

APPENDIX 1. STAKEHOLDER MEETING MINUTES

APPENDIX 1-A.
YOLO BYPASS WATER QUALITY PLANNING PROJECT
CALFED Grant # WSP01-FP-0073

STAKEHOLDER GROUP MEETING #1
MEETING MINUTES

MEETING DATE: JULY 25, 2003

LOCATION: California Department of Fish and Game
Yolo Wildlife Area Headquarters
45211 County Road 32B (Chiles Road)
Davis, CA 95616

IN ATTENDANCE: Robin Kulakow, Yolo Basin Foundation (YBF)
Dave Feliz, California Department of Fish & Game
Armand Ruby, Larry Walker Associates (LWA)
Chuck Dudley, Dudley Ag
John McNerny, City of Davis
Jan Lowrey, Cache Creek Conservancy
Chris Erichsen, LWA
Christine Engel, City of Woodland
Marianne Kirkland, California Department of Water Resources,
Division of Environmental Services
Casey Walsh Cady, Calif. Department of Food & Ag
Betty Yee, Regional Water Quality Control Board
- Central Valley
Mike Hall, Conaway Ranch

NEXT MEETING: One will be scheduled in a few months.

ACTION ITEMS:

1. Ms. Kirkland asked for a copy of the Tule Canal study by Woodland.
2. LWA will check with DPR on up to date pesticide information
3. Ms. Walsh Cady get updated pesticide use information from her office.
4. Mr. Erichsen will distribute website information on the Sacramento River Basin Plan to participants

INTRODUCTIONS:

Mr. Ruby called the meeting to order and began introductions of attendees. Many people voiced an interest in participating in the project but are on vacation. He circulated a list of interested people and asked that participants add others if necessary. He went over the fact sheet that was distributed to everyone. This project is funded under a grant from the California Bay Delta Authority's Watershed Program (formerly known as CALFED). City of Woodland (City) is grant recipient and Christine Engel is City contact. Casey is the project liaison for CALFED. LWA is a subcontractor to the City. Chuck Dudley is working with LWA to fill in information about farming in the Bypass. The overall goal is to produce a comprehensive plan to improve water quality in the Yolo Bypass (Bypass). The project scope was written a few years ago and is very ambitious. The Bypass is a very complicated system from both a hydrological and water quality standpoint. It makes our job more difficult. It is not an in and out situation like a river. The big goal of today's meeting is to decide on essential parameters for the monitoring. The monitoring is on the critical path in the project. There are two years left on the grant, which must be completed by June 30, 2005. The monitoring portion of the project will last one year. It will start in October. The ideal would be monthly monitoring. Once the monitoring is completed the analysis and planning phase will start.

PROJECT OVERVIEW

Mr. Ruby reviewed the project goal, objectives and approach.

GOAL

The overall goal of the project is production of a comprehensive plan for improvement of water quality within the Yolo Bypass. Such plan will account for the diverse interests in and uses of the Bypass, and will aim to make the best and most reasonable use of funds available for that purpose.

OBJECTIVES

The objectives of the Yolo Bypass Water Quality Planning Project are:

- 1) Identify specific Pollutants of Concern (POCs) currently impacting the beneficial uses of surface waters in the Bypass and downstream Bay-Delta
- 2) Identify effective, implementable controls for the high priority POCs;
- 3) Develop a comprehensive management plan to improve water quality in the Bypass.

APPROACH

- ❑ Form an advisory group of Yolo Bypass stakeholders to participate in a collaborative process of developing the water quality management plan;
- ❑ Compile and evaluate existing water quality, flow, and land use information;
- ❑ Identify the current water quality issues and pollutants of concern (POCs) for the Bypass;
- ❑ Conduct a surface water quality assessment and monitoring program to quantify the POCs and their apparent sources within the Bypass;
- ❑ Assess whether the measured levels of POCs are causing impairment of beneficial uses of the Bypass;
- ❑ Identify and evaluate alternative controls to reduce significant sources of POCs, including where appropriate POTWs (Publicly-Owned Treatment Works), urban runoff, and agriculture;
- ❑ For those POCs for which effective controls appear technically or economically infeasible, investigate the applicability of current water quality objectives for these POCs and suggest site-specific objectives, pollutant trading, or other alternative approaches, as appropriate;
- ❑ Provide public education and obtain public input regarding potential methods for improving water quality in the Bypass, as well reducing loads on the Bay-Delta; and
- ❑ Produce a Water Quality Management Plan report containing a recommended program of implementation to reduce POCs that are degrading beneficial uses of surface waters.

Mr. Ruby briefly covered the agenda and the purpose of the stakeholder group. This is the first meeting of the group. The stakeholder group is essential to the success of the project. It will provide the local knowledge necessary to address the issues of monitoring and planning.

If there are pollutants that are not controllable under current projects, pollutant trading is a possibility. Monetary trades may also be used. A basin plan designates specific beneficial uses that must be maintained. There are not specific ones identified for the Bypass. There are uses defined for the Tule Canal though.

A participant asked why the City of Woodland interested in this project.

Mr. Ruby: The City is subject to increasingly stringent water pollution discharge standards. Very expensive upgrades would be necessary to meet the standards. The City has questions about the reasonableness of these requirements. Dilution is available when the Bypass is flooded. City effluent provides most of the water in Tule Canal. It is considered an effluent-dominated water way. This is a state issue. The City is interested in pursuing a watershed approach to meet

the standards. State permit writers follow their defined priorities. With TMDLs (Total Maximum Daily Loads) the focus is the whole watershed. This project will expand the area of interest to the whole watershed. The watershed is defined as the Bypass for this project even though it is part of a larger watershed. The City is looking for options to meet the standards. Officials from Woodland, Davis and UCD are concerned about the need for significant rate increases to meet the state requirements. They are looking for options that seem reasonable. Some potential options: land disposal/reuse discharge to the Sacramento River north of Sacramento, and use of the Natomas Pipeline to discharge to Sacramento Regional Treatment Plant, although it is probably too late to participate in that project. It is important for the City not to act with a single point of focus. They need to look at the issues in a bigger context.

The main things to accomplish today are to discuss the role of the stakeholder group and discuss an approach to monitoring. The group needs to define parameters for monitoring. That information will provide the basis for the next step in developing a plan. The grant scope calls for quarterly stakeholder meetings. May need to meet every other month since project is compressed from 4 years to 2 years. Stakeholder group will get larger but have similar format to today. Stakeholders are encouraged to communicate with project managers in between meetings. Stakeholders will be asked to review work products. A monitoring plan will be sent out for review first. At the end of the project a report will be produced. The conclusion of the report will provide guidance for the regulatory process. Other issues that will be involved include the ag waiver. Ag monitoring is supposed to start in Jan. 2005. This project will provide information for that process.

The grant scope has funds for a facilitator. Mr. Ruby has spoken with Dave Ceppos but the group can decide if a facilitator is needed and who that will be. It is hard to decide at this stage. A group with the number of participants today is pretty manageable without a facilitator. That issue can remain on the table.

Monitoring Program Planning

LWA works on water quality issues primarily with governmental agencies. They work on surface waters primarily, not on supply. They work on ways to improve discharge quality. There are two paths of discharge from urban areas: storm water and treatment plant effluent.

Chris Erichsen has put together a number of resources for the stakeholder group (handouts were provided).

Water Quality Issues

There are a number of issues that pertain to pollutants of concern (POCs). The NPDES permit outlines the elements of concern:

Chlorine limits, a set of standards for oil, grease, total dissolved sediments, Bis2-ethylhexylphthalate, Lindane, organochlorine pesticides. DDT is still found in environment occasionally. It is called a legacy pollutant. The single largest pollutant in the Sacramento River

is mercury. It is also a legacy pollutant. It was used in gold mining and as a result there is a lot of mercury in the system.

Trihalomethanes are the common pollutants in chlorinated systems. These chlorinated compounds are very toxic.

Several metals have been detected in the City's effluent, including: beryllium, aluminum, iron, selenium

The City is discharging selenium at lower levels than drinking water in Davis.

Boron is also a problem.

Electrical conductivity, dissolved salts: this is a big issue. Reducing electrical conductivity is required to protect salt-sensitive crops. Reverse osmosis is a treatment of last resort. Dissolved solids are not easy to treat. They don't settle out. Reverse osmosis is very expensive to install and operate. Could increase rates at least 10 times. It is very energy intensive and brine disposal is required after treatment.

There is a question about how real is the need for low conductivity water for ag (no strawberries are grown in the Bypass, and it is unlikely there ever will be any).

Levels of Coliform bacteria are used as an indicator of the effectiveness of chlorination systems. It is not a pathogen itself.

Standards have gotten much lower recently for several reasons. Monitoring can detect POCs at lower levels. Treatment plants can't always treat to such low levels.

Ms. Kirkland asked for a copy of the Tule Canal study by Woodland.

Mr. Ruby can send out Tule Canal permit elements if anyone is interested.

Ms. Walsh Cady asked if the list of water quality issues for Bypass goes beyond the list reviewed today. She also asked if a beneficial use designation can be changed.

According to Mr. Ruby and Ms. Yee, they can be changed but it doesn't happen often. Must do a beneficial use attainability analysis before any changes can be made. This is not a simple process. The State is interested in improving this process.

Mr. Ruby reviewed a table of beneficial uses for the Tule Canal. The Bypass is item 52 in the review document. The state defines the beneficial uses of Tule Canal as contact recreation (swimming) and agriculture production (crops that are sold unprocessed to community), among others. MUN stands for municipal use. MUN may apply even though it is not listed for the Bypass. Down stream of the Bypass, the Delta is designated MUN. Drinking water protection is

an issue for CALFED. There is a Drinking Water program at the State. Betty was asked to track this issue for the group.

Ag uses of water include irrigation and stock water.

E = existing

P = potential

There is no industrial use since the Yolo Bypass is a floodway. Nothing permanent can be constructed.

Jones and Stokes Associates completed a recreation study of the Tule Canal in 2001. They included swimming, wading, fishing in the study. There was a question as to whether water testing is required for swimming. According to Mr. Ruby, Title 22 infers that beaches should be tested but not rivers. Local ordinances can require testing of water for swimming. Mr. Feliz noted that based on his experience in the Suisun Marsh hunting is defined as a contact sport for this purpose.

The importance of fish species using the Bypass was discussed. Fish habitat is an important use of the Bypass. Ms. Kulakow noted that several studies have been completed looking at the value of the Bypass for fish habitat and there are proposed projects to improve fish habitat.

Basin Plans set regulatory standards for watersheds. This is the fundamental context of the water quality issue. Water quality information is part of the Sacramento River basin plan on a website that Mr. Erichsen will get for the group.

This plan can reflect real beneficial uses even if they are not identified on the chart. This includes fish spawning and migration.

Mr. Ruby reviewed the list of water quality limits for the Bypass segment of the Sacramento River Basin Plan.

Mr. Ruby reviewed the state's Clean Water Act Section 303(d) list of impaired water bodies that do not meet standards. A separate set of requirements applies to these listed water bodies, including requirements to derive Total Maximum Daily Loads (TMDLs) for the offending pollutant(s). Lower Cache Creek, Lower Putah Creek, Delta Waterways, and the Sacramento River are listed.

The listing of unknown toxicity on Cache Creek was discussed. Unknown means there was toxicity observed to aquatic life but the reason was not determined. It could be anything: dissolved oxygen depression, turbidity, or pesticides.

The Tule Canal is known as an effluent-dominated waterway.

The hydrology of the Knights Landing Ridge Cut was reviewed. Mr. Dudley explained the mechanics of the Ridge Cut. The water level in the Ridge Cut is maintained at 24.5 feet during irrigation season. That was set to maintain a usable water level back to Colusa - Yolo county line. There is a permanent gate system at Knight's Landing and a seasonal weir at the bottom end of the Ridge Cut, at the Bypass. There is a winter operation of the weir and a summer operation. The weir comes out at the end of irrigation season. The level of the Sacramento River at Knights Landing determines if water goes into the Bypass. At high water it flows into the Bypass. Water flows into the river as long as the level of the river is lower than the Ridge Cut. Once the level exceeds the gate capacity at Knight's landing, the water from Colusa Basin Drain flows into the Bypass via the Ridge Cut.

The list of pollutant/stressors for the Colusa Basin Drain was discussed. POCs are found there that are not elsewhere.

Mr. Dudley asked how recently was this list updated. Mr. Ruby indicated it was updated in 2001 but many of the POCs could have been grandfathered in. Levels to qualify for listing are not standardized. They could be based on one sample taken years ago. There is a movement statewide to set standards for listing of pollutants. There is not consistency now.

Mr. Dudley pointed out that some of the listed pesticides are short lived or not used any more. Mr. Lowrey pointed out that the ag world is entirely different from 10 years ago. Diazinon is being phased out for most residential and commercial uses (ag uses will continue).

Ms. Walsh Cady asked if updated information is needed. Mr. Erichsen can look to see what is currently being applied in the field.

LWA will check with DPR on relevant information that is available.

Casey will ask for updated information from her office.

“Group A Pesticides” are organochlorine pesticides; these are mainly issues of the past.

Site Selection

What are the best sites? Look at best sites for both the irrigation season and the wet season.

Mr. Dudley recommended a site on the Tule Canal north of I-5 upstream of the City effluent discharge point. All irrigation discharges go in above this site.

Mr. Ruby said that they have asked Mr. Dudley to look at how the water works in the Bypass. LWA has focused information from previous water quality studies on points above and below the City points of discharge.

Mr. Feliz is interested in the quality of water that is being used to flood wetlands in the Yolo Bypass Wildlife Area (YBWA). He suggested a monitoring site north of Putah Creek to capture water discharge off the rice fields just south of I-80.

A participant asked about a point near the Ridge cut. A site between Ridge Cut and the City discharge point was discussed.

Ms. Walsh Cady asked about ongoing monitoring stations. USGS has a National Ambient Water Quality Assessment (NAWQA) site in Tule Canal north of I-80. They have been doing quarterly sampling since 1995. Other sites include: a USGS gauging station on Tule Canal north of I-5, and another NAWQA site on Cache Creek at Rumsey. Other agencies have stations and gauges scattered throughout the Bypass. NAWQA sites will be most useful since they measure toxic pollutants at low levels (but only during years with sufficient flow; e.g., not 2002). The NPDES dischargers also assess toxicity at the discharge sites for the City of Woodland, City of Davis, and University of California/Davis, on the Tule Canal, Willow Slough Bypass and Putah Creek, respectively. Yolo County has three ambient water quality stations along mid and lower Cache Creek. See Yolo County's Resource Management web site for details on this program. DWR is also doing some monitoring.

Mr. Lowrey asked if they want to be able to monitor all year round. Mr. Ruby replied that monthly monitoring is preferred to capture variation throughout the year.

Mr. Hall was asked about where Conaway Ranch gets its water. Water comes from the Sacramento River, Conaway Canal, and Willow Slough. They do not use the Willow Slough Bypass Water. In the winter the Willow Slough Bypass drains into Bypass. Conaway does not use water out of the Tule Canal. They capture Woodland storm water also. During the summer it is a closed system until the rice fields are drained.

It was agreed that it is a good idea to monitor below Fremont Weir during the winter. Currently DWR does not monitor flows there.

According to Mr. McNerney the City of Davis has two effluent discharge points on the Willow Slough Bypass. It is monitored regularly above the point where storm water enters.

Ms. Kulakow asked that R1 and R2 be defined. They are existing monitoring stations for the City of Woodland. R1 is 800 feet above the City point of discharge near the City property line. R2 is approximately 1800 feet downstream of the discharge.

Ms. Kulakow said that the Dixon Resource Conservation District drains water into the Bypass and that perhaps there should be a monitoring site near that discharge. The difficulty of monitoring in a tidal zone was discussed.

There was further discussion of appropriate sites and timing.

Monitoring Frequency

Monthly monitoring is preferred, according to Mr. Ruby, so as to capture annual variation. The CALFED grant scope includes quarterly monitoring for one year.

Should volunteers be used to monitor? Additional sites could be monitored if volunteers participate. Training can be provided and quality control can be handled in essentially the same way as with paid sampling staff. Possible sources of volunteers are the Riparian Improvement Organization (RIO), Yolo Basin Foundation, Cache Creek Conservancy, and Putah Creek Council.

Mr. Ruby will look at what monitoring others are doing in the Bypass to see if there is a way to coordinate collection times and constituents being monitored.

A participant asked if the most cost is in the field collection or in the analysis? The analysis is the most expensive step.

The meeting was adjourned at 1:30 PM. The next meeting will be scheduled in a few months.

Appendix 1-B.

YOLO BYPASS WATER QUALITY PLANNING PROJECT

CalFed Grant # WSP01-FP-0073

STAKEHOLDER GROUP MEETING #2

Wednesday, October 15, 2003

10:30 AM – 1:00 PM

CA Dept. of Fish and Game, Yolo Wildlife Area Headquarters

45211 County Road 32B, Davis

IN ATTENDANCE:

Doug Baxter, City of Woodland
Chuck Dudley, Dudley Ag
Christine Engel, City of Woodland
Chris Erichsen, LWA
Mike Hardesty, Reclamation District 2068
Marianne Kirkland, California Department of Water
Resources, Division of Environmental Services
Kathryn Kuivila, US Geological Service
Robin Kulakow, Yolo Basin Foundation (YBF)
Rick Landon, Yolo County Agriculture
Rich Marovich, Lower Putah Creek Coordinating
Committee
David Phillips, UC Davis
Paul Robins, Yolo County Resource Conservation District
Armand Ruby, Larry Walker Associates (LWA)
Keith Smith, City of Davis
Casey Walsh Cady, Calif. Department of Food & Ag
Betty Yee, Regional Water Quality Control Board
- Central Valley

I. Introductions

II. Project Progress and Overview

This is the 2nd Stakeholder meeting. At this point the group needs to agree on a list of pollutants of concern, what will be monitored, and where the monitoring sites will be located.

LWA and Chuck Dudley have been looking at the hydrology of the Bypass.

LWA will be directing some volunteers to take some measurements in the Bypass as part of World Water Monitoring Day to be held in November.

The project completion date goal to give the California Bay Delta Authority (CBDA) a report by June 2005.

The goal of the project is the production of a comprehensive plan for improvement of water quality within the Yolo Bypass. This plan will account for the diverse interests in and uses of the Bypass, and will aim to make the best and most reasonable use of funds available for that purpose.

III. Yolo Bypass Water Quality Issues

a. Land Uses, Pollutant Sources, Beneficial Uses

The main drive for this project is the State Water Quality Section 303D list. This list comes out of the state and then it is approved by EPA. By reviewing the 303d list we will see what the state deems to be most important. The list is organized by watershed segment. We are interested in the lower reach of Cache Creek, Putah Creek, the Delta waterways, and the Yolo Bypass.

The contaminants listed include:

Cache Creek: Mercury. This is a legacy pollutant. The specific source has not been determined

Putah Creek: Mercury. Its source is from historic mining.

Sacramento River from Knights Landing to the Delta: Diazinon. The limits are derived from data from Department of Fish and Game. Diazinon is the hottest issue in urban runoff. It is used as a dormant spray for orchards. This can be beneficial from a water quality standpoint. There are no leaves, so less spray is needed. However, it also coincides with heaviest rainfall and runoff season. A reason for modifying the Sacramento River Basin plan is to modify controls on orchard runoff. EPA has banned most residential and commercial use in recognition of the runoff issue.

There are 2 sets of evidence: storm water runoff levels and identification in the Sacramento River Basin. Programs are in place to move this board issue in the next few years. Organophosphate pesticides and mercury most of most concern but programs are in place that will control them so we may not need to worry about them as much?

Mines are a big source of Mercury. This is from the extraction of mercury itself, Its principle use was in gold extraction as an amalgam.

Betty: She commented on the total maximum daily load (tmdl) implementation plan. It identifies tmdls. Purpose is to limit pollutants to a tolerable level. We can only accept x

amount in each water way. To achieve tmdl, orchardists have to implement some steps. This is already developed by growers. They will have to produce a workplan for the regional board This project needs to keep tmdls in mind when designing a monitoring plan.

303d lists are a work in process.

Organophosphates: diazanon and chloropyrifins

Contributors include urban runoff from the Cities of Davis and Woodland, and UC Davis. This includes the discharge from 3 water pollutions control plants. At this time urban runoff of organophosphates exceeds DFG limits.

DDT was banned many years ago so why is it still on the list? Dde and ddb (??) are breakdown products of DDT. In 2002 there was an increase in DDT warnings. It's a legacy pollutant. It is present in sediments.

Difference between organophosphates and chloropyrifins:

Organophosphates photo degrade. They persist in the environment for 3-4 days. Sediments don't contain a lot.

DDT and others persist in sediments. They are brought back to the water column when sediment is stirred up during runoff from storms. Breakdown in pH7 (??) conditions was banned in the last 20 years.

Area treatment plants aren't showing signs of pesticide runoff.

The group reviewed the 303d list of water quality limits for concerning the Yolo Bypass.

There are two concerns in this area: conductivity/dissolved solids and new bacteria standards. This all means more treatment will be required in the future. Ag needs low conductivity. This mainly relates to growing strawberries.

Woodland plant: electrical conductivity levels are exceeded when ground water is pumped. To meet the required levels the treatment plants would need to do reverse osmosis. People can drink the pumped groundwater but it can't discharge into the sloughs. Here agriculture currently uses groundwater that is already high in electrical conductivity. It would cost an estimated \$40 million to start reverse osmosis in area treatment plants.

In the area, we are regulated by the Sacramento River Basin Plan. There is a set of beneficial uses compiled in the handout distributed at the meeting.

Review of 303d list of beneficial uses concerning the Yolo Bypass:

(Asked to describe freshwater habitat – potential. Why is it potential. means reg bd determined there is a potential for freshwater habitat – cold – didn't actually see fish using this type habitat but it is available) ???

Domestic water supply is not listed for the Yolo Bypass. Recently the EPA determined that all areas serve as domestic supply. So the group must consider levels anyways.

Yolo Bypass drains into the largest drinking supply in the state—the San Francisco Bay delta. So this project must consider domestic supply. This distinction means there is a whole list of conditions to meet.

b. Historical water monitoring data:

Willow Slough Bypass, Tule Canal, and Putah Creek undergo regular monitoring by treatment plants. State requires intensive monitoring for treatment plants. This monitoring focuses more on toxics. Mercury and organophosphates are covered by California toxics rules.

UC Davis treatment plant does find toxics in its water monitoring. Upstream has it. This goes for Woodland and Davis too. Metals are detected routinely. X metals not found except very sporadically and are never found in pesticides. ???

Woodland found mercury and organophosphate pesticides each time it monitors both upstream and downstream.

Bisphenol A is ubiquitous in the environment. It is found in product of plastics. Not found upstream and downstream of Woodland plant. Why is it found upstream of the treatment plant. It is a plasticizer used in the formation of flexible plastics. Cups, bags, and candy wrappers contain it. PVC doesn't have bisphenol A because it is found more in flexible plastics. It is hard to get rid of it.

Lindane is occasionally found in Woodland but has not been detected for years. Over the counter lindane is banned.

No beryllium has been found.

NAWQA is a federal program. It has excellent data. The group is fortunate to have a NAWQA monitoring site in the Bypass.. The project will include their data in database. They haven't analyzed which are above water quality objectives.

C. Seasonal Hydrology .

Chuck Dudley looked around the Bypass at seasonal use of water. Use is very seasonal. His analysis started with Oct. – Ag use is slowing down, Hunters are flooding wetlands up.

Most of the year the Bypass is a net water user. A lot of water is used in Bypass. Davis, and UC Davis treated water is used in the Bypass. There are 3 pumps north of Putah Creek and south of I-80 that use a lot of water.

Mid summer is the only time of stable water use. Chuck did the analysis for a 1-year period. There is a dry period in late spring and early fall where there is no storm runoff or ag runoff

Rich asked when the first runoff event usually occurs.

When the Colusa Basin is draining could it over run the ridge cut and cause run off in Bypass?

IV. Identification of Pollutants of concern issue

The Calfed proposal has a preliminary list of POCs – The group reviewed the Yolo Bypass Proposed Sampling and Analysis Option handout. This formed the basis for the project budget. It assumed that there would be four sites for x??? years. Since the project began additional constituents have been added to the POC list for the Yolo Bypass Watershed Management Plan matrix. The group reviewed the matrix handout.

The project must monitor for those listed on the 303d list. There are some historical artifacts on the proposal list including cyanide. UC Davis has detected it very occasionally. Less of artifact than tributyltin. That is a questionable parameter, --no one detects it any more.

The first two have been dropped from UC Davis list. They can be dropped from the project list.

If Bis2 sampled for you will get a lot of other stuff along with it.

Organophosphate pesticides have not found

The project team has a new list into Calfed for review. Calfed must approve it before any POCs be added or deleted. Bis2 limits have not been exceeded at UC Davis. The City of Davis occasionally does

Betty: should we delete Bis2 from the list? David Phillips, the UC Davis representative concurred saying that it is not that much of an issue. That would save project a lot of money also.

EPA 625 scan samples for ??? If the listed 3 are not an issue, take them off the list.

Christine: What would be the benefit of keeping them on? Could maybe learn more about distribution. It is everywhere so it is hard to get meaningful data. Even labs have a hard

time keeping it out of lab equipment. It is doubtful that it would add to the knowledge base. It may be an endocrine disruptor. Many things are.

Betty: wait to do 625 scan after more studies and a problem has been identified.

David: He suggested taking it off the list. It would save money, so project can be more focused—monitor more sites and more frequently.

Three species chronic toxicity testing will catch pollutants that are of concern for wildlife health.

Armand asked if there is consensus about taking hexachlorobutadiene, and Bis2 off the list. Yes

Is there orchard runoff in the Bypass -yes—Cache Creek, Colusa Basin, and Willow Slough. There is some minor use of diazinon on row crops. Have to keep organophosphate pesticides on the list due to urban runoff. Diazinon used very seldomly on alfalfa.

Consensus to keep organophosphates on the list

Chlorinated pesticides – should we keep them on list?

Betty- can you do a one-time sediment analysis instead of monitoring for it on a regular basis. If oc's found then design a project around it

Rick: probably not in water column just sediments.

Question on carbamates. They are not on the op list. County screens for chlorinated pesticides and organohosphates.

One option is to substitute carbamates for chlorinated pesticides. That would give up ability to test for DDT.

Sediment test is only done once.

David – it is a site specific test. It wouldn't give information on whole the Bypass.

It would be hard to take oc's off the list.

Thiodan still in use, It is an chlorinated pesticide.

Should carbamates be on list?

Should Carbaryl be on list? It is used in rice when there are infestations such as army worms.

If the project is not doing a 325 test then they test for carbamates. That would be a suitable trade. They have urban and ag uses so its found in runoff. It is used in snail pellets. It would be useful data for urban treatment plans.

Consensus was that the carbamates via EPA 632 will be added

Should we test for mercury? Testing could show something about the distribution of it in the Bypass. Does water spilling over the weir add it to the Bypass? Is it found above the Knights Landing ridge cut? It is definitely in the Tule Canal.

Are there management implications if mercury is present?

There are issues on the Sacramento River Watershed scale. Data could support closing of mines.

Methyl mercury testing: Would need to look at the water column. Fish tissue contains good data on methyl mercury. But fish move around. First need to know where it is in the Bypass and then do a fish tissue analysis as a good follow-up. Distribution data would be helpful for future studies.

Is it known which contributes more mercury Cache Creek or Putah Creek? That will be known in one year.

LUNCH

Metals – chromium – take off list?

UC Davis: Aluminum, copper, chromium 6 are all of concern, beryllium is not

City of Davis: Keep aluminum on –natural treatment has contact with soil, keep selenium on.

Chuck – Ag concerned with copper

UC Davis– iron is an emerging issue.

Agreed to switch iron with beryllium, will test for total chromium. Not III???

Will use total chromium as a screening tool to see how much total chromium is out there. Chromium 6 is more expensive to test for.

Chuck: Is color part of the ag waiver requirements?

Rick – yes

Add boron to list.

Color test not expensive.

Christine: Additional tests dependent on CalFed and additional money from City of Woodland

Higher hardness of water – metals less available, better for fish

TDS – total dissolved solids, changes seasonally quite a bit.

Consensus is to add TDS to list.

Boron – is issue to City of Woodland. Is it to Davis or UC Davis? Is it in the drinking water?

Woodland is close to the need for action level. It is advisable to keep it on the list

Betty: There are high levels of boron in Cache Creek.

Keith Smith – levels of boron in water varies with depth of aquifer, mid levels tend to have highest.

Consensus is to add boron to the list.

Nitrate – It is necessary to monitor it for the ag waiver. It is a drinking water issue.

Betty: Nutrient levels depend on more than nitrate.

Could use it as an indicator.

Delete tributyltin and cyanide.

TOC – analogous to color test – It is a good indicator of total organic carbon. This is an ag waiver issue and a drinking water issue.

TSS - Keep on the list. It is a standard water quality indicator.

E coli – changed from fecal choloform. The new levels focus on e coli.

3-species chronic toxicity – This will catch toxic effects of several factors. The three species are : Fathead minnow, cerriodaphia (water flea), an an algae (selanstrom.)

(I left the meeting here)

V. Monitoring Program Planning

Site Selection

Monitoring Frequency
Analytical Constituents
Inclusion of Volunteer Monitors
Schedule

VI. Plan and Schedule Next Meeting

Appendix 1-C.

**YOLO BYPASS WATER QUALITY PLANNING PROJECT
CALFED Grant # WSP01-FP-0073**

**STAKEHOLDER GROUP MEETING #3
MEETING MINUTES**

MEETING DATE: JUNE 22, 2004

LOCATION: Larry Walker Associates
707 4th Street, Suite 200
Davis, CA 95616

IN ATTENDANCE: Robin Kulakow, Yolo Basin Foundation (YBF)
Dave Feliz, California Department of Fish & Game
Armand Ruby, Larry Walker Associates (LWA)
Chuck Dudley, Dudley Associates
Keith Smith, City of Davis
Dawn Lindstrom, Putah Creek Council
Chris Erichsen, LWA
Christine Engel, City of Woodland
Marianne Kirkland, DWR
Ted Sommer, DWR
Casey Walsh Cady, Calif. Department of Food & Ag
Betty Yee, Regional Water Quality Control Board
Jim Beatty, City of Davis
Doug Baxter, City of Woodland
David Phillips, University of California, Davis
Janna Harren, California Department of Fish & Game
John Curry, Resource Conservation Service, Dixon
Rollie Baxter, City of Woodland

NEXT MEETING: To be scheduled in August 2004.

ACTION ITEMS:

1. Armand and Robin will coordinate August meeting and agenda.
2. Chris Erichsen to send POTW mercury effluent limits to Marianne Kirkland.

INTRODUCTIONS

Armand Ruby called the meeting to order and began introductions of attendees.

PROJECT OVERVIEW

Armand Ruby reviewed the project goal, objectives and approach.

Chris Erichsen summarized the Yolo Bypass monitoring data to date.

Jim Beatty: The City of Davis will soon begin collecting data on methyl mercury upstream of effluent discharge (on Willow Slough Bypass). The City would share this data with the stakeholder group.

Betty Yee: Delta Mercury TMDL will assign loads to mercury inputs, including Yolo Bypass. Plan will be available later this summer.

Marianne Kirkland: What are mercury limits in treatment plant effluents?

Armand Ruby: We will get this information to you.

Marianne Kirkland: Will the Yolo Bypass sampling program be extended?

Casey Walsh-Cady: Depends on funding source.

Christine Engel: Project deadline is June, 2005. When final report is delivered to Woodland, then it may be possible to look at further funding opportunities.

Armand Ruby: Yes. We will complete the project on schedule, then assess next steps.

PRESENTATIONS FROM STAKEHOLDERS

PRESENTATION #1

Davis Phillips, UC Davis, presented issues and an update on the University's compliance with EC effluent objectives.

The real EC problem is the Regional Board's approach to EC rather than EC itself.

1. UCD can not comply with either of Regional Boards' EC limits:
 - a. 700 umhos/cm, intended to protect agricultural uses
 - b. 900 umhos/cm intended to protect drinking water
2. UCD operates an advanced (tertiary) treatment plant (circa 2000), discharges 2.5 MGD (million gallons per day) and has ultraviolet disinfection; new EC limits would

- require reverse osmosis (R.O.) at substantial capital and annual operating costs – plus issues with energy use and brine disposal
3. Effluent discharges west of Old Davis Road into Putah Creek
 4. Overview of historic EC values in local waters
 5. Most EC comes from campus' deep aquifer domestic water supply
 6. Basis for 700 umhos/cm comes from United Nations crop study
 7. UCD is working on establishing a localized EC recommendation based on local modeling and crop assessment study by UCD Prof. Stephen Grattan; study is due to Regional Board in July
 8. The UN study is not suitable everywhere, including Putah Creek ag uses
 9. There are no salt sensitive crops, mostly grain, corn, and tomatoes
 10. Precip. Annually flushes salts from the Bypass, even without flooding
 11. EC compliance will cost millions, the EC model will be used to compare costs with benefit
 12. 900 umhos/cm is in NPDES permit and is being appealed to State Board. 900 is based on Title 22 drinking water standards.
 13. City of Davis drinking water quality is higher in EC than UC Davis permit limit.

Armand Ruby: How would you deal with the brine if you have to go with R.O.?

Dave Phillips: Deep well injection.

Jim Beatty: What is cost of drilling one well?

Dave Phillips: Million dollar range.

Chuck Dudley: Would you model EC seasonally?

Dave Phillips: Possibly.

Casey Walsh-Cady: Are there wildlife considerations with EC?

Dave Phillips: Wildlife issues are not driving EC limits.

Casey Walsh-Cady: Is it feasible to ask growers to not grow beans?

Dave Phillips: Considered it, but felt it was too complex.

Dave Phillips: With other issues (perchlorate in milk), so much energy spent on EC is wasteful.

PRESENTATION #2

Dave Feliz, CA DF&G presented wetland management and restoration issues.

1. Yolo Bypass Wildlife Area covers 16,000 acres; Currently scoping for consultant to work on preparation of wetland management plan EIR

2. Trying to deal with methyl mercury / wetland restoration issues
3. Not much information on methyl mercury in source waters (trapped tidal waters)
4. On Refuge, organic tomatoes and wild rice are grown, some rotation with white rice (non-organic)
5. Would like to keep Knights Landing Ridge Cut as permanently flowing water supply to Bypass (rather than divert to Sacramento R.)

Armand Ruby: What is the management plan's overriding goal?

Dave Feliz: To manage and restore wetlands, as well as generate operating income and understand how much of a problem methyl mercury is.

Armand Ruby: Would you maintain ag uses to support operating costs?

Dave Feliz: That remains to be determined.

Armand Ruby: So the water quality issues on the Refuge are: possible methyl mercury generation in wetlands. Ag side – EC effects, generation of pollutants (e.g. pesticides)?

Dave Feliz: Yes.

PRESENTATION #3

John Curry, Dixon RCD, presented information on agricultural users' issues

1. Ag waiver is important issue that requires preparation and understanding of issues, esp. those related to monitoring
2. Big question: what is ag contributing to water quality issues?

Armand Ruby: Are there any EC-related issues that you are aware of locally in the ag community?

John Curry: Have not heard any concerns.

Armand Ruby: What are ag community's concerns?

John Curry: What leaves their property, BMPs, pesticides, TOC, TSS, toxicity.

Rollie Baxter: It would be a good to share data, especially EC.

John Curry: Yes. Ag waiver can be demanding, so data sharing is critical.

PRESENTATION #4

Ted Sommer, CA DWR, Environmental Services Division

1. Brief overview of activities – functionally for DWR Bypass mainly serves flood control purpose
2. But DWR also supports other uses; some funding from CalFed for restoration-related activities
3. DWR supports restoration efforts in Yolo Bypass through pre-project monitoring, studies to understand aquatic wildlife
4. Hydrology in Bypass is roughly known
5. Discussion of aerial photography and Bypass inundation modeling
6. Other work includes biological studies (food web, migratory fish), water quality (mercury, pesticides, based in lower Bypass) – including effects of wetlands restoration on methyl mercury generation, sediment
7. Happy to share data

Armand Ruby: Future plans?

Ted Sommer: Working with Dave Feliz on wetland restoration, lower Putah Creek restoration opportunities (historic creek meander). Also Conaway Ranch acquisition and possible restoration of fish passage to Cache Creek; Fremont Weir upgrade and seasonal connection to Tule Canal. Restoring native/riparian vegetation.

Rollie Baxter: Is Yolo Bypass basin a mercury trap?

Ted Sommer: Yes, the Bypass is overall a depositional zone. For migrating species it does not appear to pose a threat or problem due to seasonal use, as opposed to year-round habitat.

Dave Feliz: In Bypass, wetlands are only seasonally inundated.

PRESENTATION #5

Betty Yee, Regional Water Quality Control Board, Central Valley (Region 5)

1. Discussion of mercury concerns on Regional Board as they pertain to Bypass – loads to be defined in draft Delta Mercury TMDL. Cache Creek and Yolo Bypass are big mercury load contributors.
2. Rice pesticides in Colusa Drain
3. Regional Board is to meet on Ag Waiver to discuss satisfaction with submitted monitoring plans / proposals.
4. Pesticide / Toxicity problems: specifics unknown, monitoring to characterize local inputs
5. Salt Loads – more than just localized usage. May be of interest to UCD.
6. Larger Problem: Drinking water in Delta – Policy formation in progress.
7. Effluent-dominated water bodies are not clearly defined, high priority in Basin Plan

Rollie Baxter: How are load reductions defined in TMDL?

Betty Yee: Undefined as of yet, but something like 50% of load comes from Cache Creek, 10% from Putah Creek, rest is unquantifiable (may be Ridge Cut and Sacramento River)

Marianne Kirkland: Some DF&G work will help quantify relationships between wetlands and methyl mercury production (Chris Foe, Mark Stephenson) is in progress.

Dave Feliz: Is the methylation – wetlands connection derived on Delta work?

Betty Yee: Not all. Also from studies in eastern states.

Casey Walsh-Cady: Are salt loads an issue for drinking water?

Betty Yee: Drinking water policy is in development, due in 2011.

Armand Ruby: Typically, when a new project changes salt/EC levels in the Delta, the big water purveyors, who are stakeholders, get involved in assessing impacts.

PRESENTATION #6

Rollie Baxter, City of Woodland

1. Woodland shares EC issues with UC Davis
2. Currently serves 50,000 people at 6.8 MGD (permitted at 7.8 MGD), to expand to 10.8 MGD
3. High quality effluent
4. Permit requires tertiary treatment although no scientific reason supports this move
5. EC and Boron are plaguing issues
6. Recently appealed NPDES permit on EC, new permit issued, no new EC limit until 2 year study is complete
7. Currently evaluating alternatives (not Reverse Osmosis) to meet low EC levels: land application, new river discharge (north to Sacramento R. near Feather R., or south to Sac Regional)
8. Possible new water supply source (Sacramento R.?) could help
9. Conaway Ranch acquisition could provide source or river water

Armand Ruby: Is that entitlement sufficient to supply city's needs?

Response: More than enough.

Marianne Kirkland: Is groundwater discharge an alternative?

Rollie Baxter: It may be.

PRESENTATION #7

Keith Smith, City of Davis

1. Davis shares EC issues with UC Davis and Woodland
2. Currently serves 65,000 people at about 6 MGD
3. Restoration of wetlands important part of future planning
4. Ammonia occasional problem in effluent
5. Aluminum effluent limit to be at 68 in new permit – derived mostly from local clay soils/groundwater supply
6. Bacteria limits also problematic due to high detention times in ponds/wetlands
7. Acquisition of Conaway Ranch by local agencies is a big topic
8. City's options: continue discharge to effluent-dominated waterway; cooperate with Woodland on possible discharge to Sacramento R.; possible discharge to surface waters (land disposal); acquire better quality water supply; impose source controls
9. Not looking seriously at coagulation/filtration or reverse osmosis

Discussion ensued about the Conaway Ranch acquisition, JPA, etc.

ASSIMILATION OF ISSUES

Armand Ruby reviewed the big issues presented and linked them with their sources and regulatory drivers:

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EC: POTW effluents and source water

- *Regulatory: Title 22 (900 umhos), Secondary drinking water standards; Ag uses (700 umhos)*
- *Downstream drinking water sources (Delta)*

Boron: POTW effluents and source water (groundwater)

Mercury, esp. transformation to methyl mercury

- *Restoration of wetlands*
- *Delta TMDL (in process)*

Selenium/Aluminum: POTW effluents, source water

Pesticides: Per ag waiver monitoring program, etc.

Flow/Supply of water for irrigation, wetlands supply - related to POTW issues, options that would reduce discharges to Bypass

Organic Carbon: phytoplankton – need more for fisheries, less for water supply

Watershed-wide solutions; Receiving water context

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Dave Phillips: Yolo Bypass does not have MUN (Municipal Supply) as Beneficial User so drinking water standards do not apply.

Betty Yee: Tributary Rule does not apply to Yolo Bypass, as it is not a named tributary, which is different than “protecting downstream Beneficial Uses”. However, drinking water policy may well apply.

Marianne Kirkland: Some fishing and swimming does occur in Bypass.

Armand Ruby: Actual Beneficial Uses should be protected. EC is a regulatory issue. Ongoing studies are needed to shed light on real ag impact from EC (UCD modeling).

Keith Smith: Rec 1 (water contact beneficial uses) is interesting; considered possible; so Title 22 is law.

Marianne Kirkland: Is there a methyl mercury limit?

Armand Ruby: No, not in the CTR.

Keith Smith: Proposed Delta Mercury TMDL sets 5 ng/l for Methyl mercury.

Rollie Baxter: If wetlands treat water low in mercury, then there are obvious wetland benefits, but if water is high in mercury, then is the source ambient?

Armand Ruby: Sources of mercury are transport of sediments, etc.

Dawn Lindstrom: Are there plants that can “bioremediate” mercury?

Armand Ruby: Not known offhand but worth looking into.

WRAP-UP

Armand Ruby: This project provides an opportunity to think outside of the every-day regulatory framework, and as a group envision cooperative solutions that would best serve the interests of the public and local stakeholders. We are charged with developing an integrated water quality management plan for the Bypass, and together we should take advantage of this opportunity to develop a plan that we think is workable and really makes sense.

Meeting was adjourned; to reconvene in August.

Appendix 1-D.

Draft Minutes

YOLO BYPASS WATER QUALITY PLANNING PROJECT
CalFed Grant #WSP01-FP-0073

STAKEHOLDER ADVISORY GROUP MEETING #4

Friday Dec. 3, 2004
10:30 a.m. to 1:30 p.m.
Larry Walker Associates
727 4th Street
Davis, California

Attendees: Armand Ruby, Armand Ruby Consulting
Keith Smith, City of Davis,
Stephen McCord, LWA
Betty Yee, Regional Water Quality Control Board
Marianne Kirkland, Department of Water Resources (DWR)
Ted Sommer, DWR
B.G. Heiland, DWR
David Phillips, UC Davis
Casey Walsh Cady, Department of Food and Agriculture,
Rollie Baxter, City of Woodland
Chris Erichsen, Larry Walker Associates (LWA)
Tess Dunham, LWA
Christine Engel, City of Woodland, Public Works
Petrea Marchand, Yolo County, Planning Department
Robin Kulakow, Yolo Basin Foundation
Denise Sagaro, Yolo Farm Bureau

I. Introductions

II. Project Update

Refer to Gantt chart for project timeline and status. Monitoring was finished in October. Now the project team is looking at the feasibility of control measures and possibly site-specific objectives. The completion date has been moved to the end of April. The final report will go to CalFed then. A draft will be sent out to this group by March 18. There will be three weeks for comments from the Stakeholder group with a deadline of April 8. There will be time for only one more stakeholder meeting in February to focus on potential control measures. At that meeting the group will review a draft outline of the proposed management plan.

Budget for tasks 7, 8, 9 has some funds left. The monitoring budget is depleted as are earlier tasks. The project is keeping on schedule. Contract end date is June 30. CalFed wants final reports before end date.

III. Monitoring Summary: Activities and Results to Date

Chris reviewed the draft water chemistry and toxicity report for November 2003-2004. This Power-point presentation is available for review and can be sent out by email to interested parties.

A handout also was provided summarizing the results of the chemical analysis, field measurements, and toxicity tests. See handout for list of POC metals. There were 12 monitoring sites in the Yolo Bypass that were used for this study. They included the Ridge Cut, Cache Creek drainage, Putah Creek, Willow Slough, the ag drainage from the Colusa Basin Drain. One site was located in the Yolo Wildlife Area. The Fremont Weir and Sacramento Weir overflows were monitored during a Bypass flood event last year. Toxicity data was collected four times. Acute toxicity results from date were taken from the ag waiver program.

During December through January of last year the monitors couldn't access the toe drain. In February and March they couldn't get to the Wildlife Area. There were 12 sites, 12 events, one flood event, 4 toxicity events, 6 full suite events, 12 mercury and bacteria events. Some Riparian Improvement Organization volunteers helped collect samples.

The samples were reviewed for detectable POCs. A Table with POCs exceeding objectives (exceedances) was reviewed. There is some temporal variability in the tables. The data is ready for an internal review then it will go on to the QACC reviewers. Group may want to discuss objectives for those with no assigned objectives. The Regional Water Quality Control Board is still considering some objectives. It was acknowledged that additional funds from the City of Woodland and City of Davis were used for additional chemistry analysis and sediment toxicity testing.

No fathead minnow toxicity was observed in January samples.

Please do not consider the data as final. It is still being reviewed. Data are summarized by constituent and compared to water quality criteria or objectives.. This is meant to be an analysis to guide development of the management plan, not a regulatory compliance analysis. Besides the levels and comparisons to objectives, we also look at how often a constituent was detected. Metals generally were detected 100 %, with some variation.

Some things to consider:

How often does each constituent exceed the criterion? Aluminum (Al) is a common element in most soils. Boron abundance is similar. These are compared to drinking water criteria. There was a discussion of variation in lab analysis. The variations will be checked for final report. The Yolo Bypass is not designated MUN (municipal drinking water supply). There were a few hits for chromium with no particular pattern.

Mercury and methyl mercury presence and sources were discussed. Ted Sommer asked the group to consider that wetlands can create methyl mercury. Question: Is there the ability to ascertain an effect from the Yolo Wildlife Area on methyl mercury using the sample data? Answer: not really. The Wildlife Area sampling site is at the upper side of the set of pumps at the lift station on the cross canal that brings water in from the Toe Drain. The project was trying to characterize the source of water serving the Wildlife Area rather than the output from it. They looked at input rather than output. During flood events there will be some mercury transport. There would need to be more monitoring to determine output of methyl mercury from the Wildlife Area. There are studies being done on production and transport of methyl mercury.

A question was asked on how the mercury sediment data were collected. Generally, the top centimeter of sediment was carefully lifted up in an effort to sample the finer deposits. At the Wildlife Area site the monitors had to scrape the rocks to obtain sufficient sample, as the access was difficult.

Based on other studies it looks like more sediment comes over the Fremont Weir than from other sources. It is presumed that the Cache Creek Settling Basin is taking out some of the mercury. It's hard to say where the boost in mercury at Woodland test sites R1 and R2 is coming from. It's important in the report to note that sampling at Wildlife Area was for inputs not output since there is so much interest in Wildlife Area's effect on methyl mercury totals.

Total dissolved solids were high as a whole. Electrical conductivity was spotty. But there were a number of exceedances here as well. This number is important to the wastewater treatment plants. Petrea said that the County is interested in compiling all of the known water data. This project will do that during the time of the contract. The Willow Slough Bypass site is downstream from City of Davis treatment plant. The Putah Creek site is down stream of the UCD treatment plant. The idea was to choose one ag monitoring site. This was down south of Putah Creek in an ag canal known as the Z Drain.

Coliform was found everywhere. City of Davis coliform level high due to birds. Coliform levels are in some ways misapplied to sites beyond the treatment plants. This is not appropriate where there is a lot wildlife use. Wildlife Area levels would be higher if measuring after water was distributed to the ponds.

Total organic carbon . There is no Basin Plan standard so no criterion is applied. CalFed is finding that most of total organic carbon is coming from the Sacramento River rather than the Delta. There may be some organic carbon work going on in Yolo County with the Yolo Resource Conservation District.

Detected pesticides were very low. Only found DDE and chlorpyrifos above criteria levels at some sites. DDE is a breakdown product of DDT even though DDT has been banned for over 30 years. Wouldn't show up if it were not being used. They will need to look into sources of pesticides. There are no surprises in this data. There is some surprise with the low levels at Knights Landing Ridge Cut. There is a pulse in the summer from the rice fields. Most rice water needs to be held 30 days in the field to breakdown pesticides. Diuron is a broad level

treatment pesticide including use on rice. Petrea asked about coordination with Colusa Basin Drain study. Ted commented that it does not appear that there are significant problems with the Colusa Basin Drain water.

Toxicity testing was added on to the data analysis. No toxicity was found for the most part. There was one hit on algae and none on Ceriodaphnia. Sediment toxicity analysis uses two organisms since they are susceptible to different toxins. One hit was noted at the Ridge Cut with *Hyalella azteca*. There were sediment toxicity hits at the Ridge Cut, Willow Slough, Tule Canal, and Toe Drain. The analysis process takes some of the sample, adds organisms, feeds them for a period of time. Then organisms are filtered out to determine survival and weight.

IV. Review of Water Quality Issues Raised by Stakeholders

Conductivity was a main issue for the POTWs. Levels of boron, bacteria, and aluminum secondary issues.

Department of Fish and Game, DWR, and the Regional Water Quality Control Board rank methyl mercury as main issue-wildlife/fish habitat, human health mercury in fish.

Next level of issues: pesticides, salts

Boron, selenium, organic carbon, aluminum – many exceedances throughout the Bypass. Exceedances match the short list of issues pretty well.

Methyl mercury – all exceedances

Fecal coliform, e coli many exceedances

Everything is related to natural conditions except pesticides. Boron, aluminum are not related to anything controllable. Four years of sampling of Cache Creek Conservancy wetlands showed an increase in methyl mercury. Data is on Yolo County website/Planning public works/ Some research has been done on invertebrates/fish. No data is available on the effects on next level of food chain.

V. Overview of Next Steps:

Project steps:

1. Complete Monitoring- done;
2. Analyze Monitoring Data- underway
3. Evaluate Control Measure and management alternatives for Pollutants of Concern
4. Investigate Feasibility of Site-Specific Water Quality Objectives. Establishment of site specific standards is a possibility.
5. Develop Coordinated Water Quality Management Plan

The CalFed scope of work emphasizes development of a management plan for POCs. A draft report outline has been done. Participants will be asked to review the outline and get back to Tess and Armand with comments.

VI. Preliminary Discussion of Potential POC Control Measures

Keith Smith, City of Davis Engineer, commented on management alternatives. The City does not have an EC limit now. Source water, from groundwater wells, is already above control levels. The water is very hard. The majority of people use water softeners which adds to the EC also. Overland treatment (wetlands) used by the City. EC is above 3,000 (?) This is a high level for agriculture. But agriculture is still using the water for irrigation. Treatment at this level is not practical. Use of membranes and disposal of that waste is very expensive. Salinity treatment is necessary. The solution is to bring in surface water for the community. It will take many years to do the environmental studies and to get water rights if it is even possible. The effluent would not be able to meet standards for many years. The City is going to make an effort toward public education.

This study is looking at management options, best management practices since treatment is not practical. How much do water softeners contribute to the problem? We need to consider the source control options in the management plan. It's a public education issue once surface water is available. One possibility is the use the Exchange-take systems vs self salting canisters. Another possibility is work on grants to change softener methods.

Rollie Baxter, City of Woodland Engineer, reported that Woodland has the same problem as Davis. Woodland water intake is about 1500 EC and discharges at about 1500. Woodland has a more capital-intensive treatment system compared to Davis. There have not been complaints from farmers that they know of.

Farmers are aware of the quality of the water available to them. They have adapted to the situation by the types of crops they grow. Woodland is looking at a different point of discharge. One option is to discharge into the Sacramento River rather than the Bypass instead of investing in more treatment. Davis discharge is insignificant in terms of volume discharged into Bypass. Davis discharges into Willow Slough and it is ciphoned off almost immediately by farmers so it doesn't usually make it to the Bypass. The Farm Bureau says that Davis/Woodland discharge is an important source of irrigation water.

Dave Phillips, engineer with UCD, reported that UCD has looked at effects of EC from discharge on crop yields. An EC of 1100-1200 in UCD's summer discharges has no effect on crop yield. There could be different discharge levels by season. Dave doesn't think the management plan needs to make recommendations in terms of treatment to improve EC discharge levels.

Betty Yee was not aware of a discharge compliance point for the Bypass. Water purveyors want EC as low as possible. The management plan could propose relief on POTW requirements but delta water policy makers may not agree. The Sacramento Basin Plan and Delta Plan have compliance points. Most points have chloride compliance levels rather than EC. The biggest issue is providing enough bay outflow rather than agriculture use issues.

We need to check into Bay-Delta compliance issues for the final report. Regulatory relief for POTW discharges is one possible outcome for the management plan, especially regarding EC. It appears that there is not a significant ag issue here in terms of EC. Farm practices also increase EC. The move toward conserving water concentrates salts. There are ways to reduce salts in everyday water use.

The management plan should address activities to reduce salts in water, check into Bay Delta water quality compliance issues, and address mercury issues.

It was noted that the Yolo Flood Control District should be contacted regarding the ground water quality study data that they have.

Petrea Marchand, with Yolo County, reported that the County is working on an integrated Regional Water Quality Management Plan. The plan is due in 2007. All water entities will be involved. Proposition 50 applications need to be on regional level. The Yolo County Water Resources Association will be submitting an application.

Preliminary data show that the Bypass is a net user of water in the summer. Ted commented on the development of a water budget for the Bypass. North of I-80 is one system. South of I-80 is mostly tidal water from the Sacramento River with some Putah Creek water. DWR is doing a study on water use in the Bypass. If you want more information on the study contact Marianne Kirkland.

Ted Sommer noted that the Yolo Bypass Working Group will be having a specific workshop on mercury issues in the Bypass.

VII. Discussion of Potential Project Follow-on Activities

Should a project of this type be continued in the future and if so with what funding?

Participants will be asked to comment on the report outline.

VIII. Plan, Schedule Next Meeting

The Stakeholders Group will meet again in early February. This will be the final meeting for the Group.

APPENDIX 2. DRAFT HYDROLOGIC TIMELINE FOR THE YOLO BYPASS

Draft Yolo Bypass Hydrologic Timeline

Courtesy of Chuck Dudley

October

Upper (North of I-80)

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and (rice) straw decomposition.
- Rice field drainage would have been concluded in Sept. and some of drain water would still be in Colusa Basin drain and Ridge Cut early in the month.
- Flows in the Tule Canal would be composed of some Ridge Cut water, some drain water from irrigation activities to support duck club/wildlife/straw, effluent from Woodland/Davis, and some storm water from Woodland/Davis (depending upon rainfall amount). Cache Creek is essentially dry.
- Reclamation Districts on east side of Bypass would not be flow contributors at this time.
- Duck clubs get water from Knights Landing Ridge Cut and Sacramento River. Conaway gets water from Sacramento River through Reclamation District 2035 pump/pipe near I-5 area.
- Willow Slough Bypass diversion is removed. Flow, if any, goes to the Bypass.
- Crop harvest is completed.

Transition area (I-80 to Putah Creek)

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Probably a small net flow from north, under I-80 (approx north end of tidal influence).
- North pumps for California Department of Fish & Game (CDFG) refuge would utilize the flow and probably some tidal from south to feed duck club/habitat/straw decomposition (late September to early March).
- The *tidal interface*, the most upstream influence of estuarine, tidal waters, is near the northern CDFG 'low-lift' pumps.

Southern Zone (south of Putah Creek)

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Water source in the zone would be principally tidal flow from the Delta, UCD wastewater effluent, and Putah Creek 'conservation release'.
- Significant amount of Toe Drain waters are pumped in this area by duck clubs.

November

Upper (North of I-80)

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Gradual transition of flow starts to occur with onset of rainy season.
- Water source in normal years would remain nearly the same with an addition of storm water from the City of Woodland and a portion of northern West Sacramento.

Transition

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Probably a small net flow from the north would increase slightly under I-80 (approximately the north end of tidal influence) due to increased rain and storm drain runoff.
- North pumps for CDFG refuge would utilize the flow and probable some tidal from south to feed duck club/habitat/straw decomposition.
- CDFG opens barrier on Putah Creek for migratory fish passage.
- The tidal interface is nearly stationary from October.

Southern Zone

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Water source in the zone would be principally tidal flow from Delta and UCD wastewater effluent and Putah Creek 'conservation release'.
- Significant amt of Toe Drain water are pumped in this area by duck clubs.

December

Upper (North of I-80)

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Assuming some significant rainfall, bypass flows would increase with water from Cache Creek, Willow Slough, east side Reclamation Districts (from field drainage), and northern West Sacramento storm drain, Davis and Woodland storm drain.
- Duck club/habitat/straw decomposition water is from Ridge Cut, Sacramento River, and Cache Creek.
- Fields in the Bypass start draining into Tule Canal.

Transition zone

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Increased flow from north moves influence of tidal water south. More of Fazio (CDFG) refuge water would come from the north through Tule Canal.

- The tidal interface is moved south by an increased volume of water from the north.

Southern Zone

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Some drain water from agricultural areas of Solano County via complex east-west drainage canals that drain into Bypass.
- Significant amt of Toe Drain water are pumped in this area by duck clubs.

January

Upper (North of I-80)

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Assuming significant rains, all tributaries to bypass have increased to significant flows.
- Duck club/habitat/straw decomposition water is from Ridge Cut, and Cache Creek.

Transition zone & Southern zone

- Principal water utilization would be the flooding and maintenance of duck clubs, wildlife habitat, and straw decomposition.
- Flow in Bypass is distinctly north to south.
- Water source through system is from north and not from Delta.
- The tidal interface could be removed from the Bypass during periods of heavy flow.

February

Upper (North of I-80)

- Water utilized is decreasing.
- Some duck clubs are drained. Straw decomposition activities are concluded.
- Water flow patterns remain much the same as Jan with all tributaries contributing to Bypass flow.

Transition zone & Southern zone

- Water utilization is decreasing.
- Some duck clubs are drained. Straw decomposition activities are concluded.
- Water flow patterns remain much the same as Jan with all tributaries contributing to Bypass flow.
- The tidal interface moves northward as flow from the north decreases.

March

Upper (North of I-80)

- Water utilization significantly decreases as habitat for waterfowl is reduced to brood pond habitat.
- As rains lessen, runoff decreases.

Transition zone & Southern zone

- Water utilization significantly decreases as habitat for waterfowl is reduced to brood pond habitat.
- As rains lessen, runoff decreases.
- The tidal interface remains south of its summer location because of Bypass flow and low water utilization.
- Yolo Basin Wildlife Area season flooding ends.

April

Upper (North of I-80)

- Water utilization is limited to waterfowl brood ponds.
- Winter flows decrease to insignificant levels from all tributaries. Still some input from Cache Creek.
- Farm work begins, land is dry enough to begin soil preparation, and crops are planted.
- Davis and Woodland treatment plant outfalls become a significant percentage of the water in the system.

Transition zone & Southern zone

- Water utilization is decreasing.
- Flow from north is limited and effluent based.
- Farm work begin, soil is prepared, crops are planted.
- Irrigation water utilized outside the Bypass is pumped from the Toe Drain.
- The tidal interface continues to shift northward.

May / June / July / August

Upper (North of I-80)

- Water utilized is primarily for crop production.
- Drain water from Ridge Cut, Bypass farming, east side Reclamation Districts, Willow Slough, all contribute to the Bypass flow.
- Most effluent is utilized north of I-80.

- Most drain water from the Clear Lake system ('Yolo County Flood Control and Conservation District') is diverted to the Conway irrigation system.
- Woodland storm drain is diverted into the Conway irrigation system.
- Conway irrigation system is closed and does not drain until September.
- Remaining flow in Cache Creek, if any, is diverted into the Conway irrigation system.

Transition Zone

- Water utilized for crop production and some wildlife activities on the Yolo Basin Wildlife Area .
- Irrigation season pattern is established with most of the water utilized in this zone coming from the Delta.
- Flow from Putah Creek is utilized by CDFG (Yolo Basin Wildlife Area).
- Balance of effluent is utilized in this zone.
- The tidal interface is near the northern CDFG 'low-lift' pumps.

Southern Zone

- Delta water dominated.
- Primary water utilized is for crop production and pasture.
- Some drain water reaches the Toe Drain from the west.

September

Upper (North of I-80)

- Water utilized for irrigation ends.
- Water utilized for duck clubs/habitat begins.
- Rice field drainage is significant part of Bypass flow.
- Conway irrigation system is opened to drain rice field water.
- After rice field draining, irrigation districts and reclamation districts contribute little water to the flow in the Bypass.

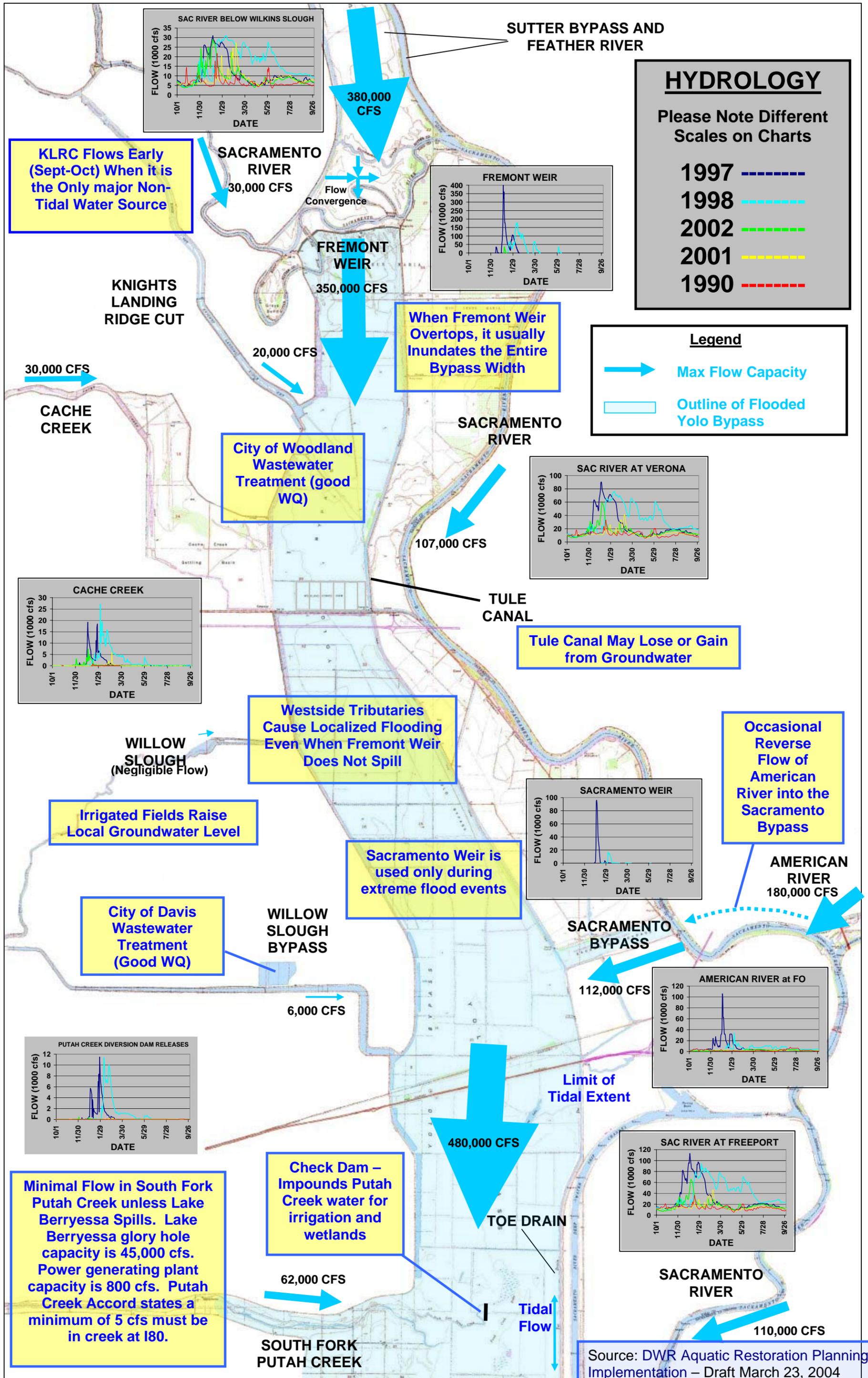
Transition Zone

- Water utilized for irrigation ends.
- Water utilized for duck clubs/habitat begins.
- Rice field drainage is significant part of Bypass flow.
- Effluent north of Putah Creek is utilized by CDFG at Yolo Basin Wildlife Area.
- The tidal interface remains near its summer point.

Southern Zone

- Water utilization for irrigation ends.
- Water utilization for duck club/habitat begins.

APPENDIX 3. PICTORIAL REPRESENTATION OF MAXIMUM FLOWS IN THE YOLO BYPASS



HYDROLOGY
 Please Note Different Scales on Charts

1997 - - - - -
1998 - - - - -
2002 - - - - -
2001 - - - - -
1990 - - - - -

Legend

Max Flow Capacity
 Outline of Flooded Yolo Bypass

KLRC Flows Early (Sept-Oct) When it is the Only major Non-Tidal Water Source

When Fremont Weir Overtops, it usually Inundates the Entire Bypass Width

Tule Canal May Lose or Gain from Groundwater

Westside Tributaries Cause Localized Flooding Even When Fremont Weir Does Not Spill

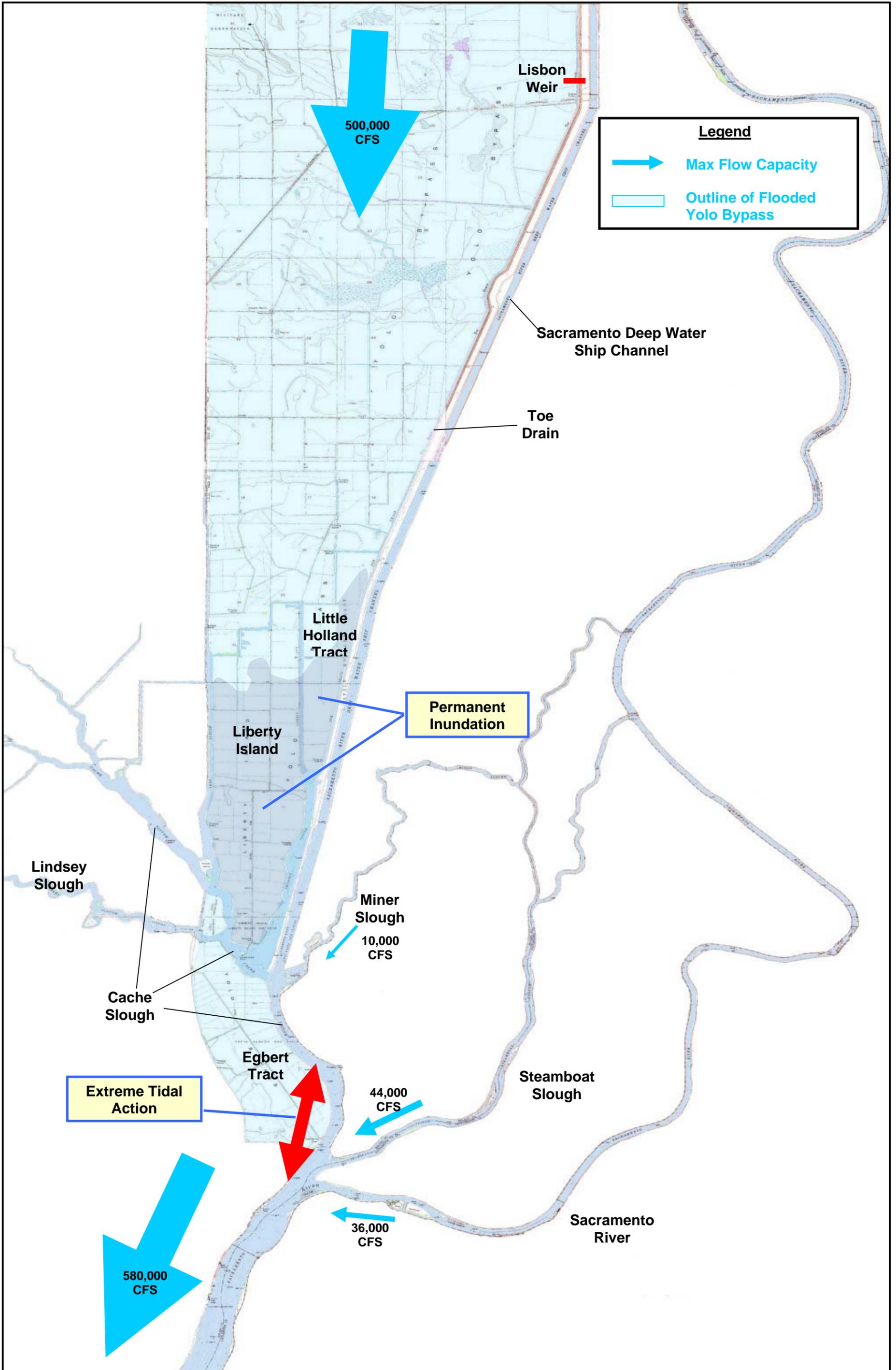
Occasional Reverse Flow of American River into the Sacramento Bypass

Sacramento Weir is used only during extreme flood events

Minimal Flow in South Fork Putah Creek unless Lake Berryessa Spills. Lake Berryessa glory hole capacity is 45,000 cfs. Power generating plant capacity is 800 cfs. Putah Creek Accord states a minimum of 5 cfs must be in creek at I80.

Check Dam – Impounds Putah Creek water for irrigation and wetlands

Source: DWR Aquatic Restoration Planning and Implementation – Draft March 23, 2004



APPENDIX 4. MONITORING SITE PHOTOGRAPHS

Appendix 4. Monitoring Site Photographs

Sites are ordered as follows:

- Weirs – Fremont and Sacramento
- Agricultural Drains – Ridge Cut, Willow Slough Bypass, and Z Drain
- West-side Tributaries – Cache Creek, Putah Creek
- In-Bypass – Woodland R1, Woodland R2, Tule Canal, YB Wildlife Area, and Toe Drain

Fremont Weir



Sacramento Weir



Ridge Cut



Willow Slough Bypass



Z Drain



Cache Creek a) low-flow outlet, b) overflow spillway



a)



b)

Putah Creek



Woodland R1



Woodland R2



Tule Canal @ 80



YB Wildlife Area



Toe Drain



APPENDIX 5. QUALITY ASSURANCE PROJECT PLAN

A. PROJECT MANAGEMENT

1. Title Page and Approvals

QUALITY ASSURANCE PROJECT PLAN FOR WATER QUALITY MONITORING FOR THE YOLO BYPASS WATERSHED PLANNING PROJECT, 2003-2004

Contract Manager	_____	
	Stefan Lorenzato, CalFed Contract Manager, CA Dept. of Water Resources	Date
QA Officer	_____	
	William Ray, State Water Resources Control Board	Date
City Project Manager	_____	
	Gary Wegener, City of Woodland	Date
Consultant Project Manager	_____	
	Armand Ruby, Larry Walker Associates	Date
Contractor QA Officer	_____	
	Claus Suverkropp, Larry Walker Associates	Date

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3. Distribution List

Table A-1. Primary Distribution List for Quality Assurance Project Plan

Name	Agency or Company
Stefan Lorenzato	CalFed Contract Manager, CA Dept. of Water Resources
William Ray	QA Officer, State Water Resources Control Board
Casey Walsh Cady	CalFed Liaison, CA Dept. of Food and Agriculture
Gary Wegener	City of Woodland
Armand Ruby	Larry Walker Associates
Claus Suverkropp	Larry Walker Associates
Chris Erichsen	Larry Walker Associates
Todd Albertson	Caltest Analytical Laboratories
Frank Colich	Frontier Geosciences Inc.
Richard Danielson	BioVir Laboratories Inc.
Jeff Miller	Aqua Science, Inc.
Robin Kulakow	Yolo Basin Foundation

4. Project Organization and Responsibility

The Yolo Bypass Water Quality Monitoring Program (Monitoring Program) is being performed by the City of Woodland (the City) as part of a Yolo Bypass Watershed Planning Project. Principal funding for the planning project is provided by a grant from the CalFed Bay-Delta Program. The grant funding is provided subject to the terms of Contract # 4600001691, between Department of Water Resources (DWR) as administrator of the grant program, and the City of Woodland as grantee. The project manager under the grant agreement is Gary Wegener, Director of Public Works, City of Woodland. The project manager for the CalFed Bay-Delta Program is John Lowrie, and the State's contract manager for the agreement is Stefan Lorenzato, Watershed Management Coordinator for DWR. The CalFed project liaison for this project is Casey Walsh Cady, of the California Department of Food and Agriculture.

A stakeholders advisory group informs and influences the decision-making process of this project. These stakeholders include representatives of local municipalities and special districts, state and federal agencies, agriculture, recreational organizations, landowners, environmental organizations, the University of California at Davis, and watershed conservancies. The first of a series of stakeholder meetings was held on July 25, 2003. Sampling sites and pollutants of concern were identified at the second stakeholder meeting, October 15, 2003.

The consultant hired by the City to provide technical and other services for the watershed planning project, including planning and conducting the monitoring program, is Larry Walker Associates (LWA) of Davis, CA. The consultant project manager is Armand Ruby of LWA. The project quality assurance manager is Claus Suverkropp of LWA. Mr. Suverkropp has served in a similar capacity for the Sacramento River Watershed Program (SRWP) and will provide guidance and oversight to assure that the Yolo Bypass Monitoring Program is consistent with the quality assurance/quality control procedures followed by the SRWP.

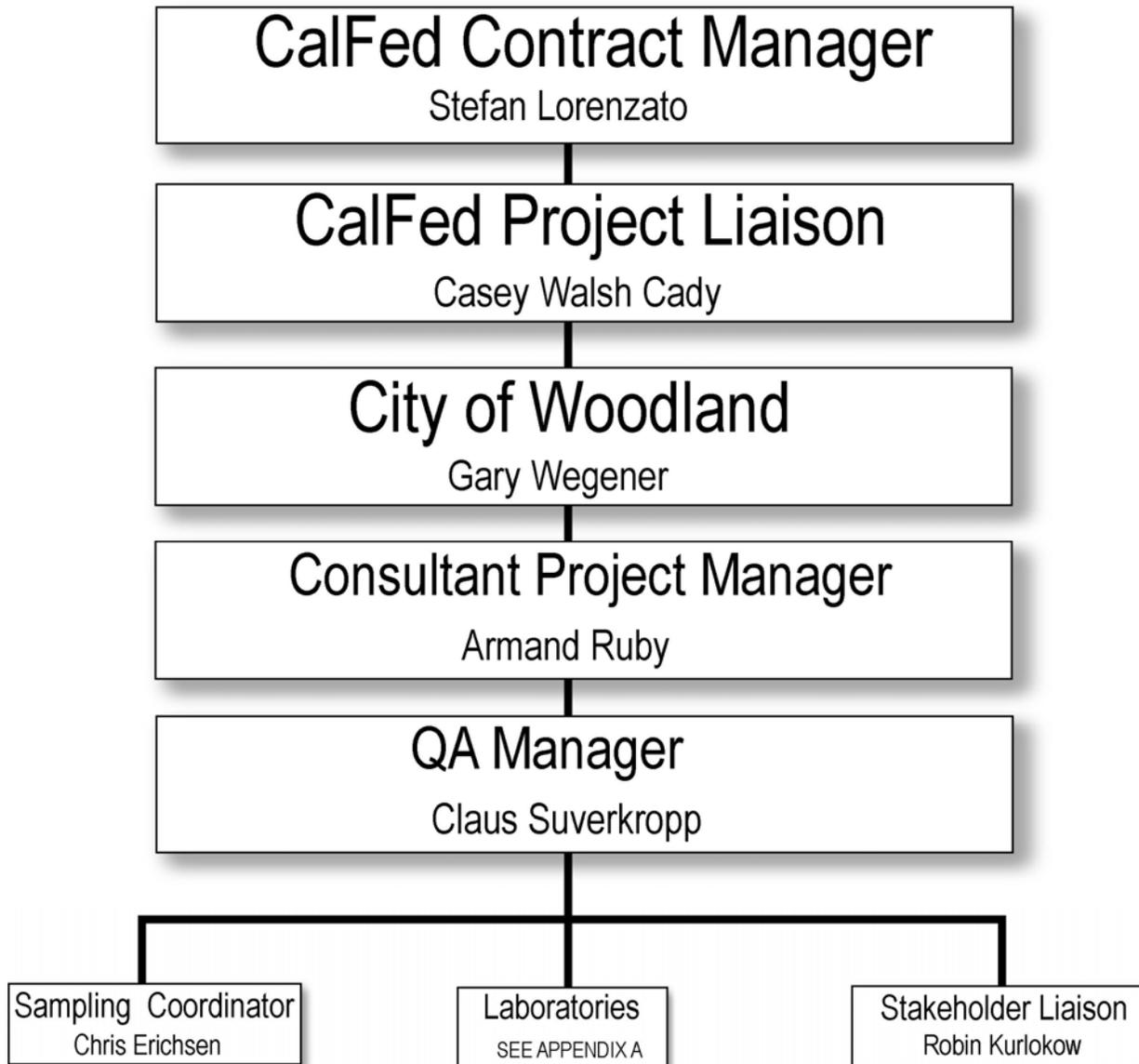
The following subcontractors and municipalities will perform sample analysis:

- Caltest Analytical Laboratories
- Frontier Geosciences Inc.
- BioVir Laboratories, Inc.
- Aqua Science, Inc.
- City of Woodland Wastewater Treatment Plant
- City of Davis Wastewater Treatment Plant

Laboratory analytical responsibilities and primary contacts are listed in Appendix A.

The organizational structure of the Monitoring Program is illustrated in Figure A-1.

Figure A-1. Yolo Bypass Monitoring Program Management Structure



5. Problem Definition

The City of Woodland has received a CalFed grant (CalFed Grant # WSP01-FP-0073; DWR Agreement # 4600001691) to conduct Watershed Management Planning for water quality issues in the Yolo Bypass. The overall goal of the grant project is production of a comprehensive plan for improvement of water quality within the Yolo Bypass. The plan will account for the diverse interests in and uses of the Bypass, and will aim to make the best and most reasonable use of funds available for water quality improvement.

The scope of work covered by the grant includes a water quality monitoring program to characterize Bypass water quality. The monitoring program is scheduled to begin in November 2003 and continue for one year.

6. Project Description

Project Objectives and Approach

Three objectives complete the scope of this watershed planning effort. They are, (1) Define the pollutants of concern affecting the Yolo Bypass and downstream water bodies, (2) Collect data on the Bypass' water quality to identify pollutant sources, their magnitude, and seasonal variation, and (3) Define reasonable and implementable control measures for the pollutants of concern. A stakeholder group was formed to provide input and guidance on implementation of these objectives.

The monitoring program will augment other monitoring efforts that are ongoing in the watershed, including the USGS National Water Quality Assessment Program, Department of Water Resources, City of Woodland, City of Davis, and University of California at Davis. The monitoring program includes chemical, physical, biological and toxicological monitoring elements.

Measurements

The following environmental monitoring elements are included in the monitoring program:

- Mercury and methylmercury in water
- Heavy metals in water
- Organophosphorus, chlorinated, and carbamate pesticides in water
- Pathogen indicator organisms in water
- Organic carbon in water
- General constituents (solids, hardness, nitrate, color, boron) in water
- Toxicity in water

Specific individual parameters measured by the Yolo Bypass monitoring effort are listed in Table A-2. The purposes for monitoring these parameters are discussed below.

Mercury in water. Low levels of mercury and methylmercury in water are of potential concern to human health. Several programs are currently planned or under way in the Yolo Bypass watershed to monitor mercury levels at various locations, including the USGS National Water Quality Assessment. Monitoring of mercury and methylmercury has also been completed in

watersheds that drain into the Yolo Bypass, including the Sacramento River Watershed Program, the USGS National Water Quality Assessment, and the CalFed Bay-Delta Program. Proposed Yolo Bypass mercury monitoring will supplement existing data, and planned and ongoing monitoring efforts, with information for six locations. Data obtained will be used to quantify ambient levels of mercury and methylmercury in the Yolo Bypass watershed and to assess whether these levels are causing or contributing to potential human health risks or otherwise adversely affecting beneficial uses. Locations for mercury monitoring were selected to augment and coordinate with existing and planned monitoring efforts in the watershed.

Metals in water. Low levels of metals in water can affect the growth, reproduction and/or survival of sensitive aquatic species. Metals also pose a serious health risk to humans recreating in waters, as well as irrigated crops. Copper is a known serious issue in the Bypass. Many metals have a natural level of occurrence in surface waters, but urban runoff and mine tailings are sources of high metal concentrations such as boron, chromium, copper, iron, lead, and selenium. Yolo Bypass monitoring for metals at six sites will augment or continue fairly extensive monitoring conducted by the USGS NAWQA program, City of Woodland, City of Davis, and the University of California at Davis.

Pesticides in water. Low levels of pesticides in water can affect the growth, reproduction and/or survival of sensitive aquatic species. Pesticides of potential concern to aquatic life in the Yolo Bypass include Organophosphorus (OP), carbamate, and triazine pesticides. The USGS National Water Quality Assessment monitors pesticides in the Yolo Bypass. Yolo Bypass pesticide monitoring will supplement the existing data with information for six locations. Locations for pesticide monitoring were selected on the basis of documented use of these pesticides upstream from the locations monitored and on pesticide-caused toxicity detected in the Bypass.

Pathogen Indicators in water. Pathogens are disease-producing organisms (protozoa, bacteria, viruses) that adversely affect the quality of drinking water and may pose health risks for water contact recreation. Some pathogens are of particular concern, due to their ineffective removal by conventional municipal wastewater treatment technologies. The Tule Canal, the perennial drain on the eastern side of the Bypass, is seasonally used for fishing and small boat recreation, and is also a source of irrigation water for unprocessed crops. The Tule Canal becomes the Toe Drain as it flows southward past Interstate Route 80, and then drains into the Sacramento-San Joaquin Bay-Delta, a drinking water source for bay-delta communities including San Francisco. Because sampling and analysis for specific pathogen organisms is difficult and problematic, indicator organisms are often used as surrogates. Pathogen indicator monitoring will be employed to assess the presence of indicator organisms (total and fecal coliforms and *Escherichia coli*) at monitoring locations throughout the Bypass.

Organic carbon in water. The organic content of water (measured as organic carbon) is a parameter important to drinking water suppliers. High levels of organic compounds in source waters can lead to the production of disinfection by-products as a result of conventional water treatment. These by-products pose human health problems at relatively low concentrations. For these reasons, baseline data on typical organic carbon levels and seasonal variability of those levels in the Yolo Bypass are important to the assessment of drinking water uses. Yolo Bypass monitoring for organic carbon (dissolved and total) at six sites will augment or continue fairly

extensive monitoring conducted by the USGS NAWQA program, City of Woodland, City of Davis, and the University of California at Davis.

General constituents (suspended and dissolved solids, total and dissolved organic carbon, hardness, color, nitrate and boron) in water. These conventional water quality parameters are important to the evaluation of the attainment of a variety of uses, including drinking water supply, recreation, irrigation, aquatic habitat, and agricultural supply. Data on these parameters is available from a number of other programs, including USGS NAWQA, SRWP, City of Woodland, City of Davis, and the University of California at Davis. Yolo Bypass monitoring will augment these ongoing data collection efforts for these constituents at six sites.

Toxicity in water. Ambient samples of water can be tested in the laboratory for toxicity to provide an indication of the conditions that exist in the natural environment. Standard test species and test procedures are used to provide reliable and comparable results. Toxicity is considered to occur when test species are adversely affected by exposure to ambient water. Adverse effects may include impaired growth or reproduction, abnormalities, or mortality of test species. Effects may occur rapidly (acute toxicity) or may occur over a longer period (chronic toxicity). Toxicity testing in water will be performed at four locations in the watershed to assess chronic toxicity testing using both the fathead minnow (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*). Sites for aquatic toxicity monitoring were selected to provide an overall survey of the distribution of toxicity in the watershed, to coordinate with existing monitoring programs, and to characterize causes of observed toxicity.

Table A-2. Parameters Measured for the Yolo Bypass Monitoring Program

Analyte
Organophosphate Pesticides by EPA 614/8141
Chlorinated Pesticides by EPA 608/8081
Carbamates by EPA 632/8032
Mercury (total)
Methyl Mercury
Metals (Al, B, Cr, Cu, Pb, Se) - dissolved and total
Hardness
Nitrate
TOC
Color
DOC
TSS
TDS
Total & Fecal Coliform, plus E. coli
Chronic Toxicity

Assessment Tools

The QAPP and any amendments to QAPP elements will be reviewed and approved by project Quality Assurance Officers, and by the Quality Assurance Manager prior to the initiation of monitoring.

Project Schedule

The proposed schedule for Yolo Bypass monitoring is summarized in Table A-3.

Table A-3. Project Implementation Schedule for 2003-2004 Monitoring

Finalize and Execute Contracts for 2003-2004 Monitoring	11/1/03
Submit Revised QAPP to CalFed for Review	11/12/03
Receive Comments on Amended QAPP	12/8/03
Respond to CalFed Comments on Revised QAPP	12/22/03
Conditional Approval for QAPP for 2003-2004 Monitoring	11/21/03
Initiate 2003-2004 Monitoring	11/22/03
Final Approval for QAPP	12/31/03

Sampling Schedule

The sample collection frequency varies by site, flooding season, and parameter to be tested. The proposed monitoring includes six sites and six events (bimonthly) for most constituents, and 10 sites and 12 events for mercury, bacteria, and the field parameters. (Note that although there are 12 sites, under typical conditions the Fremont Weir and Sacramento Weir will not be spilling, so of the 12 sites only 10 will nominally be collectable.)

7. Quality Objectives and Criteria for Measurement Data

The objective of data collection for this program is to produce data that represent, as closely as possible, *in situ* conditions of the Yolo Bypass watershed. This objective will be achieved by using the methods specified in this QAPP to collect and analyze water samples. Assessing the program's ability to meet this objective will be accomplished by evaluating the resulting laboratory measurements in terms of detection limits, precision, accuracy, comparability, representativeness, and completeness, as presented in Section B of this document.

8. Documentation and Records

Data to be included in data reports

For each sample event, the field crew shall provide the Quality Assurance Manager with copies of relevant pages of the field logs and copies of the Chain of Custody forms for all samples submitted for analysis. At a minimum, the following sample-specific information will be provided for each sample collected:

- sample ID (unique for each sample and replicate)
- monitoring location
- sample depth
- sample type, e.g. grab or composite type (cross-sectional, flow-proportional, etc.)
- number of sub-samples in composite (if appropriate)
- QC sample type (if appropriate)
- date and time(s) of collection
- requested analyses (specific parameters or method references)

For each sample analyzed, the analyzing laboratory shall provide the Quality Assurance Manager with the following information:

- sample ID
- date of sample receipt
- dates of analysis
- analytical method(s)
- method detection limit (if appropriate)
- reporting limit (if appropriate)
- measured value of the analyte or parameter.

In addition, the analyzing laboratory shall provide results from all laboratory QC procedures (blanks, duplicates, spikes, reference materials, etc.) and the sample IDs associated with each analytical sample batch.

Reporting Format

In addition to the laboratory's standard reporting format, all results meeting data quality objectives, and results having satisfactory explanations for deviations from objectives, shall be reported in tabular format on electronic media.

B. DATA ACQUISITION

1. Sampling Design

The monitoring program includes monitoring at 10 locations in the Yolo Bypass. Four sites are located on the perennial channel, the Tule Canal (e.g., Toe Drain). Eight sites are located on major inputs to the Bypass, including two sites at flood weirs. These sites cover over 45 miles of the Yolo Bypass system and represent a drainage area of over 59,000 acres. The Yolo Bypass monitoring sites are listed in Table B-1 and illustrated in Figures B-1 and B-2.

Water quality monitoring samples will be collected as “event-based” grab samples. Table A-3 in the previous section provides a summary of sampling frequency and parameters monitored at each site.

Table B-1. Yolo Bypass Monitoring Sites

Site description	Site ID	Site Type
Sacramento River Overflow/Fremont Weir	1	Input – Sac R overflow
Knight's Landing Ridge Cut	2	Input channel
Cache Creek	3	Input creek
Willow Slough Bypass	4	Input channel
Yolo Bypass Wildlife Area – lift pump	5	Input – pumped
Putah Creek	6	Input creek
Z Drain – Dixon RCD	7	Input channel
Sacramento River Overflow/Sacramento Weir	8	Input – Sac R overflow
Tule Canal – Woodland R1	9	East side drain channel
Tule Canal – Woodland R2	10	East side drain channel
Tule Canal at north-east corner of I-80	11	East side drain channel
Toe Drain at north-east corner of Little Holland	12	East side drain channel

Figure B-1. Sampling Sites, Northern Yolo Bypass

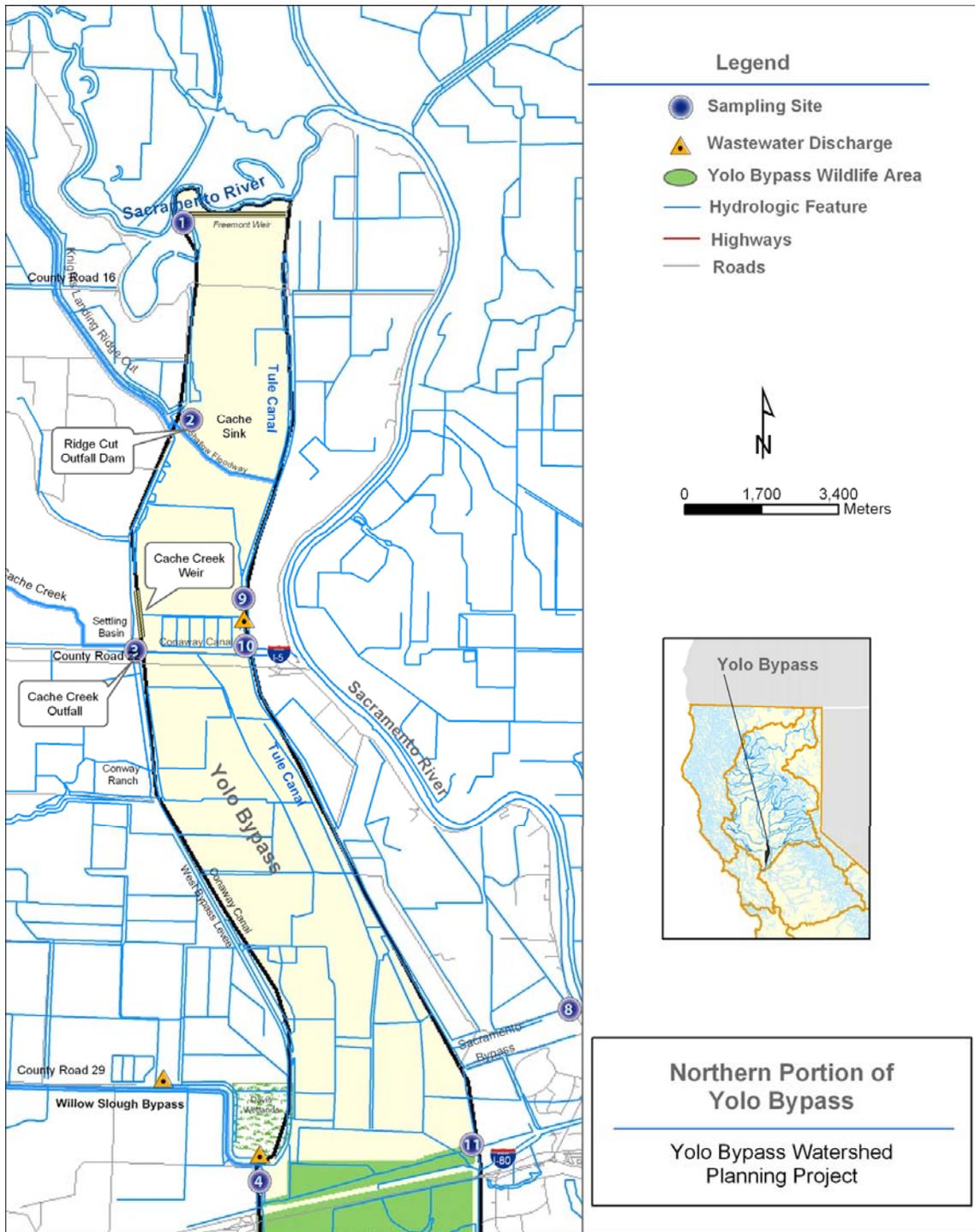
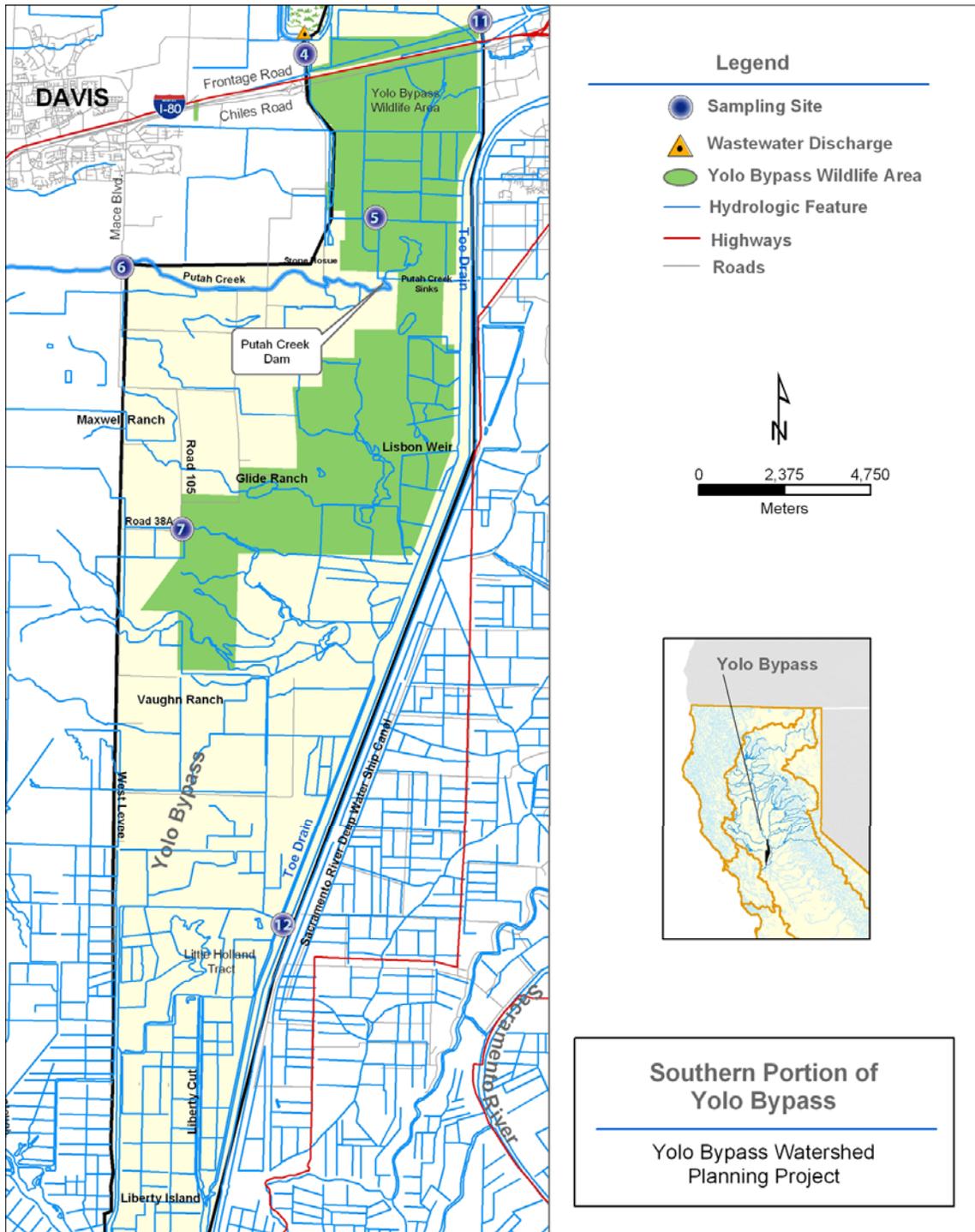


Figure B-2. Sampling Sites, Southern Yolo Bypass



2. Sampling Methods Requirements

Samples will be collected from surface waters only. Three different sample collection methods will be used for the monitoring elements in water: (1) basic water quality sampling, (2) pathogen indicator sampling, and (3) toxicity sampling. For each of these methods described or referenced, it is the combined responsibility of field crew manager to determine if the performance requirements of the specific sampling method have been met, and to collect an additional sample if required. Sampling personnel will carry copies of the QAPP and any relevant SOPs with them in the field for reference during sampling. Descriptions of specific sampling methods and requirements are provided below.

2.1 Basic Water Quality Characteristics

Basic water quality monitoring will include sampling for mercury and methylmercury, pesticides, metals (Al, B, Cu, Be, Cr, Pb, Se), hardness, total suspended solids, total dissolved solids, nitrate, total organic carbon, dissolved organic carbon, and color. Field-measured parameters (temperature, dissolved oxygen, specific conductivity, and pH) will also be measured at each site and event. Field parameters will be measured using a YSI Model 57 Oxygen Meter for dissolved oxygen, VWR Scientific Traceable Digital Thermometer (Cat. #61220416) for temperature, Orion Model 230A pH meter, and an Orion Model 130 conductivity meter, or comparable instrument(s).

All water quality samples will be collected using clean techniques that minimize sample contamination. Sampling methods will generally conform to EPA “clean” sampling methodology described in *Method 1669: Sampling Ambient Water for Trace Metals* (USEPA 1995a). Specific methods are also documented in Appendix B. Samples will generally be mid-depth grab samples and will be collected from shore using an extendable grab pole or using a peristaltic pump and acid-cleaned polyethylene or Teflon™ tubing. Grab samples will be collected directly into the required sample containers.

After collection, samples will be stored at 4°C until arrival at the contract laboratory. Samples to be analyzed for mercury will be preserved using ultrapure hydrochloric or bromochloric acid at the contract laboratory, immediately on arrival. Samples to be analyzed for other constituents will be preserved in the field, as appropriate (Table B-2).

This sample collection method requires that the sample collection tubing, and the sample bottle and lid come into contact only with surfaces known to be clean, or with the water sample. Additionally, mercury samples must have no air bubbles or head space present in the bottle immediately following sample collection. If air is present in the sample container for mercury analyses, additional sample will be aliquotted into the same sample bottle. If the performance requirements for specific samples are not met, the sample will be re-collected. If contamination of the sample container is suspected, a fresh sample container will be used.

2.2 Pathogen Indicators

Pathogen monitoring will include sampling for pathogen indicator organisms (fecal and total coliform bacteria, and *E. coli*). Samplers must wear gloves when collecting any pathogen indicator samples.

Bacteria

Samples analyzed for bacteria will be collected as near-surface grab samples from mid-stream. Sampling for bacteria will be performed according to the sampling procedures detailed for Standard Methods 9221B and 9221E (APHA *et al.* 1995). In brief, the sampling procedures are summarized as follows:

- Sample containers should be cleaned and sterilized using procedures described in Standard Methods 9030 and 9040.
- Wherein waters suspected to contain a chlorine residual, sample bottles should contain a small amount of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) sufficient to neutralize bactericidal activity. For water containing high concentrations of copper or zinc, sample bottles should contain sufficient EDTA solution to reduce metal toxicity. Note that these conditions are rare in surface waters.
- Sample bottles may be glass or plastic (e.g. polypropylene) with a capacity of at least 120 mL. Once sterilized, sample bottles are to be kept closed until they are to be filled.
- When removing caps from sample bottles, be careful to avoid contaminating inner surface of caps or bottles.
- Using aseptic techniques fill sample bottles leaving sufficient air space to facilitate mixing by shaking. Do not rinse bottles.
- Recap bottles tightly.

If at any time the sampling crew suspects that the sample or sampling container has been contaminated, the sample should be re-collected into a new sample container.

After collection, store samples at 4°C until arrival at the contract laboratory. Bacteriological tests must be set up within 6 hours from collection. The 20th edition of Standard Methods (APHA *et al.* 1995) recommends analysis of samples as soon as possible, but specifies that potable water samples analyzed for compliance purposes may be held for up to 6 hours (below 10°C) until time of analysis.

2.3 Aquatic Toxicity

Collection of water samples for analysis of ambient water column toxicity will be performed in accordance with guidance for sampling and sample handling documented in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (USEPA 1994a). In brief, the sampling requirements for toxicity testing are as follows:

- Water collected for toxicity tests will consist of grab samples.
- Samples will be collected directly into 4-L amber glass bottles, using the same equipment and procedures as for basic water quality samples (previously described in section 2.1).
- Samples will be filtered in the laboratory as required for specific toxicity tests.
- After collection, samples will be chilled and maintained at 4°C until testing.
- Toxicity tests will be initiated within 48 hours of sampling.

In some cases where significant toxicity is observed during aquatic toxicity testing, samples may be analyzed for any of the chemical parameters included in this QAPP. The specific analyses to be performed will depend on the pattern of toxicity observed, including any decision to filter samples for chemical analysis. Every effort will be made to be consistent with the sample requirements documented herein for the specific analyte. Because requirements for sample and preservation holding times, filtration, and original sample containers may not be strictly met, the results of the analyses will be used primarily for determining or confirming causes of toxicity, and will be qualified for any other use. Laboratories selected to perform these analyses must meet the same QA performance criteria used to select other laboratories for this monitoring program.

A summary of the numbers of sampling sites and events for the parameters to be analyzed is provided in Table B-3. A schedule of the sampling frequency for analytes by site and event are provided in Table B-4. The list of sampling sites in Table A-3 supersedes all lists of sampling sites included in previous versions of QAPPs or monitoring plans, approved or unapproved, relating to the monitoring described herein.

Table B-2. Sampling Requirements

Parameter	Sample Container	Sample Volume ⁽¹⁾	Immediate Processing and Storage	Holding Time ⁽²⁾
Mercury				
Total Mercury	Teflon™, or glass w/ PTFE-lined cap	250 mL	Store at 4°C; Preserve with HCl within 48 hours	28 days
Methylmercury ⁽³⁾	Teflon™, or glass w/ PTFE-lined cap	250 mL	Store at 4°C; Preserve with HCl within 48 hours	6 months
Pesticides				
Organophosphates	Amber Glass	1 Liter	Store at 4°C; Extract within 7 days	7 days
Carbamates	Amber Glass	1 Liter	Store at 4°C; Extract within 7 days	7 days
Chlorinated	Amber Glass	1 Liter	Store at 4°C; Extract within 7 days	7 days
General Constituents				
Hardness	Polyethylene	250 mL	Preserve to =pH 2 with HNO ₃ ; Store at 4°C	6 months
Total Suspended Solids	Polyethylene	200 mL	Store at 4°C;	7 days
Total Dissolved Solids	Polyethylene	100 mL	Filtered; Store at 4°C	7 days
Total Organic Carbon	Amber Glass, PTFE-lined cap	40 mL	Preserve w/ H ₂ SO ₄ ; Store at 4°C;	7 days
Dissolved Organic Carbon	Amber Glass, PTFE-lined cap	40 mL	Field-filtered ⁽³⁾ ; Preserve w/ H ₂ SO ₄ ; Store at 4°C;	7 days
Color	Polyethylene	100 mL	Store at 4°C;	48 hours
Nitrogen and Phosphorus Compounds				
Nitrate	Polyethylene	500 mL	Store at 4°C	48 hours
Pathogens				
Total & fecal coliforms, <i>E. coli</i>	Polyethylene	100 mL	Store at 4°C	6 hours ⁽⁴⁾
Toxicity				
Aquatic bioassays and chemistry ⁽⁶⁾	Amber Glass	10 L	Store at 4°C	36 hours ⁽⁵⁾
Metals				
Trace metals (total & dissolved) B, Cu, Be, Cr, Pb, Se), (Al,	Polyethylene	500 mL	Filter for dissolved fraction prior to preservation Preserve to =pH 2 with HNO ₃ ; store at 4°C	6 months

1. Additional volumes may be required for QC analyses; NA = Not Applicable
2. Holding time after initial preservation or extraction.
3. Field-filtration and preservation are preferred, but DOC samples may be filtered and preserved in the laboratory within 48 hours, if field filtration is not practical.
4. Samples for bacteria analyses should be set up as soon as possible.
5. Results for tests initiated after 36 hours will be qualified, as appropriate.
6. For interpretation of toxicity results, samples may be split from aquatic toxicity samples in the laboratory and analyzed for specific chemical parameters. All other sampling requirements (sample containers, filtration, preservation, holding times) for these samples are as specified in this document for the specific analytical method. Results of these analyses are qualified for any other use (e.g. characterization of ambient conditions) because of potential holding time exceedances and variance from sampling requirements.

Table B-3. Summary of Sampling Sites, Frequency, and Parameters.

Analyte	Laboratory	Sites	Events
Organophosphate Pesticides by EPA 614/8141	CalTest	6	6
Chlorinated Pesticides by EPA 608/8081	CalTest	6	6
Carbamates by EPA 632/8032	CalTest	6	6
Mercury (total)	Frontier	10	12
Methyl Mercury	Frontier	6	6
Metals (Al, B, Be, Cu, Cr, Pb, Se)	CalTest	6	6
Nitrate	CalTest	6	6
Hardness	CalTest	6	6
Color	CalTest	6	6
TDS	CalTest	6	6
TOC	CalTest	6	6
DOC	CalTest	6	6
TSS	CalTest	6	6
Total & Fecal Coliform, and <i>E. coli</i>	BioVir	10	12
3-Species Chronic Toxicity	TBD	4	4
Field Measurements			
Electrical Conductivity		10	12
Turbidity		10	12
Dissolved Oxygen		10	12
pH		10	12
Temperature (F)		10	12

Table B-4. Sampling Schedule for Analytes by Site and Event

SITE		EVENTS											
		Nov 1	Dec 2	Jan 3	Feb 4	March 5	April 6	May 7	June 8	July 9	Aug 10	Sept 11	Oct 12
Class	#												
Inputs	1			1, 2, 4	1, 2, 4	1, 2, 4							
	2	1, 2, 3, 4	1	1, 2, 3, 4, 5	1	1	1, 2, 3, 4, 5	1	1, 2, 3, 4	1,	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1
	3	1, 2, 3, 4	1	1, 2, 3, 4, 5	1	1	1, 2, 3, 4, 5	1	1, 2, 3, 4	1	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1
	4	1, 2, 3, 4	1	1, 2, 3, 4, 5	1	1	1, 2, 3, 4, 5	1	1, 2, 3, 4	1	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1
	5	1	1	1	1	1	1	1	1	1	1	1	1
	6	1, 2, 3, 4	1	1, 2, 3, 4	1	1	1, 2, 3, 4	1	1, 2, 3, 4	1	1, 2, 3, 4	1, 2, 3, 4	1
	7	1	1	1	1	1	1	1	1	1	1	1	1
	8			1, 2, 4	1, 2, 4	1, 2, 4							
East Channel	9	1	1	1	1	1	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1	1	1	1	1	1
	11	1, 2, 3, 4	1	1, 2, 3, 4, 5	1	1	1, 2, 3, 4, 5	1	1, 2, 3, 4	1	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1
	12	1, 2, 3, 4	1	1, 2, 3, 4	1	1	1, 2, 3, 4	1	1, 2, 3, 4	1	1, 2, 3, 4	1, 2, 3, 4	1

1 = Total Mercury and Total and fecal coliforms, including E. Coli (10/12)

2 = Methylmercury and Trace Metals (6/6)

3 = Pesticide group: Chlorinated, organophosphorus, and carbamates (6/6)

4 = General constituents: Hardness, TOC, DOC, TSS, TDS, Color, and Nitrate (6/6)

5 = Aquatic bioassay and chemistry (4/4)

Grey indicates site sampled only when weir is breached

3. Sample Handling and Custody

All samples will be packed in wet ice or frozen ice packs during shipment, so that they will be kept at approximately 4°C. Samples will be shipped in insulated containers. All caps and lids will be checked for tightness prior to shipping. All samples will be handled, prepared, transported and stored in a manner so as to minimize bulk loss, analyte loss, contamination or biological degradation. Sample containers will be clearly labeled with an indelible marker. Where appropriate, samples may be frozen to prevent biological degradation. Water samples will be kept in Teflon™, glass, or polyethylene bottles and kept cool at a temperature of 4°C until analyzed. Maximum holding times for specific analyses are listed in Table B-2.

All samples remaining after successful completion of analyses will be disposed of properly. It is the responsibility of the personnel of each analytical laboratory to ensure that all applicable regulations are followed in the disposal of samples or related chemicals.

Chain-of-custody procedures require that possession of samples be traceable from the time the samples are collected until completion and submittal of analytical results. A complete chain-of-custody form is to accompany the transfer of samples to the analyzing laboratory. A sample is considered under custody if:

- it is in actual possession;
- it is in view after in physical possession;
- it is placed in a secure area (accessible by or under the scrutiny of authorized personnel only after in possession)

With the exception of aquatic toxicity samples, samples will be kept for a minimum of 28 days after collection. The QA officer for each laboratory will evaluate the data before the end of the 28 day period. After this period, samples may be disposed of properly when all analyses have been completed, and data quality objectives have been met. Aquatic toxicity samples may be disposed of after initial testing is complete and no further analyses are warranted.

3.1 Sample Holding Times

Data quality objectives for sample holding times conform to recommendations documented in the analytical methods for individual parameters. The contract laboratory will analyze all samples before the maximum allowable holding time for any sample is exceeded. Holding times for specific parameters are presented in Table B-2.

3.2 Field Log

Field crews shall be required to keep a field log for each sampling event. The following items should be recorded in the field log for each sampling event:

- site name and/or number;
- time of sample collection;
- sample ID numbers, including etched bottle ID numbers for Teflon™ mercury sample containers and unique IDs for any replicate or blank samples;
- results of any field measurements (temperature, D.O., pH, conductivity, turbidity) and the time that measurements were made;

- qualitative descriptions of relevant water conditions (e.g. color, flow level, clarity) or weather (e.g. wind, rain) at the time of sample collection;
- description of any unusual occurrences associated with the sampling event, particularly those that may affect sample or data quality.

Appropriate pages from the sampling log will be photo-copied and transmitted to the Quality Assurance Manager at the conclusion of each sampling run.

The field crews shall have custody of samples during field sampling. Chain of custody forms will accompany all samples during shipment to contract laboratories. All water quality samples will be transported to the analytical laboratory by the field crew or by overnight courier.

3.3 Laboratory Custody Log

Laboratories shall maintain custody logs sufficient to track each sample submitted and to analyze or preserve each sample within specified holding times.

4. Analytical Methods Requirements

4.1 Basic Water Chemistry Analyses

Water quality samples may be analyzed for filtered and unfiltered fractions of mercury and methylmercury, trace elements, pesticides, and conventional water quality constituents. Analytical methods are summarized in Tables B-5 through B-8.

Field Measurements

Prior to analysis of any environmental samples, the field equipment must have demonstrated the following instrument measurement resolutions:

Parameter	Resolution
Dissolved Oxygen	0.1 standard unit
Flow (cfs)	0.1 cfs
pH	0.1 standard unit
Specific Conductivity	10 microSiemens/cm
Temperature	0.5 °C

Mercury and Trace Metals

Prior to analysis of any environmental samples for mercury, methylmercury, or other trace metals, the laboratory must have demonstrated the ability to meet the minimum performance requirements for each analytical method. Initial demonstration of laboratory capability includes the following:

- the ability to produce a detection limit equal to or less than the method detection limit (MDL) listed in Table B-5;
- the ability to generate acceptable precision and recovery, as defined by *s* and *X* in Table B-5;
- the ability to generate average recoveries within 15% of the stated concentration in a Standard Reference Material (SRM).

Procedures for analytical performance requirements, extraction procedures, and waste disposal and pollution prevention requirements are detailed in the laboratory's Standard Operating Protocols or EPA Method documents for each analytical method. EPA's recommended minimum performance requirements are summarized for each trace element in Table B-5.

Pesticides

Prior to analysis of any environmental samples for pesticides, the laboratory must have demonstrated the ability to meet the minimum performance requirements for each analytical method. Initial demonstration of laboratory capability includes the following:

- the ability to produce a reporting limit equal to or less than the reporting limit (RL) listed in Table B-6;
- the ability to generate acceptable precision and recovery, as defined by the specified method;

Procedures for demonstrating analytical performance requirements, extraction procedures, and waste disposal and pollution prevention requirements are detailed in the EPA Method documents for each analytical method. EPA's recommended minimum performance requirements are summarized in the method documents.

Conventional Constituents

Analyzing laboratories must demonstrate the ability to produce reporting limits approximately equal to or below the estimated reporting limits listed in Table B-7. Precision and replicate measurements in ambient waters should be less than 20% Relative Percent Difference for all constituents. Average recovery of appropriate reference materials should be between 80 and 120% for all constituents.

Table B-5. Trace Metals: Laboratory Performance Requirements for Analysis of Water Quality Samples for Trace Metals

Analyte	Method ⁽¹⁾	MDL ⁽²⁾ , µg/L	RL ⁽³⁾ , µg/L	Accuracy ⁽⁴⁾ , X	Precision ⁽⁵⁾ , s	MS Rec ⁽⁶⁾	MS/MSD RPD ⁽⁷⁾
Aluminum	EPA 200.8	.06	0.1	80-120	20	80-120	20
Beryllium	EPA 200.8	.7	10	80-120	20	80-120	20
Boron	EPA 200.8	0.1	0.5	80-120	20	80-120	20
Chromium	EPA 200.8	0.2	0.5	80-120	20	80-120	20
Copper	EPA 200.8	0.3	0.5	80-120	20	80-120	20
Lead	EPA 200.8	0.04	0.25	80-120	20	80-120	20
Mercury	EPA 1631 ⁽⁸⁾	0.15	0.15	75-125	25	75-125	25
Methyl-mercury	EPA 1630 ⁽⁸⁾	0.025	0.025	75-125	25	75-125	25
Selenium	EPA 200.8	0.02	0.1	80-120	20	80-120	20

(1) SOP or EPA Method number

(2) Method Detection Limit

(3) Target Project Reporting Limit

(4) X = Average recovery for demonstration of initial performance

(5) s = standard deviation of recovery for demonstration of initial performance

(6) Percent recovery of matrix spike

(7) Relative percent difference of matrix spike duplicates

(8) Mercury and methyl-mercury analytical methods may be modified by laboratory in accordance with USEPA performance-based analytical performance criteria

Table B-6 Pesticides: Analytical Methods and Estimated Reporting Limits

Analyte	RL ¹	Analyte	RL ¹
<i>Organophosphorus pesticides by EPA Method 614/8141</i>			
Azinphosmethyl	1.0	Fenthion	0.10
Bolstar	0.10	Malathion	0.10
Chlorpyrifos	0.05	Merphos	0.10
Coumaphos	0.20	Mevinphos	0.70
Def	0.10	Naled	0.50
Demeton-S	0.20	Parathion, ethyl	0.10
Diazinon	0.05	Parathion, methyl	0.10
Dichlorovos	0.20	Phorate	0.10
Dimethoate	0.10	Prowl	0.10
Disulfoton	0.10	Ronnel	0.10
EPN	0.10	Stirophos	0.10
EPTC	0.10	Tokuthion	0.10
Ethion	0.10	Trichloronate	0.10
Ethoprop	0.10	Trifluralin	0.10
Fensulfotion	0.50		
<i>Carbamate pesticides by EPA Method 632/8032</i>			
Aldicarb	0.8	Linuron	0.8
Aminocarb	0.8	Methiocarb	0.8
Barban	7.0	Methomyl	7.0
Benomyl (Carbendazim)	0.8	Mexacarbate	0.8
Bromacil	0.8	Monuron	0.8
Carbaryl	0.14	Neburon	0.8
Carbofuran	0.14	Oxamyl	7.0
Chloroprotham	7.0	Propachlor	7.0
Chloroxuron	0.8	Propoxur	0.8
Diuron	0.8	Siduron	0.8
Fenuron	0.8	Tebuthiuron	0.8
Fluometuron	0.8		
<i>Chlorinated pesticides by EPA Method 608/8081</i>			
Aldrin	0.005	Lindane	0.01
BHC-beta isomer	0.01	o,p'-DDD	0.01
Cis-Chlordane	0.01	o,p'-DDE	0.01
Dieldrin	0.01	o,p'-DDT	0.01
Endrin	0.01	p,p'-DDD	0.01
Heptachlor epoxide	0.01	p,p'-DDE	0.01
Heptachlor	0.01	p,p'-DDT	0.01
Hexachlorobenzene (HCB)	0.01		

(1) Reporting Limit for project, based on detection limits achievable by analyzing laboratory. Because detection limits are affected by differences in sample matrices, the RLs listed are estimates.

Table B-7. General Constituents: Analytical Methods and Project Reporting Limits

Constituent	Fractions	Method # (1)	RL, mg/L (2)
Suspended solids	Total	EPA 160.2	5
Hardness	Total, as CaCO ₃	EPA 130.2	5
Turbidity	Total	EPA 180.1	1.0 NTU
Dissolved solids	Dissolved	EPA 160.1	5
Nitrate	Total	EPA 300	0.05
Organic Carbon	Total, Dissolved	SM 5310 C	0.2
Color	Filtered	EPA 110.1	NA

- (1) Standard Methods (SM), EPA Method number, or reference.
 (2) Reporting Limit for project, based on detection limits achievable by analyzing laboratory

4.2 Pathogen Analyses

Water quality samples will be analyzed for fecal and total coliform bacteria, and *E. coli*. Analysis for coliform bacteria must be performed in accordance with the methods referenced in Table B-8. The laboratory must demonstrate the ability to meet the performance requirements described in this method.

Table B-8. Pathogen Indicators: Analytical Methods and Estimated Reporting Limits

Constituent	Method (1)	RL (2)
Total Coliform	SM 9221B	2 MPN/100 mL
Fecal Coliform	SM 9221E	2 MPN/100 mL
<i>E. coli</i>	SM 9221B/E mod. MUG	2 MPN/100 mL

- (1) Standard Methods (SM) number or method reference.
 (2) Reporting Limit for project.

4.3 Aquatic Toxicity Analyses

Water quality samples will be analyzed for short-term chronic toxicity using both the fathead minnow (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*). All samples are to be initially tested at the 100% solution concentration. Determination of chronic toxicity shall be performed generally as described in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (USEPA 1994).

5. Quality Control Requirements

The types of quality control assessments used in the Yolo Bypass Monitoring Program are discussed below. Quality control requirements and schedules are summarized in Tables B-9a through B-9g. Detailed procedures for preparation and analysis of quality control samples are provided in the analytical method documents. A project quality control schedule for the Yolo Bypass project is provided in Table B-10.

5.1 Qualitative Objectives

Comparability

Comparability of the data can be defined as the similarity of data generated by different monitoring programs. For the purpose of the Yolo Bypass Monitoring Program, this objective is addressed primarily by using standard sampling and analytical procedures where possible. Additionally, comparability of analytical data is addressed by analysis of standard reference materials (discussed subsequently in this document).

Representativeness

Representativeness can be defined as the degree to which the environmental data generated by the monitoring program accurately and precisely represent actual environmental conditions. For the Yolo Bypass, this objective is addressed by the overall design of the monitoring program. Specifically, assuring the representativeness of the data is addressed primarily by selecting appropriate locations, methods, times, and frequencies of sampling for each environmental parameter, and by maintaining the integrity of the sample after collection. Each of these elements of the quality assurance program are addressed elsewhere in this document.

Completeness

Data completeness is a measure of the amount of successfully collected and validated data relative to the amount of data planned to be collected for the project. Completeness is usually expressed as a percentage value. A project objective for percent completeness is typically based on the percentage of the data needed for the program or study to reach valid conclusions. Because this is a one year long monitoring program with monthly sample collection, data that are not successfully collected for a specific sample event or site can not be recollected at a later sampling event. For this reason, most of the data planned for collection are considered absolutely critical. Therefore, program personnel will strive for a 100% completion rate for the 12 months of collection. The program goals for data completeness are based on the planned sampling frequency and a subjective determination of the relative importance of the monitoring element within the Monitoring Program. As shown in Tables B-9b – B-9f, the acceptable completeness is set at 90% for laboratory sample analysis, to account for circumstances beyond the control of field personnel, such as Bypass flooding or loss of samples in shipping. The acceptable completeness for field measurements is set at 95%, as shown in Table B-9g.

5.2 Field Procedures

For basic water quality analyses, quality control samples to be prepared in the field will consist of field blanks and field duplicates. The number of field duplicates and field blanks are set to achieve an overall rate of at least 10% of all analyses for a particular parameter. The external QA samples are rotated among sites and events to achieve the overall rate of 10% field duplicate samples and 10% field blanks (as appropriate for specific analyses).

Field Blanks

The purpose of analyzing field blanks is to demonstrate that sampling procedures do not result in contamination of the environmental samples. Field blanks will be prepared and analyzed for all analytes of interest at the rate of one per sample event, along with the associated environmental samples. Field blanks will consist of laboratory-prepared blank water processed through the sampling equipment using the same procedures used for environmental samples. If any analytes of interest are detected at levels greater than the Reporting Limit (RL) for the parameter, the sampling crew should be notified so that the source of contamination can be identified (if possible) and corrective measures taken prior to the next sampling event. If the concentration in the associated samples is less than five times the value in the field blank, the results for the environmental samples may be unacceptably affected by contamination and should be qualified as an *upper limit* (UL) at the reported value.

Field Duplicates

The purpose of analyzing field duplicates is to demonstrate the precision of sampling and analytical processes. Field duplicates will be prepared at the rate of one per sampling event, and analyzed along with the associated environmental samples. Field duplicates will consist of two aliquots from the same composite sample, or of two grab samples collected in rapid succession. If the relative Percent Difference (RPD) of field duplicate results is greater than 25% and the absolute difference is greater than the RL, both samples should be reanalyzed. If an RPD greater than 25% is confirmed by reanalysis, environmental results will be qualified as *estimated*. The sampling crew should be notified so that the source of sampling variability can be identified (if possible) and corrective measures taken prior to the next sampling event.

5.3 Laboratory Analyses

For basic water quality analyses, quality control samples prepared in the contract laboratory(s) will typically consist of equipment blanks, method blanks, standard reference materials, laboratory duplicates, matrix spikes, and matrix spike duplicates. Laboratory analyses for bacteria will include negative and positive quality control samples, as specified in the method documents.

Equipment Blanks

The purpose of analyzing equipment blanks is to demonstrate that sampling equipment is free from contamination. Prior to using sampling equipment for the collection of environmental samples, the laboratory responsible for cleaning and preparation of the equipment will prepare bottle blanks and sampler blanks. These will be prepared and analyzed at the rate of one each per batch of bottles or sampling equipment. The blanks will be analyzed using the same analytical methods specified for environmental samples. If any analytes of interest are detected at levels greater than the MDL, the source(s) of contamination should be identified and corrected, the

affected batch of bottles or equipment should be re-cleaned, and new equipment blanks should be prepared and analyzed.

Bottle blanks will consist of one of each type of sample container required for water quality analyses, selected randomly from the set of available bottles. The bottles will be filled with laboratory-prepared blank water (acidified to pH < 2 for metals samples) and allowed to stand for a minimum of 24 hours before analysis.

Sampler blanks will consist of laboratory-prepared blank water processed through the sampling equipment using the same procedures used for environmental samples.

Note that these procedures will not be necessary if grab samples are collected by direct submersion of sample bottles, without intermediate sampling equipment.

Method Blanks

The purpose of analyzing method blanks is to demonstrate that the analytical procedures do not result in sample contamination. Method blanks will be prepared and analyzed by the contract laboratory at a rate of at least one for each analytical batch. Method blanks will consist of laboratory-prepared blank water processed along with the batch of environmental samples. The method blank should be prepared and analyzed before analysis of the associated environmental samples. If the result for a single method blank is greater than the MDL, or if the average blank concentration plus two standard deviations of three or more blanks is greater than the RL, the source(s) of contamination should be corrected, and the associated samples should be reanalyzed. If reanalysis is not possible, the associated sample results should be qualified as an *upper limit* (UL) at the reported value.

Laboratory Control Samples

The purpose of analyzing laboratory control samples is to demonstrate the accuracy of the analytical method. Laboratory control samples will be analyzed at the rate of one per sample batch. Laboratory control samples will consist of laboratory fortified method blanks. If recovery of any analyte is outside the acceptable range for accuracy, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and the laboratory control sample should be reanalyzed. If reanalysis is not possible, the associated sample results should be qualified as *low or high biased*.

Laboratory Duplicates

The purpose of analyzing laboratory duplicates is to demonstrate the precision of the analytical method. Laboratory duplicates will be analyzed at the rate of one pair per sample batch. Laboratory duplicates will consist of duplicate laboratory fortified method blanks. If the RPD for any analyte is greater than the precision criterion *and* the absolute difference between duplicates is greater than the RL, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and laboratory duplicates should be reanalyzed. If reanalysis is not possible, the associated sample results should be qualified as *not reproducible* due to analytical variability.

Matrix Spikes and Matrix Spike Duplicates

The purpose of analyzing matrix spikes and matrix spike duplicates is to demonstrate the performance of the analytical method in a particular sample matrix. Matrix spikes and matrix spike duplicates will be analyzed at the rate of one pair per sample batch. Each matrix spike and matrix spike duplicate will consist of an aliquot of laboratory-fortified environmental sample. Spike concentrations should be added at between 2 to 10 times the expected sample value. If matrix spike recovery of any analyte is outside the acceptable range, the results for that analyte have failed the acceptance criteria. If recovery of laboratory control samples is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. Attempt to correct the problem (by dilution, concentration, etc.) and re-analyze the samples and the matrix spikes. If the matrix problem can't be corrected, qualify the results for that analyte as appropriate (*low or high biased*) due to matrix interference.

If matrix spike duplicate RPD for any analyte is greater than the precision criterion, the results for that analyte have failed the acceptance criteria. If the RPD for laboratory duplicates is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. Attempt to correct the problem (by dilution, concentration, etc.) and re-analyze the samples and the matrix spike duplicates. If the matrix problem can't be corrected, qualify the results for that analyte as *not reproducible*, due to matrix interference.

Aquatic Toxicity Quality Control

For aquatic toxicity tests, the acceptability of test results is determined primarily by performance-based criteria for test organisms, culture and test conditions, and the results of control bioassays. Control bioassays include testing with reference toxicants, and negative and solvent controls.

In addition to the QA requirements for the toxicity testing methods, a minimum of ten percent of the samples collected for aquatic toxicity testing will be reserved for other QC analyses. These analyses will consist of interlaboratory splits, field duplicates, or spiked samples. At least one laboratory split analyses will be performed during the monitoring year, *if possible*. If no appropriate laboratories are willing to perform these analyses at a reasonable cost, these QA samples will be analyzed as field duplicates by Aqua Science. Field duplicate samples analyzed for aquatic toxicity will also serve as field duplicates for alkalinity and hardness analyses. Although the laboratory has no formal limit of acceptability for analysis of spiked samples, the pattern and progress of toxic responses are evaluated subjectively for consistency with expected responses for the level of the spiked compound. Acceptable results for tests with blanks are no significant toxicity.

Table B-9a. Project Quality Control Requirements for Analysis of Water Quality Samples: Frequency¹ and Numbers of Field Quality Assurance Samples for Mercury, Organic Carbon, General Water Quality Constituents, Pesticides, and Pathogen Indicators.

Parameter(s)	Field Duplicates	Field Blanks	Total QA Samples
Mercury	12 (1 per event)	12 (1 per event)	24
Methylmercury	12 (1 per event)	12 (1 per event)	24
Hardness	6 (1 per event)	0	6
TOC and DOC	6 (1 each per event)	6 (1 per event)	12
Color	6 (1 per event)	0	6
TSS	6 (1 per event)	0	6
TDS	6 (1 per event)	0	6
Nitrate	6 (1 per event)	6 (1 per event)	12
OP Pesticides	6 (1 per event)	6 (1 per event)	12
Carbamate Pesticides	6 (1 per event)	6 (1 per event)	12
Chlorinated Pesticides	6 (1 per event)	6 (1 per event)	12
Trace Metals	6 (1 per event)	6 (1 per event)	12
Fecal coliform	12 (1 per event)	12 (1 per event)	24

(1) External QA samples are rotated among sites to provide at least one field duplicate sample and one field blank per event for a particular parameter (as appropriate for specific analyses).

Table B-9b. Project Quality Control Requirements for Analysis of Water Quality Samples: Trace Metals, Organic Carbon, and General Water Quality Constituents.

QA Procedure	QA Parameter	Frequency ¹	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle lot, reagent lot, or equipment lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	Various, see Table B-8a	< RL <i>or</i> < sample ÷ 5	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	Various, see Table B-8a	RPD ≤ 25% if Difference ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Method Blank	Contamination	≥1 per batch, (trace metals and OC)	< MDL <i>or</i> , if n ≥ 3, avg ± 2 s.d. < RL	Identify contamination source. Reanalyze method blank and all samples in batch.
LCS or SRM	Accuracy	1 per batch	80-120% REC	Recalibrate and reanalyze LCS or SRM and samples
Lab Duplicate	Precision	1 per batch	RPD ≤ 20% if Difference ≥ RL	Recalibrate and reanalyze.
Matrix Spike	Accuracy	1 per batch	80-120% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike Duplicate	Precision	1 per batch	RPD ≤ 20%	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

- (1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.
The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table B-9c. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Chlorinated Pesticide Analyses by EPA Method 608.

QA Procedure	QA Parameter	Frequency ¹	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	1 per event	< RL <i>or</i> < (sample ÷ 5)	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per event	RPD ≤ 25% if Difference ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Matrix Spike & LCS	Accuracy	1 per batch	28-163% REC 60-117% REC 60-150% REC 76-140% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike & LCS Duplicates: BHC-alpha isomer BHC-beta isomer Cis-Chlordane Dieldrin Endrin Heptachlor epoxide Heptachlor Hexachlorobenzene (HCB) Lindane o,p'-DDD o,p'-DDE o,p'-DDT p,p'-DDD p,p'-DDE p,p'-DDT Trans-chlordane	Precision	1 per batch	31% RPD 25% RPD	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

- (1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.
The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table B-9d. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Organophosphorus Pesticide Analyses by EPA Method 614.

QA Procedure	QA Parameter	Frequency ¹	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent lot	< MDL	Identify contamination source. Reclean equipment. □ Reanalyze blank(s).
Field Blanks	Contamination	1 per event	< RL <i>or</i> < (sample ÷ 5)	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per event	RPD ≤ 25% if Difference ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Matrix Spike & LCS Phorate Diazinon Disulfoton Methyl Parathion Stirophos Ethion Tributylphosphate Triphenylphosphate	Accuracy	1 per batch	22-96% REC 57-130% REC 47-117% REC 55-164% REC 68-128% REC 65-134% REC 60-150% REC 76-140% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike & LCS Duplicates: Phorate Diazinon Disulfoton Methyl Parathion Stirophos Ethion	Precision	1 per batch	24% RPD 21% RPD 22% RPD 24% RPD 25% RPD 20% RPD	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

- (1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.
The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table B-9e. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Carbamate Pesticide Analyses by EPA Method 632.

QA Procedure	QA Parameter	Frequency ¹	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	1 per event	< RL <i>or</i> < (sample ÷ 5)	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per event	RPD ≤ 25% if Difference ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Matrix Spike & LCS Methomyl Bromacil Neburon Oryzalin	Accuracy	1 per batch	37-113% REC 58-111% REC 55-132% REC 40-140% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike & LCS Duplicates: Methomyl Bromacil Neburon	Precision	1 per batch	25% RPD 25% RPD 25% RPD	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

- (1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.
The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table B-9f. Project Quality Control Requirements for Analysis of Water Quality Samples for Pathogens and Pathogen Indicators.

QA Procedure	Parameter	Frequency ¹	Criterion	Corrective Action
Field Blanks	Contamination	1 per event	< RL <i>or</i> < sample ÷ 5	Examine field log. Identify contamination source. Qualify data as needed.
Method Blanks (Sterility Checks)	Contamination	1 per batch	< RL	Identify contamination source. Clean equipment and slides. Check reagents. Re-analyze blank.
Lab Duplicate	Precision ²	1 per 10 samples, and at least 1 per batch	$R_{log} \leq 3.27 \cdot \text{mean } R_{Log}$	Recalibrate and reanalyze.
Negative Control Samples	Contamination	1 per culture medium or reagent lot	< RL	Identify source. Clean equipment and prepare new media. Re-examine negative control
Positive Control Samples	Assay function	1 per culture medium or reagent lot	\geq RL	Identify and correct problem. Re-examine positive control.
Assess percent of data successfully collected	Data Completeness	1 per planned sample event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

(1) The method documentation defines an analytical batch as an “uninterrupted series of analyses”.

(2) R_{log} is the absolute difference between logarithms of coliform counts for duplicate analyses. The mean R_{log} is determined by performing duplicate analyses on the first 15 positive sample analyzed for each matrix type.

Table B-9g. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Field Measurements.

QA Procedure	QA Parameter	Frequency ¹	Criterion	Corrective Action
Field Duplicate	Precision	1 per event	$RPD \leq 25\%$	Reanalyze both samples. Identify variability source. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	95%	Reschedule sample events as necessary or appropriate.

Notes: RPD = Relative Percent Difference;

Table B-10. Project Quality Control Schedule

SITE	EVENTS											
	Nov 1	Dec 2	Jan 3	Feb 4	March 5	April 6	May 7	June 8	July 9	Aug 10	Sept 11	Oct 12
1												
2	FB/FD									MS/MSD		
3		FB/FD							MS/MSD			
4			FB/FD					MS/MSD				
5				FB/FD			MS/MSD					
6					FB/FD	MS/MSD					MS/MSD	
7					MS/MSD	FB/FD					FB/FD	
8												
9				MS/MSD			FB/FD					
10			MS/MSD					FB/FD				
11		MS/MSD							FB/FD			MS/MSD
12	MS/MSD									FB/FD		FB/FD

FB = Field Blank

FD = Field Duplicate

MS/MSD = Matrix Spike/Matrix Spike Duplicate

5.4 Sample Equipment Cleaning Procedures

Equipment used for sample collection (peristaltic pump tubing, carboys and carboy caps, and sample bottles) will be cleaned according to the specific procedures documented for each analytical method.

A minimum of one equipment blank will be generated and analyzed for mercury and methylmercury prior to initiating monitoring for the current program year, and additional equipment blanks will be analyzed for new lots of critical cleaning reagents. In addition, for all analytes where contamination is considered a significant concern, field blanks will be collected and analyzed as directed in Section B-5 of this document. If the results of these analyses indicate any contamination, the source will be identified and corrected, and the equipment will be re-cleaned and re-tested. The combined regimen of equipment blanks and field blanks is considered to provide adequate control against potential systematic equipment contamination problems.

5.5 Analytical Instrument and Equipment Testing Procedures and Corrective Actions

Testing, inspection, maintenance of analytical equipment used by the contract laboratory, and corrective actions are documented in the Quality Assurance manuals for each analyzing laboratory. Laboratory QA Manuals are made available for review at the analyzing laboratory.

6. Calibration Procedures and Frequency

6.1 Laboratory Analytical Equipment

Frequency and procedures for calibration of analytical equipment used by each contract laboratory is documented in the Quality Assurance Manual for each contract laboratory. Laboratory QA Manuals are made available for review at the analyzing laboratory.

6.2 Field Instruments

Calibration of all instruments used for measurement of field parameters (temperature, pH, dissolved oxygen, and electroconductivity) are performed as described in the owner's manuals for individual instruments. Instruments used to measure pH, dissolved oxygen, and electroconductivity should be calibrated prior to taking field measurements at each site for each event. Typical field instrument calibration procedures are as follows:

- Temperature calibration is factory-set and requires no subsequent calibration.
- Calibration for pH measurement is accomplished using standard buffer solutions.
- Calibration for dissolved oxygen measurements is accomplished using an oxygen-saturated water sample.
- Calibration for electroconductivity measurements is generally accomplished using potassium chloride standard solutions.

7. Inspection/Acceptance Requirements for Supplies and Consumables

Gloves, sample containers, and any other consumable equipment used for sampling will be inspected by the sampling crew on receipt and will be rejected/returned if any obvious signs of contamination (torn packages, etc.) are observed. Inspection protocols and acceptance criteria for laboratory analytical reagents and other consumables are documented in the Quality Assurance Manuals for individual laboratories. Laboratory QA Manuals are made available for review at the analyzing laboratories.

8. Quality Control Requirements for Indirect Measurements

Water quality data collected by this monitoring program is intended to complement data collected by several other programs, including NAWQA, and receiving water monitoring conducted by the City of Woodland, the City of Davis, and the University of California at Davis.

9. Data Management

Copies of field logs, copies of chain of custody forms, original preliminary and final lab reports, and electronic media reports will be sent to the Quality Assurance Manager. Each type of report will be stored separately and ordered chronologically. The field crew will retain original field logs. The contract laboratory will retain original chain of custody forms. The contract laboratory(s) will retain copies of the preliminary and final data reports.

Concentrations of chemicals and toxicity endpoints, and all numerical biological parameters will be calculated as described in the laboratory Standard Operating Procedures or referenced method document for each analyte or parameter.

The various data and information generated from the Yolo Bypass Monitoring Program will be stored and maintained at the Monitoring Program Manager's offices (Larry Walker Associates). The data generated from the monitoring program will be transmitted to the Quality Assurance Manager in various formats and converted to a standard database format maintained on personal computers in the Monitoring Program Manager's office. After data entry or data transfer procedures are completed for each sample event, data will be inspected for data transcription errors, and corrected as appropriate. After the final QA checks for errors are completed, the data are added to the final database. Data tables are generated from this database.

In cases where environmental results are less than the reporting limit for a parameter, the results will be reported as "less than" the reporting limit; e.g. an analytical result of 4 µg/L for an analyte with a reporting limit of 5 µg/L will be reported as <5 µg/L. In cases where field blank results exceed the acceptance criteria listed in Table B-0.1, data collected during the associated sample run will be qualified and reported as follows:

- Measured environmental sample concentrations greater than or equal to 5 times the field blank level will be reported with no qualification.

- Measured environmental sample concentrations less than 5 times the field blank level will be qualified as “less than” the measured value, e.g. if a field blank is equal to 1.5 µg/L, a measured environmental concentration of 4.0 µg/L will be reported as <4.0 µg/L.
- Any data qualifications resulting from QC analyses will be reported with the environmental data as appropriate.

C. ASSESSMENT AND OVERSIGHT

1. Assessments and Response Actions

Assessments of compliance with quality control procedures will be undertaken on a routine basis during the data collection phase of the project:

- Performance assessments of sampling procedures will be performed by the field sampling crews. Corrective actions shall be carried out by the field sampling crew and reported to the Quality Assurance Manager.
- Assessment of laboratory QC results and implementation of corrective actions will be the responsibility of the QA officer at each laboratory and shall be reported to the Quality Assurance Manager as part of any data reports.
- Assessment of field QC results and implementation of corrective actions shall be the responsibility of the Quality Assurance Manager.

Routine procedures to assess precision and accuracy, criteria for success, and corrective actions have been discussed previously (Section B) and are summarized in Table B-9a through B-9f.

Monthly status reports will be produced by the Monitoring Program Manager to document project status, results of performance evaluations, data quality assessments, and any significant QA problems and recommended solutions. Monthly status reports will be distributed to the Project Manager and the CalFed liaison officer.

2. Quality Assurance Reports to Management

On completion of the monitoring season, a quality assurance report will be prepared by the Quality Assurance Manager, as part of the annual report produced for the Yolo Bypass. The quality assurance report will summarize the results of QA/QC assessments and evaluations, including precision, accuracy, comparability, representativeness, and completeness of the monitoring data. The annual report will be distributed to the project managers, stakeholder group members, and interested parties.

D. DATA VALIDATION AND USABILITY

1. Data Review, Validation, and Verification

In addition to the data quality objectives presented in Tables B-9a through B-9f, the standard data validation procedures documented in the contract laboratory's Quality Assurance Manuals will be used to accept, reject, or qualify the data generated by the laboratory. Laboratory's QA officer will be responsible for validating data generated by the laboratory. The field monitoring coordinator will be responsible for initial verification of data submitted by analyzing labs, including electronic data reports. The Quality Assurance Manager will be responsible for final validation and for qualifying all data based on the evaluation of field and laboratory quality control samples.

Mercury and methyl-mercury data shall be reviewed to evaluate whether the data are reasonable; i.e, methyl-mercury concentrations should not exceed the corresponding total mercury concentrations.

2. Data Reporting

Laboratory personnel will verify that the measurement process was "in control" (i.e., all specified data quality objectives were met or acceptable deviations explained) for each batch of samples before proceeding with the analysis of a subsequent batch. In addition, each laboratory will establish a system for detecting and reducing transcription and/or calculation errors prior to reporting data.

The laboratory will only consider submitted data that have met data quality objectives, or have acceptable deviations explained. When QA requirements have not been met, the samples will be reanalyzed when possible and only the results of the reanalysis will be submitted, provided they are acceptable.

For mercury and methyl-mercury, all laboratory QA information will be reported along with the analytical results.

E. REFERENCES

- APHA, AWWA, and WEF 1995. Standard Methods for the Examination of Water and Wastewater, 19th Edition. American Public Health Association (APHA), American Waterworks Association (AWWA), and Water Environment Association (WEF). Washington, DC.
- USEPA 1979. Handbook for Analytical Quality Control in Water and Wastewater Laboratories. U.S. Environmental Protection Agency (USEPA). EPA 600-4-79-019.
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- USEPA 1994. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms (EPA 600/4-91-002). U.S. Environmental Protection Agency (USEPA), Office of Research and Development. July 1994.
- USEPA 1995. Guidance on the Documentation and Evaluation of Trace Metals Data Collected for Clean Water Act Compliance Monitoring. EPA 821-B-95-002. U.S. Environmental Protection Agency, Office of Water, Washington DC.
- USEPA 1995. Method 1631: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry. U.S. Environmental Protection Agency (USEPA), Office of Water. EPA 821-R 95-027.
- USEPA 1995. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. U.S. Environmental Protection Agency (USEPA), Office of Water. EPA 821-R-95-034.
- USEPA 2001. Method 1630 (*DRAFT*): Methyl Mercury in Water by Distillation, Aqueous Purge and Trap, and CVAFS. EPA-821-R-01-020. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

APPENDIX 6. PROJECT MONITORING RESULTS AND SUMMARY STATISTICS

Appendix 6-A. Analytical Results for Samples Collected During the Study Period

Water Column Samples

Electrical Conductivity (uS/cm)

Site #	Sampling Site	Results											
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT
1	Fremont Weir				158								
2	Ridge Cut	491	491	569	319	826	731	923	985	1109	964	888	688
3	Cache Creek	562	570	585	334	602	741	470	280	675	555	802	570
4	Willow Slough Bypass	1596	1352	1120	608	1107	890	640	812	925	1267	917	775
5	YB Wildlife Area	760	615	560			603	664	592	361	732	920	830
6	Putah Creek	611	522	514	359	365	853	504	480	472	541	651	421
7	Z Drain	610	764	797	790	1087	996	447	411	415	540	595	538
8	Sacramento Weir				81								
9	Woodland R1	513	520	578	80	916	498	564	668	634	545	541	665
10	Woodland R2	896	485	560	158	789	603	770	817	842	614	640	878
11	Tule Canal @ 80	686	530	620	210	615	702	895	760	823	840	827	752
12	Toe Drain	827		590		479	514	310	210	193	278	1013	260

Hardness (mg/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	180	190	270	390	660	280
3	Cache Creek	230	240	300	140	260	340
4	Willow Slough Bypass	390	400	330	260	390	310
6	Putah Creek	220	270	220	280	250	240
11	Tule Canal @ 80	200	220	190	290	280	250
12	Toe Drain	240	210	230	100	160	310

Total Organic Carbon (mg/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEP
2	Ridge Cut	4	9	10	4	5	5
3	Cache Creek	3	3	5	3	4	8
4	Willow Slough Bypass	8	15	8	8	11	12
6	Putah Creek	2	5	6	5	4	10
11	Tule Canal @ 80	4	9	8	7	9	9
12	Toe Drain	11	7	6	5	8	11

Dissolved Organic Carbon (mg/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEP
2	Ridge Cut	4	8	9	4	9	8
3	Cache Creek	ND	6	4	4	6	10
4	Willow Slough Bypass	7	7	7	8	9	13
6	Putah Creek	ND	4	5	4	6	6
11	Tule Canal @ 80	6	7	7	6	8	9
12	Toe Drain	10	8	8	4	6	9

Color (cu)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEP
2	Ridge Cut	70	85	85	150	140	200
3	Cache Creek	35	40	28	120	70	250
4	Willow Slough Bypass	100	40	50	130	200	17
6	Putah Creek	20	15	12	80	20	400
11	Tule Canal @ 80	70	70	80	130	60	200
12	Toe Drain	60	65	50	170	160	400

Total Dissolved Solids (mg/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEP
2	Ridge Cut	340	370	390	680	650	570
3	Cache Creek	340	350	380	200	360	520
4	Willow Slough Bypass	880	740	440	500	710	650
6	Putah Creek	330	330	250	270	250	360
11	Tule Canal @ 80	460	360	290	570	460	480
12	Toe Drain	440	360	330	190	180	580

Total Suspended Solids (mg/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEP
2	Ridge Cut	69	46	76	88	80	46
3	Cache Creek	46	40	25	62	16	18
4	Willow Slough Bypass	53	40	58	32	64	110
6	Putah Creek	ND	9	12	14	8	3
11	Tule Canal @ 80	42	50	80	80	38	58
12	Toe Drain	37	66	52	96	36	62

Fecal Coliform (MPN/100ml)

Site #	Sampling Site	Results											
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT
1	Fremont Weir				3000								
2	Ridge Cut	20 <20		2	2800 <20		20	3000	1300	50	1700	90	50
3	Cache Creek	70	40	50	34	20	20	3000	80	1300	50	1700	5000
4	Willow Slough Bypass	1400	50000	17000	4000	40	70	1400	3000	13000	3000	17000	2400
5	YB Wildlife Area	20	20	50			40	40	80	60	30		2200
6	Putah Creek	20	20	50	70	1100	40	1700	1100	90	230	1700	23
7	Z Drain	80	5000	50	2400	20	11000	6000	5000	5000	30000	14000	50
8	Sacramento Weir				9000								
9	Woodland R1	1300	20	30	16000	40	20	8000	1300	50	3000	2200	50
10	Woodland R2	1700	40	70	17000	70	20	1700	1100	80	2400	1000	2400
11	Tule Canal @ 80	80	20	17	5000	9000	20	2200	80	50	1700	5000	1100
12	Toe Drain	40		1100		17000 <20		40	23	50	30	50	5000

E. Coli (MPN/100ml)

Site #	Sampling Site	Results											
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT
1	Fremont Weir				3000								
2	Ridge Cut	20	<20	2	2,800	<20	20	3,000	1,300	50	30	60	50
3	Cache Creek	70	40	17	34	20	20	3,000	22	1,300	50	1,700	5,000
4	Willow Slough Bypass	1,400	50,000	1,700	4,000	40	70	1,400	1,700	8,000	3,000	8,000	11,000
5	YB Wildlife Area	20	20	50			40	20	80	60	17		30
6	Putah Creek	20	20	30	70	1,100	40	1,700	30	50	13	8	23
7	Z Drain	80	5,000	21	2,400	20	11,000	6,000	5,000	5,000	30,000	9,000	50
8	Sacramento Weir				5,000								
9	Woodland R1	1,300	20	30	16,000	40	20	5,000	22	50	27	1,700	50
10	Woodland R2	1,700	20	50	17,000	70	20	1,700	70	80	17	1,000	80
11	Tule Canal @ 80	80	20	11	3,000	900	20	2,200	80	30	80	50	1,100
12	Toe Drain	40		1,100		17,000	<20	40	23	50	30	50	2,200

Total Coliform (MPN/100ml)

Site #	Sampling Site	Results											
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT
1	Fremont Weir				500								
2	Ridge Cut	2,700	17,000	21	1,600	17,000	17,000	17,000	3,000	3,000	3,000	3,000	3,000
3	Cache Creek	8,000	7,000	2,200	1,200	600	5,000	17,000	3,000	3,000	3,000	3,000	17,000
4	Willow Slough Bypass	30,000	50,000	9,000	160,000	11,000	3,000	80,000	1,400	1,400	1,400	1,400	50,000
5	YB Wildlife Area	2,300	1,700	1,100			3,000	3,000	40	40	40		50,000
6	Putah Creek	40	1,700	80	3,500	8,000	8,000	24,000	1,700	1,700	1,700	1,700	3,000
7	Z Drain	8,000	17,000	1,700	3,000	13,000	17,000	220,000	6,000	6,000	6,000	6,000	90,000
8	Sacramento Weir				11,000								
9	Woodland R1	3,000	2,600	1,400	300,000	5,000	5,000	160,000	8,000	8,000	8,000	8,000	5,000
10	Woodland R2	5,000	1,700	1,100	900,000	9,000		17,000	1,700	1,700	1,700	1,700	5,000
11	Tule Canal @ 80	8,000	3,000	9,000	17,000	170,000	3,000	33,000	2,200	2,200	2,200	2,200	16,000
12	Toe Drain	1,700		170,000		160,000	3,000	24,000	40	40	40	40	16,000

TOTAL ALUMINUM (ug/L)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	1200	1500	2200	3300	2100	700
3	Cache Creek	1800	700	800	2800	1200	500
4	Willow Slough Bypass	1600	800	1800	1800	2400	4100
6	Putah Creek	110	230	450	1800	140	70
11	Tule Canal @ 80	1800	1700	3000	2800	1300	1800
12	Toe Drain	1600	2600	2300	6000	3200	2800

DISSOLVED ALUMINUM (ug/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	-10	20	20	-10	-10	-10
3	Cache Creek	-10	-10	10	20	-10	-10
4	Willow Slough Bypass	-10	-10	10	-10	-10	-10
6	Putah Creek	-10	-10	10	-10	-10	-10
11	Tule Canal @ 80	-10	10	10	-10	-10	-10
12	Toe Drain	-10	20	20	20	20	-10

TOTAL BORON (ug/L)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	250	200	910	2700	2400	1000
3	Cache Creek	1700	1400	1700	550	1200	2300
4	Willow Slough Bypass	1300	1700	1400	1400	1400	1500
6	Putah Creek	350	400	390	1400	840	510
11	Tule Canal @ 80	1100	800	550	1700	1100	1000
12	Toe Drain	1700	700	550	140	170	1700

DISSOLVED BORON (ug/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	260	200	880	2,700	2,200	1,400
3	Cache Creek	1,600	1,300	1,700	490	1,200	2,400
4	Willow Slough	1,300	1,500	1,300	1,300	1,400	1,400
6	Putah Creek	340	400	360	430	390	500
11	Tule Canal @ 80	1,000	700	530	1,500	1,100	1,000
12	Toe Drain	800	700	510	130	140	1,700

Nitrate as N (mg/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	0	1.1	0	2	0	0
3	Cache Creek	0.8	5.4	2	0	0	1
4	Willow Slough Bypass	0.3	0.3	0	1	0	1
6	Putah Creek	1.3	1.3	2	1	1	1
11	Tule Canal @ 80	1.0	0.3	1	1	1	1
12	Toe Drain	0.2	0.8	1	0	0	3

TOTAL CHROMIUM(III) (ug/L)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
3	Cache Creek	9	3.8	6.2	13	6.6	2.7
6	Putah Creek	4	4.4	6	6.2	2.3	2.8
2	Ridge Cut	4	4.1	8	15	8.5	8.9
12	Toe Drain	8	8.3	8.6	19	12	6.0
11	Tule Canal @ 80	7	5.7	10	10	5.3	1.1
4	Willow Slough Bypass	7	2.7	6.3	5.9	10	14

DISSOLVED CHROMIUM(III) (ug/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	0.4	1.0	1.2	2.5	0.9	0.8
3	Cache Cre	1.2	2.2	3.4	1.1	1.4	1.1
4	Willow Slo	1.6	2.2	1.5	1.4	2.9	1.2
6	Putah Cree	4.0	4.8	4.5	3.1	1.6	1.9
11	Tule Canal	0.5	2.1	1.3	1.2	1.7	0.6
12	Toe Drain	0.8	1.3	1.7	1.1	1.0	0.8

TOTAL COPPER (ug/L)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	4	5.9	8	9	7	3
3	Cache Creek	5	3.5	3	8	5	3
4	Willow Slough Bypass	7	4.6	5	5	9	11
6	Putah Creek	2	1.8	3	5	2	2
11	Tule Canal @ 80	8	6	9	9	6	6
12	Toe Drain	5	7.4	7	12	8	9

DISSOLVED COPPER (ug/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	2.4	2.5	3.6	2.2	2.5	2.0
3	Cache Cre	1.4	1.6	1.3	1.7	1.8	2.3
4	Willow Slo	3.4	3.2	1.7	1.8	3.3	2.8
6	Putah Cree	1.9	1.7	1.5	1.6	1.7	1.4
11	Tule Canal	3.1	2.5	2.5	2.7	2.4	2.3
12	Toe Drain	2.4	2.8	2.7	2.5	2.8	4.5

TOTAL LEAD (ug/L)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	0.53	0.98	1	2	1	0
3	Cache Creek	0.70	0.40	0	2	1	1
4	Willow Slough Bypass	0.83	0.53	1	1	2	2
6	Putah Creek	0	0	0	1	0	0
11	Tule Canal @ 80	0.91	0.91	1	1	1	1
12	Toe Drain	0.65	1.3	1	2	1	1

DISSOLVED LEAD (ug/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	-0.3	-0.3	0.3	-0.25	-0.25	0.25
3	Cache Cree	-0.3	-0.3	0.3	-0.25	-0.25	-0.25
4	Willow Slo	-0.3	-0.3	0.3	-0.25	-0.25	-0.25
6	Putah Cree	-0.3	-0.3	0.3	-0.25	-0.25	-0.25
11	Tule Canal	-0.3	-0.3	0.3	-0.25	-0.25	-0.25
12	Toe Drain	-0.3	-0.3	0.3	-0.25	-0.25	-0.25

TOTAL SELENIUM (ug/L)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	1	-1	2	5	5	2
3	Cache Creek	1	-1	1	-1	2	3
4	Willow Slough Bypass	3	2	5	1	3	2
6	Putah Creek	1	-1	1	1	1	1
11	Tule Canal @ 80	1	1	2	1	1	1
12	Toe Drain	1	-1	1	-1	1	1

DISSOLVED SELENIUM (ug/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	1	-2	2	6	4	-2
3	Cache Cree	1	-2	1	1	1	-2
4	Willow Slo	2	2	4	3	3	-2
6	Putah Cree	1	-2	1	1	1	-2
11	Tule Canal	1	-2	1	2	1	-2
12	Toe Drain	-1	-2	1	1	1	-2

Total Mercury (ng/l)

Site #	Sampling Site	Results												
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	
1	Fremont Weir				25									
2	Ridge Cut	4	3	5	10	6	6	15	27	12	10	4	6	
3	Cache Creek	15	13	12	34	11	6	23	25	13	16	7	13	
4	Willow Slough Bypass	9	3	4	11	7	8	15	11	12	16	18	10	
5	YB Wildlife Area	8	11	12			10	30	43	18	22	14	8	
6	Putah Creek	1	3	3	17	3	6	10	8	3	6	2	3	
7	Z Drain	6	7	5	6	6	4	10	15	11	12	12	10	
8	Sacramento Weir				18									
9	Woodland R1	5	5	7	37	6	9	12	11	9	9	15	6	
10	Woodland R2	9	5	9	30	10	10	12	10	8	9	13	7	
11	Tule Canal @ 80	8	8	12	41	12	10	19	17	10	10	9	8	
12	Toe Drain	9		19		8	13	27	25	19	16	15	14	

Methylmercury (ng/l)

Site #	Sampling Site	Results					
		NOV	JAN	APR	JUN	AUG	SEPT
2	Ridge Cut	0.3	0.3	0.2	0.3	0.6	0.2
3	Cache Creek	0.3	1.1	0.3	0.6	0.5	0.3
4	Willow Slough Bypass	0.4	0.2	0.3	0.3	0.4	0.3
6	Putah Creek	0.1	0.1	0.1	0.3	0.2	0.1
11	Tule Canal @ 80	0.3	0.5	0.3	0.4	0.4	0.2
12	Toe Drain	0.1	0.9	0.3	0.3	0.1	0.2

Streambed Sediment Samples

Effects of Yolo Bypass sediment samples on *Hyalella azteca* survival and growth.

Sample ID	Mean % Survival	Mean Weight (mg, dry wt)
Control	97.5	0.15
Ridge Cut	87.5*	0.13*
Tule Canal	96.2	0.14
Putah Creek	97.5	0.14
Willow Slough	93.8	0.14
Cache Creek	96.2	0.18
Toe Drain	97.5	0.14

* Significantly less than the Control treatment response at $p < 0.05$

Effects of Yolo Bypass sediment samples on *Chironomus tentans* survival and growth.

Sample ID	Mean % Survival	Mean Weight (mg, dry wt)
Control	92.5	0.82
Ridge Cut	67.5*	0.8
Tule Canal	81.2*	0.83
Putah Creek	76.2*	1.13
Willow Slough	96.2	0.65*
Cache Creek	83.8	0.97
Toe Drain	77.5*	0.88

* Significantly less than the Control treatment response at $p < 0.05$

Total Mercury (ng/g)

Site #	Sampling Site	Wet Weight
		SEPT
2	Ridge Cut	72
3	Cache Creek	220
4	Willow Slough Bypass	104
5	YB Wildlife Area	50
6	Putah Creek	628
7	Z Drain	17
9	Woodland R1	65
10	Woodland R2	46
11	Tule Canal @ 80	53
12	Toe Drain	80

Methylmercury (ng/g)

Site #	Sampling Site	Wet Weight
		SEPT
2	Ridge Cut	0.33
3	Cache Creek	0.67
4	Willow Slough Bypass	0.28
5	YB Wildlife Area	1.31
6	Putah Creek	0.31
7	Z Drain	0.19
9	Woodland R1	0.53
10	Woodland R2	0.38
11	Tule Canal @ 80	0.13
12	Toe Drain	0.11

Aluminum (mg/kg)

RIDGE CUT	1500
CACHE CREEK	7100
TULE CANAL	13000
TOE DRAIN	9200
PUTAH CREEK	7700
WILLOW SLOUGH	13000

Boron (mg/kg)

Not Detected

Chromium (mg/kg)

RIDGE CUT	57
CACHE CREEK	54
TULE CANAL	52
TOE DRAIN	69
PUTAH CREEK	79
WILLOW SLOUGH	62

Copper (mg/kg)

RIDGE CUT	39
CACHE CREEK	21
TULE CANAL	32
TOE DRAIN	22
PUTAH CREEK	20
WILLOW SLOUGH	32

Lead (mg/kg)

RIDGE CUT	10
CACHE CREEK	4
TULE CANAL	11
TOE DRAIN	6
PUTAH CREEK	6
WILLOW SLOUGH	9

Selenium (mg/kg)

RIDGE CUT	2
CACHE CREEK	ND
TULE CANAL	ND
TOE DRAIN	ND
PUTAH CREEK	ND
WILLOW SLOUGH	ND

Toxicity Test Results for Water Column Samples

Acute (96-hr) Toxicity Tests

Ceriodaphnia (% Survival)						
Site #	Sampling Site	JUNE	JULY	AUG	SEPT	OCT
7	Lab Control	100	100	100	100	100
	Z Drain	100	100	100	100	100
11	Tule Canal @ 80	95	100	100	100	100
12	Toe Drain	100	100	100	100	100

Algae (Cell Growth)						
Site #	Sampling Site	JUNE	JULY	AUG	SEPT	OCT
7	Lab Control	100	100	-	-	-
	Z Drain	100	100	<100	100	100
11	Tule Canal @ 80	100	100	<100	100	100
12	Toe Drain	100	100	<100	100	100

Fathead Minnow (% Survival)						
Site #	Sampling Site	JUNE	JULY	AUG	SEPT	OCT
7	Lab Control	100	100	100	95	100
	Z Drain	98	98	100	78	95
11	Tule Canal @ 80	100	98	100	93	100
12	Toe Drain	98	98	100	65	100

Chronic (7-day) Toxicity Tests

Ceriodaphnia (% Survival)					
Site #	Sampling Site	JAN	APRIL	AUG	SEPT
	Ceriodaphnia (% Survival)				
2	Lab Control	90	100	100	100
	Ridge Cut	100	100	100	100
3	Cache Creek	100	80	100	100
4	Willow Slough Bypass	100	100	100	100
11	Tule Canal @ 80	100	90	100	100

Algae (Cell Growth)					
Site #	Sampling Site	JAN	APRIL	AUG	SEPT
	Algae (Cell Growth)				
	Lab Control	100	100	-	-
2	Ridge Cut	100	100	<100	100
3	Cache Creek	100	100	<100	<100
4	Willow Slough Bypass	100	100	<100	100
11	Tule Canal @ 80	100	100	<100	100

Fathead Minnow (% Survival)				
Site #	Sampling Site	APRIL	AUG	SEPT
	Fathead Minnow (% Survival)			
	Lab Control	100	100	92.5
2	Ridge Cut	72.5	100	83
3	Cache Creek	100	100	93
4	Willow Slough Bypass	77.5	100	80
11	Tule Canal @ 80	97.5	100	85

Toxicity Test Results for Streambed Sediment Samples

Effects of Yolo Bypass sediment samples on *Hyalella azteca* survival and growth.

Sample ID	Mean % Survival	Mean Weight (mg, dry wt)
Control	97.5	0.15
Ridge Cut	87.5*	0.13*
Tule Canal	96.2	0.14
Putah Creek	97.5	0.14
Willow Slough	93.8	0.14
Cache Creek	96.2	0.18
Toe Drain	97.5	0.14

* Significantly less than the Control treatment response at p<0.05

Effects of Yolo Bypass sediment samples on *Chironomus tentans* survival and growth.

Sample ID	Mean % Survival	Mean Weight (mg, dry wt)
Control	92.5	0.82
Ridge Cut	67.5*	0.8
Tule Canal	81.2*	0.83
Putah Creek	76.2*	1.13
Willow Slough	96.2	0.65*
Cache Creek	83.8	0.97
Toe Drain	77.5*	0.88

* Significantly less than the Control treatment response at p<0.05

Appendix 6-B. Summary Statistics for Samples Collected During the Study Period

Water Column Samples

TOTAL COLIFORM (MPN/100ml)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
1	Fremont Weir	1	1	5,000	5,000	5,000	5,000	2	na
2	Ridge Cut	12	12	21	160,000	23,122	16,000	2	na
3	Cache Creek	12	12	1,200	50,000	13,742	7,750	2	na
4	Willow Slough Bypass	12	12	9,000	160,000	45,583	30,000	2	na
5	YB Wildlife Area	9	9	1,100	50,000	11,289	3,000	2	na
6	Putah Creek	12	12	40	24,000	6,702	3,000	2	na
7	Z Drain	12	12	1,700	220,000	66,700	26,500	2	na
8	Sacramento Weir	1	1	11,000	11,000	11,000	11,000	2	na
9	Woodland R1	12	12	1,400	160,000	34,500	5,000	2	na
10	Woodland R2	12	12	1,100	90,000	22,025	13,000	2	na
11	Tule Canal @ 80	12	12	2,200	170,000	31,192	16,500	2	na
12	Toe Drain	10	10	1,700	160,000	25,670	12,000	2	na

na. Objective not available

FECAL COLIFORM (MPN/100ml)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances (a)
1	Fremont Weir	1	1	3,000	3,000	3,000	3,000	2	1
2	Ridge Cut	12	10	2	2,800	552	50	2	3
3	Cache Creek	12	12	20	5,000	760	50	2	3
4	Willow Slough Bypass	12	12	40	50,000	8,692	3,000	2	10
5	YB Wildlife Area	9	9	20	2,200	282	40	2	1
6	Putah Creek	12	12	17	1,100	232	40	2	2
7	Z Drain	12	12	20	30,000	6,600	5,000	2	7
8	Sacramento Weir	1	1	9,000	9,000	9,000	9,000	2	1
9	Woodland R1	12	12	20	16,000	2,668	675	2	6
10	Woodland R2	12	12	20	17,000	2,298	1,050	2	7
11	Tule Canal @ 80	12	12	17	9,000	2,006	80	2	5
12	Toe Drain	10	9	20	17,000	2,590	50	2	3

a. California Basin Plan, Region 5 Bacteria Criteria, Rec-1, 30-Day Period = 200 MPN/100ml as 30-Day Average

E. COLI (MPN/100ml)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances (a)
1	Fremont Weir	1	1	3,000	3,000	3,000	3,000	2	1
2	Ridge Cut	12	10	2	3,000	614	40	2	3
3	Cache Creek	12	12	17	5,000	939	45	2	4
4	Willow Slough Bypass	12	12	40	50,000	6,926	1,700	2	10
5	YB Wildlife Area	9	9	17	80	40	40	2	0
6	Putah Creek	12	12	8	1,700	259	30	2	2
7	Z Drain	12	12	20	30,000	5,456	3,700	2	8
8	Sacramento Weir	1	1	5,000	5,000	5,000	5,000	2	1
9	Woodland R1	12	12	20	16,000	2,022	45	2	4
10	Woodland R2	12	12	17	17,000	1,817	75	2	4
11	Tule Canal @ 80	12	12	11	3,000	631	80	2	4
12	Toe Drain	10	9	20	17,000	2,055	45	2	3

a. Proposed Basin Plan criteria for REC-1 = 126 MPN/100ml as geometric mean of at least 5 samples in a 30-day period.

ALUMINUM (ug/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances (a)
TOTAL									
2	Ridge Cut	6	6	700	3,300	1,833	1,800	0.7	6
3	Cache Creek	6	6	500	2,800	1,300	1,000	0.7	6
4	Willow Slough Bypass	6	6	800	4,100	2,083	1,800	0.7	6
6	Putah Creek	6	6	70	1,800	467	185	0.7	5
11	Tule Canal @ 80	6	6	1,300	3,000	2,067	1,800	0.7	6
12	Toe Drain	6	6	1,600	6,000	3,083	2,700	0.7	6
DISSOLVED									
2	Ridge Cut	6	2	20	20	20	20	0.6	na
3	Cache Creek	6	2	10	20	15	15	0.6	na
4	Willow Slough Bypass	6	1	10	10	10	10	0.6	na
6	Putah Creek	6	1	10	10	10	10	0.6	na
11	Tule Canal @ 80	6	2	10	10	10	10	0.6	na
12	Toe Drain	6	4	20	20	20	20	0.6	na

a. US EPA Ambient Water Quality Report 2002 = 87 ug/l

na. Objective not available

BORON (ug/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances (a)
TOTAL									
2	Ridge Cut	6	6	200	2,700	1,243	955	0.02	4
3	Cache Creek	6	6	550	2,300	1,475	1,550	0.02	5
4	Willow Slough Bypass	6	6	1,300	1,700	1,450	1,400	0.02	6
6	Putah Creek	6	6	350	1,400	648	455	0.02	2
11	Tule Canal @ 80	6	6	550	1,700	1,042	1,050	0.02	5
12	Toe Drain	6	6	140	1,700	827	625	0.02	3
DISSOLVED									
2	Ridge Cut	6	6	200	2,700	1,273	1,140	0.02	na
3	Cache Creek	6	6	490	2,400	1,448	1,450	0.02	na
4	Willow Slough Bypass	6	6	1,300	1,500	1,367	1,350	0.02	na
6	Putah Creek	6	6	340	500	403	395	0.02	na
11	Tule Canal @ 80	6	6	530	1,500	972	1,000	0.02	na
12	Toe Drain	6	6	130	1,700	663	605	0.02	na

a. UN Agriculture Goals = 700 ug/l

na. Objective not available

CHROMIUM (ug/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
TOTAL									
2	Ridge Cut	6	6	9	13	11	11	0.02	(a) 1
3	Cache Creek	6	6	4	6	5	5	0.02	0
4	Willow Slough Bypass	6	6	4	15	9	8	0.02	1
6	Putah Creek	6	6	8	19	13	12	0.02	2
11	Tule Canal @ 80	6	6	7	10	9	10	0.02	0
12	Toe Drain	6	6	7	14	10	10	0.02	1
DISSOLVED									
2	Ridge Cut	6	6	0.4	0.4	0.4	0.4	0.02	0
3	Cache Creek	6	6	1.2	1.2	1.2	1.2	0.02	0
4	Willow Slough Bypass	6	6	1.6	1.6	1.6	1.6	0.02	0
6	Putah Creek	6	6	4	4	4	4	0.02	0
11	Tule Canal @ 80	6	6	0.49	0.49	0.49	0.49	0.02	0
12	Toe Drain	6	6	0.8	0.8	0.8	0.8	0.02	0

a. California Toxics Rule, total Chromium VI, chronic freshwater organism = 11.43 ug/l

a. California Toxics Rule, dissolved Chromium VI, chronic freshwater organism = 11 ug/l

COPPER (ug/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
TOTAL									
2	Ridge Cut	6	6	3	9	6	7	0.03	(a) 0
3	Cache Creek	6	6	3	8	5	5	0.03	0
4	Willow Slough Bypass	6	6	5	11	7	7	0.03	0
6	Putah Creek	6	6	2	5	3	2	0.03	0
11	Tule Canal @ 80	6	6	6	9	7	7	0.03	0
12	Toe Drain	6	6	5	12	8	8	0.03	0
DISSOLVED									
2	Ridge Cut	6	6	2.4	2.4	2.4	2.4	0.02	(b) 0
3	Cache Creek	6	6	1.4	1.4	1.4	1.4	0.02	0
4	Willow Slough Bypass	6	6	3.4	3.4	3.4	3.4	0.02	0
6	Putah Creek	6	6	1.9	1.9	1.9	1.9	0.02	0
11	Tule Canal @ 80	6	6	3.1	3.1	3.1	3.1	0.02	0
12	Toe Drain	6	6	2.4	2.4	2.4	2.4	0.02	0

a. California Toxics Rule, chronic freshwater organism, total calculated with average hardness of Tule Canal and

Toe Drain of 220 mg/l = 18.3 ug/l

b. California Toxics Rule, chronic freshwater organism, dissolved calculated with average hardness of Tule Canal and

Toe Drain of 220 mg/l = 17.6 ug/l

LEAD (ug/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
TOTAL									
2	Ridge Cut	6	6	0.4	1.7	1.2	1.3	0.04	(a) 0
3	Cache Creek	6	6	0.4	1.5	0.8	0.6	0.04	0
4	Willow Slough Bypass	6	6	1.1	2.3	1.6	1.5	0.04	0
6	Putah Creek	6	6	0.1	1.1	0.4	0.2	0.04	0
11	Tule Canal @ 80	6	6	0.7	1.4	1.1	1.2	0.04	0
12	Toe Drain	6	6	1.1	2.2	1.5	1.3	0.04	0
DISSOLVED									
2	Ridge Cut	6	1	0.3	0.3	0.3	0.3	0.04	(b) 0
3	Cache Creek	6	1	0.3	0.3	0.3	0.3	0.04	0
4	Willow Slough Bypass	6	1	0.3	0.3	0.3	0.3	0.04	0
6	Putah Creek	6	1	0.3	0.3	0.3	0.3	0.04	0
11	Tule Canal @ 80	6	1	0.3	0.3	0.3	0.3	0.04	0
12	Toe Drain	6	1	0.3	0.3	0.3	0.3	0.04	0

a. California Toxics Rule, chronic freshwater organism, total calculated with average hardness of Tule Canal and

Toe Drain of 220 mg/l = 8.68 ug/l

b. California Toxics Rule, chronic freshwater organism, dissolved calculated with average hardness of Tule Canal and

Toe Drain of 220 mg/l = 5.9 ug/l

MERCURY (ng/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
TOTAL MERCURY									
1	Fremont Weir	1	1	25.00	25.00	25.00	25.00	0.15	(a) 0
2	Ridge Cut	12	12	3.06	27.10	8.99	5.89	0.15	0
3	Cache Creek	12	12	6.29	33.80	15.67	12.95	0.15	0
4	Willow Slough Bypass	12	12	2.71	17.80	10.31	10.28	0.15	0
5	YB Wildlife Area	10	10	7.98	43.00	17.66	13.20	0.15	0
6	Putah Creek	12	12	1.39	16.70	5.42	3.35	0.15	0
7	Z Drain	12	12	4.05	14.90	8.58	8.32	0.15	0
8	Sacramento Weir	1	1	18.10	18.10	18.10	18.10	0.15	0
9	Woodland R1	12	12	4.99	37.30	10.86	8.60	0.15	0
10	Woodland R2	2	2	5.25	30.10	10.91	9.16	0.15	0
11	Tule Canal @ 80	12	12	8.08	40.90	13.73	10.23	0.15	0
12	Toe Drain	10	10	8.12	26.80	16.47	15.25	0.15	0
METHYLMERCURY									
2	Ridge Cut	6	6	0.15	0.58	0.30	0.28	0.025	(b) 6
3	Cache Creek	6	6	0.25	1.06	0.48	0.38	0.025	6
4	Willow Slough Bypass	6	6	0.24	0.44	0.32	0.29	0.025	6
6	Putah Creek	6	6	0.07	0.32	0.15	0.13	0.025	6
11	Tule Canal @ 80	6	6	0.21	0.51	0.35	0.34	0.025	6
12	Toe Drain	6	6	0.13	0.90	0.32	0.24	0.025	6

a. California Toxics Rule for Total Mercury = 51 ng/l

b. Proposed Cache Creek Mercury TMDL for Methylmercury = 0.06 ng/l

SELENIUM (ug/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
TOTAL									
									(a)
2	Ridge Cut	6	5	1	5	3	2	0.05	2
3	Cache Creek	6	4	1	3	2	2	0.05	0
4	Willow Slough Bypass	6	6	1	5	3	3	0.05	1
6	Putah Creek	6	5	1	1	1	1	0.05	0
11	Tule Canal @ 80	6	6	1	2	1	1	0.05	0
12	Toe Drain	6	4	1	1	1	1	0.05	0
DISSOLVED									
									(b)
2	Ridge Cut	6	4	1	6	3	3	0.05	1
3	Cache Creek	6	4	1	1	1	1	0.05	0
4	Willow Slough Bypass	6	4	2	4	3	3	0.05	0
6	Putah Creek	6	4	1	1	1	1	0.05	0
11	Tule Canal @ 80	6	4	1	2	1	1	0.05	0
12	Toe Drain	6	4	1	1	1	1	0.05	0

a. California Toxics Rule, total, chronic freshwater organism = 5 ug/l

b. California Toxics Rule, dissolved, chronic freshwater organism = 5 ug/l

NITRATE as N (mg/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances (a)
2	Ridge Cut	6	4	0.4	1.7	0.8	0.4	0.03	0
3	Cache Creek	6	4	0.1	1.7	1.1	1.4	0.03	0
4	Willow Slough Bypass	6	6	0.1	1.0	0.5	0.5	0.03	0
6	Putah Creek	6	6	0.7	1.7	1.1	1.0	0.03	0
11	Tule Canal @ 80	6	6	0.8	1.3	1.0	0.9	0.03	0
12	Toe Drain	6	4	0.2	2.9	1.2	0.5	0.03	0

a. US EPA Ambient WQ = 10 mg/l

ORGANIC CARBON (mg/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
TOTAL									
2	Ridge Cut	6	6	4	10	6	5	0.09	na
3	Cache Creek	6	6	3	8	4	4	0.09	na
4	Willow Slough Bypass	6	6	8	15	10	10	0.09	na
6	Putah Creek	6	6	2	10	5	5	0.09	na
7	Z Drain	5	5	8	10	9	9	0.09	na
11	Tule Canal @ 80	8	8	4	13	8	9	0.09	na
12	Toe Drain	8	8	3	11	7	8	0.09	na
DISSOLVED									
2	Ridge Cut	6	6	4	9	7	8	0.09	na
3	Cache Creek	6	5	4	10	6	6	0.09	na
4	Willow Slough Bypass	6	6	7	13	9	8	0.09	na
6	Putah Creek	6	5	4	6	5	5	0.09	na
7	Z Drain	5	5	4	10	7	7	0.09	na
11	Tule Canal @ 80	8	8	6	19	9	7	0.09	na
12	Toe Drain	8	8	4	10	7	8	0.09	na

na. Objective not available

PESTICIDES (ug/L)

Site #	Site	n	n det	Min	Max	Average	Median	MDL	Exceedances
CARBAMATE		36	9						(a)
<i>Diuron</i>									
2	Ridge Cut	6	2	0.2 (f)	0.3 (f)	0.3	0.3	0.4	0
4	Willow Slough Bypass	6	3	0.2 (f)	0.8	0.47	0.4	0.4	0
11	Tule Canal @ 80	6	2	0.1 (f)	0.3 (f)	0.2	0.2	0.4	0
12	Toe Drain	6	1	0.5	0.5	0.5	0.5	0.4	0
<i>Methomyl</i>									
3	Cache Creek	6	1	0.07	0.07	0.07	0.07	0.07	0
CHLORINATED		36	3						(c)
<i>4,4'-DDE</i>									
2	Ridge Cut	6	2	0.01	0.02	0.015	0.015	0.001	2
4	Willow Slough Bypass	6	1	0.01	0.01	0.01	0.01	0.001	1
ORGANOPHOSPHATE		40	6						(d)
<i>Chlorpyrifos</i>									
2	Ridge Cut	7	2	0.011	0.043	0.027	0.027	0.005	1
4	Willow Slough Bypass	7	1	0.01	0.01	0.01	0.01	0.005	0
6	Putah Creek	6	1	0.017	0.017	0.017	0.017	0.005	1
<i>Diazinon</i>									(e)
2	Ridge Cut	7	1	0.032	0.032	0.032	0.032	0.005	0
3	Cache Creek	7	1	0.035	0.035	0.035	0.035	0.005	0

- a. Diuron criterion = 10 ug/L, USEPA lifetime health advisory
- b. Methomyl criterion = 0.52 ug/L, USEPA National Recommended Ambient Water Quality Criterion
- c. 4,4' DDE criterion = 0.0005 ug/L, CTR Human Health Criterion
- d. Chlorpyrifos criterion = 0.014 ug/L, CA DFG Hazard Assessment criterion
- e. Diazinon criterion = 0.1 ug/L, draft USEPA National Recommended Ambient Water Quality Criterion
- f. Value reported below the analytical detection limit.

TOTAL SOLIDS (mg/L)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
DISSOLVED									(a)
2	Ridge Cut	6	6	340	680	500	480	0.05	3
3	Cache Creek	6	6	200	520	358	355	0.05	1
4	Willow Slough Bypass	6	6	440	880	653	680	0.05	5
6	Putah Creek	6	6	250	360	298	300	0.05	0
7	Z Drain	5	5	200	340	266	270	0.05	0
11	Tule Canal @ 80	8	8	290	570	455	470	0.05	4
12	Toe Drain	8	8	130	580	296	260	0.05	1
SUSPENDED									
2	Ridge Cut	6	6	46	88	68	73	na	na
3	Cache Creek	6	6	16	62	35	33	na	na
4	Willow Slough Bypass	6	6	32	110	60	56	na	na
6	Putah Creek	6	5	3	14	9	9	na	na
7	Z Drain	5	5	66	110	90	94	na	na
11	Tule Canal @ 80	8	8	32	80	54	48	na	na
12	Toe Drain	8	8	36	96	60	58	na	na

- a. UN Agriculture Goals = 450 mg/l
- na. MDL or Objective not available

EC (umhos/cm)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances(a)
1	Fremont Weir	1	1	158	158	158	158	na	0
2	Ridge Cut	12	12	319	1,109	749	779	na	7
3	Cache Creek	12	12	280	802	562	570	na	2
4	Willow Slough Bypass	12	12	608	1,596	1,001	921	na	10
5	YB Wildlife Area	10	10	361	920	664	640	na	4
6	Putah Creek	12	12	359	853	524	509	na	1
7	Z Drain	12	12	411	1,087	666	603	na	5
8	Sacramento Weir	1	1	81	81	81	81	na	0
9	Woodland R1	12	12	80	916	560	555	na	1
10	Woodland R2	12	12	158	896	671	705	na	6
11	Tule Canal @ 80	12	12	210	895	688	727	na	7
12	Toe Drain	10	10	193	1,013	467	395	na	2

- a. UN Agriculture Goals = 700 uS/cm

HARDNESS (mg/L)

Site #	Site Name	n	n det	Min	Max	Average(a)	Median	MDL	Exceedances
2	Ridge Cut	6	6	180	660	328	275	1.3	na
3	Cache Creek	6	6	140	340	252	250	1.3	na
4	Willow Slough Bypass	6	6	260	400	347	360	1.3	na
6	Putah Creek	6	6	220	280	247	245	1.3	na
11	Tule Canal @ 80	6	6	190	290	238	235	1.3	na
12	Toe Drain	6	6	100	310	208	220	1.3	na

a. Used to calculate CTR objectives for total copper and lead

na. Objective not available

COLOR (cu)

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
2	Ridge Cut	6	6	70	200	122	113	na	na
3	Cache Creek	6	6	28	250	91	55	na	na
4	Willow Slough Bypass	6	6	17	200	90	75	na	na
6	Putah Creek	6	6	12	400	91	20	na	na
7	Z Drain	5	5	140	400	209	175	na	na
11	Tule Canal @ 80	8	8	60	200	101	78	na	na
12	Toe Drain	8	8	50	400	148	130	na	na

na. Objective not available

Toxicity Test Results for Water Column Samples

7 Day Chronic Toxicity

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
Ceriodaphnia (% Survival)									
	Lab Control	4	4	90	100	98	100	na	
2	Ridge Cut	4	4	100	100	100	100	na	0
3	Cache Creek	4	4	80	100	95	100	na	0
4	Willow Slough Bypass	4	4	100	100	100	100	na	0
11	Tule Canal @ 80	4	4	90	100	98	100	na	0
Algae (Cell Growth)									
	Lab Control	4	4	100	100	100	100	na	
2	Ridge Cut	4	4	100	100	100	100	na	0
3	Cache Creek	4	4	100	100	100	100	na	0
4	Willow Slough Bypass	4	4	100	100	100	100	na	0
11	Tule Canal @ 80	4	4	100	100	100	100	na	0
Fathead Minnow (% Survival)									
	Lab Control	3	3	93	100	98	100	na	
2	Ridge Cut	3	3	73	100	85	83	na	1
3	Cache Creek	3	3	93	100	98	100	na	0
4	Willow Slough Bypass	3	3	78	100	86	80	na	0
11	Tule Canal @ 80	3	3	85	100	94	98	na	0

Exceedance = significant toxicity

96 Hour Acute Toxicity

Site #	Site Name	n	n det	Min	Max	Average	Median	MDL	Exceedances
Ceriodaphnia (% Survival)									
	Lab Control	5	5	100	100	100	100	na	
7	Z Drain	5	5	100	100	100	100	na	0
11	Tule Canal @ 80	5	5	100	100	100	100	na	0
12	Toe Drain	5	5	100	100	100	100	na	0
Algae (Cell Growth)									
	Lab Control	5	5	100	100	100	100	na	
7	Z Drain	5	5	<100	100	100	100	na	0
11	Tule Canal @ 80	5	5	<100	100	100	100	na	0
12	Toe Drain	5	5	<100	100	100	100	na	0
Fathead Minnow (% Survival)									
	Lab Control	5	5	95	100	99	100	na	
7	Z Drain	5	5	78	100	93	96	na	1
11	Tule Canal @ 80	5	5	93	100	98	99	na	0
12	Toe Drain	5	5	65	100	91	99	na	1

Exceedance = significant toxicity

APPENDIX 7. LWA TECH MEMO OF POTENTIAL CONTROL MEASURES FOR POCs



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MEMORANDUM

Control Measures for Pollutants of Concern in the Yolo Bypass

**Prepared for:
Yolo Bypass Water Quality Management Plan Stakeholder
Advisory Group**

March 9, 2005

Introduction

This technical memorandum presents a compilation and assessment of potential control measures to reduce pollutants of concern (POCs) in the Yolo Bypass.

POCs Addressed

The POCs addressed in this memorandum are briefly described below. The priorities for which the POCs have been categorized are based on the monitoring results from a year-long monitoring program that was conducted throughout the Yolo Bypass.

High Priority:

- **Mercury.** Mercury is a concern throughout the region because of bioaccumulation through the aquatic food chain and potential health risks to fish-eating wildlife and humans. Mercury was mined extensively in the Cache and Putah Creek watersheds prior to any environmental regulations. Mercury from these and natural sources such as erosion of native soils and discharges from mineral springs continue to contaminate local waterways. Methylmercury is the form of most concern from the standpoint of bio-uptake. Wetlands tend to enhance the methylation process that drives bioaccumulation of mercury in the food web.
- **Salinity.** High salts content in water potentially impacts productivity of agricultural crops and may create problems for municipal uses. Local groundwater aquifers, the principal water supply source for the Cities of Davis and Woodland, are relatively high in salts content. Urban water uses, particularly the use of water softeners, increase salts content in wastewater discharges even more. Irrigation practices that enhance evaporation and leaching also increase salt content of irrigation return flows.

Medium Priority:

- **Aluminum.** There are two primary forms of aluminum that may be found in water, aluminum silicate and aluminum hydroxide. Aluminum silicate is naturally aluminum that is bound to sediment particles and is not considered to be toxic. The aluminum hydroxide form of aluminum can be toxic to aquatic organisms. Aluminum is a major component of the Earth's crust, and is commonly present in groundwater and runoff due to natural sources (soil and parent geological materials).
- **Bacteria.** Total coliform, fecal coliform and E. coli are used by regulatory agencies as indicators of human pathogens. The presence of these constituents may also indicate contamination from domestic animals and wildlife. The presence of high levels of coliform and E. coli may indicate the presence of pathogens of human health concerns in waters used for contact recreation. The presence of high levels of coliform and E. coli in irrigation water may also indicate the presences of pathogens that cause human health concerns in some food crops.
- **Boron.** Boron is an element commonly found in saline groundwater sources. It has properties that are somewhat like metals. The major source locally is leaching from soil and extraction in groundwater. High concentrations of boron can stress rice and other irrigated crops.
- **Organic Carbon.** Organic carbon in water increases productivity of aquatic ecosystems but is detrimental to drinking water supplies. The presence of high levels of organic carbon in drinking water requires drinking water providers to increase the chlorination process in order for drinking water to meet appropriate standards when delivered to

consumers. However, the chlorination process creates harmful disinfection by-products known as trihalomethanes. Trihalomethanes are considered to be carcinogenic.

- **Pesticides.** Carbamate, organochlorine, and organophosphate based pesticides have been detected in Bypass water by existing water monitoring programs. The presence of these pesticides above threshold concentrations can cause negative impacts on aquatic life within the Bypass. Common sources of such pesticides, such as agricultural and urban runoff, exist in the watershed.

Seasonality Issues

The water quality of the Bypass and control measures to improve it can be divided into three broad “seasons”:

- **Dry (Irrigation) Season:** Major sources of water include effluent from the municipal wastewater treatment plants (POTWs) of the Cities of Woodland and Davis and the UC Davis campus, imported Sacramento River water (for irrigation purposes), and water from the Toe Drain that is pumped onto agricultural fields for irrigation and to wildlife habitat. Low flows from Putah Creek, Willow Slough, Cache Creek, and Knight’s Landing Ridge Cut also contribute. Agricultural tailwater is largely recycled
- **Wet Season:** Pulses of urban stormwater runoff combine with POTW effluent and higher flows in creeks to provide the primary sources of water within the Bypass. The available water created during the wet season is often used to flood public and private lands for duck clubs, wildlife habitat and the break-down of rice stubble remaining on rice fields after harvest.
- **Flooded:** Flood flows in the Bypass come from the Feather River and upper Sacramento River watersheds via the Fremont Weir at the northern end of the Bypass, from the American River via the Sacramento Weir along the east side of the Bypass, and from local creeks. These flood flows drastically alter what would be considered “average” conditions. It is not uncommon for flood flows to exceed 150,000 cfs in the Bypass during wet years, as compared to 20,000 cfs in Cache Creek, and 20 cfs combined POTW effluent.

Options for Addressing the POCs

Potential options for addressing the high and medium priority POCs fall into three main categories:

- Implement control measures;
- Continue monitoring and undertake special studies; and
- Develop a site-specific objective and change the designated beneficial uses through a Use Attainability Analysis.

The focus of this memorandum is to identify and quantify to the extent practicable potential control measures to implement. Control measures are defined as structures, activities, management practices, or processes that may minimize pollutant loads to the Yolo Bypass. Best Management Practices (BMPs) are control measure activities recognized to minimize pollutant loads in the most effective, efficient manner. However, the term “Best” is not meant to imply that such practices are the only effective and efficient way to minimize pollutant loads. The

term “control measure” is used to represent any activity or structural device used to control the discharge of POCs to the Bypass. In general, BMPs traditionally apply to agricultural non-point sources of pollution and urban stormwater while control measures are often associated with point sources of pollution such as POTW effluent.

Control measures that could potentially be used to address at least one of the POCs are listed in Table 1. They are generally in order of upstream/source control to downstream/discharge control. Each control measure listed in this table is described in its own section, following a standard format:

- POCs addressed;
- Description;
- Benefits;
- Costs; and
- Other considerations.

Costs and benefits are quantified to the extent practicable and generally in terms of order-of-magnitude estimates. Information on past, present, and future planned implementation of these control measures is also provided, where known.

Table 1. Summary table of control measures described in this memorandum.

BMP or Control Measure		POCs Addressed						
#	Name	Aluminum	Bacteria	Boron	Mercury	Org. C	Pesticides	Salinity
1	Conduct Outreach and Education		X		X	X	X	X
2	Reduce Local Groundwater Use							
2a	Develop Alternative Water Supplies			X			?	X
2b	Reduce Urban Water Demand			X				X
3	Reduce POTW Influent Loads							
3a	Encourage Alternatives to Conventional Water Softeners							X
3b	Outreach on Proper Operation of Water Softeners							X
3c	Conduct Mercury-specific Outreach and Education				X			
3d	Enhance Industrial Pretreatment	X			X			X
4	Enhance POTW Treatment							
4a	Install Tertiary Treatment	X	X		X	X	X	
4b	Install Microfiltration – Reverse Osmosis Filters			X				X
5	Improve Urban Storm Water Management							
5a	Minimize Effects of New Development		X			X	X	
5b	Outreach to Minimize Stormwater Impacts	X	X	X	X	X	X	X
6	Improve Rural Land and Water Management							
6a	Construct or Improve Settling Basins	X			X		X	
6b	Enhance IPM Programs						X	
6c	Enhance Irrigation Water Management						X	X
6d	Optimize Pesticide Applications						X	
6e	Restrict or Change Pesticide Use						X	
6f	Minimize Erosion and Sediment Transport to Waterways	X	X		X	X	X	
6g	Remove or Stabilize Mine Waste				X			
7	Manage Water Resources for Water Quality Benefits							
7a	Minimize POTW Discharges to the Bypass							X
7b	Manage Water Use in Bypass Wetlands	X	?	?	?	X	X	?
7b	Alter Inter-basin Water Transfers				?	?	?	X

"X" indicates some benefits *likely* could be realized by applying this control measure in the watershed.

"?" indicates some potential *benefits or detriments* could be realized by applying this control measure in the watershed.

1 Conduct General Outreach and Education

POCs addressed: bacteria, mercury, organic carbon, pesticides, salinity

Description

General outreach efforts that could be considered include: 1) post information on web sites maintained by municipalities and environmental organizations; 2) develop fact sheets for dissemination to the public; 3) utilize press releases at appropriate times (e.g., Earth Day); 4) prepare and give PowerPoint presentations at appropriate venues; and 5) enhance communication and collaboration among agencies and other authorities that manage water resources affecting the Bypass. These activities improve the public's general awareness of local water quality issues impacted by their actions. Pollutant-specific outreach is addressed separately in this memo and would overlap considerably with this control measure.

An additional outreach activity is to inform farm workers and recreational visitors in the Bypass that bacteria levels are high to discourage swimming.

Another outreach activity could be to discourage the consumption of fish high in mercury. However, although the state has data on methylmercury in small fish in the Bypass, it has no information on sizes and species consumed by people. A possibly useful activity would be to collect data on species targeted by people and, if the levels are above recommended levels, post notices at popular fishing sites.

Benefits

Outreach and education provide relevant information to people regarding the condition of their environment, the impacts that such conditions may have on them, the impacts they may have on the environment, and options for how to change their practices. Outreach can be an effective means of pollutant reduction and risk reduction for humans. Education provides the foundation for outreach, while also encouraging decision-makers and the people they serve to implement additional control measures.

Focused interactions among responsible authorities improve efficiency and consistent understanding of responsibilities for protecting water quality.

Costs

Effective public outreach campaigns for municipalities the size of Davis and Woodland would cost on the order of \$100,000 per year (Elzufon, 2000). Agency collaboration activities require staff time, but presumably are balanced by improved operating efficiency. Outreach to potential swimmers in the Bypass could be accomplished through fliers distributed to farm workers and notices on message boards at the Yolo Basin Wildlife Area.

Other Considerations

While outreach and education can be fairly effective in comparison to the cost, it does not usually solve a water quality issue on its own. In addition, such campaigns take time to change the behavior of the general population. However, it remains an important element of any management plan and should not be overlooked. More focused outreach activities are described elsewhere in this report.

2 Reduce Local Groundwater Use

Municipalities and agriculture within the Yolo County region rely on local groundwater resources as a water supply for municipal and irrigation uses. Groundwater in the area is known to contain high levels of salinity and boron. Therefore, by using groundwater as a source of water supply, municipal discharges and irrigation return flows automatically contain higher levels of such constituents. Consequently, one control measure to reduce such inputs would be to reduce the use and reliance on local groundwater by developing other water sources or by reducing demand.

2.a Develop Alternative Water Supplies

POCs addressed: boron, salinity

Description

Typical salinity levels measured in City of Woodland wells (LWA, 2003; pers. comm. Christine Engel, City of Woodland to S. McCord, 3/5/05) are:

- Supply wells = 900-1100 umhos/cm
- POTW influent = 1650-2000 umhos/cm

Assuming a fixed increase in salinity, municipal uses commonly increase salinity by approximately 550 umhos/cm. Lower hardness supply water should result in a smaller decrease in salinity as softener salts can be dosed less and soaps work better.

Recognizing that groundwater is the dominant source of high hardness and salinity in irrigation tailwater and POTW effluent, reducing the flow from that source by developing alternative water sources is a potential solution. Alternative sources are described here.

- Sacramento River – Sacramento River water¹ has an average conductivity of 140 umhos/cm.
- Deep aquifer groundwater wells that are less saline – such wells in the City of Davis produce water that has an average conductivity of 550 umhos/cm.

Installing deep aquifer wells as a means to reduce salinity in the UC Davis campus wastewater is not an option because all domestic wells serving the campus are already in the deep aquifer.

Benefits

Based on the salinity levels given above, POTW influent EC would be in the range of 700-1600 umhos/cm if Sacramento River water were the supply source, depending on the blend of supplies that could be provided. As a result, wastewater effluent would be considerably lower in salinity and would therefore not be of concern for agricultural or municipal uses of the effluent.

The City of Davis and UC Davis campus have already tapped into deeper wells to try and reduce the salinity of their water supply. However, the use of such wells does not solve the salinity issues for the municipal wastewater dischargers. For example, POTW influent EC would be in the range of 1100-1600 umhos/cm if deeper well water were used as a supply source, depending on the blend of supplies that could be provided.

Costs

In order to obtain a surface water supply, the municipalities must go through the State Water Resources Control Board and obtain an appropriative right, or contract with other entities that currently have surface water rights. In either case, the Cities, UC Davis, and agricultural water suppliers would incur costs associated with this process. In addition, surface water supplies may cost more per acre foot than the cost that is currently associated with groundwater pumping costs.

Installation costs for new wells tapping the deep aquifer cost on the order of \$1.2 million (pers. comm., David Phillips, UC Davis, to S. McCord, 2/10/05). The cost of installing deep aquifer wells for agricultural groundwater users may not be practical.

Other Considerations

Besides a potential cost increase, the ability to successfully obtain rights to a surface water source for water supply is not guaranteed. As the population in California continues to grow,

¹ Based on measurements at Veteran's Bridge reported in the Coordinated Monitoring Program's 2003 Annual Report, available on-line at <http://www.srcsd.com/pdf/rpt-cmp-03.pdf>.

there are additional demands on California's surface water supplies. As a result, obtaining surface water rights is a competitive process that offers no guarantees.

Another consideration is the actual need for municipalities to obtain alternative sources of water in order to reduce salinity in the effluent. Currently, the primary beneficial uses that are driving the issue are municipal and agricultural uses. The drinking water level for municipal uses is set at 900 umhos/cm and the most conservative number currently used for agriculture is 700 umhos/cm. Both of these water quality standards may or may not be appropriate under the current circumstances.

For example, the 900 umhos/cm for municipal uses applies to Putah Creek and therefore the University of California, Davis' discharged effluent. It is based on the secondary maximum contaminant level (MCL), which is a consumer acceptance taste and odor standard and not a public health level.

The 700 umhos/cm level for agriculture is subject to even further questions of applicability in this area. The standard comes from a United Nations study that recommends water quality goals and guidelines. The 700 umhos/cm is the most conservative recommended standard for the most salt sensitive crops in all climates throughout the world, including arid and desert regions. It does not account for natural conditions, actual crops grown or rainfall. As a result, studies are currently underway to determine what may be an appropriate standard for the Yolo Bypass area considering all the necessary factors. The studies are being conducted by researchers at the University of California, Davis.

In addition to the studies, the local agricultural community is not convinced that 700 umhos/cm is necessary for the crops grown in and near the Bypass. The agricultural community appears to be more concerned with potentially losing the irrigation water created from these discharges than with receiving irrigation water with a slightly higher level of salinity.

Residential development in Lake County may develop surface water storage. These reservoirs could provide some additional relatively low salinity water to Cache Creek during the dry season.

2.b Reduce Urban Water Demand

POCs addressed: boron, salinity

Description

Groundwater pumping for urban areas could be reduced by reducing water demand directly or by expanding local water reuse to effectively reduce demand for new water. One potentially effective tool is the installation of water meters and water use fees based on use rates.

Benefits

Salt and boron loads introduced from groundwater aquifers could be reduced by reducing groundwater use and subsequent discharge.

Costs

Minimal costs to municipalities would be incurred for conducting outreach and education to reduce water demand.

Residents can purchase improved technologies for plumbing fixtures, washing machines, irrigation systems, and water heaters. Industrial and commercial units can install low-flow toilets and high efficiency cooling towers. Costs associated with designing, constructing and operating local water reuse systems are undetermined.

Increased energy efficiency tends to balance costs of irrigation controller systems and indoor technologies (DWR, 1998). Similarly, WWTP treatment costs could be slightly reduced for the lower influent flows.

Other Considerations

The net result of reducing water use would be to reduce discharges to local waterways. However, the salt concentration in POTW influent would be slightly higher as the slightly lower load of salinity added in the service area would be concentrated in proportionally less influent water. As a result, the effluent load of salinity would also be increased. Consequently, the advantage of increased water efficiency may not improve water quality. In addition, the loss of effluent may negatively impact the agricultural community that relies upon the effluent discharge for irrigation purposes.

Local agencies are required by the 1990 Water Conservation in Landscaping Act to enforce ordinances intended to promote water-efficient designs. The Act's requirements apply to landscapes greater than 2,500 square feet in area.

DWR (2000) deferred implementing regional scale urban water conservation options, reasoning that no significant depletion reductions were attainable.

3 Reduce POTW Influent Loads

POTW influent loads of some POCs can be reduced by focusing on the major sources of those POCs. This section describes several control measures that could be implemented within POTW service areas to reduce influent POC loads. These measures would consequently reduce POTW effluent loads.

3.a Encourage Alternatives to Conventional Water Softeners

POCs addressed: salinity

Description

The typical self-regenerating water softener operates by removing the ions contributing to hardness with an ion exchange resin column. Over time, the column becomes saturated with the hardness ions, and it becomes necessary to replenish the sodium ions via regeneration. By passing a strong brine solution (about 3 pounds of salt per gallon, equivalent to approximately 360,000 mg/L) through the bed, the hardness ions are overwhelmed by the strength of the sodium ions and are driven off the bed. At the end of the process, the waste brine is discharged to the sanitary sewer. The waste brine is a source of salts discharged to POTWs.

Salts can be reduced in POTW influent by implementing tighter controls for water softeners, and perhaps new pre-treatment technology for some industrial equipment (e.g., boiler feed water). Alternatives to self-generating water softeners include portable tank exchange services, magnetic / electronic / catalytic water conditioners, reverse osmosis, carbon filtration, and distillation. Similar alternatives to conventional softeners could also be applied at wellheads rather than at individual buildings.

Benefits

UCD has estimated that a 3-10% reduction in POTW influent salinity may be possible by incorporating advanced technology for boiler feed water and other major water uses (pers. comm., D. Phillips).

It is estimated that the Cities of Davis and Woodland combined may be able to reduce total salt loads to the Bypass by approximately 5,000 pounds per day if 40% of the households with self-generating water softeners would replace such systems. This is assuming that there are 40,000 households in Davis and Woodland combined and that 20% of households have self-regenerating water softeners.

Costs

Rebates, credits and buy-back programs can be used to promote alternatives to conventional water softeners. Assuming 40,000 households in Davis and Woodland combined, 20% of households have self-regenerating water softeners, 40% of those households would decide to participate in the program, and \$800 for providing an alternative softener system, total costs for implementing a water softener replacement program would be approximately \$2.5 million if it is assumed that a \$800 rebate is given to 40% of the households with self-regenerating water softeners.

Other Considerations

Brine produced by softening all potable water and disposal of brine from wellheads distributed throughout the municipalities would be problematic.

Municipalities could ban water softeners for new development. Although they cannot legally ban existing water softeners, they may be able to provide incentives for alternatives. However, alternatives can be expensive to purchase and maintain. Any brine, precipitate or filters must be disposed rather than discharged back to the sanitary sewer.

3.b Outreach on Proper Operation of Water Softeners

POCs addressed: salinity

Description

For wastewater dischargers into the Yolo Bypass, salinity issues are of the greatest concern. A large source of salinity in wastewater comes from self-generating water softeners. Outreach and education to members of the public regarding the impact of inefficient water softeners could help to reduce salt loads significantly.

Benefits

If only 40% of the households participated in a program to increase water softener efficiency (assuming 40,000 households in Davis and Woodland combined and 20% of the households having self-regenerating water softeners) each of those participating systems could be made 10% more efficient, total salt loads to the Bypass could be reduced by approximately 500 pounds per day.

Costs

Effective public outreach campaigns for municipalities the size of Davis and Woodland would cost on the order of \$100,000 per year (Elzufon, 2000). Such a campaign could incorporate multiple elements besides water softeners.

Other Considerations

None identified.

3.c Conduct Mercury-specific Outreach and Education

POCs addressed: mercury

Description

Mercury's unique chemical characteristics, sources and environmental impacts may require special control measures. Potential control strategies identified for mercury are listed in Table 2.

Table 2. Potential Mercury Source Control Strategies.

Potential Source	Control Strategy
Dentists	Business outreach with BMPs; regulate
Household products (thermometers, contact lens solution, fluorescent light bulbs)	Outreach to pharmacies; public thermometer collection program; fluorescent light bulb exchange program
Hospitals; laboratories	Outreach; sewer line cleaning
Laundry	Promote graywater systems

Benefits

It is difficult to quantify the potential benefit that municipalities in the bypass may obtain by implementing the control strategies above. However, examples from other POTWs may provide a useful illustration of potential benefits.

First, the City of Palo Alto quantified its annual influent loading of mercury by source (Elzufon, 2000). These potentially controllable sources represented approximately 30% of the total influent mercury load. Assuming that these loads could be reduced by approximately 50%, the potential total influent load reduction by implementing all of these control strategies would be on the order of 15%. The resulting reduction in effluent load would be 0-15%. The low end of this range is in recognition that a reduction in influent mercury load does not necessarily translate into reduction in effluent load.

Second, the Sacramento Regional County Sanitation District (SRCSD) has implemented an effective mercury reduction program that could be mimicked in the Yolo Bypass watershed². SRCSD's residential mercury outreach and collection efforts have resulted in the removal of an estimated 18.5 pounds of elemental mercury and approximately 192 pounds of mercury and

² See the "Be Mercury Free" website at <http://www.bemercuryfree.net/index.html>.

mercury-containing products over the past two years. Scaling these values by the proportional populations (~100,000 in the Davis and Woodland communities versus ~1 million in the Sacramento service area), local outreach efforts would result in approximately 2 pounds of elemental mercury being collected. The proportion of this mercury that would have eventually entered local waterways is uncertain.

Costs

Costs to POTWs for implementing these control strategies are primarily associated with staff time needed for interact with businesses such as dentists, pharmacies and hospitals that may not be regulated currently. Public outreach activities would require educational materials and staff resources as well. There may also be some costs associated with monitoring the collection system to better determine the amount of mercury that is entering the POTW from the various areas of the collection system.

Other Considerations

The City of Woodland is currently surveying local dentists to determine current mercury reduction efforts.

Both POTW effluent and urban stormwater would benefit from these outreach activities. However, POTW effluent is not considered to be a major source of mercury to the Bypass and therefore may do little to address this water quality issue.

3.d Enhance Industrial Pretreatment

POCs addressed: aluminum, mercury, salinity

Description

Pretreatment programs for industries such as vehicle service facilities, printers, and commercial car washes can reduce metals loads to sewers. Food processing industries often discharge high salt loads that could be reduced.

Benefits

Load reductions of 30-99% for many heavy metals (e.g., copper, mercury, lead, silver, zinc) can be achieved by such facilities. The resulting percent reduction in POTW influent depends on the relative contribution of industries.

Costs

Effective pretreatment programs for municipalities the size of Davis and Woodland cost on the order of \$50,000 per year (Elzufon, 2000).

Other Considerations

The City of Davis, in particular, is a residential community with a small industrial base. The industrial pretreatment programs for both the Cities of Woodland and Davis prioritize BOD, solids, fats, oil, and grease for pretreatment. Local limits for City of Woodland's four Significant Industrial Users include the pollutants of concern mercury and DDT. The City of Davis and UC Davis campus do not have local limits.

Industries that tend to produce high-salinity wastewater include, for example, textiles, food processors, and petroleum refineries. None of these or similar industries exist on a large scale in the watershed. Thus, industrial pretreatment local limits for salts would have negligible benefits on salinity in POTW effluent.

4 Enhance POTW Treatment

Three advanced wastewater treatment technologies are discussed in this section:

- Tertiary treatment;
- Carbon adsorption; and
- Microfiltration – reverse osmosis.

Other technologies such as nitrification-denitrification and ultraviolet disinfection would not address high or medium priority POCs.

4.a Install Tertiary Treatment

POCs addressed: aluminum, bacteria, mercury, organic carbon, pesticides

Description

Primary treatment of wastewater reduces oils, grease, fats, sand, grit, and coarse (settleable) solids. Secondary treatment of wastewater means biological oxidation to reduce further BOD and suspended solids concentrations. Tertiary treatment of wastewater provides additional treatment for more specific water quality benefits. Common tertiary treatment processes include filtration, polishing wetlands, and biological filters for denitrification.

Benefits

Organic pesticides and inorganic compounds such as nitrogen, sulfides, and heavy metals are generally reduced to nondetected levels by tertiary treatment.

Costs

The City of Woodland estimated that total 20-year life-cycle costs to upgrade to tertiary treatment would be approximately \$20 million (ECO:LOGIC Engineering, 2003).

The UC Davis campus wastewater treatment facility operates a tertiary treatment facility. The filters cost approximately \$1.8 million for the current 2.5 MGD design flow rate (pers. comm., David Phillips, UC Davis, to S. McCord, 2/10/05). Operation and maintenance costs will result in similar life-cycle costs as for the City of Woodland.

Other Considerations

Because tertiary treatment processes tend to target specific pollutants, systems must be designed to address specific concerns and cannot be expected to reduce effluent concentrations of other pollutants.

4.b Install Microfiltration – Reverse Osmosis Filters

POCs addressed: boron, salinity

Description

Microfiltration following tertiary treatment produces effluent suitable as a feed source for reverse osmosis. Reverse osmosis (RO) is a water treatment technology that utilizes membrane filters to remove dissolved substances. This control measure only addresses constituents that were not removed by tertiary treatment. Water is separated from dissolved salts in solution by filtering through a semi-permeable membrane at a pressure greater than the osmotic pressure caused by the dissolved salts in the wastewater.

Benefits

High-salinity effluent can be treated to reduce salinity as well as other particulate and dissolved compounds. An RO system could be operated at moderate performance levels to simply improve conditions, or at maximum efficiency to produce potable water.

Costs

The major costs associated with RO systems include construction, operation, and brine disposal. Approximate costs for Florida (United States Navy, 2005) are:

- Construction (\$mil/MGD capacity): 1.4-2.1
- Operation and maintenance (\$/million gallons of production): 1,060-1,550

Total costs approximated for a 10 MGD facility with a 20-year life cycle and not discounted would be \$5-7 million per year. A deep well in which to inject the brine would cost on the order of \$1 million.

The City of Woodland estimated that total 20-year life-cycle costs to treat approximately half of its wastewater through RO filters and evaporate the brine would be approximately \$110 million (ECO:LOGIC Engineering, 2003).

Other Considerations

The major constraints to installing and operating RO systems include:

- Disposal of a continuous waste stream of RO brine (the process water that does not pass through the filters) is especially problematic in inland areas. Brine could be injected into deep wells. Potential impacts on groundwater aquifers are unknown. Piping or otherwise transporting brine to the ocean is not perceived to be a realistic option;
- Effluent discharges are reduced by approximately 20%, decreasing water supply available to current water users in the Bypass; and
- Operation of RO systems requires higher energy for pressuring the process water.

Because the major water supplies for the Cities of Davis and Woodland are groundwater, wells are decentralized. A separate piping system to remove and treat the brine from each of the dozens of wells would require an entirely new piping system. Brine injection wells would each cost on the order of \$1 million to construct and operate.

5 Improve Urban Storm Water Management

Water quality studies have shown impacts on receiving water caused by stormwater runoff from impervious surfaces. Pollutants associated with residential, commercial and industrial activities in a watershed include sediment, fertilizers, pesticides, other chemicals, paints, waste oil, other vehicle fluids, petroleum hydrocarbons, heavy metals, and coliform from human and animal wastes. Stormwater runoff that comes in contact with these pollutants are transported quickly and efficiently to and through the stormwater sewer system and discharged to receiving waters. In addition, stormwater runoff rates and quantity may significantly increase as a result of impervious surfaces cause by new development.

Stormwater discharges are regulated in California by NPDES permits. Separate permit programs relevant to the local Yolo Bypass watershed are described here.

- The Cities of Davis, Woodland, and West Sacramento, the County of Yolo and the UC Davis campus are regulated under Phase II of the NPDES General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems. Their stormwater management programs will be fully implemented by 2008.
- Construction sites disturbing greater than 1 acre of land are required to comply with the statewide NPDES General Permit for Discharges of Storm Water Runoff Associated with Construction Activity.
- Qualifying industrial facilities are required to comply with the statewide NPDES Industrial Storm Water General Permit. The State Board web site³ indicates that two facilities in Davis, 6 on the UC Davis campus, 28 in Woodland, and 3 in Winters actively participate in the industrial stormwater permit program.

Permittees regulated by these stormwater programs are required to reduce pollutant loads in their discharges to the maximum extent practicable. Specific activities expected to provide the greatest water quality benefits to the Bypass are described in this section.

Costs for municipal stormwater programs are difficult to distinguish from normal practices. A recent survey by the California Stormwater Quality Association found costs ranging from \$18 to \$48 per household (pers. comm., Brian Currier, CSUS, to S. McCord, 3/9/05). Descriptions of costs associated with specific program elements described in this section are provided only for initial guidance.

5.a Minimize Effects of New Development

POCs addressed: bacteria, organic carbon, pesticides

Description

The Small MS4 General Permit requires municipalities to develop, implement and enforce a program for stormwater runoff from new development and redevelopment projects that result in land disturbance of one acre or more to prevent and minimize water quality impacts. The program must include a plan to implement site-appropriate and cost-effective treatment and source BMPs and ensure long-term operation and maintenance of such BMPs. The Small MS4 General Permit requires the City to adopt a set of design standards for certain development categories.

³ Site accessed on January 19, 2004 at <http://swrcbnt3.swrcb.ca.gov/stormwater/search/IndSearch.asp>.

Benefits

Impacts to water quality and the physical and biological characteristics of an aquatic habitat caused by new development can be minimized through implementing post-construction stormwater BMPs. BMP handbooks such as those available from the California Stormwater Quality Association⁴ provide some measure of removal efficiencies for various BMPs. Removal efficiencies depend greatly on site-specific conditions.

Costs

Costs for developers to incorporate stormwater BMPs are difficult to distinguish from normal practices. Revising design standards, training staff, revising municipal code, and inspecting and maintaining facilities increase costs for municipalities. Additional land requirements for structural BMPs require more land. A recent survey by the California Stormwater Quality Association found costs ranging from \$**[available in late February] per household for new development.

Other Considerations

None identified.

5.b Outreach to Minimize Stormwater Impacts

POCs addressed: aluminum, bacteria, boron, mercury, organic carbon, pesticides, salinity

Description

Outreach in urban areas is required for permitted municipal stormwater management programs. Municipal stormwater outreach activities that could be promoted and the POCs that they address are:

Activity

Promote use of “doggy bags”
Announce bulk waste collection dates
Announce hazardous waste collection events
Conduct general stormwater awareness campaigns
Efficient operation of lawn irrigation systems

Promote IPM programs and appropriate residential pesticide applications
Provide containerized green waste pick-up

POCs Addressed

Bacteria
Organic carbon
Metals, pesticides
All
Boron, pesticides, salinity
Pesticides
Organic carbon

⁴ Available on-line at <http://www.cabmphandbooks.org/>.

Benefits

The benefits of stormwater-related outreach are difficult to quantify because they depending on several factors such as current level of awareness, the design and timing of the campaign, and the imprecise relationship between the polluting activities and water quality impacts.

Several of the activities described are already practiced in the Cities of Davis and Woodland, so the additional benefit derived from increased awareness are uncertain.

Costs

Effective public outreach campaigns for municipalities the size of Davis and Woodland would cost on the order of \$100,000 per year (Elzufon, 2000).

Other Considerations

Green waste containers would be most useful in the City of Woodland, and such a program is being implemented in the new portions of the City. The remainder of the City will be phased into the program. Discharges from the City of Davis are largely captured in stormwater detention ponds, in which organic carbon is not identified as a pollutant of concern.

6 Improve Rural Land and Water Management

Rural land management focuses on agriculture but also includes other non-point source rural areas. For agriculture, control measures typically take the form of management practices for crop cultivation, irrigation and pesticide applications. While the Regional Board can not require specific BMPs, they can requires that agricultural and other nonpoint source dischargers implement BMPs. Up until recently, the Regional Board had allowed agricultural dischargers to operate under a waiver of the requirement to file a report of waste discharge. The revision of the California Water Code that dealt with waivers forced the Regional Board to rescind the old waiver and develop a new one that complied with the new law. The new waiver requires agricultural dischargers to comply with water quality standards and allowed such compliance through the individual or group development of water quality management plans. It is anticipated that water quality management plans developed for this purpose will identify various management practices that are designed to address the pollutant (or pollutants) that is causing a violation of an applicable water quality standard. The development of a water quality management plan that is specific to agriculture in the area should be considered to be a control measure.

While it is not feasible to identify all of the potential management practices because of the variability in agriculture in and near the Yolo Bypass, several common control measures are identified and discussed below.

6.a Construct or Improve Settling Basins

POCs addressed: aluminum, mercury, pesticides

Description

Settling basins are essentially a specialized type of treatment wetland. Additional opportunities – or lack thereof – for installing new basins or optimizing the sediment removal efficiency of existing basins are as follows:

- The Cache Creek Settling Basin's sediment removal efficiency could be increased by raising the weir height or at least maintained by regularly excavating accumulated sediment.
- The 100-acre UCD Arboretum Waterway serves as a settling basin for campus runoff. All stormwater runoff from the central campus is routed into the Arboretum Waterway. Water collected in the channel largely infiltrates into the local aquifer. During a storm event, water from the Arboretum Waterway spills over a weir at the west end and large pumps send the water via pipeline into the South Fork of Putah Creek. Water in this basin could be pumped to and treated at the campus wastewater treatment facility during off-peak periods.

Because Lake Berryessa and Lake Solano trap the vast majority of sediment from the Putah Creek watershed, a settling basin near the mouth of Putah Creek would be redundant and ineffective. Approximately two-thirds of land within the City of Davis drains into retention ponds. The ponds are managed primarily to control floodwaters and maximize removal of particulates before discharging to agricultural drains. Wildlife and vegetation in these ponds are regularly monitored. Excavation of sediments within the Bypass is not necessary because sediment does not appear to be accumulating.

Benefits

Maintaining the Cache Creek Settling Basin at approximately maximum efficiency would remove, on average, an estimated additional 50 pounds per year of total mercury from entering the Bypass, compared to not maintaining the Basin.

Water quality benefits to Putah Creek and the Delta from treating the Arboretum Waterway would be negligible. The primary benefits would be improved water quality in the Arboretum and the potential for local water reuse.

Costs

The lowest-cost alternative is to maintain the existing Cache Creek Settling Basin. Maintenance costs are estimated to be as high as \$15 million⁵, but depend greatly on feasible soil disposal and reuse options.

Planning, design, and construction of the project to process water from the Arboretum Waterway through the campus wastewater treatment facility will cost approximately \$350,000.

Other Considerations

The State of California, acting through DWR, is responsible for maintaining the Cache Creek Settling Basin. The Delta mercury TMDL being developed in 2005 could require maintenance of the basin as a component of the implementation strategy.

Additional study to be recommended in the management plan calls for measuring sediment accumulation rates in various regions of the Bypass.

⁵ Present-worth cost assuming a 30-year project life cycle, assuming the soil is disposed at the Yolo County landfill.

UC Davis facilities engineers are currently planning a project to reroute treated water from the Campus Wastewater Treatment Plant through the Arboretum Waterway to provide a source of fresh water during dry weather.

6.b Enhance IPM Programs

POCs addressed: pesticides

Description

Integrated pest management (IPM) is “an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.”⁶ To the extent that IPM programs decrease the use of broad spectrum pesticides, it can be an effective control measure for some pesticides that have been identified as a pollutant of concern.

Benefits

IPM targets the pests of concern and tries to avoid using broad spectrum pesticides.

Costs

Other Considerations

IPM may not be appropriate in all circumstances. Occasionally there are wide spread pest infestations that can not be controlled through the use of IPM.

6.c Enhance Irrigation Water Management

POCs addressed: pesticides, salinity

Description

Irrigation water can be managed differently to potentially reduce salinity and pesticide concentrations in tailwater. Adoption of new irrigation technology to reduce applied water will most likely result in a reduction of deep percolation, tailwater runoff, evapotranspiration (ET), or leaching effects. Reductions of deep percolation and tailwater runoff can be achieved by improving irrigation water application and management. ET can be reduced by minimizing irrigating with minimal loss in productivity. However, a reduction in irrigation water may further concentrate salt levels in the soil causing greater damage to crops than using more, high salinity irrigation water. When water is high in saline, one management practice to maintain crop yields

⁶ Taken from UC Davis, Division of Agriculture and Natural Resources website, www.ipm.ucdavis.edu/IPMPROJECT.

is to increase the amount of water used for irrigation in order to ensure that salt is not accumulating in the root zone.

Benefits

Longer holding times would reduce concentrations of degradable pesticides but increase salinity concentrations through evapotranspiration. Shorter holding times would have the opposite effect.

Costs

Recycling water is an efficient process that reuses local water supplies. Using “new” water to irrigate fields would cost more to withdraw water from farther and lower locations. Within the Bypass, the typical scenario would be west-side farms needing to pump from the east-side Tule Canal or Toe Drain.

Other Considerations

Leaching generally cannot be reduced because it would result in soil salinization, rendering the soil less productive and consequently reducing water use efficiency.

6.d Optimize Pesticide Applications

POCs addressed: pesticides

Description

Application practices could be optimized to minimize pesticide loads to water by using any or a combination of several methods:

- Use new sprayer technologies;
- Calibrate sprayer equipment more frequently;
- Use unidirectional spray equipment on the outer rows (to spray only in toward the crops);
- Not spray when rain is in the near-term forecast;
- Use drift retardants;
- Apply pesticides only in alternate years;
- Target pesticide applications only to areas with infestations; and
- Improve mixing/loading procedures.

In summary, a wide variety of options are available to farmers in response to efforts to reduce runoff of pesticides that are potentially harmful to water quality. The precise suite of management practices adopted by a given farmer would vary, but could be chosen in a manner to minimize the off-site movement of pesticides.

Benefits

Implementing improved pesticide application practices would result in more uniform applications at the most appropriate rate. Lower pesticide application rates would save money. Pesticide loads to local waterways would decrease by implementing this control measure.

Costs

Additional time and expense would be needed to install upgraded equipment and implement improved practices. No cost figures have been generated. Potential reductions in crop yields caused by reduced pesticide use have not been quantified, but are expected to be minimal.

Other Considerations

None noted.

6.e Restrict or Change Pesticide Use

POCs addressed: pesticides

Description

One control measure that is often raised when addressing the issue of pesticides is further restricting (or banning) the use of a specific pesticide. This control measure is currently applied to urban uses of the organophosphate pesticides chlorpyrifos and diazinon. Discharge prohibitions⁷ apply to orchards in the Sacramento River watershed, which apply diazinon during the dormant (winter) season.

One alternative to water-soluble organophosphate- and carbamate-based pesticides in fields that drain directly into waterways is pyrethroid-based pesticides. These tend to be less water-soluble, resulting in lower concentrations in irrigation tailwater (Freeman Long et al., 2002). However, there are concerns regarding the sediment toxicity of pyrethroids. If adsorbed to eroded sediments, control measures such as buffer strips or fescue in drains would minimize off-site transport.

An alternative to diuron-based herbicides is Roundup. A Roundup-ready alfalfa is coming to market in 2005. Paraquat, containing gramaxone as its active ingredient, is a contact herbicide rather than a pre-emergent herbicide applied to prevent seed germination. This type of chemical and its application tends to reduce losses to local waterways. An alternative to methomyl is Steward (indoxycarb is its active ingredient), which appears to have lower toxicity to aquatic life (pers. comm., Rachel Long, UCD Cooperative Extension, to S. McCord, 2/1/05).

Benefits

In most cases, the elimination of use should eliminate the pesticide of concern from the Bypass.

Costs

While there may be little cost to actually implement a restriction, there will be indirect costs that result from the pesticides elimination. For example, crop yields may decrease due to an increase in pests and disease; the use of alternative pesticides may be more costly for growers; and the research and development costs for replacement products is extremely costly.

⁷ The applicable TMDL document is available on-line at http://www.waterboards.ca.gov/centralvalley/programs/tmdl/sac_feather_diaz/FinalStaffRpt.pdf.

Other Considerations

In California, the governmental agency with sole jurisdiction to implement such a control measure is the California Department of Pesticide Regulation. Local governmental entities and the Regional Water Quality Control Boards do not have the legal authority to restrict the use of pesticides.

The elimination of some pesticides may result in the increased application of more environmentally harmful pesticides. For example, the organophosphate pesticides (chlorpyrifos and diazinon) are considered to be broad spectrum pesticides that dissipate fairly quickly in water. As the use of these crop protection chemicals becomes more restrictive, growers are turning to alternative pesticides. In some cases, the alternatives are pyrethroids for which little information is available. The pyrethroids do not usually impact water column concentrations but may be more prevalent in the soil since these compounds bond very tightly to soil. Consequently, the pyrethroids may exist in the environment much longer than other pesticides.

In addition, the elimination of use does not automatically mean that the pesticide will disappear from the environment. There are several pesticides that are creating concern even though they have been banned for a number of years (e.g. DDT).

6.f Minimize Erosion and Sediment Transport to Waterways

POCs addressed: aluminum, bacteria, mercury, organic carbon, pesticides

Description

Three control measures that minimize erosion and sediment transport from agricultural lands are commonly promoted locally, as described below⁸.

- Double-section design tailwater ponds are designed such that silt-laden irrigation tail water and storm runoff enters the first pond (narrow trench design) which functions as a sediment trap. Captured silt is easily reincorporated into the field each fall. Nutrient-laden water exits this sediment pond via drop pipe inlet to the second, a recharge/return pond. Nutrients can be removed from tailwater by aquatic and shore plants before release into lower fields, drainage canals, or natural sloughs.
- A grassed waterway/vegetated filter system is a natural or constructed vegetated channel that is shaped and graded to carry surface water at a non-erosive velocity to a stable outlet that spreads the flow of water before it enters a vegetated filter. They can be constructed where water concentrates and gully erosion is a problem.
- A riparian forest buffer is an area of trees and shrubs located adjacent to water bodies. These areas have year-around and seasonal water available. They minimize streambank erosion, provide a wind buffer to adjacent properties, and they provide wildlife habitat.

Erosion control could be improved for farmland throughout the watershed. For the Willow Slough watershed, a total of 2,440 acres of actively farmed cropland could be converted to

⁸ These and other control measures are described in the NRCS web site at <http://www.ca.nrcs.usda.gov/programs/buffer.html>. These specific measures were suggested by Arturo Carvajal, USDA/NRCS Water Management Specialist Engineer.

tailwater ponds, riparian corridors, or large perennial wetlands. This is approximately 3.5% of the active cropland in the watershed (Jones and Stokes, 1996).

The major source of mercury to the Bypass is mercury-laden sediments. A large but poorly quantified portion of this sediment is eroded native soil, while more contaminated soils emanate from historical mining areas. Erosion from lands managed by the US Bureau of Land Management will be reduced through appropriate restrictions on livestock grazing, surface mining, and off-road vehicle use (USBLM, 2004).

Benefits

A Pilot Program funded by CALFED and conducted by Yolo County RCD found that newly dug traps removed 98% of incoming sediment in the first irrigation (which caused most soil erosion). The percent of sediment captured during the growing season in tailwater ponds studied ranged between 11 and 97%. In the one tailwater pond built in combination with a sediment trap, combined sediment capture was consistently higher, ranging between 46 and 99% (pers. comm., A. Carvajal to S. McCord, 1/24/05). The types and relative proportions of benefits for a given pond depend on location, design, and duration of impoundment.

In tail ditches, portable canvas dams slow runoff and collect sediments that may extend the utility life of the sediment traps, which need to be excavated to entrain new sediments. Sediment traps that are properly maintained and built in combination with a tailwater pond sediment collection become more effective and the life of the pond is increased.

Sediment traps and filters also tend to remove bacteria through the processes of filtration and degradation. Removal rates of 95% for total coliform are common⁹.

Costs

Trap installations cost approximately \$600 to \$1,000, including cost of flashboard risers, culverts and excavation. Pond construction cost depends on pond size and type of return system (if included). The range of costs found in the Yolo County area for ponds with capacities between 1.5 and 4 acre-feet is \$4,000 to \$12,000 for pond and inlet/outlet structures. Addition of native vegetation on the area around the pond would add an additional \$1,000 to \$3,000 for material, labor, and irrigation system (pers. comm., A. Carvajal to S. McCord, 1/24/05). Filter strips and riparian buffers would cost on the order of \$500 per acre per year to construct and maintain¹⁰.

Assuming local farmland has a value of \$250 per acre per year¹¹, the cost associated with converting productive agricultural land to use as a control measure on 2,440 acres would be on the order of \$610,000 per year.

Other Considerations

While tail water recovery ponds and other sediment impoundments can work effectively to minimize pollutants entering the waterways through sedimentation and erosion, many growers are concerned about the loss of productive agricultural land and potential liability associated with the creation of additional wildlife habitat. Once habitat has been created on agricultural land, it becomes difficult to remove the habitat due to other environmental regulations and laws

⁹ Referenced on-line at <http://www.wsi.nrcs.usda.gov/products/waterborn-pathogens.html>.

¹⁰ Cost estimate is adjusted from 1995 to 2005 costs, and adapted from NRCS (1995).

¹¹ Cost estimate provided by the California Chapter of the American Society of Farm Managers and Rural Appraisers, available on-line at <http://www.calasfmra.com/landvalues/2003/Reg01.pdf>.

such as the state and federal Endangered Species Acts, state streambed alteration laws, and Corps of Engineer regulations governing wetlands. Growers and their neighbors are concerned that such control measures may attract endangered species to their property, therefore creating the potential liability for taking the species during the course of normal, cultural practices. Growers are also concerned that once created, growers lose flexibility to alter cropping practices and patterns because now the habitat may be considered a water of the U.S. or state and therefore require some sort of permit for removal.

In addition, above-grade impoundments always pose a risk of dam failure. Crops could be eaten by wildlife inhabiting wetlands. Flooding of fields can accelerate leaching of pesticides, herbicides, and nitrogen, thereby increasing the risk of groundwater contamination. Vehicle access to densely vegetated riparian reaches is difficult. On the plus side, actively managing riparian vegetation provides an opportunity to selectively remove problematic invasive weeds.

Erosion control within the Bypass is actually discouraged. The Bypass' flood conveyance capacity would be reduced if sediment were not flushed regularly.

6.g Remove or Stabilize Mine Waste

POCs addressed: mercury

Description

Various conventional technologies exist to reduce the load of contaminated sediments entering water bodies. These include:

- Erosion control – common practices such as drainage modifications, re-grading, re-vegetation and slope stabilization;
- Containment and stabilization/encapsulation – application of non-contaminated covering soils or encapsulation using soil stabilizers; and
- Removal and disposal – excavation and disposal in a landfill for highly concentrated mercury-containing wastes.

Benefits

Mine waste cleanup addresses contamination of local waterways from erosion and leaching, both at mine sites and in contaminated streambanks. Mine site cleanup will be required by the Cache Creek mercury TMDL for several mercury mines in that watershed. It is estimated that on the order of 95% of the current mercury load can be stopped through effective site remediation. However, the net load reduction of total mercury entering the Bypass would be approximately 5% of the total load from that watershed, thus less than 10 lbs/yr.

Costs

Remediation of the Sulphur Bank Mercury Mine by Clear Lake has taken over a decade and is still not completed. Costs to date exceed \$12 million for remediation work alone, not including numerous studies over the past two decades.

Mine remediation projects in the Cache Creek and Lake Berryessa watersheds could cost on the order of \$5 million per site, depending on the size of the site and local conditions.

Other Considerations

Many of the abandoned mercury mine sites are on land now owned and managed by the federal Bureau of Land Management (BLM). BLM would be responsible for cleaning up contaminated areas on those properties. Private landowners, who generally inherited similarly contaminated sites, would be responsible for their land. In both ownership situations, funding would be the primary concern.

There is currently considerable uncertainty regarding a third party's liability associated with cleaning up contaminated property. At a minimum, there would be a delay in evaluating a property owner's obligation and ability to conduct the remediation. The load reduction provided by a mine remediation project in the Cache Creek or Putah Creek watersheds would primarily benefit local water quality. Loads to the Bypass are already reduced significantly by deposition in streambanks, lakes and settling basins.

7 Manage Water Resources for Water Quality Benefits

7.a Minimize POTW Discharges to the Bypass

POCs addressed: salinity

Description

City of Woodland, City of Davis, and UC Davis campus POTW effluents with relatively high salinity are discharged into Bypass tributaries or directly into the Bypass. These sources could be applied to land seasonally or discharged instead into the Sacramento River.

The City of Woodland is investigating the viability of discharging its effluent directly into the Sacramento River near the Feather River confluence. The City of Davis is also investigating, as part of its Master Planning process, the viability of discharging its effluent directly into the Sacramento River south of West Sacramento.

Benefits

Salinity levels in the Yolo Bypass in the vicinity of removed POTW effluent discharges (Woodland or Davis) could decrease by approximately 25% during the dry season if POTW effluent were diverted out of the watershed.

Costs

Land application of wastewater would incur costs to purchase or lease the land (several hundred acres), install pipelines or irrigation channels, and manage the land and water. The City of Woodland estimated that total 20-year life-cycle costs to change its current method of effluent disposal from surface water discharge to reclamation via irrigation of fodder crops would be approximately \$90 million (ECO:LOGIC Engineering, 2003). Offsetting benefits of increased land value and crop sales were not considered.

The City of Woodland estimated that total 20-year life-cycle costs to change its current effluent discharge point from Tule Canal in the Bypass to the Sacramento River would be approximately \$18 million (ECO:LOGIC Engineering, 2003). Cost associated with installing and operating pipes from the City of Davis across the Bypass and through West Sacramento would be similar.

Other Considerations

Discharging treated effluent to land would not be effective during the wet season when soils are saturated. Although POTW discharges are used currently for irrigation, the more direct application to land is regulated more stringently. Recent NPDES permits in the Central Valley have increased treatment requirements for land disposal in recognition that the water could impact drinking water aquifers.

Growers in the Bypass rely on urban runoff and municipal wastewater discharges for irrigation purposes. Removing this water supply may harm local agricultural operations. Transferring POTW discharges to the Sacramento River would not reduce salt loads to the Delta.

7.b Manage Water Use in Bypass Wetlands

POCs addressed: aluminum, organic carbon, pesticides

Description

Wetlands have been found to effectively remove many pollutants if managed for that purpose. Various parcels within the Bypass are managed differently, creating a mosaic of wetland types. These lands can potentially be managed to improve water quality while also providing benefits such as flood retention, recreation, and wildlife habitat.

Benefits

Sediment removal efficiency in wetlands can vary with settling velocity of the particles and the hydraulic characteristics of the system, (e.g., retention time, depth, aspect ratio, percent open water area). However, wetland systems designed to remove other pollutants, such as nitrogen, typically will be over-designed with respect to suspended solids removal and systems can generally be expected to produce TSS levels close to background concentrations. Background concentrations are typically in the range of 3 to 15 mg/L and are the result of vegetation decomposition and wildlife activity. Many other POCs such as other metals, organic material and pesticides associated with sediments would also be removed.

Costs

Costs for altering wetland management practices would come from developing management plans and monitoring, in addition to any control structures. A managed wetland project would cost in the range of \$20,000-\$50,000 per acre (pers. comm., Tom Cannon, Wildlands, to S. McCord, 2/9/05).

Other Considerations

Residence time, seasonality of flows, soil types, plant communities, and influent quality can all impact pollutant removal rates.

Hardness and salinity, including boron, tend to increase through wetlands by the process of evaporative concentration. Heavy wildlife use of wetlands tends to increase fecal coliform concentrations.

In a national pilot study of mercury contamination in aquatic ecosystems, USGS found that wetland density (area of wetlands per area of watershed) was the single most important basin-scale factor controlling methylmercury production (Brumbaugh et al., 2001). The only local study on this issue found that the Cache Creek Nature Preserve wetlands functioned as a clear

source of methylmercury to lower Cache Creek (Slotton and Ayers, 2004). The Delta mercury TMDL is expected to recommend that there be a no net increase in methylmercury loads from restored marshes and new water impoundments.

Because sulfate-reducing bacteria tend to drive the methylation process, it is believed that limiting the available sulfate could be a key to minimizing the rate of methylation. The most concentrated sources of sulfate are mineral springs in the Cache Creek watershed (Domagalski et al., 2004). However, the highest concentration of sulfate enters the Bypass through the Ridge Cut (Schemel et al., 2002).

Costs and potential benefits of projects to control methylation cannot be generated until specific projects are identified.

7.c Alter Inter-basin Water Transfers

POCs addressed: salinity

Description

Inter-basin water transfers refers to the delivery of water from one watershed (basin) to another. Two major options are considered:

- Much of the Colusa Basin Drain water is discharged into the Sacramento River. More water could be diverted from the Drain into the Knights Landing Ridge Cut, which discharges into the upper Bypass. It is assumed that this diversion of water into the Bypass may worsen water quality in the Bypass; however, until monitoring data is compiled and evaluated it is not possible to determine the actual impact this change in water management may have on the Bypass.
- A low-flow fish passage could be constructed in the Fremont Weir. Water from the Sacramento River would be diverted continuously through the passage, supplying relatively high-quality water to the Bypass.

Water from Putah Creek is diverted at Lake Solano and largely transferred out of the watershed to Solano County for irrigation and potable supply. Diverting less water could provide greater dilution in lower Putah Creek and in the lower Bypass. A settlement agreement provided 50% greater flows to lower Putah Creek, along with a winter “pulse” flow to encourage salmon spawning. However, because allocations of that water have been determined by court ruling, additional flows are considered relatively unavailable.

Benefits

Colusa Basin Drain water would provide additional water volume for irrigation.

Sacramento River water diverted through a low-flow passage in the Fremont Weir would provide some year-around diluting flow to the entire Bypass. There are no major water quality concerns with this source.

Costs

Designing and constructing a low-flow passage through the Fremont Weir and purchasing water rights would incur costs. Current activities are aimed at determining project feasibility and estimating these costs.

Other Considerations

Colusa Basin Drain water is generally considered to be of poor quality, although monitoring under this project did not find levels of concern for any POCs. There is nonetheless the potential for water quality in the Bypass to be negatively impacted by this source. Farmers in the Bypass are generally opposed to this project because of the potential for more regulatory concerns associated with the supply of poorer water quality.

Water diverted from the Sacramento River through a low-flow passage would be designated primarily for salmon migration. It would likely not be available for local irrigation.

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