	2	2	75%	50%	50%
August Event	8/21/2012	6.22	7.60	5.58	5.42	5.42	6.20	5.90	7.60	0.98	0.99	4	3	2	0	75%	50%	0%
September Event	9/18/2012	3.16	7.61	5.92	5.30	3.16	5.50	5.61	7.61	3.39	1.84	4	3	3	1	75%	75%	25%
Site Low		3.16	6.92	3.86	4.99													
Site Mean		5.86	7.52	6.18	5.71													
Site Median		6.22	7.60	5.92	5.42													
Site High		7.47	8.14	7.97	6.93													
Site Variance		2.58	0.20	2.74	0.58													
Site Standard Deviation		1.61	0.44	1.66	0.76													
N		5	5	5	5													
Number of obs. DO<7		4	1	3	5													
Number of obs. DO<6		1	0	3	4													
Number of obs. DO<5		1	0	1	1													
Percent of obs. DO<7		80%	20%	60%	100%													
Percent of obs. DO<6		20%	0%	60%	80%													
Percent of obs. DO<5		20%	0%	20%	20%													

DO values of less than 6 mg/L were observed at CBD1 and SSB (Table 5-3). These observations occurred in June (SSB only), July (both CBD1 and SSB), and August (both CBD1 and SSB). Both CBD1 and SSB also had DO readings of less than 5 mg/L at one event during the season (July). These results are consistent with prior observations at CBD1, which has historically had low DO throughout the summer months. SSB historically has not had low DO during any of the sampling events.

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 5-3 shows oxygen solubility as a function of temperature. Oxygen solubilities on the graph are approximate because additional factors, such as salinity, influence oxygen solubility.

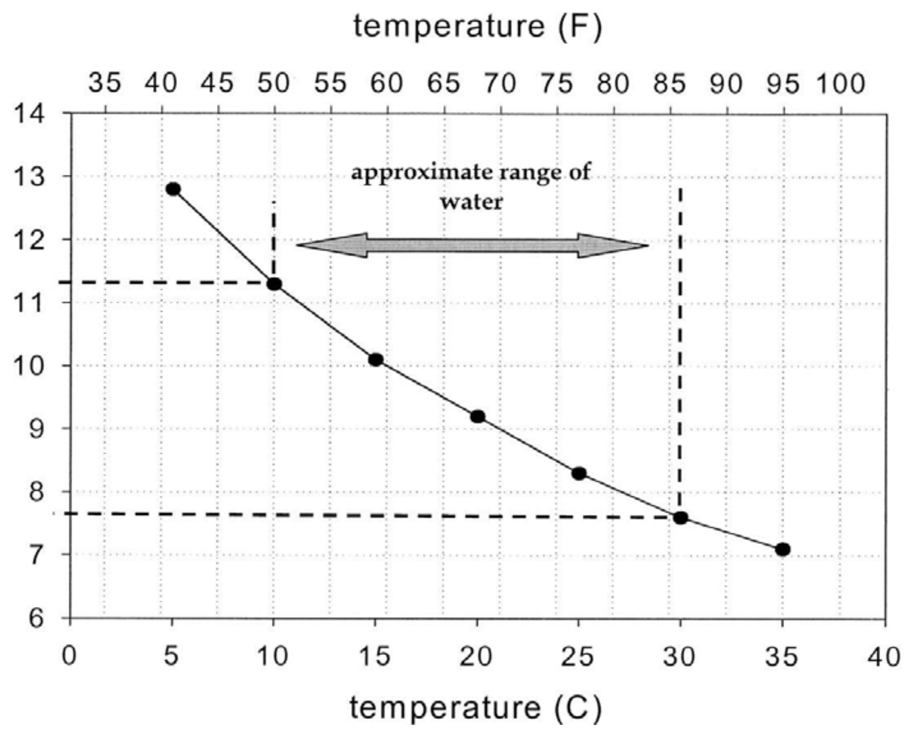


FIGURE 5-3
Oxygen Solubility as a Function of Temperature

pH Measurements

The multiprobe instrument was used in the field to measure pH. Figure 5-4 shows the 2012 pH measurements. Table 5-4 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 5-4 also includes an evaluation of the number of times the observed field pH was less than 6.5 or greater than 8.5 (WQOs). There were no observations that fell outside the 6.5 to 8.5 pH range in 2012.

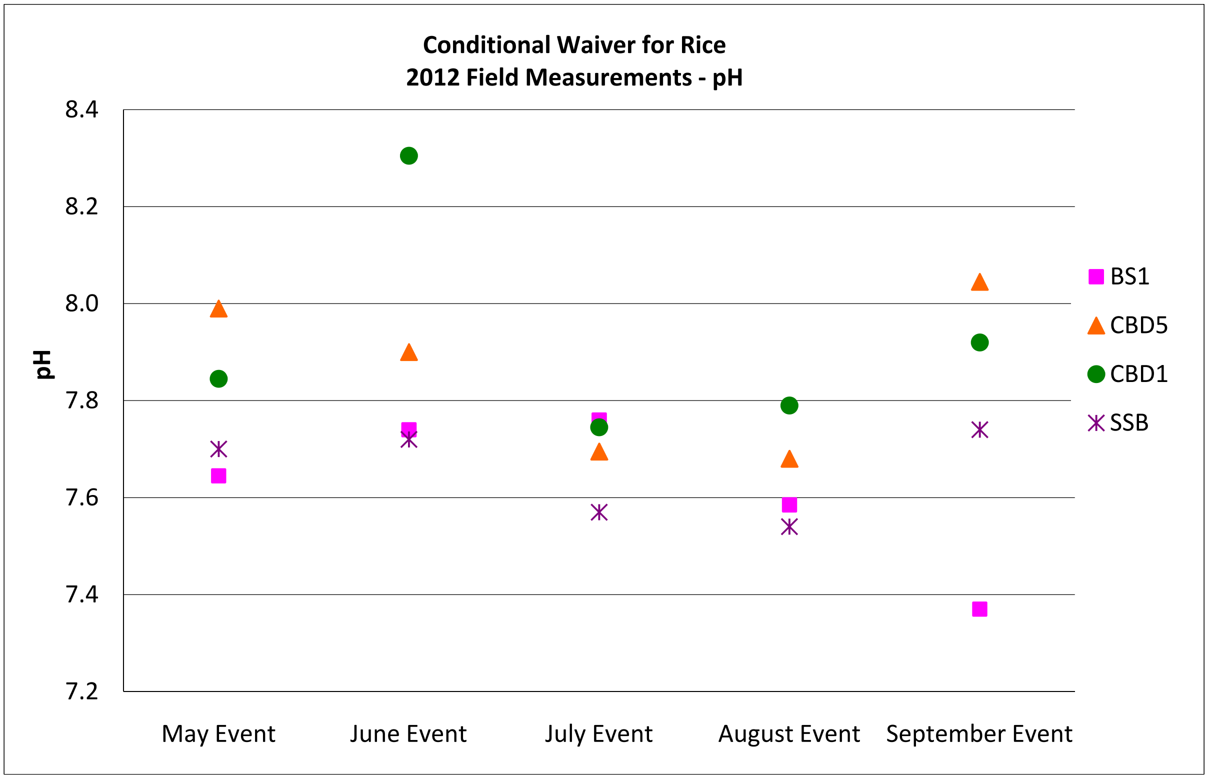


FIGURE 5-4
pH Field Measurements, 2012

TABLE 5-4
pH Field Measurements, 2012

Sample Event	Sample Date	pH BS1	pH CBD5	pH CBD1	pH SSB	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
May Event	5/8/2012	7.65	7.99	7.85	7.70	7.65	7.80	7.77	7.99	0.02	0.15	4	0	0	0%	0%
June Event	6/12/2012	7.74	7.90	8.31	7.72	7.72	7.92	7.82	8.31	0.07	0.27	4	0	0	0%	0%
July Event	7/17/2012	7.76	7.70	7.75	7.57	7.57	7.69	7.72	7.76	0.01	0.09	4	0	0	0%	0%
August Event	8/21/2012	7.68	7.68	7.79	7.54	7.54	7.65	7.63	7.79	0.01	0.11	4	0	0	0%	0%
September Event	9/18/2012	7.37	8.05	7.92	7.74	7.37	7.77	7.83	8.05	0.09	0.29	4	0	0	0%	0%
Site Low		7.37	7.68	7.75	7.54											
Site Mean		7.62	7.86	7.92	7.63											
Site Median		7.65	7.90	7.82	7.64											
Site High		7.76	8.05	8.31	7.72											
Site Variance		0.02	0.03	0.05	0.01											
Site Standard Deviation		0.016	0.17	0.22	0.09											
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

The multiprobe instrument was used to take field EC measurements. Figure 5-5 shows the 2012 EC measurements. Table 5-5 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 5-5 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.

All samples had EC readings below 700 µmhos/cm during the 2012 sampling season.

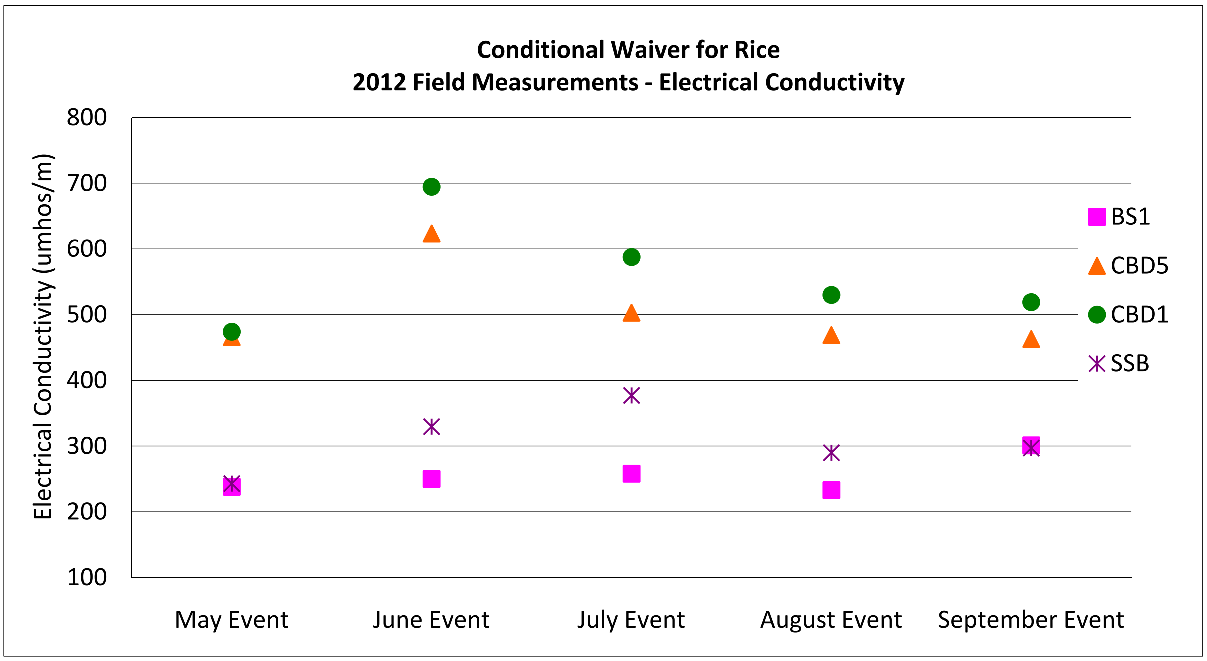
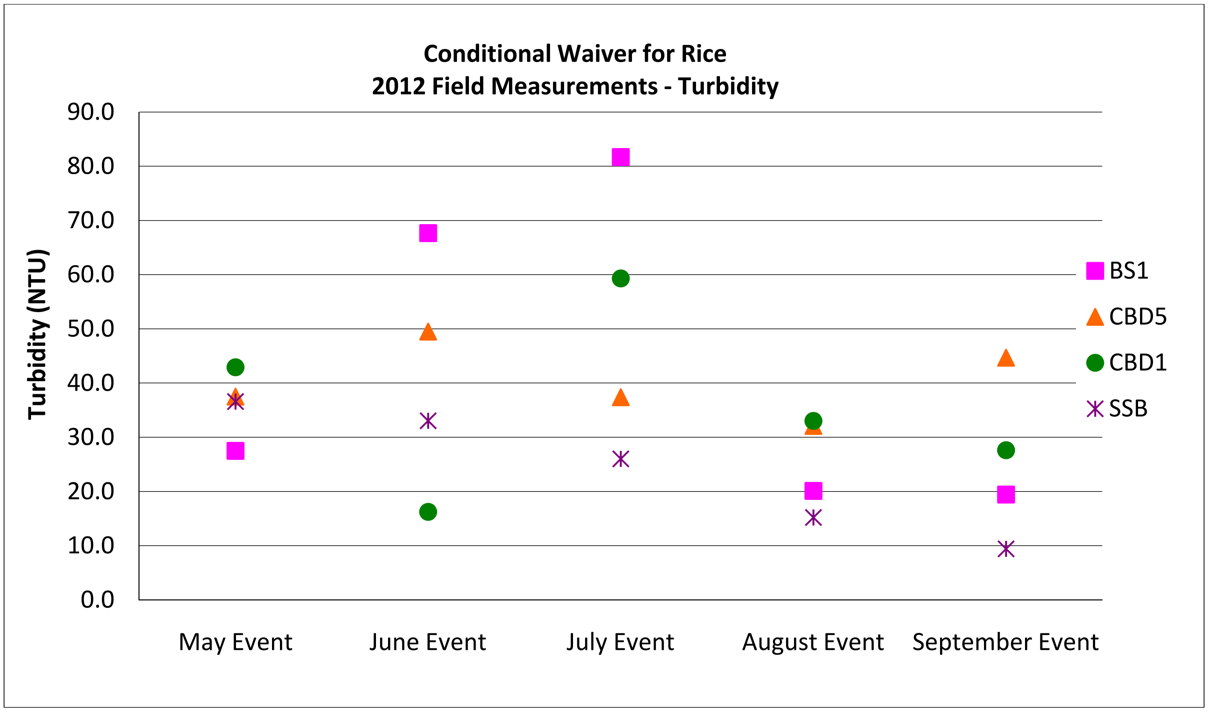


FIGURE 5-5
Electrical Conductivity Field Measurements, 2012

Turbidity

Turbidity measurements are taken in the field using the multiprobe instrument. Figure 5-6 shows the 2012 turbidity measurements. Table 5-6 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.



Note: NTU = nephelometric turbidity unit

FIGURE 5-6
Turbidity Field Measurements, 2012

TABLE 5-5
Electrical Conductivity Field Measurements, 2012

Sample Event	Sample Date	Electrical Conductivity (µS/cm)				Event Low	Event Mean	Event Median	Event High	Event Variance	Event Std. Deviation	N	Number of obs. EC>700	Percent of obs. EC>700
		BS1	CBD5	CBD1	SSB									
May Event	5/8/2012	238	466	474	243	238	355	355	474	17572	133	4	0	0%
June Event	6/12/2012	250	624	695	330	250	474	477	695	47342	218	4	0	0%
July Event	7/17/2012	258	503	588	377	258	431	440	588	20840	144	4	0	0%
August Event	8/21/2012	233	469	530	290	233	381	380	530	20043	142	4	0	0%
September Event	9/18/2012	301	463	519	297	297	395	382	519	12813	113	4	0	0%
Site Low		233	463	474	243									
Site Mean		256	505	561	307									
Site Median		250	469	530	297									
Site High		301	624	695	377									
Site Variance		730	4657	7205	2473									
Site Std. Deviation		27.0	68.2	84.9	49.7									
N		5	5	5	5									
Number of obs. EC>700		0	0	0	0									
Percent of obs. EC>700		0%	0%	0%	0%									

µS/cm = microSiemens per centimeter

TABLE 5-6
Turbidity Field Results, 2012

Sample Event	Sample Date	Turbidity (NTU)				Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
		BS1	CBD5	CBD1	SSB							
May Event	5/8/2012	27.5	37.5	42.9	36.6	27.5	36.1	37.1	42.9	40.8	6.4	4
June Event	6/12/2012	67.7	49.5	16.3	33.0	16.3	41.6	41.3	67.7	486.0	22.0	4
July Event	7/17/2012	81.7	37.4	59.3	26.0	26.0	51.1	48.4	81.7	607.1	24.6	4
August Event	8/21/2012	20.1	32.1	33.0	15.20	15.2	25.1	26.1	33.0	78.1	8.8	4
September Event	9/18/2012	19.4	44.7	27.6	9.4	9.4	25.3	23.5	44.7	222.6	14.9	4
Site Low		19.4	32.1	16.3	9.4							
Site Mean		43.3	40.2	35.8	24.1							
Site Median		47.6	37.5	38.0	29.5							
Site High		81.7	49.5	59.3	36.6							
Site Variance		905.0	54.2	325.2	89.0							
Site Standard Deviation		30.1	7.4	18.0	9.4							
N		4	4	4	4							

Flow Measurements

Table 5-7 contains the estimation of flow from the flow measurements collected during the 2012 monitoring season. Flow measurements were taken at 10 cross-sections at each CWFR monitoring site. The wetted width of the waterbody 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 20 and 80 percent of the total depth from the water surface, and then averaged. Field measurements were documented on field sheets contained in Appendix B-1.

TABLE 5-7
Flow Results, 2012

Sample Event	Sample Date	Estimated Flow (cubic feet per second)			
		BS1	CBD5	CBD1	SSB
May Event	5/8/2012	31	29	0*	145
June Event	6/12/2012	18	140	0*	75
July Event	7/17/2012	63	543	198	0*
August Event	8/21/2012	47	856	791	195
September Event	9/18/2012	46	1032	748	918

Note:
* Instantaneous flow result, as calculated from field crew measurements, was zero. Field sheets confirm observed low flow condition.

General Physical Parameter Results – Lab Parameters

Monitoring during 2012 included laboratory analysis of TDS, TOC, dissolved copper, and hardness.

TDS Measurements

TDS samples were collected in the field and analyzed in the lab. Figure 5-7 shows the 2012 TDS results. Table 5-8 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 5-8 shows the 2012 TOC results. Table 5-9 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.

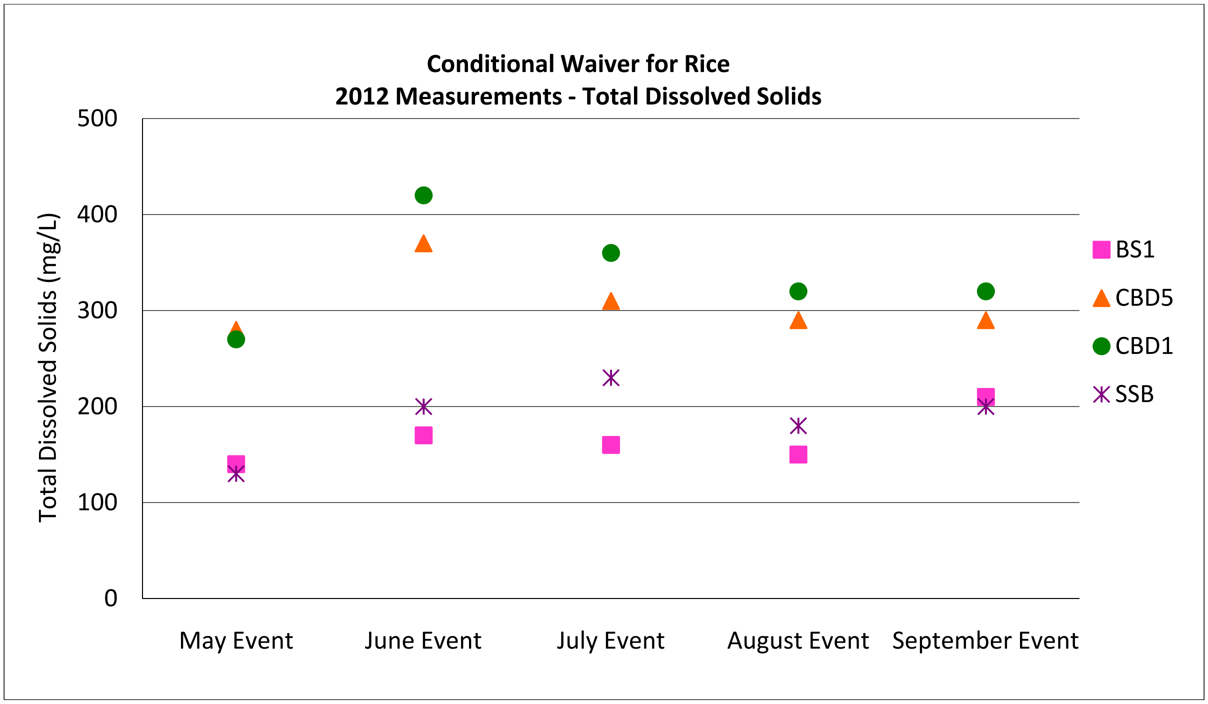


FIGURE 5-7
TDS Results, 2012

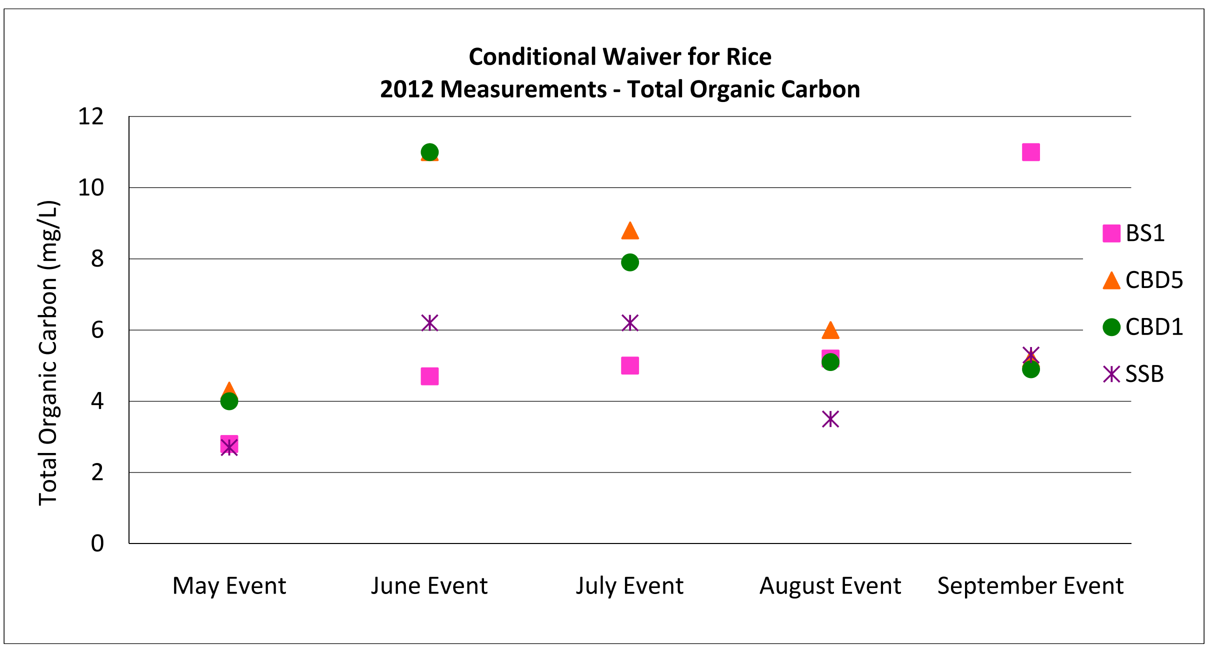


FIGURE 5-8
TOC Results, 2012

TABLE 5-8
TDS Lab Results, 2012

Sample Event	Sample Date	Total Dissolved Solids (mg/L) BS1	CBD5	CBD1	SSB	Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
May Event	5/8/2012	140	280	270	130	130	205	205	280	6567	81	4
June Event	6/12/2012	170	370	420	200	170	290	285	420	15267	124	4
July Event	7/17/2012	160	310	360	230	160	265	270	360	7767	88	4
August Event	8/21/2012	150	290	320	180	150	235	235	320	6833	83	4
September Event	9/18/2012	210	290	320	200	200	255	250	320	3500	59	4
Site Low		140	280	270	130							
Site Mean		166	308	338	188							
Site Median		160	290	320	200							
Site High		210	370	420	230							
Site Variance		730	1320	3120	1370							
Site Standard Deviation		27.0	36.3	55.9	37.0							
N		5	5	5	5							

TABLE 5-9
TOC Lab Results, 2012

Sample Event	Sample Date	Total Organic Carbon (mg/L) BS1	CBD5	CBD1	SSB	Event Low	Event Mean	Event Median	Event High	Event Variance	Event Standard Deviation	N
May Event	5/8/2012	2.8	4.3	4.0	2.7	2.7	3.5	3.4	4.3	1	1	4
June Event	6/12/2012	4.7	11	11	6.2	4.7	8.2	8.6	11.0	11	3	4
July Event	7/17/2012	5.0	8.8	7.9	6.2	5.0	7.0	7.1	8.8	3	2	4
August Event	8/21/2012	5.2	6.0	5.1	3.5	3.5	5.0	5.2	6.0	1	1	4
September Event	9/18/2012	11	5.2	4.9	5.3	4.9	6.6	5.3	11.0	9	3	4
Site Low		2.8	4.3	4.0	2.7							
Site Mean		5.7	7.1	6.6	4.8							
Site Median		5.0	6.0	5.1	5.3							
Site High		11.0	11.0	11.0	6.2							
Site Variance		10	8	8	3							
Site Standard Deviation		3.09	2.77	2.87	1.60							
N		5	5	5	5							

Dissolved Copper and Hardness Analysis

Samples were collected for copper and hardness analysis during the first two events of the season, in accordance with the MRP. The early season monitoring events represent the time of copper application and possible release. Samples were analyzed for copper using U.S. Environmental Protection Agency (USEPA) Method 200.8, and hardness using EPA Method 200.7 and calculation SM2340B. Results are shown in Table 5-10.

The California Toxics Rule (CTR) 1-hour maximum criterion for dissolved copper is:

$$\text{1-hour maximum copper concentration } (\mu g/L) = (e^{0.9422[\ln(\text{hardness})]-1.700}) \times 0.960$$

The CTR 4-day maximum criterion for dissolved copper is:

$$\text{4-day maximum copper concentration } (\mu g/L) = (e^{0.8545[\ln(\text{hardness})]-1.702}) \times 0.960$$

The hardness-adjusted copper criteria, based on the actual hardness measured for the sample location and date, are shown in Table 5-11. All 2012 samples were below the 1-hour and 4-day maximum copper criteria.

TABLE 5-10
Copper and Hardness Results, 2012

Sample Event	Sample Date	Dissolved Copper Concentration (µg/L)				Hardness as $CaCO_3$ (mg/L)			
		BS1	CBD5	CBD1	SSB	BS1	CBD5	CBD1	SSB
May Event	5/8/2012	1.4	2.5	2.2	6.2	87	120	120	88
June Event	6/12/2012	2.8	7.0	6.2	3.6	91	140	160	110

TABLE 5-11
Hardness-adjusted CTR Copper Water Quality Criteria (1-hour and 4-day maximum)

Sample Event	Sample Date	1-Hour Maximum Dissolved Copper Concentration (µg/L)				4-Day Maximum Dissolved Copper Concentration (µg/L)			
		BS1	CBD5	CBD1	SSB	BS1	CBD5	CBD1	SSB
May Event	5/8/2012	11.8	16.0	16.0	11.9	8.0	10.5	10.5	8.0
June Event	6/12/2012	12.3	18.5	20.9	14.7	8.3	11.9	13.4	9.7

Nutrient Monitoring

Water samples from the July and August events were analyzed for nutrients, pursuant to the MRP (Table 5-12).

Nutrient samples were required for the 2012 sampling season to support the UC Davis nutrient monitoring results submitted in 2009. The submitted report had 2 years of field outflow monitoring performed every 1 to 2 weeks. More than 300 samples of field discharge were taken and analyzed for each nutrient parameter. The highest concentrations for nitrate (NO_3-N) and P were found in the winter, when rice fields are generally flooded for rice straw decomposition and become habitat for waterfowl. The maximum nitrate concentration found during this period was 9.52 mg/L, and the average concentration for all samples was 0.12 mg/L for the 2 years studied. Nitrate has a WQO for delivered drinking water municipal and domestic use of 10 mg/L. The high concentration found in 2009 was below this level at discharge from the field. Ammonia (NH_4-N) was reported with a maximum value of 3.61 mg/L and an average of 0.10 mg/L.

In-stream nitrogen results from 2012 were much lower than those reported in the UC Davis study, with a high NO_3-N sample of 0.35 mg/L (350 µg/L), and a high NH_4-N value of 0.35 mg/L.

TABLE 5-12
Nutrient Monitoring Results, 2012

Site	Ammonia as N, Un-ionized (mg/L)	Ammonia as N (mg/L)	Nitrate / Nitrite as N (µg/L)	Total P (mg/L)	TKN (mg/L)	Orthophosphate as PO4, dissolved (mg/L)
	MRL=0.10	MRL=0.10	MRL=400	MRL=0.050	MRL=0.20	MRL=0.15
July Event – 7/17/2012						
BS1	ND <0.10	0.16	120j	0.18	0.59	ND <0.15
CBD5	ND <0.10	0.20	270j	0.16	0.64	ND <0.15
CBD1	ND <0.10	0.22	350j	0.26	0.94	0.28
SSB	ND <0.10	0.18	110j	0.21	0.48	0.26
August Event – 8/21/2012						
BS1	ND <0.10	0.35	98j	0.10	0.38	ND <0.15
CBD5	ND <0.10	0.23	110j	0.13	0.45	ND <0.15
CBD1	ND <0.10	0.21	150j	0.22	0.60	ND <0.15
SSB	ND <0.10	0.14	98j	0.027j	0.32	ND <0.15

Notes: MRL = Method Reporting Limit; j = result is below the MRL

Pesticide Monitoring

Samples were collected on a monthly basis from May through August for pesticide analysis. Two pesticides, clomazone and triclopyr, were selected for monitoring during the 2012 season. Table 5-13 provides additional information about these pesticides. Results of the pesticide analysis are presented in Table 5-14. Complete laboratory results of the pesticide analysis are included in Appendix B-2.

Clomazone was detected in one sample during the May event (CBD5). Peak detections were observed in the peak use month of June, with detectable clomazone observed at all sites; the maximum observed concentration of clomazone, 12 µg/L, is an order of magnitude below the toxicity informal trigger value for this pesticide. July concentrations were below the MRL at three sites (j-flagged data included in Table 5-14), with one observation just above the MRL (BS1). August concentrations were all non-detect.

Triclopyr was not detected during the May or June events. Triclopyr was detected at all four sites during the July event, at concentrations ranging from 2.9 µg/L to 6.4 µg/L. These concentrations are two orders of magnitude below the toxicity informal trigger value for this pesticide. August concentrations were below the MRL (j-flagged) for two sites (CBD1 and CBD5) and non-detect for the other two sites. This, and the levels detected in the samples, indicates that the peak 2012 triclopyr use period was near the July event. The timing of applications in 2012 was later than the typical application timings shown in Table 3-1 because of the late planting dates. Later planting dates resulted in later 2012 pesticide use periods.

The triclopyr samples from May were analyzed approximately 30 hours after the USEPA holding time expired. The initial pesticide samples had insignificant volume to analyze for both USEPA 8141A and USEPA 8151A (clomazone and triclopyr), so the hold sample volume from Kleinfelder cold storage was requested by CLS. The hold samples were picked up the same day the USEPA holding time was expiring, and the extraction for these samples was started approximately 30 hours after the USEPA holding time expired. The results for these samples were all ND; it is not expected that the results would have been different if analyzed within the hold time because of the timing of the samples compared to typical application of triclopyr.

TABLE 5-13
Herbicides Identified for Analysis under the 2012 MRP

Herbicide	USEPA Method	Detection (MRL)	Typical Application Period	Sequential Applicatio n	Water Hold Period	Rice Herbicide?	Used for Other Crops?
Clomazone	USEPA 8141A	0.20 µg/L	April–May	No, 120-day PHI	14 day	Yes	No
Triclopyr	USEPA 8141A	2.0 µg/L	May–June	Yes	20 day	Yes	Yes

TABLE 5-14
Pesticide Monitoring Results, 2012

Sample Event	Sample Date	Clomazone (µg/L)				Triclopyr (µg/L)			
		BS1	CBD5	CBD1	SSB	BS1	CBD5	CBD1	SSB
May Event	5/8/2012	ND	0.85	ND	ND	ND*	ND*	ND*	ND*
June Event	6/12/2012	2.1	5.6	12	2.8	ND	ND	ND	ND
July Event	7/17/2012	0.30	0.17j	0.31	0.74	2.9	4.2	5.2	6.4
August Event	8/21/2012	ND	ND	ND	ND	ND	1.0j	1.6j	ND

*Extraction for these samples was started approximately 30 hours after the USEPA holding time expired, due to a broken sample and a delay in the lab's request of back-up sample. See narrative.

Clomazone MRL = 0.20 µg/L
Triclopyr MRL = 2.0 µg/L
j = result is below the MRL

Aquatic Toxicity Testing

Aquatic toxicity analyses were conducted in accordance with MRP requirements. Acute and chronic aquatic toxicity tests were performed on three test species:

- Fathead minnow (*Pimephales promelas*)
- Water flea (*Ceriodaphnia dubia*)
- Green algae (*Selenastrum capricornutum*)

The aquatic toxicity tests are performed on samples collected at each station, concurrently with tests on control samples. The following discussion explains the methodology used to perform the required test, and then provides details and summary results for each species-specific toxicity test.

Whole Effluent Test Methodology

Whole effluent toxicity (WET) tests, or bioassays, are one approach for evaluating the quality of discharged water and its potential to adversely affect biota in receiving waters. WET tests are laboratory toxicity studies in which standard test species are exposed to field-collected water samples by using standardized protocols, and the resulting toxicity (or absence of toxicity) is observed. Suter et al. (2000) identified strengths and weaknesses of bioassays. Strengths of bioassays include the following:

- Realistic representation of the form and bioavailability of the contaminants
- Effects due to multiple contaminants or contaminants that lack toxicity data may be evaluated
- The spatial distribution of toxicity can be determined by testing multiple locations

Weaknesses of bioassays include the following:

- Test media may be modified by collection and preparation for toxicity testing
- Forms and concentrations of chemicals may be modified by sample collection and processing
- Samples may be unrepresentative
- Most media toxicity tests have short durations and test species may not adequately represent species in the field
- If toxicity is observed, the cause of the toxicity is unknown

These limitations do not negate the considerable advantages of media toxicity testing. The first three limitations can be avoided to a considerable degree by exercising care in the collection and handling of samples and in the conduct of the tests. The fourth limitation requires analysis and interpretation of the results. The fifth limitation requires additional testing to identify which components of the contaminant mixture are responsible, a process called toxicity identification evaluation (TIE) (USEPA, 1998a and 1998b). In the TIE process, the toxic components of a mixture are identified by removing components of a mixture and testing the residue, fractionating the mixture and testing the fractions, or adding components of the mixture to a background medium and testing the artificially contaminated medium.

Control and reference media both should be tested along with the contaminated media. Control media are laboratory media known to be appropriate for the test species. That is, control media support the maximal rates of survival, growth, and reproduction of the test species. The characteristics of control media are usually prescribed in standard test protocols. Reference media are media that come from near the site, and are physically and chemically similar to the test media except that they do not contain the site contaminants. The control tests determine whether the test was conducted properly using healthy organisms. The local reference tests provide the basis for determining how much toxicity the site adds to proximate media. If a separate clean reference is used, it provides the basis for determining whether the differences from controls are due to contaminants or to properties of the media, such as pH.

Standard toxicity tests have been developed for determining the acceptability of aqueous effluents and are widely used in effluent permitting in the United States. These tests are unique in the extent to which they have been validated against biosurvey data (Dickson et al., 1992; Grothe et al., 1996). In numerous studies, the 7-day fathead minnow and *Ceriodaphnia dubia* tests have been found to be predictive of reductions in the species richness of aquatic communities. As a result of this intensive development and validation, these tests are widely used.

In accordance with the MRP Order, acute and chronic toxicity tests were performed on three test species. Tests are performed on samples collected at each station and are performed concurrently with tests on control samples. All toxicity tests performed in 2012 resulted in no statistically significant toxicity.

Fathead Minnow (*Pimephales promelas*)

The MRP includes acute toxicity tests using the test species *Pimephales promelas* to detect toxicity to fish species. This minnow is considered a sensitive test species, and toxicity to *P. promelas* can indicate a water quality concern.

AQUA-Science Laboratories performed the 2012 *P. promelas* toxicity tests; the detailed results of these tests are shown in Table 5-15. There was no statistically significant observed toxicity to fathead minnow, and no resamples were triggered. These results indicate that sampled waters were not toxic to sensitive indicator fish species.

Water Flea (*Ceriodaphnia dubia*)

The MRP includes acute toxicity tests using the test species *Ceriodaphnia dubia* to detect toxicity to invertebrates. *C. dubia* is considered a sensitive test species, and toxicity to *C. dubia* can indicate a water quality concern.

AQUA-Science performed the 2012 *C. dubia* toxicity tests; the detailed results of these tests are shown in Table 5-15. There was no statistically significant observed toxicity to the *C. dubia*, and no resamples were triggered. These results indicate that sampled waters were not toxic to sensitive indicator invertebrates.

TABLE 5-15
Aquatic Toxicity Test Results, 2012

Month	Sample Date	*P. promelas* 96-Hour Percent Survival (% control[a])				*C. dubia* 96-Hour Percent Survival (% control[a])				*Selanastrum* 96-Hour Percent Growth as Compared to Control (% control[a])			
		BS1	CBD5	CBD1	SSB	BS1	CBD5	CBD1	SSB	BS1	CBD5	CBD1	SSB
May	5/8/2012	100	93	95	98	100	100	100	100	128	107	109	125
June	6/12/2012	100	100	100	100	100	100	100	100	135	216	179	154
July	7/17/2012	100	100	100	100	100	100	100	95	255	363	241	208
August	8/21/2012	100	100	98	100	100	100	100	100	473	478	404	319

NOTE:
[a] percent control = (sample absorbance) / (control absorbance) * 100

Green Algae (*Selenastrum capricornutum*)

The MRP includes chronic toxicity tests using the test species *Selenastrum capricornutum* to detect toxicity to aquatic plants. *Selenastrum* is a green algae species and is considered the most sensitive test species. Toxicity to *Selenastrum* can indicate a water quality concern.

Selenastrum toxicity tests were performed by AQUA-Science; the detailed results of the *Selenastrum* toxicity tests are shown in Table 5-15. There was no statistically significant observed toxicity to *Selenastrum*, and no resamples were triggered. These results indicate that sampled waters were not toxic to sensitive indicator aquatic plants.

Comparison of Algae Toxicity with Copper Results

Sampling for copper analyses occurred during the same events as the algae toxicity sampling to assist in assessment of copper relative to algae toxicity. Lab results show that copper was present in all the samples; however, there was no measured algae toxicity during any of the sampling events. This indicated that there does not seem to be a relationship between copper presence/concentration and algae toxicity.

Sediment Toxicity and Total Organic Carbon Testing

The MRP requires sediment toxicity testing using the test species *Hyalella azteca* to detect toxicity to benthic organisms. *Hyalella azteca* is considered a sensitive test species, and toxicity can indicate a sediment quality concern. As required, sediment toxicity tests were performed on assessment site samples collected in late September 2012.

Methods

Sediment samples that show statistically significant toxicity to *Hyalella azteca* and that exhibit a ≥ 20 percent reduction in organism survival compared to the control require pesticide analysis for the same sample to determine a possible cause of toxicity. When sediment samples are collected for toxicity analysis, additional volume sufficient for the recommended chemical and physical analyses must be collected. This additional sample volume must be held in frozen storage until the results of the toxicity analysis are available. If the sample is not toxic to the test species, the additional sample can be discarded.

In addition, all sediment samples for monitoring must be analyzed for TOC. Analysis for TOC is necessary to evaluate the expected magnitude of toxicity to the test species. If the toxicity criterion described above is exceeded, then the additional sample volume also must be analyzed for lambda-cyhalothrin and cypermethrin, the only two pyrethoids used in rice operations. Analysis at practical reporting limits of 1 nanogram per gram (ng/g) on a dry weight basis for each pesticide is required to allow comparison to established lethal concentrations of these chemicals to the test species. This follow-up analysis must begin within 5 business days of receipt of results indicating that the toxicity criterion described above is exceeded.

Results

H. azteca toxicity tests performed on samples collected at the core sites in September showed no statistically significant effects (Table 5-16). In fact, they had better survival than the control in many cases. Because no statistically significant effects were recorded, no resampling or pesticide analysis was required. Levels of TOC in the assessment sediment samples ranged from 5,900 to 7,600 mg/kg, as shown in Table 5-16. This information was not utilized because pesticide testing was not required.

TABLE 5-16
September *H. azteca* Sediment Toxicity Results, 2012

Site	Mean Percent Survival	Percent Survival Compared to Control	TOC (mg/kg)
Control	95	--	--
BS1	97	102	7,600
CBD5	92	97	6,100
CBD1	97	102	6,200
SSB	95	0	5,900

SECTION 6

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 QAPPs were 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
  - Rinse blanks
- Lab QA/QC samples
  - Method blanks
  - Matrix spikes and matrix spike duplicates (MS/MSDs)
  - Laboratory control spikes (LCSs)
  - Surrogate samples

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 2012 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 2012 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.

Rinse Blanks

Rinse blanks were collected for two 2012 sampling events, and analyzed with the environmental samples. Rinse blanks consist of distilled water processed through the sampling equipment using the same procedures used for environmental samples, after decontamination has been performed. Results from these blank samples are examined to ensure that concentrations of constituents of concern are below detection limits. If there are concentrations above the detection limit, then sampling and decontamination procedures will be reevaluated. Results from the rinse blanks represent a total of field and laboratory sources of contamination.

Laboratory QA/QC Samples

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

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

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.

Surrogate Standards

Surrogate standards are samples that have been spiked with an organic compound that is chemically similar to the analyte of interest, but is not expected to occur in the environmental sample. The recovery of the surrogate standard is used to monitor for errors, unusual effects, and other anomalies. Surrogate recovery is evaluated by comparing the measured concentration with the amount added to the sample.

Quality Assurance Objectives

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

Precision

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

The following formula determines the RPD between two samples:

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

Where:

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

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

Accuracy

Accuracy is a determination of how close the measurement is to the true value. Accuracy can be assessed using MS/MSD, LCS, and 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:

- Conventional constituents (TDS, TOC, nutrients) = 80-120%
- Synthetic organic analytes (pesticides) = 50-150%
- Trace metals (Cu) = 75-125%

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 laboratory control spike duplicate (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 2012 sampling events included field blanks and field duplicates. The dates, events, and sites of these samples are shown in Table 6-1. Results for field QA/QC samples are provided below.

TABLE 6-1
Field QA/QC Samples, 2012

Sample Date	Sample Event	QA/QC Sample Type(s)
5/08/2012	May Event	Field Blank at CBD1 Field Duplicate at CBD1
6/12/2012	June Event	Field Blank at CBD5 Field Duplicate at CBD5
7/17/2012	July Event	Field Blank at BS1 Field Duplicate at BS1
8/21/2012	August Event	Field Blank at SSB Field Duplicate at SSB
9/21/2012	September Event	None

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; however, detectable levels of dissolved copper below the MRL were found in the May and June event samples (Table 6-2).

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 was expected (Table 6-3).

TABLE 6-2
Field Blank Results, 2012

		Analyte		
Sample Event	Sample Location	Dissolved Copper (MRL = 0.5 µg/L)	Clomazone (MRL = 0.2 µg/L)	Triclopyr (MRL = 2.0 µg/L)
May Event	CBD1	0.30j	ND	--
June Event	CBD5	0.39j	ND	ND
July Event	BS1	--	ND	ND
August Event	SSB	--	ND	ND

Notes:
ND = non-detect above the MRL
-- = not required during the sampling event
j = result is below the MRL

TABLE 6-3
Field Duplicate Results, 2012

	Analyte					
Sample Event	Dissolved Copper (MRL = 0.5 µg/L)		Clomazone (MRL = 0.2 µg/L)		Triclopyr (MRL = 2.0 µg/L)	
	Primary	Secondary	Primary	Secondary	Primary	Secondary
May Event	2.2	2.3	ND	ND	--	--
June Event	7.0	7.0	5.6	5.8	ND	ND
July Event	--	--	0.31	0.28	2.7	3.0
August Event	--	--	ND	ND	ND	ND

Notes:
ND = non-detect above the MRL
-- = not scheduled during that sampling event

Laboratory QA/QC Samples

The laboratory QA/QC samples included method blanks, matrix spikes, LCSs, and surrogate standard samples; the results for each follow.

Method Blank

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 6-4).

TABLE 6-4
Method Blank Results, 2012

Sample Event	Analyte (MRL)											
	TDS (10 mg/L)	**TOC (1.0 mg/L)**	**Total Hardness (1.0 mg $CaCO_3$/L)**	**Dissolved Copper (0.50 µg/L)**	**Clomazone (0.20 µg/L)**	**Triclopyr (2.0 µg/L)**	**Nitrate /Nitrite as N (400 µg/L)**	**Orthophosphate as PO_4, Dissolved (0.15 mg/L)**	**Total Phosphorus as P (0.050 mg/L)**	**Ammonia as N (0.10 mg/L)**	**Ammonia as N, Unionized (0.10 mg/L)**	**TKN (0.20 mg/L)**
May Event	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--
June Event	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--
July Event	ND	ND	ND	--	ND	ND	ND	ND	ND	ND	ND	ND
August Event	ND	ND	ND	--	ND	ND	ND	ND	ND	ND	ND	ND
September Event	ND	ND	ND	--	--	--	--	--	--	--	--	--

Notes:

-- = not required during the sampling event
ND = non-detect above the MRL

MS/MSD

MS and MSD samples were prepared and analyzed for each sampling event (Table 6-5). Some MS/MSD samples were out of the QAPP range in 2012. In all cases, the QC sample batch was accepted because the LC/LCS recoveries were within range. The reason for out-of-range results was explained by CLS as "due to analyte concentration four times greater than the spike level. When the spike level is insignificant compared to the analyst concentration of the sample (which is used for matrix spike), the spike recovery data is no longer relevant in assessing the sample matrix effect."Because of this, no corrective actions were taken. The MS/MSD samples identified as out of range included:

- Hardness from the May and June events (below the QAPP limits/under-recovered)
- Clomazone from the June event (above the QAPP limit/over-recovered)
- Nitrate/nitrite as N from the July and August events (below the QAPP limits/under-recovered)
- Total phosphorus from the August event (above the QAPP limit/over-recovered)

LCS

LCS samples were prepared and analyzed for each sampling event. The recoveries and RPD percentages for most 2012 samples were within the QAPP limits (Table 6-6). One sample, the TOC sample from the May event, was below the QAPP limits.

TABLE 6-5
Laboratory MS/MSD Samples, 2012

Sample Event	Analyte	Spike Level (µg/L)	Matrix Result (µg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
May Event	TOC	10.0	9.06	82	90	80-120	5	25
	Hardness (MS1)	83.0	124	**68**	NA	80-120	NA	25
	Copper (MS1)	100	16.1	100	NA	75-125	NA	25
	Copper (MS2)	100	2.33	93	NA	75-125	NA	25
	Clomazone	1.25	ND	117	111	50-150	5	25
June Event	Triclopyr	1.74	ND	149	145	50-150	2	25
	Hardness (MS1)	83.0	557	**40**	NA	80-120	NA	25
	TOC	10.0	11.3	100	103	80-120	1	25
	Copper (MS1)	100	7.67	103	103	75-120	0	25
	Copper (MS2)	100	2.76	105	NA	75-120	NA	25
	Clomazone	1.25	5.60	117	**154**	50-150	6	25
July Event	Triclopyr	1.74	2.70	129	106	50-150	9	25
	Nitrate/Nitrite as N	1060	10700	**54**	**64**	80-120	1	25
	Hardness (MS1)	83.0	130	99	NA	80-120	NA	25

TABLE 6-5
Laboratory MS/MSD Samples, 2012

Sample Event	Analyte	Spike Level (µg/L)	Matrix Result (µg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
	Hardness (MS2)	83.0	422	89	NA	80-120	NA	25
	Orthophosphate as PO_4, dissolved	0.918	ND	114	106	80-120	7	25
	Total Phosphorus as P	0.300	0.183	104	107	80-120	1	25
	Ammonia as N	0.500	0.0859	86	87	80-120	1	25
	TOC	10.0	5.03	118	114	80-120	2	25
	TKN	1.00	0.0785	77	77	80-120	0	25
	Clomazone	1.25	0.311	91	86	50-150	4	25
August Event	Orthophosphate as PO_4, dissolved	0.918	1.18	103	97	80-120	3	25
	Nitrate/Nitrite as N	1060	6860	**71**	**64**	80-120	1	25
	Ammonia as N	0.500	0.118	91	91	80-120	0	25
	Total Phosphorus as P	0.300	0.0269	**147**	**146**	80-120	0	25
	TOC	10.0	ND	104	104	80-120	0	25
	Hardness (MS1)	83.0	2.96	89	91	80-120	2	25
	Hardness (MS2)	83.0	69.2	94	NA	80-120	NA	25
	TKN	1.00	0.320	88	87	80-120	0	25
	Clomazone	1.25	ND	97	111	50-150	13	25
September Event	TOC	10.0	ND	106	106	80-120	0	25
	Hardness (MS1)	83.0	172	98	NA	80-120	NA	25
	Hardness (MS2)	83.0	870	81	NA	80-120	NA	25

Note:

ND = non-detect

NA = not applicable

TABLE 6-6
Laboratory Control Spikes (LCS), 2012

Sample Event	Analyte	Spike Level (µg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
May Event	TOC	10.0	**77**	85	80-120	10	25
	Total Hardness	83.0	97	NA	80-120	NA	25
	Copper	100	110	NA	75-125	NA	25
	Clomazone	1.25	98	94	50-150	4	25
	Triclopyr	1.74	88	111	50-150	23	25
June Event	Triclopyr	1.74	126	140	50-150	11	25
	Total Hardness	83.0	98	NA	80-120	NA	25
	TOC	10.0	96	94	80-120	1	25
	Copper	100	107	NA	75-125	NA	25
	Clomazone	1.25	106	105	50-150	1	25
July Event	Triclopyr	1.74	112	114	50-150	2	25
	Nitrate/Nitrite as N	1060	100	100	80-120	0	25
	Total Hardness	83.0	97	NA	80-120	NA	25
	Orthophosphate as PO_4, dissolved	0.918	98	98	80-120	0	25
	Total Phosphorus as P	0.300	102	100	80-120	2	25
	Ammonia as N	0.500	95	97	80-120	2	25
	TOC	10.0	83	84	80-120	1	25
	Ammonia as N, un-ionized	5.00	103	94	80-120	9	25
	TKN	1.00	84	84	80-120	0	25
	Clomazone	1.25	93	99	50-150	6	25
August Event	Orthophosphate as PO_4, dissolved	0.918	108	102	80-120	5	25
	Nitrate/Nitrite as N	1060	94	95	80-120	2	25
	Ammonia as N	0.500	82	81	80-120	1	25
	Total Phosphorus as P	0.300	111	110	80-120	0.5	25
	Ammonia as N, un-ionized	5.00	109	107	80-120	2	25
	TOC	10.0	87	89	80-120	2	25
	Total Hardness	83.0	92	NA	80-120	NA	25

TABLE 6-6
Laboratory Control Spikes (LCS), 2012

Sample Event	Analyte	Spike Level (µg/L)	Spike Recovery (%)	Duplicate Recovery (%)	Recovery Limits	RPD (%)	RPD Limits
	TKN	1.00	89	89	80-120	0	25
	Clomazone	1.25	85	101	50-150	17	25
September Event	TOC	10.0	104	106	80-120	2	25
	Total Hardness	83.0	99	NA	80-120	NA	25

Notes: NA = not applicable

Surrogate Standard

Surrogate standard samples were prepared for analysis with each pesticide (clomazone and triclopyr) sample batch. The laboratory selects surrogates based on similar chemistry. The two surrogates used are not chemicals used on rice. Several surrogate standard results fell outside of the QAPP recovery range (Table 6-7). All of the out of range samples were for method EPA 8151A, and included the SSB sample from May, the CBD5 sample from June, and all samples from August. The August surrogates all showed an over-recovery as compared to the QAPP ranges. Kleinfelder is contacting CLS to determine the cause of the out of range samples from the August event.

TABLE 6-7
Surrogate Standard Sample Results, 2012

Sample Event	Sample Location	Surrogate Recovery Results (%)	
		Surrogate 1 *(USEPA 8141A)* (65-135)*	Surrogate 2 *(USEPA 8151A)* (65-135)*
May Event	CBD1	101	80
	CBD1-Dup	106	NA
	CBD1-FBL	105	NA
	SSB	114	**58**
	BS1	114	116
	CBD5	108	85
June Event	CBD1	84	122
	SSB	85	129
	BS1	89	123
	CBD5	92	**136**
	CBD5-Dup	94	130
	CBD5-FBL	88	122
July Event	CBD1	119	104
	SSB	117	101

TABLE 6-7
Surrogate Standard Sample Results, 2012

		Surrogate Recovery Results (%)	
Sample Event	**Sample Location**	**Surrogate 1 *(USEPA 8141A)* (65-135)***	**Surrogate 2 *(USEPA 8151A)* (65-135)***
	BS1	120	111
	BS1-Dup	116	91
	BS1-FBL	120	90
	CBD5	122	99
August Event	CBD1	101	**148**
	SSB	100	**141**
	SSB-Dup	94	**145**
	SSB-FBL	88	**138**
	BS1	91	**143**
	CBD5	86	**147**

*Control limits

Surrogate 1: EPN (not a chemical used on rice; included in this report only for lab QA/QC purposes)

Surrogate 2: 2,4-DCAA (not a chemical used on rice; included in this report only for lab QA/QC purposes)

FBL = field blank

Dup = duplicate

Analysis of Precision

Field duplicate samples were collected during the first two CWFR events and all propanil events for each matrix 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 6-3.

MS/MSD sample sets were prepared and analyzed for every sampling event during the 2012 season. All the sample sets had acceptable RPD limits for all analytes. MS/MSD results and RPD values are presented in Table 6-5.

LCS samples were prepared and analyzed for every sampling event during the 2012 season. The RPD percentages for all samples were within the acceptable limits. LCS results and RPD values are presented in Table 6-6.

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 6-2.

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 6-4.

MS and MSD samples were prepared and analyzed for every sampling event during the 2012 season. The majority of the MS/MSD results were within the QAPP recovery limits (Table 6-5). Four events had analyte recoveries outside the limits: hardness from the May and June events (below QAPP limit), clomazone from the June event (above QAPP limit, nitrate/nitrite as N from the July and August events (below QAPP limit), and total phosphorus from the August event (above the QAPP limit). In all cases, the QC sample batch was accepted because the LC/LCS recoveries were within range.

LCS samples were prepared and analyzed for every sampling event during the 2012 season. The majority of the LCS results were within the QAPP recovery limits (Table 6-6). The one exception was the TOC sample from the May event, which was below QAPP limits.

Surrogate standard samples were prepared for every pesticide sample batch during the 2012 season. Several surrogate standard results fell outside the QAPP range (Table 6-7). All of the out of range samples were for method EPA 8151A, and included the SSB sample from May, the CBD5 sample from June, and all samples from August.

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. Four events had analyte recoveries outside QAPP limits: hardness from the May and June events, clomazone from the June event, nitrate/nitrite as N from the July and August events, and total phosphorus from the August event.
- LCS samples had RPD values within QAPP limits. One, the TOC sample from the May event, was outside the QAPP recovery limits.
- Several surrogate standard results fell outside QAPP ranges. All were for method USEPA 8151A, and included the SSB sample from May, the CBD5 sample from June, and all samples from August.

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 B-1.

SECTION 7

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 *Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands.* The monitoring and reporting requirements for the 2012 CWFR are specified in the CRC MRP, under Resolution No. R5-2010-0805.

CWFR monitoring included field assessment of field parameters, including temperature, DO, pH, and EC. Lab analyses were conducted as required for TDS, TOC, hardness, dissolved copper, nutrients, pesticides, and toxicity. 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 June monitoring event, with a high of 78.3°F.
- **DO:** DO results were generally consistent with observations in previous years. DO typically trended above the 6 mg/L warm water standard. Low DO (less than the WARM WQO of 5 mg/L) was observed during the July event at sites CBD1 and SSB.
- **pH:** There were no observations outside the 6.5 to 8.5 WQO range during 2012.
- **EC:** There were no samples with an EC greater than the 700 µmhos/cm threshold for reporting.
- **TDS:** TDS samples were collected at all events. TDS was generally highest in June. The maximum observed TDS was 420 mg/L, at CBD1 in June.
- **TOC:** TOC samples were collected at all events. TOC was generally lowest in May and highest in June and September. The maximum observed TOC values were all 11 mg/L; these samples were taken at CBD5 and CBD1 during the June event, and BS1 during the September event. Most other samples had TOC values of less than 8.0 mg/L.
- **Copper and Hardness:** Samples from the first two events were analyzed for hardness and dissolved copper, in accordance with the MRP. The 1-hour and 4-day CTR hardness-adjusted copper criterion also were calculated based on the actual hardness measured for the sample location and date. All the copper samples taken during the 2012 monitoring season fell below the 1-hour and 4-day criteria.
- **Nutrients:** New for 2012 was nutrient monitoring. Samples from July and August were analyzed for ammonia as N, nitrate/nitrite as N, total P, TKN, and orthophosphate as PO_4. The main nutrient of concern based on the UC Davis nutrient results was nitrate (based on the WQO of 10 mg/L). The high result for this sampling was 0.35 mg/L, which is well below the WQO.

- **Pesticides:** Samples were analyzed for clomazone and triclopyr in 2012. Clomazone detects were highest in June, with a maximum concentration of 5.6 μg/L (at CBD5). Triclopyr detects were highest in July, with a maximum concentration of 6.4 μg/L (at SSB).
- **Toxicity**: Aquatic toxicity tests were performed on three indicator species, at four core sites, May through August. The species were Fathead minnow, *Pimephales promelas;* Water flea, *Ceriodaphnia dubia, and* Green algae, *Selenastrum capricornutum.* No statistically significant toxicity was observed for any test species at any site. Sediment toxicity tests were performed for the core sites in September, and no statistically significant toxicity was observed at any site.

Assessment of the 2012 CWFR Program

This year represents the eighth full year of the CWFR program. The key successes and challenges faced during 2012 program implementation are summarized as follows:

- Water quality results as compared to trigger values did not trigger resampling or management plan actions.
- Late rains and unseasonable cool weather resulted in an atypical year for rice production. Late rains delayed planting, and cool weather postponed plant maturity, resulting in a later harvest.
- 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 pesticides), including analysis for dissolved copper and hardness during the first two events, and analysis for nutrients during the middle two events (July and August).
- The CRC continued to implement a Surface Water Ambient Monitoring Program (SWAMP)-compliant electronic data submittal system, including laboratory prepared SWAMP-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 2012, 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.

CWFR Recommendations for 2013

- The CVRWQCB is developing a Long-Term Irrigated Lands Regulatory Program (LT-ILRP), scheduled for Board consideration in 2013. The CRC anticipates a rice-specific MRP under the LT-ILRP. Consideration should be given to the 2004 through 2012 data that have been collected under the CWFR. It is anticipated that a regime of assessment and core monitoring will continue, with constituents and timing based on the information developed under past CWFR monitoring.

- Consideration should be given to reducing the number of months during which pesticide monitoring is required. Peak use is typically restricted to a 1 to 2 month period, and the non-detect results observed in the months prior to and following the peak season have demonstrated low threat to water quality during the non-peak season.

- Close consultation with CVRWQCB staff regarding the program should continue in an effort to refine the program to focus on identified water quality concerns or identified uncertainties and appropriate implementation actions, if warranted.

SECTION 8

References

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