Delta Regional Monitoring Program

A Proposal for a

Regional Monitoring and Assessment Framework

and its

Implementation

Prepared for
Central Valley Regional and State Water Boards
June 2012

Brock Bernstein
Thomas Jabusch

AQUATIC SCIENCE CENTER

ACKNOWLEDGEMENTS

This project was funded by the Central Valley Regional Water Quality Control Board and managed by the Aquatic Science Center. The content of the report is based in part on discussions with representatives of a wide range of regulated, regulatory, and research organizations. Members who participated for all or part of this effort included:

Agency	**Staff**
Aquatic Science Center	Rainer Hoenicke
California Association of Wine Growers	Camron King
California Department of Fish and Game	Adam Ballard
California Rice Commission	Roberta Firoved
California Water Quality Monitoring Council	Jon Marshack
Central Valley Clean Water Association	Debbie Webster
Central Valley Regional Water Quality Control Board	Jerry Bruns
	Pamela Creedon
	Chris Foe
	Stephanie Fong
	Christine Joab
	Ken Landau
	Jim Marshall
	Diane Messina
	Margie Read
	Meghan Sullivan
City of Brentwood	Casey Wichert
City of Lodi	Charlie Swimley
City of Sacramento	Delia McGrath
City of Tracy	Eric Delmas
City of Vacaville	Tony Pirondini
Coalition for Urban and Rural Environmental Stewardship	Parry Klassen
County of Sacramento	Ken Ballard
Delta Stewardship Council	Steve Blecker
Interagency Ecological Program	Anke Mueller-Solger
Ironhouse Sanitation District	Jenny Skrel
Larry Walker Associates	Karen Ashby
	Brian Laurenson
	Kate Lund
McCord Environmental, Inc.	Stephen McCord
Mountain House Community Services District	Ahmad Haya
	Nader Shareghi
Port of Stockton	Jeff Wingfield
Port of West Sacramento	Amy Cameron

Agency	Staff
Sacramento Area Sewer District	Steve Nebozuk
Sacramento Regional County Sanitation District	Linda Dorn
	Jason Lofton
	Vyomini Pandya
Sacramento Valley Water Quality Coalition	Tina Lunt
Sanitation Districts of Los Angeles County	Phil Markle
San Joaquin County	Chang Cao
San Joaquin County and Delta Water Quality Coalition	Mike Wackman
Southern California Water Research Project	Steve Bay
State and Federal Contractors Water Agency	Val Connor
State Water Resources Control Board	Johnny Gonzales
	Karen Larsen
Town of Discovery Bay Community Services District	Lori Gabriel
	Virgil Koehne
University of California, Davis	Brian Anderson
U.S. Army Corps of Engineers	Brooke Schlenker
U.S. Fish and Wildlife Service	Matt Dekar
U.S. Geological Survey	Roger Fujii
	Tom Kimball
	Jim Orlando
Western Plant Health Association	Nasser Dean

Contents

SUMMARY

This report presents a design for core water quality components of a Delta Regional Monitoring Program (Delta RMP), which responds to the need to improve coordination across multiple monitoring programs and to create a more comprehensive picture of conditions across the Delta as a whole. The Delta RMP is thus a complement to existing larger-scale regional monitoring efforts throughout the state that attempt to address questions and concerns about regional conditions and trends in these (e.g., San Francisco Bay RMP, Southern California Bight Monitoring Program).

The report describes fundamental design principles for the Delta RMP and design details for three key initial aspects of the Delta RMP:

- Deltawide aquatic and sediment toxicity assessment (supplemented with aquatic and sediment chemistry analyses), through the design of a regional ambient (i.e., receiving water) monitoring program
- Permittee compliance monitoring, through effluent and discharge monitoring supplemented where necessary by targeted receiving water monitoring
- Data management and access, through ongoing efforts to implement and provide feedback on Regional and State Water Board data management initiatives

These and other components of the Delta RMP to be developed over time will be designed and implemented to complement and/or coordinate with other related efforts such as the Surface Water Ambient Monitoring Program (SWAMP), agricultural coalition monitoring in and upstream of the Delta, and resource agency monitoring. While the proposed Delta RMP reflects ongoing discussion with a wide stakeholder community, implementing the Delta RMP, with its adjustments to existing compliance monitoring, will require further and more detailed discussions among involved stakeholders.

The proposed Delta RMP is based on the question-driven monitoring approach described in the State Water Quality Control Board's SWAMP Assessment Framework (Bernstein 2010), which defines a hierarchy of questions leading from broad concerns about beneficial uses to more detailed questions that guide the specifics of monitoring design. The initial focus on aquatic life beneficial uses represents a useful starting point while acknowledging that additional beneficial uses may be addressed in the future, and leads to the following overarching motivating question:

Is the Delta aquatic ecosystem healthy?

Two secondary questions provide additional focus for the initial Delta RMP monitoring design:

- Question 1: Are receiving waters meeting water quality objectives?
- Question 2: Do point and nonpoint discharges comply with permit limits and other relevant thresholds?

The proposed monitoring design addresses each management question with a different type of monitoring design.

Question 1 addresses concerns related to the condition of the Delta as a whole. The recommended monitoring design has the following elements:

- A hybrid (probabilistic and targeted) sampling scheme (30 – 120 sites)
- Monitoring of toxicity and chemistry using indicators validated by SWAMP and/or other long-term programs
- Chemistry analyses conducted only on samples shown to be toxic and a random subset of nontoxic samples
- Sampling 1 – 3 times/year, in winter (storm event), spring, and fall for the water column, and in the fall for sediments, with each time period treated as a separate temporal stratum
- An annual assessment period for aquatic conditions and a five-year assessment period for sediment conditions, and
- Special studies to elucidate processes and identify stressors and/or sources.

Question 2 addresses concerns related to the performance of discharges and includes the following elements:

- Replace existing receiving water monitoring stations with a regional ambient monitoring program
- Water chemistry monitoring of effluent and discharges for those constituents with permit-based limits or objectives
- Toxicity testing of effluent and discharges
- Targeted receiving water monitoring, implemented on a case-by-case basis where needed to provide a basis for assessing compliance and/or to follow up on or improve the understanding of effluent and discharge monitoring, and
- Coordination across multiple dischargers of surveys needed to conduct reasonable potential analyses.

The Regional Water Board has determined that no changes will be made at this time to permit mandated effluent or discharge monitoring. Thus, the major changes to current monitoring practice are the removal of routine receiving water monitoring and the improved coordination among individual dischargers' reasonable potential analyses.

Elements of the Delta RMP will be executed beginning in 2013, following additional discussion with stakeholders and approval by the Regional Water Board. It is proposed that the program be funded through a combination of in-kind sampling and laboratory analysis contributions from program partners and a set of approved permanent compliance monitoring reductions or offsets for dischargers in the Delta with NPDES permits. While partnering and in-kind support will be essential, the program will also require its own funds (from monitoring offsets and other sources) to fulfill the core requirements of reporting, data management and integration, and program management and stewardship. The planned schedule is to negotiate the details of monitoring designs and finalize a detailed draft monitoring plan by August 2012. Coordination and cost sharing agreements will then be completed by October 2012 and the Delta RMP plan will be presented to the Regional Water Board in early December 2012.

The initial implementation of the Delta RMP will be defined after costing exercises are completed and program elements have been prioritized according to a set of agreed-upon criteria. Initial cost estimates range from $180,000 for a very restricted minimal program, to about $1.7 million for a mid-range program with a somewhat limited number of indicators at fewer sites, and about $3.0 million for a program that includes a larger number of indicators and sites.

As the Delta RMP develops further, it will be necessary to clarify the management structure of the program and the balance of authority and responsibility between an operational lead and stakeholders. The proposed program planning cycle suggests an in-depth independent review of all key aspects of the program every five years.

1.0 Introduction

This report presents a design for core water quality components of a Delta Regional Monitoring Program (Delta RMP). The Delta RMP was initiated by the Central Valley Regional Water Quality Control Board (Regional Water Board) with the primary goal of tracking and documenting the effectiveness of beneficial use protection and restoration efforts through comprehensive monitoring of contaminants and contaminant effects in the Delta. All elements of the Delta RMP will be supported by a common question-driven approach, data management and data access policies, and governance structure. As explained in previous publications (Aquatic Science Center 2011, 2012; Jabusch and Bernstein 2010) describing the Delta RMP's purpose, philosophy, and implementation strategy, Delta-wide monitoring and assessment will be developed in coordination with related programs conducted by other entities, in collaboration with involved stakeholders, and in parallel with efforts to improve the efficiency and effectiveness of existing compliance monitoring.

The development of the Delta RMP was initially prompted by the collapse of the populations of several species of fish in the early 2000s, an event that triggered new inquiries into the potential role of contaminants in what is now termed the Pelagic Organism Decline (POD). However, these inquiries highlighted shortcomings in the ability of existing monitoring efforts to address questions at the scale of the Delta. The recognition that data from current monitoring programs was inadequate in its coverage, could not easily be combined, and was not adequate to support a rigorous analysis of contaminants' role in the POD persuaded regulatory agencies of the need to improve coordination across multiple monitoring programs.

In addition, the Delta RMP reflects an increasing desire among water quality and resource managers throughout the state for more integrated information about ambient conditions across watersheds and regions and about patterns and trends in those conditions. This is a natural response to the growing awareness that habitats, physical features, and processes (both human and natural) stretch across typical regulatory and management boundaries and are not well captured by the more spatially restricted focus of most compliance monitoring systems. In addition, many stressors on ecosystem functions and beneficial uses are interrelated and must be addressed more holistically. The Delta RMP can be seen as a complement to existing larger-scale regional monitoring efforts throughout the state that attempt to address questions and concerns about regional conditions and trends in these (e.g., San Francisco Bay RMP, Southern California Stormwater Monitoring Coalition (SMC) regional watershed assessment program, Southern California Bight Monitoring Program).

The remainder of this report describes fundamental design principles for the Delta RMP and design details for key initial aspects of the Delta RMP that reflect the Regional Water Board's initial priorities for the Delta RMP:

- Deltawide aquatic and sediment toxicity assessment (supplemented with aquatic and sediment chemistry analyses), through the design of a regional ambient (i.e., receiving water) monitoring program
- Permittee compliance monitoring, through effluent and discharge monitoring supplemented where necessary by targeted receiving water monitoring and special studies
- Data management and access, through ongoing efforts to implement and provide feedback on Regional and State Water Board data management initiatives

These and other components of the Delta RMP will be designed and implemented to complement and/or coordinate with other related efforts such as the Surface Water Ambient Monitoring Program (SWAMP), agricultural coalition monitoring in and upstream of the Delta, and resource agency monitoring. This could include:

- Collaboration on planned monitoring efforts to defray financial and logistical costs
- Coordination and standardization of field sampling, laboratory analysis, and data management methods
- Collaboration, either in terms of financial or in-kind support, on preparation of periodic assessment reports that integrate and synthesize monitoring data at the Delta scale

The Delta RMP monitoring components described below are structured around a set of key management questions that reflect specific concerns about different aspects of the Delta and the impacts of human activities on these. For each question, the Delta RMP describes a monitoring design, including its overall approach and rationale, indicators to be measured, recommended monitoring sites and frequencies, and expected data products. The monitoring program presented in Sections 3 and 4 includes technical descriptions of all elements identified as potentially useful for answering the key management questions. However, the cost of implementing the full range of monitoring elements is likely to exceed resources available from partnerships, in-kind support, and funds reprogrammed from current NPDES compliance monitoring efforts. The initial implementation of the Delta RMP will therefore be defined after costing exercises are completed and the prioritization criteria listed in Section 6.3 are applied.

The proposed program clearly recognizes that any final decisions about modifications to existing monitoring efforts and/or about the initiation of new efforts will depend on detailed negotiations among dischargers, other agency monitoring programs, regulatory agencies, and other stakeholders. Thus, decisions about certain design details, coordination among related efforts, available resources and funding, logistics, phasing, and reporting remain to be resolved by the parties during subsequent detailed implementation. This is a realistic acknowledgement of the diversity of key questions, the large number of stakeholders, and the range of existing monitoring efforts, some permit-based and some not. Thus, the proposed Delta RMP components described below are intended as a carefully considered starting point for detailed implementation discussions among involved stakeholders.

2.0 Principles and Framework for Delta Monitoring

The three components of this initial phase of the Delta RMP include regional water quality monitoring, discharge compliance monitoring at the site-specific level, and data management, governance, and reporting. The primary objective is to collect more robust information about the health of the Delta and conduct regular assessments. The secondary objective is cost efficiency, i.e. contain or possibly reduce monitoring costs through implementation of a regional receiving water monitoring program and improved coordination among NPDES dischargers and other monitoring entities at the local, state, and federal levels.

2.1 Key management questions

The proposed Delta RMP is based on the question-driven monitoring approach described in the State Water Quality Control Board's SWAMP Assessment Framework (Bernstein 2010), which defines a hierarchy of questions leading from broader, core questions about beneficial uses to more detailed questions that convert these into specific monitoring designs. Core questions identify fundamental management concerns that can be expressed in broad, readily understood terms. These core management questions are then connected to specific assessments or study elements by more detailed tiers of questions that can serve as the basis of explicit monitoring designs and assessment designs. Core management questions can be reviewed after a length of time and revised as necessary.

The proposed Delta RMP initially focuses on the following overarching question from the SWAMP Assessment Framework:

Is the Delta aquatic ecosystem healthy?

This question encompasses the following beneficial uses in the Central Valley Region Basin Plan (Basin Plan, Central Valley Regional Water Board 2011) and the Bay-Delta Water Quality Control Plan (Bay-Delta Plan, State Water Board 2006):

- Cold Freshwater Habitat (COLD)
- Commercial and Sport Fishing (COMM)
- Estuarine Habitat (EST)
- Fish Spawning (SPWN)
- Migration of Aquatic Organisms (MIGR)
- Rare, Threatened, or Endangered Species (RARE)
- Shellfish Harvesting (SHELL)
- Warm Freshwater Habitat (WARM)
- Wildlife Habitat (WILD)

This list of beneficial uses captures the key regulatory and management priorities identified in discussions with stakeholders as well as reflecting the primary objectives of traditional permit monitoring in the Delta. It thus represents a useful starting point for the Delta RMP while acknowledging that additional beneficial uses may be addressed in the future.

There are two secondary questions that articulate Regional Water Board priorities and provide additional focus and a starting point for the Delta RMP design:

- Question 1: Are receiving waters meeting water quality objectives?
- Question 2: Do point and nonpoint discharges comply with permit limits and other relevant thresholds?

Question 1 will be addressed through a regional ambient (i.e., receiving water) monitoring design and additional special studies. Question 2 will be addressed through site-specific effluent and discharge monitoring supplemented where necessary by targeted receiving water monitoring and special studies. Efforts to answer both questions will be supported through initiatives to improve data management and data access at both the statewide and regional scales.

2.2 Design framework and principles

The proposed Delta RMP monitoring design addresses each management question with a different type of monitoring design. Question 1, related to receiving water, is addressed with a hybrid regional design that includes both probabilistic (or random) and targeted sites. This acknowledges the fact that the structural and hydrological complexity of the Delta makes it impossible to ask and answer questions at the scale of the Delta by simply combining data from a number of distinct point-source monitoring programs. Question 2, related to effluent and discharges, is addressed with site-specific effluent or discharge monitoring. The hybrid regional design may be enhanced through local intensification to address concerns in certain subsets of the Delta. Special studies may focus on specific issues such as source identification or other process-based and/or causal analyses.

The following principles will guide development of the Delta RMP to ensure it is feasible, sustainable, and widely supported:

- Start small and focus on clear questions of broad interest
- Strive for cost efficiency
- Approach planning and implementation in several consecutive phases that build on each other
- Institutionalize periodic external program review and provide mechanisms for the continuous adaptation of the Delta RMP based on information generated
- Pursue an inclusive approach, supported by the program's governance structure, based on broad stakeholder involvement

Proposed monitoring designs themselves will observe the following guidelines:

- Monitoring should be focused on decision making; data not helpful in making a decision about clearly defined regulatory, management, or technical issues should not be collected
- The level of monitoring effort should reflect the potential for impact, with more monitoring allocated to situations where the potential impact (in terms of both the probability of an impact's occurrence and its extent and magnitude) is higher and less monitoring to situations where such potential is lower or where monitoring is not likely to provide useful information
- Monitoring designs should be integrated into a logically consistent whole, in which all aspects of the design support the key management question, and strive for both cost effectiveness and scientific rigor
- Monitoring should be adaptive, in terms of its ability to both trigger follow-on studies as needed and make necessary midcourse corrections based on monitoring findings

2.3 Geographic Scope

The sampling boundary is the legal Delta as defined by section 12220 of the Water Code, including water bodies that directly drain into the Delta. The Chipps Island area is outside the jurisdiction of the Regional Water Board and monitoring here may involve coordination with the San Francisco Bay RMP. In addition, the upstream boundary of the Delta RMP may extend beyond the legal Delta to accommodate the interests of specific potential partners.

3.0 Question 1: Are Receiving Waters Meeting Water Quality Objectives?

This question is relevant to all of the beneficial uses related to aquatic life:

- Cold Freshwater Habitat (COLD)
- Commercial and Sport Fishing (COMM)
- Estuarine Habitat (EST)
- Fish Spawning (SPWN)
- Migration of Aquatic Organisms (MIGR)
- Rare, Threatened, or Endangered Species (RARE)
- Shellfish Harvesting (SHELL)
- Warm Freshwater Habitat (WARM)
- Wildlife Habitat (WILD)

Question 1 addresses concerns related to the condition of the Delta as a whole, rather than issues only or primarily at specific or fixed sites.

Potential assessment questions that address such concerns (and that reflect questions in the SWAMP Assessment Framework) include:

- What is the quality of waters relative to beneficial uses?
- What is the extent and magnitude of water quality impacts in the Delta?
- How do the extent and magnitude of water quality impacts compare among different parts of the Delta?
- What are the trends in the extent and magnitude of water quality impacts in the Delta?
- What are the sources of water quality problems?
- Are efforts to address these problems working?

In overview, the monitoring design (Table 3.1) recommended to address such questions has the following elements:

- Sampling scheme
  - A randomized, or probabilistic, sampling scheme that includes the entire Delta, with the Delta treated as a single spatial stratum and sampling conducted at 30-40 sites per year
  - A targeted, or fixed site, sampling scheme that focuses on key inflows, sources of potential toxicity, and areas of particular concern
- Monitoring of toxicity and aquatic and sediment chemistry using indicators validated by SWAMP and/or other long-term programs
- Chemistry analyses conducted only on samples shown to be toxic and a small, random subset of nontoxic samples
- Sampling in winter (storm event), spring, and fall for the water column, and in the fall for sediments, with each time period treated as a separate temporal stratum
- An annual assessment period for aquatic conditions and a five-year assessment period for sediment conditions
- Special studies to elucidate processes and identify stressors and/or sources

The types of data products resulting from this monitoring design and appropriate for answering Question 1 may include:

- Cumulative frequency distribution plots of key individual indicators or metrics and of synthesized results or condition scores
- Estimates of the areal extent of the Delta above/below benchmarks of interest for key indicators and for synthesized results
- Maps of the areal distribution of monitoring sites in the Delta above/below benchmarks of interest for key indicators and for synthesized results
- Estimates of difference in water quality indicators among different segments of the Delta
- Measures of water quality indicators at targeted sites or areas of concern
- Trends over time in water quality indicators
- Identification and prioritization of potential sources and other results of special studies

The following subsections provide details on the design approach selected, as well as on the recommended indicators and the sampling frequencies.

3.1 Design approach

A hybrid monitoring design, containing both probabilistic and targeted sites, supplemented by special studies to elucidate key processes and identify stressors and/or sources, is best suited to address the key management question about the overall condition of water quality in the Delta. The strength of this approach is that the probabilistic element will support conclusions about conditions across the entire Delta, and about any strata or subpopulations defined through poststratification in the data analysis, while the targeted element will support conclusions about conditions at specific sites or areas of particular concern. Process studies, along with stressor and/or source identification, will then provide the additional information needed to develop effective source control / reduction efforts.

The presence of multiple programs in the Delta conducting monitoring and assessment at different scales presents opportunities for coordination as well as duplication of effort and inefficiency. To prevent duplication of effort and to achieve maximum sampling efficiency, the water quality component of the Delta RMP will continue to pursue efforts to coordinate with these and other programs to create monitoring partnerships wherever possible (see Section 3.3 Coordination with other efforts, below).

3.1.1 Probabilistic sampling

In probability-based designs, stations are located randomly in order to provide the ability to draw statistically valid inferences about an area as a whole, rather than about just the site itself. Such designs can allocate monitoring sites randomly throughout the entire region, or can subdivide the region into a number of strata that are relatively homogeneous. For example, SWAMP's statewide stream and toxicity assessments have defined the three broad strata of open, agricultural, and urbanized land uses. Other programs, such as several watershed programs in southern California, have subdivided watersheds based on a combination of hydrology and land use (e.g., mainstem, tributaries in the undeveloped upper watershed, tributaries dominated by urban runoff). Whatever the stratification scheme, the basic design principle is that samples are allocated randomly among strata, with the number of samples per stratum based on a consistent weighting factor (e.g., area or number of stream miles within each stratum).

The level of sampling effort required in probability-based designs depends, as in all designs, on the specific questions being asked, the underlying levels of variability in the data, and on the level of precision needed for decision-making. The primary intent of this component of the Delta RMP is to answer questions about the frequency of sampled areas above or below different benchmarks of interest. Given that the confidence limits around the cumulative frequency curve are widest at the 0.5 point on the curve, other programs in California using probabilistic designs have generally made a subjective decision to accept a 15% confidence limit for this statistic, which equates to a sampling requirement of 30 samples per stratum per assessment period (see Strata, subpopulations, and sampling requirements, below).

The design effort for this component of the Delta RMP involves developing explicit answers to the following series of subsidiary technical questions:

- Which type of aquatic resources will be monitored?
- Where in the Delta will monitoring occur and how will the Delta be stratified?
- How frequently will monitoring occur?
- How will water quality be defined?
- What other related data will be collected?

These questions are addressed in the following sections.

Target population and sampling frame. The target population is the ecological resource about which information is desired and is defined by three criteria:

- The legal Delta as defined by Section 12220 of the Water Code, including waterways draining directly to the Delta and possible upstream extensions to accommodate the interests of specific potential partners
- Surface water channels (both natural and modified) and open surface waters that fit the definition of "waters of the State"
- Subtidal waters only, excluding the intertidal zone

More detailed definitions and descriptions of these boundary conditions follow.

The legal Delta is defined in Section 12220 of the Water Code and shown in Figure 3.1.

Channels and surface water are defined to include water from all sources, including natural (local) and imported water, urban runoff, irrigation tailwater, and treated effluent from municipal wastewater treatment plants. While this may result in the inclusion of some segments that are effluent-dominated, it is difficult if not impossible to cleanly distinguish such segments. In addition, such segments have the potential to support the beneficial uses listed above and should therefore be assessed. Waters of the State are defined in the Porter-Cologne Water Quality Control Act and include all waters. Subtidal is defined as the open water zone that remains submerged at low tide.

Because the amount and location of flowing water in the Delta and the nature of water quality impacts can shift seasonally, the definition of the sampling frame (a representation of the target population used to select the sample sites and that must have the attributes needed to implement the monitoring design) should also include a time frame. There are a number of issues related to the choice of sampling period.

Sampling after a winter rain event will be required to detect any stormwater-related contamination and toxicity in the water column, as demonstrated in special studies for the POD-WT (Werner et al. 2010, Weston et al. 2010). Timing this sampling to capture the first major flush into the Delta will require judgment on a case-by-case basis and consideration of information such as predicted size of storm, antecedent rainfall and dry period, and ground saturation. Proposed rules of thumb to guide this judgment are presented in Table 3.2.

Comment [TJ1]: Build on prior sampling strategies and first flush criteria for sampling in and around the Delta.

While there is a spring runoff period in the Delta's larger drainage area, flows into and through the Delta are highly managed. Nevertheless, spring is a critical period for the X2 salinity standard and for several pelagic species, and the spring runoff period is more likely to carry pesticides applied to agricultural crops in the winter and early spring (e.g., winter dormant sprays (e.g., pyrethroids, organophosphate pesticides), weed sprays (e.g., diuron) and pesticides (e.g., pyrethroids) on alfalfa). In addition, spring flows are also likely to carry any toxic contaminants from urban runoff. The spring runoff period was therefore identified as an important monitoring period.

Summer and early fall is the irrigation season for agriculture and urban areas, and a fall sampling period would be positioned to catch toxic effects due to drift or runoff of pesticides, herbicides, and other toxic compounds. On the other hand, discharge from municipal wastewater treatment plants does not have a strong seasonal signal. Thus, a third sampling period in the early fall is also recommended for documenting potential water quality impacts. Contaminants bound to particles (e.g., pyrethroids) may cause sediment toxicity but sediments are less variable than the water column and a single sampling event during the year is therefore recommended for monitoring sediment impacts.

Strata, subpopulations, and sampling requirements. Stratification could be used to subdivide the Delta into more homogeneous sections to better answer questions about differences between distinct portions of the Delta. However, sampling requirements in randomized designs increase linearly with the number of strata. Thus, the value of increased resolution must be balanced against the associated increase in cost and effort, because each stratum requires a full complement of sampling sites.

An alternative to stratification is to subsample specific areas, or subpopulations, of the Delta, yet still treat the entire Delta as a single stratum. This approach ensures representation of all subpopulations by distributing samples in desired proportions across the various sections of the Delta. The advantage of this approach is that it does not require a complete set of 30 samples for each area of interest. The disadvantage is that it does not allow statistically robust comparison between the subpopulations of the watershed until an adequate number of samples have been accumulated.

While defining *a priori* strata (or subpopulations) can improve sampling efficiency and the ability to address a specific set of questions (e.g., what is the difference between hydrological regimes A, B, and C), not all relevant questions fit a single stratification scheme. Therefore, the Delta RMP design treats the Delta as one overall stratum, which reflects the primary purpose of this aspect of Question 1 -- to assess the Delta as a whole. However, there are substantial differences in morphology, habitat, and water quality across the Delta, and these could be examined during the data analysis by poststratification, a procedure that involves resorting samples into various categories or subpopulations. Treating the Delta initially as a single stratum and allocating sampling sites randomly throughout the Delta will avoid the necessity of making difficult choices among alternate stratification approaches during the design phase and provide the maximum amount of flexibility during the data analysis and assessment.

However, the Delta RMP design treats each of the three sampling periods (winter, spring, fall) as separate strata because each period is intended to capture the Delta condition when distinctly different processes are occurring.

The number of sites sampled under the random design depends on the desired confidence level in the data. A larger sample size translates to less uncertainty associated with differences or trends in the data, and vice-versa. Data from the randomized design will be used to produce cumulative frequency distributions of the indicator measures. These distribution curves can then be used to make descriptive statements about the proportion of the stratum (i.e., the Delta) that is above or below any particular threshold level of interest. The confidence level attached to these estimates of proportion depend on the size of the error bars around the cumulative frequency distribution curve. As with all statistical estimates, the larger the error bars, the less the confidence of the estimate. The error bars around the binomial cumulative frequency distribution curve are widest at a proportion, or "p", of 0.5, that is, halfway along the curve. Thus, selecting a sampling intensity that ensures the error bars will be acceptable at p = 0.5 means that, even in the worst case, useful estimates can be produced. Error bars are associated with several representative levels of sampling effort:

- 50 sites + / - 12%
- 30 sites + / - 15%
- 12 sites + / - 24%.

Thirty samples per stratum have generally been accepted in other regional programs to provide a reasonable level of confidence for assessment and this rule of thumb has been applied to the Delta RMP design.

Sampling frequency and intensity. The recommended sampling frequency was selected as described above (Target population and sampling frame) to capture major types of runoff events (for aquatic sampling) and to establish a representative index period for sediment sampling. The length of time required to collect the desired number of samples per stratum depends on the assessment period. Thus, if a program goal is to complete a full assessment of Delta conditions every year, then 30 samples would be required every year for each of the three sampling periods (i.e., temporal strata). Similarly, if the assessment period were three years, then ten samples per sampling period would be required.

The recommended assessment cycle for the Delta RMP is annual for aquatic conditions and five years for sediment conditions. This will require a minimum of 90 aquatic samples and six sediment samples per year for the probabilistic component of the program. The longer assessment period for sediment conditions reflects the fact that this is currently a lower priority for the Regional Water Board and the relatively greater stability of sediment conditions.

Local intensification. Depending on existing questions and pending initial monitoring results, local intensification of the random design may be desired.

3.1.2 Targeted sampling

While the proposed Delta RMP design envisions replacing discharger receiving water compliance monitoring with the regional program described in this chapter, there are nevertheless site-specific concerns about the condition of water quality that would require additional monitoring at two types of targeted locations:

- Indicator or integrator sites that provide information about the potential input of contaminants to surface waters of the Delta (considering both upstream sources and in-Delta sources)
- Locations of special significance for aquatic resources

Where possible, the Delta RMP will coordinate with existing programs to capture their data, cooperate in sample collection, and/or add additional parameters to laboratory analyses.

Delta surface waters can receive contaminants from agricultural and urban land uses inside and upstream of the Delta boundary. Documenting the toxicity of these inputs, the magnitude and extent of their potential impacts, and the chemical characteristics of toxic samples will be useful in putting Delta monitoring results into context, and also in providing needed information about potential sources of water quality impacts. In addition, improved scientific understanding has begun to identify areas within the

Delta as having particular ecological significance for processes such as productivity, survival, and growth and/or habitat for key species.

There are several ongoing monitoring efforts that include sites of potential value to the Delta RMP and that therefore offer opportunities for collaborative monitoring and analysis. These include at a minimum the IEP and discharge stations maintained by agricultural coalitions and stormwater programs. Selection of the following proposed sites was influenced by opportunities for collaboration with these programs.

Key inflow sites include the following, some of which will also provide data needed to address Question 2 (see Section 4.0):

- Hood (Sacramento River basin, downstream of SRCSD) (DWR)
- Vernalis – McCune station (San Joaquin River basin terminus) (DWR)
- Ulatis Creek (Sacramento Valley Water Quality Coalition)
- [other agriculture coalition sites within Delta or on boundary]
- Calaveras River only during storm (Stockton Stormwater Monitoring)
- Freeport (Sacramento River basin, upstream of SRCSD) (USGS)
- Toe Drain)DWR)

Key in-Delta sources include:

- A random sample of the hundreds of small agricultural drainage inputs, based on a review of the available information on this source category
- Stormwater discharge monitoring sites of the City of Stockton and County of San Joaquin, Sacramento Stormwater Quality Partnership Program, and Port of Stockton.

Certain locations in the Delta are considered to have unique ecological value, either because they are key migratory or spawning locations, are associated with increased productivity, or are important habitat for species of concern. Such locations where water quality would be a concern include:

- A random sample of shallow sloughs that are important areas for productivity and potential contaminant impacts on the foodweb
- Cache Slough / Prospect Slough Complex
- Benthos sampling sites of the IEP EMP

Proposed targeted sites are illustrated in Figure 3.2.

3.2 Indicators

3.2.1 Aquatic and sediment toxicity

Existing data and previous assessments have documented the presence of both acute and chronic (e.g., growth and reproduction) toxicity in aquatic and sediment habitats in the Delta and this experience, as well as experience from elsewhere, provides a basis for identifying potential indicators. Table 3.3 summarizes applicable toxicity tests. It is likely that not all of these will be used and those included in the program will be selected based on the prioritization exercise described in Section 6.3.

For aquatic toxicity testing, a standard approach is to use a three –species test using a fish (fathead minnow, *Pimephales promelas*), a cladoceran copepod (*Ceriodaphnia dubia*), and a green alga (*Selenastrum capricornutum*). However, this approach has several caveats. *Pimephales promelas* is generally regarded as not very sensitive to many toxicants. *Selenastrum capricornutum* is also problematic because ammonia retards its growth, but other nutrients may cause it to grow faster, making it difficult to interpret test results. These tests also do not fully capture pesticide toxicity.

Preferred tests for water toxicity in other regional programs are *Ceriodaphnia* (short-term chronic, 6-8 days, survival, growth, reproduction) and *Hyallela* (acute, 10-day survival and growth). *Hyalella* is native to California, relatively hardy, and sensitive to low levels of pyrethroid pesticides, which have been implicated in sediment and water toxicity in the Delta. A criticism of this approach is that such taxonomically similar test species would most likely result in a relatively narrow response range to potential toxicants[1]. For example, it would not capture ammonia that may be detectable if testing with the fathead minnow or herbicide toxicity that would be detectable if testing with *Selenastrum*.

Available standardized tests for sediment toxicity include *Hyallela* (acute, 10-day sand 20-day survival and growth) and *Chironomu*s (10 day survival and growth). Both test species are benthic invertebrates that are somewhat similar in their sensitivities, with *Hyallela* being more sensitive to pyrethroid pesticides. The 10-day *Hyalella azteca* survival and growth test is the most commonly used method. While the 10-day *Hyalella* test's growth endpoint is less sensitive than that of the 20-day test, the 20-day is more expensive and there are more issues with *Hyalella* viability and interferences not related to toxicity. In addition, the San Francisco Bay RMP has begun using a new test with *Ceriodaphnia* exposed at the sediment / water interface. One of the key advantages of this test is that it captures metals toxicity that neither *Hyalella* nor *Chironomus* are sensitive to. *Ceriodaphnia* would also be more sensitive to the presence of organophosphorus (OP) pesticides than either species.

Water column and sediment sampling for toxicity tests would preferably occur at the same time.

3.2.2 Aquatic and sediment chemistry

Chemistry is often sampled in conjunction with aquatic and sediment toxicity tests in an attempt to identify the source(s) of any observed toxicity. However, aquatic toxicity in the Delta has generally been found to occur sporadically and at low levels, thus reducing the likelihood of finding any direct link to water column chemistry. The Sediment Quality Objectives program conducted the so far most comprehensive assessment of sediment toxicity in the Delta and found effects in less than 5% of tests for lethal endpoints but sublethal effects in between 15% and 20% of tests. Patterns of toxicity corresponded only poorly to sediment chemistry collected at the same time and location. While pesticides were detected regularly (particularly diuron, which was found at every site), concentrations were low and the limited toxicity that was found was not clearly related to sediment concentrations of any individual contaminants. A possible explanation for the lack of a clear connection between contaminant concentrations and detected sediment toxicity includes interactions between different types of contaminants, such as synergistic effects or the presence of contaminants that are not analyzed or whose toxicity is not known.

Although there is sometimes no obvious causal linkage between toxicity and detected constituents, aquatic and sediment chemistry data can provide an overall picture of spatial patterns and temporal trends of contamination and thus provide an indication for progress in meeting water quality objectives. In addition, such data can prove useful in assessments that attempt to explain events such as the POD or other aspects of ecological condition. However, in support of the Delta RMP's initial focus on toxicity, chemistry analyses will be performed only on water and sediment samples found to be toxic and on a small, random subset of nontoxic samples. The size of the random subset will be determined based on results of the prioritization exercise described in Section 6.3.

[1] A single species test is open to the same criticism.

Aquatic and sediment chemistry indicators are based on the recommended SWAMP indicators (SWAMP 2010) supplemented with additional information about contaminants and other indicators of water quality in the Delta (Table 3.1).

3.2.3 Stressor identification

While patterns of toxicity and contamination can provide information about levels of impact and trends in these, management actions can more effectively be targeted when the sources of such impacts are identified. For toxicity, desired information would be the chemicals of concern that are likely to cause toxicity. For chemicals themselves, desired information would be the land use type, activity, and/or specific location through which chemicals of concern enter the Delta system.

For toxicity, previous experience (e.g., San Francisco Bay-Delta, Newport Bay) has shown that simple correlations between toxicity and chemistry are insufficient to reliably identify stressors, especially where:

- Newer chemicals may be involved that are not part of routine monitoring requirements
- Toxicity is sporadic and/or at low levels
- Toxicity may result from mixtures of chemicals as opposed to elevated levels of one or a few constituents

In these cases, toxicity identification evaluations (TIEs) and other stressor identification methods can be applied, although these are better developed for examining aquatic than sediment toxicity. Any sediment TIEs performed should therefore be done so as special studies. Selection of appropriate stressor identification methods will depend on several factors including the type of toxicity, its magnitude and extent, characteristics of the local environment, and the availability of other information. For example, toxicity above a threshold of 30% could trigger a requirement for additional chemical sampling and/or TIEs (for aquatic toxicity only), depending on the nature of the toxicity (e.g., amount of toxicity, spatial / temporal patterns) and/or the type of site. Methods could include one or more of the following:

- Preliminary evaluation of all information using a structured assessment process such as USEPA's Causal Analysis / Diagnosis Decision Information System (CADDIS)
- TIEs, including evaluation of newer methods that include temperature modification and pesticide degrading enzymes that increase the specificity of analysis results
- Laboratory sediment spiking studies with local sediments to estimate effects levels on test organisms; equilibrating sediments for several months can better mimic natural levels of bioavailability
- Improved chemistry to identify a broader range of potential toxicants
- Expanded sediment chemistry that includes whole sediments, pore water, and other bioavailable portions
- Use of additional test organisms to expand the range of possible response
- Genetic fingerprinting approaches more suited to lower levels of toxicity and/or toxicity due to mixtures of several chemicals

Some of these methods (e.g., use of enzymes in TIEs, genomic methods) are under development and have not yet progressed to agreement on standardized methods. For this reason, and also because stressor identification is an inherently site-specific process, the identification of stressors responsible for toxicity should be designed and implemented as special studies.

Identifying the source(s) of specific chemicals of concern can begin with information from the types of analyses described above, supplemented with data from effluent and discharge monitoring programs.

However, unless a particular contaminant has a unique source, any effort to identify the sources(s) of contaminants found in specific locations or areas of the Delta will require more sophisticated analyses involving estimates of loading and transport. Special studies could be developed to provide estimates of the flux of key constituents into and between different segments of the Delta and out of the Delta into the Bay. For example, past studies have had success in tracking toxicity downstream of specific sources. Information on the more complex back-and –forth- transport pattern of contaminants or nutrients inside the Delta would require modeling analyses based on compatible datasets for chemistry and flow. Such date could be obtained, for example, through targeted chemical monitoring at USGS in-Delta flow gauges.

3.3 Coordination with other efforts

Comment [B2]: Will be revised substantially as the coordination plan is developed

One of the key opportunities for coordination will be to conduct reasonable potential (RP) analyses required by NPDES dischargers at the same time as the sampling conducted by the Delta RMP. The coordination of RP analyses with sampling by the RMP would produce a more spatially robust picture of the Delta at that time and could also lead to potential cost-efficiencies.

The regional water quality component of the Delta RMP will require close coordination with several other programs in order to achieve the spatial and temporal coverage, cost effectiveness, and management utility desired for the program. For example, IEP conducts targeted water sampling throughout the Delta. The U.S. Geological Survey (USGS) monitors general water quality, mercury, nutrients, and pesticides at integrator sites at the bottoms of the Sacramento (Freeport) and San Joaquin (Vernalis) watersheds and in the Yolo Bypass. The SWAMP Statewide Stream Contaminant Trend Monitoring program takes sediment samples annually at Sacramento River at Hood and San Joaquin River at Airport Way (Vernalis) for contaminant analysis and toxicity testing. A Central Valley Regional Water Board Seasonal Trend study is linked to the statewide program and analyzes water quality and water column toxicity four times per year. In addition, SWAMP carries out periodic probabilistic regional assessments that include toxicity while discharge agencies conduct targeted monitoring at the local scale that also include toxicity testing. The San Francisco Bay RMP measures water and sediment chemistry and toxicity at two stations near the confluence of the San Joaquin and Sacramento rivers and collects bivalves as biosentinels for tissue analyses of mercury and other metals. The Sacramento Coordinated Monitoring Program (CMP) tests for general water quality, nutrients, and toxic contaminants at two receiving water sites in the Sacramento River (see Jabusch & Gilbreath 2010 for more details). Agricultural coalitions also conduct targeted aquatic chemistry and toxicity sampling at several locations, including several at or just outside the boundary of the Delta.

In addition, continuous monitoring networks collect continuous data at over 100 sites and provide an extensive coverage of the entire Delta. Continuous monitoring is focused on real-time data of flow and general water quality characteristics such as salinity, temperature, and dissolved oxygen (DO), with more limited coverage of a few other parameters such as chlorophyll florescence, organic carbon (OC), and nutrients. Municipal Water Quality Investigations (MWQI), the State Water Project (SWP) Water Quality Monitoring Program, and Contra Costa Water District (CCWD) monitor water quality in the Delta from a drinking water perspective.

These programs represent significant opportunities for a variety of collaborative efforts involving sample collection, laboratory analysis, data management, and data analysis and assessment. Identifying and finalizing such opportunities will require completing the specifics of the Delta RMP ambient monitoring design, identifying potential opportunities, and negotiations with each party to formalize logistical and cost sharing arrangements.

The following specific coordination opportunities have been identified:

- The IEP collects monthly water and sediment samples at fixed sites throughout the Delta. Coordination could involve IEP field teams collecting additional water for toxicity tests to be conducted by the Delta RMP. Some adjustments may be required to make this compatible with the Delta RMP's random sampling component
- Agricultural coalitions, stormwater programs, NPDES dischargers, the SWAMP, and the San Francisco Bay RMP conduct aquatic chemistry and toxicity testing in the Delta. Stations of these programs are potential targets for collaborative sampling and toxicity testing

3.4 Opportunities for special studies

An important part of the Delta RMP will be special studies that enable the program to focus on specific questions, monitoring findings, or methodological issues that are not suitable for routine, long-term monitoring. As in other regional monitoring and assessment programs, special studies should be identified by the program's governing body, be managed as distinct projects with start / end dates and clearly defined products. Preliminary discussions with Regional Water Board staff and some program partners have identified the following candidate special studies.

3.4.1. Nutrients

The magnitude and extent of nutrient enrichment and its potential impacts have implications for several management policies and decisions, including:

- Development of a nutrient strategy for the Delta in 2012-2013
- Implementation of the San Joaquin River Dissolved Oxygen TMDL

Nutrients are expected to become a high priority topic for the Delta RMP and would be a logical, initial focus for coordinated special studies. The Delta RMP would be an appropriate umbrella for joint fact-finding and identifying opportunities for collaborative, nutrient-related studies that address questions of mutual interest to regulators, dischargers, resource agencies, and water agencies. The Delta RMP could also play a role in science coordination with ongoing efforts in Region 2 (development of a San Francisco Bay nutrient strategy, monitoring plan, and NNEs). One question of broad mutual interest that could guide the development of special studies through prioritized subsidiary questions is:

Are nutrient concentrations and ratios negatively affecting beneficial uses?

Priority questions. Within this broader question, a number of subsidiary questions could then guide nutrient (and beneficial use indicator) special studies (including the synthesis and assessment of existing data) during the first five years of the Delta RMP:

1. What are the magnitude, frequency, and extent of harmful algal blooms (HAB) in the Delta?
2. What are the trends in phytoplankton abundance, biomass, and community composition in the Delta?
3. What are the spatial extent, density, and biomass of invasive aquatic plant species?
4. What are the magnitude, frequency, and extent of low dissolved oxygen episodes?
5. Will nutrient controls
    a. Decrease the frequency and severity of harmful algal blooms (HAB)?
    b. Result in beneficial changes to the phytoplankton community?
    c. Decrease the spread and abundance of invasive aquatic plant species?

d. Decrease the frequency and severity of low dissolved oxygen episodes in Delta sloughs?

Proposed initiatives for year one. During the Delta RMP's first year, two studies that could provide a basis for a broader investigation into nutrients include:

- Literature summary and conceptual model: by fall 2013, write a review paper on each key issue summarizing what is known from the peer reviewed and grey literature about important physical and biological factors and nature of impairment in delta. Answer three questions: (1) how much of the problem might be controllable by nutrients, (2) what are predicted limiting nutrient concentrations and forms, and (3) what additional data will be needed to answer above two questions
- Data inventory: by summer 2013, collate all available nutrient data for the Central Valley and Delta. The inventory will form the basis for a Central Valley and Delta nutrient synthesis report

3.4.2. Yolo Bypass focused toxicity study

The Yolo Bypass area is of particular interest because of ongoing restoration studies. An intensive monitoring program focused on the time period (fall and winter) when delta smelt and salmon are in the Yolo Bypass would provide information that would both support restoration planning and complement Deltawide data. It would involve the sampling of potential sources of toxicity (e.g., agricultural drains) at increased frequency with indicators that could include toxicity testing with three species (Pimephales-Ceriodaphnia-Selenastrum) plus *Hyalella*, fish health diagnoses (Teh 2007), and pesticide analyses.

3.4.3 Sediment toxicity patterns

The proposed Delta RMP design included sediment toxicity testing during a fall index period, on the assumption that sediment conditions and thus toxicity are relatively stable seasonally compared to aquatic conditions. This key design assumption could be tested with a special study that compared sediment toxicity at the same sites during two or more periods of the year. Indicators could include toxicity tests as well as sediment characteristics and sediment chemistry.

3.4.3 Bioanalytical tools

This special study would evaluate the feasibility of using bioanalytical tools (e.g., biomarker responses in rainbow trout) for assessing chronic effects in fish. Elements of this study could include literature review, one or more workshops, a white paper, and a pilot study.

Table 3.1. Design overview for the water and sediment quality component of the Delta RMP.

Design element	Description	Details
Design approach	Probabilistic design	All channels and water bodies with flowing water Legal Delta treated as one stratum
	Targeted sites	Key indicator (integrator) sites for in-Delta and upstream contaminant sources Locations of unique ecological interest or importance
Number of sites	Random: TBD	All sites selected randomly
	Targeted: TBD	TBD
Sampling frequency	Aquatic toxicity/chemistry Sediment toxicity/chemistry	3/yr: winter (storm), spring, fall (dry) 1/yr in fall
Toxicity indicators	Aquatic	Daphnid (*Ceriodaphnia dubia*) survival and reproduction *or* Three-species test (fathead minnow – *Ceriodaphnia* – *Selenastrum*)
		10 day *Hyalella azteca* survival and growth
	Sediment	10 day *Hyalella azteca* survival and growth *Ceriodaphnia dubia* 4-day sediment-water interface test (*or Chironomus* 10-day)
Biological indicators	Phytoplankton community	Basic taxonomy (fall only), chlorophyll, microcystin (fall only), phaeophytin
Aquatic chemistry indicators	Ancillary parameters	Dissolved organic carbon (DOC) and particulate organic carbon (POC), Dissolved oxygen (DO), conductivity, pH, salinity, optical background scatter (OBS), hardness
	Nutrients	Ammonia, nitrate, nitrite, phosphate (discharge and Delta inflow sites only)
Follow-up analyses (for toxic samples and subset of nontoxic samples)	Trace elements	Cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), selenium (Se), silver (Ag), zinc (Zn)
	Pesticides	Multi-residue pesticide analysis. A good starting point would be the suite of pesticides analyzed by the USGS/SFCWA study led by Val Connor and Kathy Kuivila
	Cyanide	
Sediment chemistry indicators	Ancillary parameters	Grainsize, percent solids, total organic carbon (TOC)
	Nutrients	Total nitrogen (TN), ammonia, phosphate (discharge and Delta

		inflow sites only)
Follow-up analyses (for toxic samples and subset of nontoxic samples)	Trace elements	Aluminum (Al), Arsenic (As), Cd, Cu, Fe, Hg, Mn, Ni, Pb, Ag, Zn
	Trace organics	Pesticides (chlorpyrifos, diuron, pyrethroids), synergists, ammonia

Table 3.2. Proposed rules of thumb to guide decisions about the timing of the winter storm-related sampling event.

[INSERT TABLE]

Table 3.3. The range of toxicity tests that could potentially be applied in the Delta RMP. Each test has specific strengths, weaknesses, and sensitivity to toxic constituents. Test to be implemented in the program will be selected based on results of the prioritization exercise described in Section 6.3.

Test	Strength / weakness	Relative sensitivities
Aquatic		
Ceriodaphnia dubia: short-term chronic, 7 day		Organophosphate pesticides, metals
Hyalella azteca: acute, 10-day survival and growth	Commonly used, less sensitive than 20-day test but less problematic and costly	Low levels of pyrethroids, metals
Pimephales promelas: 7-day larval survival and growth	Less sensitive to many toxicants	Ammonia
Selenastrum capricornutum: growth	Ammonia retards growth but other nutrients stimulate	Herbicides
Sediment		
Hyalella azteca: acute, 10-day survival and growth	Commonly used, less sensitive than 20-day test but less problematic and costly	Low levels of pyrethroids, cationic metals, somewhat more sensitive to PAHs
Chironomus: 10-day survival and growth	Standardized EPA and ISO method; does not add much in sensitivity if used in combination with *Hyallela*	Similar to *Hyalella*, but somewhat more sensitive to OP pesticides and carbamates
Ceriodaphnia dubia: short-term chronic, 7 day	Conducted at sediment / water interface, more sensitive to metals than other two tests; Hyallela/Ceriodaphnia combined would be a more sensitive 2-species testing system compared to *Hyallela/Chironomus* detecting a broader range of toxicants; not a standardized official method	Organophosphate pesticides, metals

Figure 3.1. Extent of the legal Delta, with the downstream boundary of the Delta RMP at Chipps Island illustrated. The upstream boundary of the Delta RMP may extend beyond the legal Delta depending on the interests of specific program partners.

[INSERT MAP]

Figure 3.2. Example random sample draw for the Delta RMP aquatic and sediment toxicity component, illustrating the locations of randomized sites.

[INSERT MAP FIGURE]

4.0 Question 2: Are Discharges Meeting Water Quality Objectives?

This question focuses on all of the key beneficial uses:

- Cold Freshwater Habitat (COLD)
- Commercial and Sport Fishing (COMM)
- Estuarine Habitat (EST)
- Fish Spawning (SPWN)
- Migration of Aquatic Organisms (MIGR)
- Rare, Threatened, or Endangered Species (RARE)
- Shellfish Harvesting (SHELL)
- Warm Freshwater Habitat (WARM)
- Wildlife Habitat (WILD)

This question reflects concerns related to potential impacts from NPDES permitted point and nonpoint source discharges into the Delta.

There are several potential assessment questions that address such concerns:

- Do contaminant levels in discharges meet permit limits and other water quality objectives?
- Are contaminant levels in discharges increasing or decreasing over time?
- What is the frequency of exceedances of water quality objectives?
- Is the frequency of exceedances of water quality objectives getting better or worse over time?

In overview, the monitoring design recommended to address such questions has several elements:

- Replacement of existing receiving water monitoring stations with the Deltawide program described in the preceding chapter
- Water chemistry monitoring of effluent and discharges for those constituents with permit-based limits or objectives
- Toxicity testing of effluent and discharges
- Targeted receiving water monitoring, implemented on a case-by-case basis where needed to provide a basis for assessing compliance and/or to follow up on or improve the understanding of effluent and discharge monitoring
- Coordination across multiple dischargers of surveys needed to conduct reasonable potential analyses

Several types of data products resulting from this monitoring design are appropriate for answering Question 2:

- Discharge-by-discharge summaries of compliance with permit conditions
- Discharge-by-discharge summaries of each sampled data type (tables and figures of individual measurements and relevant averages)
- Discharge-by-discharge interpretations and conclusions based on synthesized results (narrative conclusions, decision trees specifying adaptive responses to monitoring results)
- Comparisons across discharges for each sampled data type (tables highlighting differences, cumulative frequency distributions, maps)
- Trend plots over time of increases / decreases in parameters of interest and in measures of compliance
- Summaries of overall patterns and trends across discharge types and across all discharges

The Regional Water Board has determined that no changes will be made at this time to permit mandated effluent or discharge monitoring. Thus, the only aspects of monitoring for Question 2 to be addressed during initial implementation of the Delta RMP are the targeted receiving water monitoring needed to support assessment of effluent compliance and the coordination of surveys to support reasonable potential analyses. However, the efficiency and effectiveness of effluent and discharge monitoring may be addressed in the future and Section 4.1 (Design approach) below describes criteria for evaluating the effectiveness of such monitoring.

Thus, the major changes to current monitoring practice are the removal of routine receiving water monitoring and the improved coordination among individual dischargers' reasonable potential analyses.

4.1 Design approach

The overall approach to the monitoring design for Question 2 focuses the assessment of compliance on effluents (e.g., from municipal wastewater treatment plants) and discharges (e.g., tributaries draining agricultural areas, stormwater discharges), based on the following rationale:

- Effluents and discharges represent the most direct measures of water quality from specific sources and thus the most straightforward means of assessing compliance with effluent and discharge limits
- Receiving water monitoring tied to specific discharge permits:
  - Is often redundant with effluent and discharge monitoring
  - Can be confounded by cumulative influences from other sources
  - Does not always fit into a clear upstream-downstream monitoring design because of the complexities of Delta channel structure and tidal flows
  - Is best addressed through the regional monitoring program described above in Chapter 3

Current effluent and discharge monitoring designs are constrained to some extent by explicit regulatory requirements that specify the manner in which comparison to limits and objectives should occur and will therefore remain in place. Any future adjustments to these requirements intended to improve the efficiency of current effluent and discharge monitoring must therefore be carefully evaluated to ensure they are consistent with these requirements. Discussions to date with dischargers and Regional Water Board staff have identified a number of potential design criteria that would be helpful in any future evaluation of the efficiency and effectiveness of current compliance monitoring:

- Does the existing frequency of monitoring provide sufficient information content and decision-making value?
- Monitored parameters
  - Are there constituents that are currently monitored that rarely or never occur, or do not provide useful information, and that are therefore candidates for either removal from the constituent list or a reduced sampling frequency?
  - Does the list of monitored constituents reflect current knowledge about the nature of known and potential contamination problems?
  - Are detection limits appropriate?
- Are adaptive monitoring approaches suited to addressing compliance questions?

The following subsections address the two aspects of effluent and discharge compliance monitoring that are involved in the initial Delta RMP implementation. While the basic approach is clear, details remain to be resolved in discussion with dischargers, Regional Water Board staff, and other involved stakeholders.

4.1.1 Upstream receiving water monitoring

While routine receiving water monitoring is being replaced with the Deltawide monitoring program described in the preceding chapter, there is a need in some cases to assess effluent compliance against upstream receiving water conditions. In the past, this has been achieved by locating receiving water stations directly upstream of the discharge. However, such locations are not necessarily representative of background conditions and therefore not always the most appropriate basis of comparison for compliance determinations.

In other areas, regulatory agencies have used probabilistic data from a regional program (e.g., from an entire watershed or subpopulation of a watershed) to define representative background conditions. Another option would be to identify a set of targeted sites to represent upstream conditions for selected discharges. Where possible, sites should be selected to enhance collaboration opportunities with other components of the Delta RMP and with other potential partners.

4.1.3 Reasonable potential analyses

Leading up to permit renewal, NPDES dischargers are required to collect data needed to perform a reasonable potential analysis (RPA) to determine which pollutants in the discharge have a reasonable potential to violate water quality standards. Limits are then included in the permit for those pollutants with a reasonable potential to violate standards.

At present, permit renewals are not synchronized and dischargers collect data for their RPAs independently, with the result that potential opportunities for collaboration, data sharing, and improved overall efficiency are not realized. In addition, coordination data collection could both benefit from the Delta-wide sampling conducted for Question 1 as well as contribute to the overall picture of water quality conditions in the Delta, a primary goal of the Delta RMP.

Under the auspices of the Delta RMP, Regional Water Board staff will work with the relevant dischargers to develop a more coordinated schedule for conducting RPAs.

4.2 Coordination with other efforts

[TBD]

5.0 Assessment, Data Management, and Program Stewardship

There are three key aspects of the Delta RMP's management and long-term stewardship that should be considered in more detail during the program's initial implementation phase:

- Reporting
- Data management and integration
- Program management and stewardship

Specific suggestions for these aspects of the program were developed by stakeholders and incorporate elements from other successful regional monitoring programs.

5.1 Reporting

The Delta RMP will yield its full value only to the extent that the data it produces are consistently organized, synthesized, compared to relevant data from other sources, and reported in a manner accessible to its various audiences in the public and the management, scientific, and advocacy communities. A variety of report types could meet these needs:

- Data reports and summaries that present basic data and trends with little or no interpretation
- Periodic reports that directly address the management questions described in Section 2.1 with more intensive data analysis and interpretation
- Synthesis reports that combine Delta RMP monitoring data with other data types to address more complex questions and concerns
- An annual report that makes Delta RMP monitoring results accessible to a wider audience (Pulse of the Delta)
- A web portal, modeled on those developed by the California Water Quality Monitoring Council, that provides ready access to reports, other assessment products, and raw data, organized in terms of the program's core management questions. The Estuary Portal currently under development would be the appropriate vehicle for hosting the Delta RMPs data and products

Producing such reports will furnish the motivation for accomplishing the technical and organizational steps needed to synthesize monitoring information at the scale of the Delta, a central goal of the Delta RMP:

- Developing and implementing data management protocols and data transfer formats
- Framing data sharing agreements with other regional programs
- Fostering effective collaboration in the synthesis and interpretation of data from the Delta
- Articulating useful questions that can serve as focal points for data analysis and interpretation
- Devising data presentation and reporting formats suited to each of several potential audiences
- Identifying potential modifications to the monitoring plan
- Identifying potential special studies to address specific questions on Delta condition and the processes that affect it

All of these activities require focused and consistent effort, because they involve data from several sources, as well as the thoughtful input of scientists and other staff from multiple organizations. They will occur only if they are motivated by a clear goal, such as production of Delta-scale reports and assessment products, and are led by a central entity with responsibility for managing and coordinating the effort involved (see Section 5.3 Program stewardship, below).

5.2 Data management and integration

The success and efficiency of the data analysis and reporting effort will depend on the program's ability to readily acquire, transfer, and integrate data from a number of sources. There are two reasons for this. First, some elements of the program's monitoring design may be implemented by different partner agencies and/or contractors. Second, analyzing and interpreting the program's data, and placing it in a relevant context, will sometimes require integrating the program's data with research and/or monitoring results from other sources.

Data collected by the Delta RMP will be input into the California Environmental Data Exchange Network (CEDEN), which has been identified by the State Water Board as the primary repository for ambient water quality monitoring data. As it is developed further, CEDEN will support the ability to link to and access data from databases maintained by other agencies that may be needed to complete a more comprehensive analysis and synthesis of toxicity and related monitoring data.

5.3 Program stewardship

There are several specific activities involved in conducting the Delta RMP:

- Planning and logistics
- Field sampling
- Laboratory analyses and intercalibration studies
- Data management
- Data analysis and reporting
- Overall program management
- Periodic program review and evaluation

Of these, planning and logistics, data management, and data analysis and reporting should be conducted or coordinated by a single entity. Even if specific activities are performed by stakeholder workgroups (as in the Bight Program in southern California), oversight, management, coordination, and production of final products will need to be centralized for efficiency and to ensure quality control. Field sampling and laboratory analyses might be conducted by an independent contractor, by individual program partners, or by a combination of such efforts. Any actual decision about the relative allocation of sampling and laboratory effort will depend on a consideration of the staffing available within the partners to conduct such effort and which allocation would be most efficient. However, even if monitoring and laboratory analysis are conducted by a number of program partners, a central entity should be tasked with coordination to ensure collaborative agreements are made and updated as needed, sampling schedules and logistics arrangements are finalized, and quality control checks and data submission accomplished as planned.

Based on experience with other collaborative programs in the Delta and elsewhere in the state, two alternative models for program management appear most applicable to the Delta RMP. The first is an interagency model, such as the IEP, in which participating entities are directly responsible of all aspects of program oversight, coordination, management, and operation. The second is a neutral third party model, such as the RMP for San Francisco Bay, the Bight Program, and watershed programs in southern California, in which a neutral entity such as an NGO (e.g., Council for Watershed Health) or a science organization (e.g., SFEI, SCCWRP) provides overall program management and coordination, guided by a steering committee and a technical review committee.

The Delta RMP should be evaluated periodically by an independent, external party such as the Delta Stewardship Council's Independent Science Board. This review should address:

- The degree to which the program has fulfilled the sampling and analysis design
- Compliance with the program's quality assurance plan
- The ease of access to the program's data and data products
- Whether data analyses, reports, and other assessment products have been produced on schedule
- The perceived quality of the program's data and products
- Whether the program's core questions are being answered
- The degree to which the program has improved the coordination and efficiency of monitoring in the Delta
- Whether the program's data have enabled researchers and managers to undertake more complex and comprehensive analyses of Delta condition and the causes of impairment

6.0 Implementation: Offsets, Costs, and Funding Mechanism

Elements of the Delta RMP will be executed beginning in 2013 according to this program design and implementation plan. As has been the case for other regional programs, the Delta RMP may be phased in over a multi-year period, based on the availability of funding and in-kind support from other partners and the relative priority of different program elements.

It is proposed that the program be funded through a combination of in-kind sampling and laboratory analysis contributions from program partners such as DWR, [others such as ag coalitions, NPDES dischargers, etc.] and a set of approved permanent compliance monitoring reductions or offsets for dischargers in the Delta with NPDES permits (see Section 6.2, Funding mechanism). Any surplus funds from the annual offset would be accumulated to fund more intensive periodic assessment effort at the scale of the Delta and to conduct more in-depth monitoring or special studies and laboratory analyses. Substantive changes to the Delta RMP's structure or goals would be subject to agreement by the Regional Water Board Executive Officer in consultation with the program's steering committee, technical workgroup, or other decision-making body. Adaptive or routine adjustments to monitoring locations, constituent lists, and laboratory procedures, as well as the design and implementation of special studies intended to follow up on monitoring results, would be agreed on by Regional Water Board staff and the program's technical decision-making body.

6.1 Implementation costs and schedule

The estimated costs to conduct the monitoring recommended for the initial components of the Delta RMP described in preceding sections are contained in Table 6.1. These costs were derived using costs from the San Francisco Bay RMP as a starting point. The overall estimated annual cost of the Delta RMP's components, including program management and reporting, ranges from about $180,000 for a very restricted minimal program, to about $1.7 million for a mid-range program with a somewhat limited number of indicators at fewer sites, and about $3.0 million for a program that includes a larger number of indicators and sites. However, these estimates do not account for any partnering or in-kind support from other programs, and the size of such contributions will become clearer as these discussions proceed.

Determining the level of effort and associated implementation costs for the Delta RMP's initial phase must wait until final cost estimates for a number of components are completed (see following subsection).

The planned schedule is to negotiate the details of monitoring designs and finalize a detailed draft monitoring plan by August 2012. Coordination and cost sharing agreements will then be completed by October 2012 and the Delta RMP plan will be presented to the Regional Water Board in early December 2012. Implementation will then begin in 2013.

6.2 Funding mechanism

Comment [B3]: Additional detail needed on how funds will be shifted, disbursed, and overseen; how partnering and other in-kind support will be valued.

Shifting receiving water monitoring from dischargers' site-specific compliance monitoring to the Delta RMP's regional ambient water quality monitoring effort (see Section 3.0) will reduce dischargers' routine compliance monitoring costs by the amounts shown in Table 6.2. Additional funding offsets may be available from synchronizing dischargers' RPA monitoring and analysis (see Section 4.0). These resources could be shifted to the Delta RMP either as cash or as in-kind contributions of field, laboratory, data management, and/or data analysis efforts. There are a number of models for this throughout the state for how this could be accomplished. In addition to these contributions from dischargers, partnering arrangements (e.g., shared sample collection) may reduce the raw costs shown in Table 6.1. While partnering and in-kind support will be essential, the program will also require its own funds (from monitoring offsets and other sources) to fulfill the core requirements of reporting, data management and integration, and program management and stewardship.

In addition to monitoring offsets and in-kind support, additional funding opportunities should be explored. The review of D-1641 provides opportunities to implement Delta RMP as part of revised flow requirements. The Science Programs of SRCSD and SFCWA have both indicated interest in funding independent organizations and science.

6.3 Prioritization

The monitoring program presented in Sections 3 and 4 includes technical descriptions of all elements identified as potentially useful for answering the key management questions. However, the cost of implementing the full range of monitoring elements (Table 6.1) is likely to exceed resources available from partnerships, in-kind support, and funds reprogrammed from current NPDES compliance monitoring efforts. The initial implementation of the Delta RMP will therefore be defined after costing exercises are completed and the following prioritization criteria are applied:

1. First priority: Document Delta-wide condition
    a. Probabilistic sampling
        i. Toxicity (at least one aquatic and one sediment test)
        ii. Chemistry for toxic samples
        iii. Chemistry for subset of non-toxic samples
2. Second priority: Condition at targeted locations
    a. Major inflows
    b. Random subsample of shallow sloughs
    c. Random subsample of smaller inflows
    d. Key ecological sites
3. Special studies

These priorities are intended to provide guidance in trading off allocation of effort across program elements. Their intention is to ensure that higher priorities are minimally (not necessarily exhaustively) satisfied before allocation available effort to lower priorities.

Table 6.1. Estimated Delta RMP program costs

Delta RMP - Minimal, Moderate and Detailed Sampling Plans			Low end	Mid range	High end
	Number of Sites	Water -Random	30	40	40
		Water - Targeted	-	30	40
		Sediment - Probabilistic	-	10	40
		Sediment - Targeted	-	10	40
	Events	Water	1	3	3
		Sediment	-	1	2
	QA/QC		2	3	3
	Total Number of Samples	Water	*32*	*213*	*243*
	Total Number of Samples	Sediment	-	*23*	*163*
		Cost/Sample	**Total Cost ($)**	**Total Cost ($)**	**Total Cost ($)**
1. Toxicity Indicators			**50,720**	**691,420**	**1,254,215**
	1.1. Aquatic Toxicity		**50,720**	**646,455**	**737,505**
	Selenastrum	700		149,100	170,100
	Ceriodaphnia dubia	725	23,200	154,425	176,175
	Fathead minnow	750		159,750	182,250
	10-day *Hyallela azteca*	800	25,600	170,400	194,400
	Lab reporting	60	1,920	12,780	14,580
	1.2. Sediment Toxicity		**-**	**44,965**	**516,710**
	10d *H azteca*	1100		25,300	179,300
	28d *H azteca*	1545			
	10d *C. dilutus*	1215			198,045
	C. dubia 96h SWI	855		19,665	139,365
	Lab reporting	included			
2. Biological Indicators			-	-	-
	2.1. Phytoplankton		-	-	-
	Basic taxonomy			fall only (in-kind: DWR)	fall only (in-kind: DWR)
	Chlorophyll a and phaeophytin	50	(in-kind: DWR)	(in-kind: DWR)	(in-kind: DWR)
	Microcystin		-	fall only (in-kind: DWR)	fall only (in-kind: DWR)

Comment [TJ4]: This is mainly to provide some bounds to work with. Some assumptions made here need to be confirmed in follow-ups i.e. level of in-kind support various partners are willing to provide. The estimate for costs of follow-up analyses is based on the assumption that 40% of all samples would be analyses (i.e. 20% samples with significant toxicity + equal number of non-toxic samples). For all estimates, I was trying to err to be on the conservative side.

3. Water Chemistry			**8,480**	**56,445**	**64,395**
	3.1. Ancillary Parameters		**6,880**	**45,795**	**52,245**
	DOC	80	2,560	17,040	19,440
	POC	105	3,360	22,365	25,515
	Salinity, conductivity	45	(in-kind: DWR)	(in-kind: DWR)	(in-kind: DWR)
	WQ (Hardness)	30	960	6,390	7,290
	3.2. Nutrients		**1,600**	**10,650**	**12,150**
	Ammonia	60	(in-kind: DWR)	(in-kind: DWR)	(in-kind: DWR)
	Nitrate and nitrite	50	1,600	10,650	12,150
	Phosphate	55	(in-kind: DWR)	(in-kind: DWR)	(in-kind: DWR)
	4.4. Lab Reporting		**3,840**	**25,560**	**29,160**
	Data package & Reporting/ EDD/ narrative	120	3,840	25,560	29,160
4. Water - Follow-up analyses			**18,598**	**123,796**	**151,924**
	4.1. Trace Elements		**4,006**	**26,668**	**30,424**
	Ag, As, Cd, Co, Cu, Cr, Fe, Ni, Pb, Se, Zn	313	4,006	26,668	30,424
	4.2. Pesticides		**11,520**	**76,680**	**87,480**
	Pest (MRES list)	900	11,520	76,680	87,480
	Column/Filter/spike prep	475			64,125
	4.3. Cyanide		**-**	**-**	**10,692**
	Cyanide	110			10,692
	4.4. Lab Reporting		**3,072**	**20,448**	**23,328**
	Data package & Reporting/ EDD/ narrative	240	3,072	20,448	23,328
5. Sediment Chemistry			**-**	**8,855**	**62,755**
	5.1. Ancillary Parameters		**-**	**6,440**	**45,640**
	SedQuality (prep)	30	-	690	4,890
	SedQuality (TOC and percent solids)	50	-	1,150	8,150
	SedQuality (Grain size - sieve)	200	-	4,600	32,600
	5.2. Nutrients		**-**	**2,415**	**17,115**
	Ammonia	60	-	incl. in toxicity tests	incl. in toxicity tests
	Total nitrogen	50	-	1,150	8,150
	Phosphate	55	-	1,265	8,965

6.Sediment - Follow-up analyses			**-**	**12,586**	**89,194**
	6.1. Trace Elements		**-**	**6,872**	**48,704**
	Al, Ag, Cd, Cu, Fe, Pb, Mn, Ni, Zn	189	-	1,739	12,323
	Hg	103.5	-	952	6,748
	mHg	202.5	-	1,863	13,203
	As & Se	252	-	2,318	16,430
	6.2. Trace Organics		**-**	**9,274**	**65,722**
	Pesticides	575	-	5,290	37,490
	Pyrethroids	433	-	3,984	28,232
	6.3. Lab Reporting		**-**	**3,312**	**23,472**
	Project Management & Reporting	360	-	3,312	23,472
7. Field Work & Logistics			**32,000**	**377,600**	**649,600**
	Field crew		(in-kind: DWR/USBR)	141,600	243,600
	Vessel	2,400	(in-kind: DWR/USBR)	(in-kind: DWR/USBR)	(in-kind: DWR/USBR)
	Logistics coordination		32,000	236,000	406,000
8 Data and Program Management			**31,119**	**357,240**	**648,993**
	Data management		19,450	223,275	405,621
	Program management		11,670	133,965	243,372
2.3.8 Reporting			**40,000**	**145,000**	**145,000**
	Pulse report			85,000	85,000
	"Mini"-Pulse report (~$40K) Annual monitoring "results" (i.e. detailed methods)		40,000	40,000	40,000
	Printing			20,000	20,000
	Estimated TOTAL		**180,918**	**1,772,942**	**3,066,075**

Table 6.2. Funds available from offsets due to reprogramming discharger receiving water compliance monitoring. [table will detail savings from reductions in logistical, sampling, and laboratory analysis efforts for each discharger]

[INSERT TABLE]

7.0 Governance

On November 20, 2008, a stakeholder workgroup reviewed a governance straw proposal, which outlined options for four key aspects of RMP governance: operational lead, stakeholder participation, program organization, and degree of formality. The workgroup's consensus was that:

- Operational lead (i.e., program management) should build on an existing organization or structure
- Independence can be achieved through external review
- Decisions for the long-term RMP must be consensus based with all interested stakeholders given an opportunity to provide meaningful input

7.1 Program Management

As the Delta RMP develops further, an implementing agency must be selected. A major advantage of using an existing organization or structure, as recommended by an earlier stakeholder workgroup, is that the new Delta RMP would build on an established institutional framework, resources and facilities, and staff expertise, avoiding the need to create these essential elements. Not only will it be necessary to identify this organization or management structure, it will also be necessary to clarify stakeholder roles as well as the balance of authority and responsibility between any operational lead and stakeholders. However these issues are resolved, past experience with other regional programs suggests that stakeholders will play an important guiding and decision-making role, perhaps through a steering committee. At a minimum, key stakeholders include:

- Agricultural water quality coalitions
- Central Valley Clean Water Association (CVCWA)
- Central Valley Regional Water Board
- City of Stockton
- IEP
- Sacramento Regional County Sanitation District (SRCSD)
- Small POTWs/local public works departments
- State Water Board
- Stormwater agencies
- U.S. Army Corps of Engineers
- Water agencies

7.2 Program Review

A proposed program planning cycle is presented in Table 7.1. The IEP Science Advisory Group (IEP SAG) could serve as an independent science review group for an ongoing technical review. Alternatively, ASC and/or the IEP POD contaminants work team (CT-WT) could convene a technical review panel (<$40K). The Independent Science Board (ISB) should be solicited for a periodic, intensive program review on a broader scale. An in-depth program review would be appropriate every five years. Guided by these recommendations, the workgroup(s) would develop 5-yr program plans describing objectives and management questions, sampling design, sources and allocation of resources, quality assurance (QA), data management, data analysis, and information dissemination. The SC/TRC would implement an annual program planning cycle that would allow adaptive program management and continuing re-evaluation and adjustment of questions and monitoring.

Table 7.1 Proposed program planning cycle.[2]

Document	Content / process step	Released by
Draft Program Plan	Describes interim organizational structure, projects, and anticipated organizational budget for the first year of long-term implementation	June 2012
Final Program Plan	Reviewed by stakeholder workgroup	August 2012
	Reviewed by Regional Board Management Team	October 2012
	Presented to Regional Board	December 2012
Comprehensive 5-year Plan	Development/re-evaluation of core monitoring questions, priority topics, budget, activities (incl. monitoring and special studies)	5-year cycle (starting in December 2013)
Annual Program Plan	Development of annual monitoring questions, budget, activities (incl. monitoring and special studies)	Annually (starting in December 2013)
5-year Review	In-depth review of objectives and management questions, sampling design, overall adequacy and allocation of resources, QA, data management, data analysis, information dissemination, use of information by target audiences	5-year cycle (starting in 2013 with an in-depth review of the initial Program Plan)
Ongoing technical review	Review of annual plan and activities	5-year cycle (starting in 2013 with an in-depth review of the initial Program Plan)

[2] A structure for decision making and process coordination will be developed in parallel with the development of processes and decisions.

8.0 References

Aquatic Science Center. 2012. The Pulse of the Delta: Monitoring and Managing Water Quality in the Sacramento–San Joaquin Delta. Linking science and management through regional monitoring. Contribution xxx. Aquatic Science Center, Richmond, CA.

Aquatic Science Center. 2011. The Pulse of the Delta: Monitoring and Managing Water Quality in the Sacramento–San Joaquin Delta. Re-thinking water quality monitoring. Contribution 630. Aquatic Science Center, Oakland, CA.

Bernstein, B. 2010. SWAMP Assessment Framework. Prepared for the Surface Water Ambient Monitoring Program. State Water Resources Control Board. Sacramento, CA.

California Water Board. 2008. Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/strategic_plan/docs/baydelta_workplan_final.pdf

Central Valley Regional Water Board. 2011. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basin and the San Joaquin River Basin. http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr.pdf

Jabusch, T., and A. Gilbreath. 2009. Summary of current water quality monitoring programs in the Delta. http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/comprehensive_monitoring_program/draftfinal_deltamon_25nov09.pdf

Jabusch, T., and B. Bernstein. 2010. Delta Regional Monitoring Program. http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/comprehensive_monitoring_program/draft_prog_plan_may2010.pdf

Johnson, M.L., Werner, I., Teh, S., and F. Loge. 2010. Evaluation of chemical, toxicological, and histopathological data to determine their role in the Pelagic Organism Decline. University of California, Davis, California. URL http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/comprehensive_monitoring_program/contaminant_synthesis_report.pdf

State Water Resources Control Board. 2006. Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/wq_control_plans/2006wqcp/docs/2006_plan_final.pdf

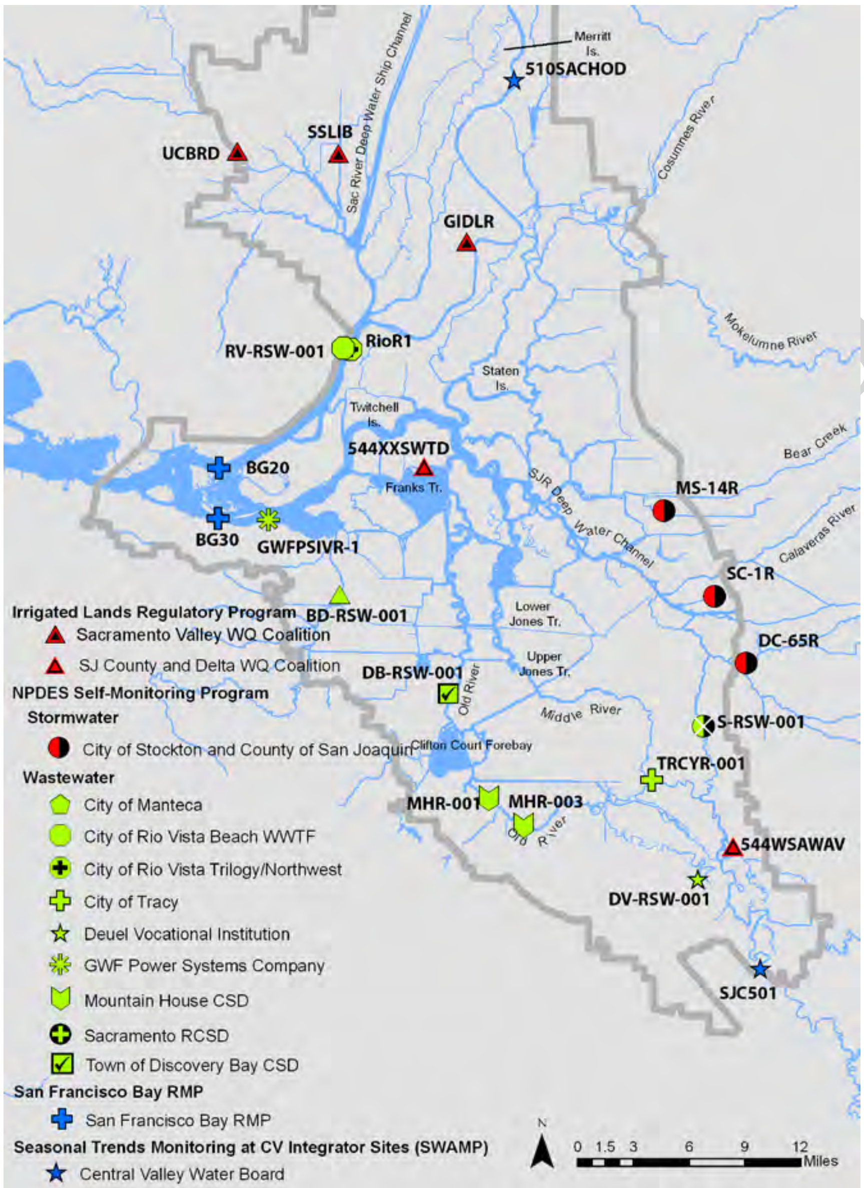
State Water Resources Control Board. 2010. 2010 SWAMP Strategy. Prepared by the Surface Water Ambient Monitoring Program.

Teh, S.J. 2007. Final report of histopathological evaluation of starvation and/or toxic effects on pelagic fishes: pilot study of the health status of 2005 adult delta smelt in the upper San Francisco Estuary. Report to the POD Management Team, U.C. Davis, Davis, CA.

Werner, I., Deanovic, L.A., Markiewicz, D., Khamphanh, J., Reece, C.K., Stillway, M., and C. Reece. 2010. Monitoring acute and chronic water column toxicity in the northern Sacramento-San Joaquin Estuary, California, USA, using the euryhaline amphipod, Hyalella azteca: 2006-2007. Environmental Toxicology and Chemistry 29(10): 2190–2199.

Weston D. P. and M. J. Lydy. 2010. Urban and Agricultural Sources of Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California. Environ. Sci. Technol. 44 (5): 1833–1840. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/sfwc/spprt_docs/sfwc_exh3_weston_urban_and_ag.pdf

Appendix 1. Existing Water Toxicity Monitoring Sites in the Delta



Water Toxicity Monitoring Sites

City of Brentwood
BD-RSW-001 100 feet upstream of Discharge Point No. 001

City of Rio Vista Beach WWTF
RV-RSW-001 Sac R~ 1 mile u/s of Discharge Point No. 1

City of Rio Vista Trilogy/Northwest
RioR1 ~ 100 feet upstream of Discharge Point 001

City of Stockton
S-RSW-001 San Joaquin River and Bowman Road

City of Stockton & County of San Joaquin
DC-65R Duck Creek in vicinity of El Dorado street overcrossing
MS-14R Mosher Slough in vicinity of Mariners Drive
SC-1R Smith Canal (in the vicinity of Pershing)

City of Tracy
TRCYR-001 Old River, ~1 mile upstream of Outfall 001

Delta & San Joaquin County Water Quality Coalition
544WSAWAV Walthall Slough @ Woodward Avenue
544XXSWTD South Webb Tract Drain

Deuel Vocational Institution
DV-RSW-001 450 ft upstream from point of discharge of Discharge Pt No. 003 in Deuel Drain

GWF Power Systems Company
GWFPSIVR-1 328 feet east of the point of discharge

Mountain House Community Services District
MHR-001 Old River, Midstream
MHR-003 Old River, Midstream

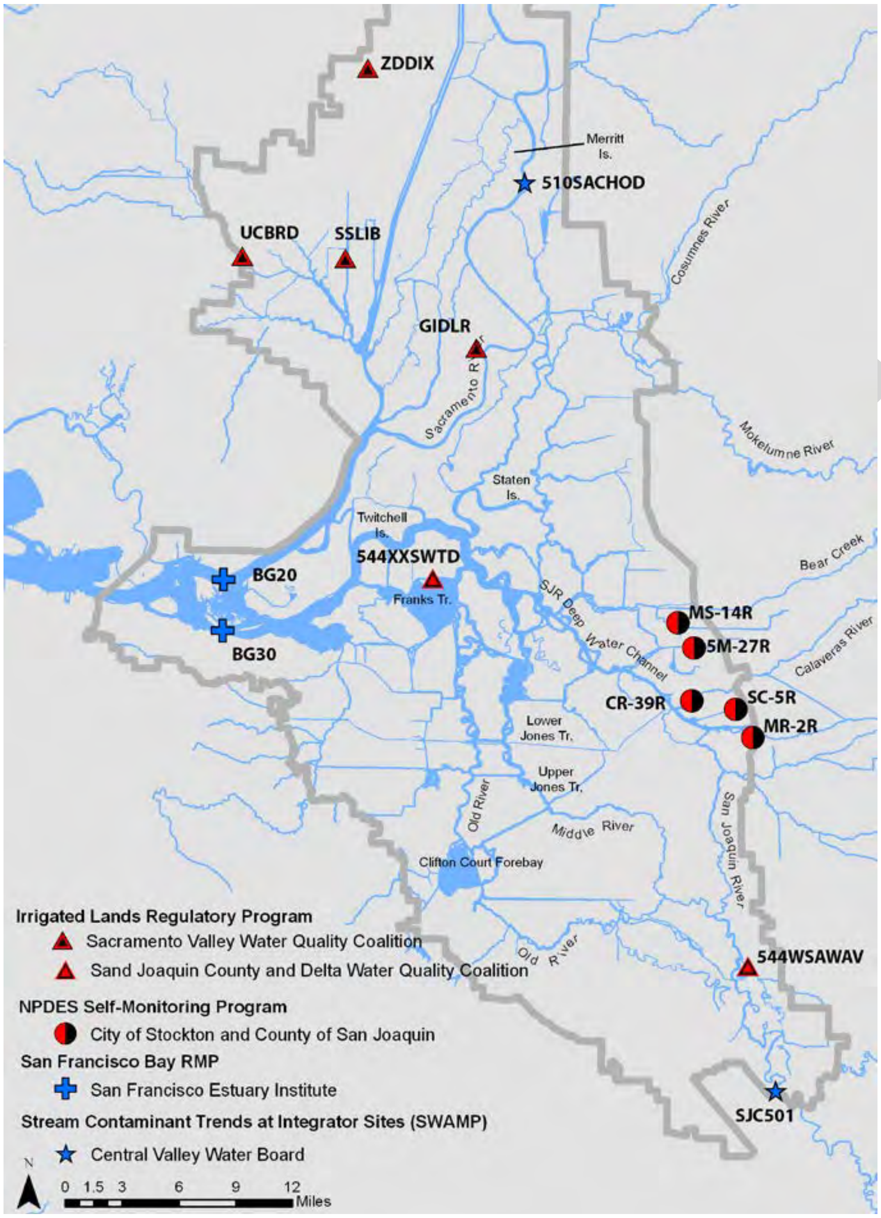
Sacramento Valley Water Quality Coalition
GIDLR Grand Island Drain near Leary Road
SSLIB Shag Slough at Liberty Island Bridge
UCBRD Ulatis Creek at Brown Road

San Francisco Bay RMP
BG20 Sacramento River
BG30 San Joaquin River

Seasonal Trend Monitoring at Central Valley Integrator Sites (SWAMP0
510SACHOD Sacramento River at Hood
SJC501 SJR @ Airport Way

Town of Discovery Bay Community Services District
DB-RSW-001 RSW-001, 500 feet upstream from the point of discharge to Old River

Appendix 2. Existing Sediment Toxicity Monitoring Sites in the Delta



Sediment Toxicity Monitoring Sites

City of Stockton & County of San Joaquin
5M-27R Five-Mile Slough at Swenson Park Golf Course
CR-39R Calaveras River at Brookside
MR-2R Mormon Slough at Commerce Street
MS-14R MS-14R, Mosher Slough in vicinity of Mariners Drive
SC-5R Smith Canal - Site 5R

Delta & San Joaquin County Water Quality Coalition
544WSAWAV Walthall Slough @ Woodward Avenue
544XXSWTD South Webb Tract Drain

Sacramento Valley Water Quality Coalition
GIDLR Grand Island Drain near Leary Road
SSLIB Shag Slough at Liberty Island Bridge
UCBRD Ulatis Creek at Brown Road
ZDDIX Z Drain - Dixon RCD

San Francisco Bay RMP
BG20 Sacramento River
BG30 San Joaquin River

Stream Contaminant Trends at Integrator Sites (SWAMP)
510SACHOD Sacramento River at Hood
SJC501 SJR @ Airport Way

Appendix 3. Meeting and Product Schedule

The following meetings and interactions will be needed to complete the remaining technical and implementation details of the initial components of the Delta RMP. Each meeting will require upfront planning and preparation (e.g., identify issues, set agenda, develop meeting materials, scheduling).

Meetings

Meeting	Participants	Product	Decisions
Program plan			
Review draft program plan	Regional Board staff	Revised program plan	Reporting Independent Science Review Long-term funding arrangements Reporting Implementation (who?) Overall coordination
Review final draft	Regional Board staff, dischargers, other partners	Final program plan	
Monitoring design			
Regional monitoring design	Small technical team (toxicologist, hydrologist, Board staff, etc.)	Detailed toxicity monitoring design, description of assessment product(s)	Monitoring objectives (Year 1) Indicators Monitoring Design Participants Coordinating entity Funding sources/allocation
Monitoring coordination	Monitoring partners (IEP, DWR, dischargers, Board staff)	Monitoring and assessment coordination agreements	
Discharger monitoring efficiency			
Discharger monitoring follow-up	Follow-up with each discharger	Recommended monitoring adjustments	
Review recommendations	Regional Board staff	List of concerns, requested changes	
Negotiate monitoring changes	Regional Board staff, dischargers	Revised monitoring and reporting plans	
Data management			
Highlight data management issues in all meetings	See above	Detailed description of data management issues	
Resolve data management issues	See above; Regional and State Board staff	Data management procedures for regional toxicity and discharger compliance monitoring	

Schedule

Meeting	Apr	May	Jun	Jul	Aug
Program plan					
Review draft program plan					
Review final draft					
Monitoring design					
Regional monitoring design					
Monitoring coordination					
Discharger monitoring efficiency					
Discharger follow-up					
Review recommendations					
Negotiate monitoring changes					
Data management					
Highlight data management issues in all meetings					
Resolve data management issues					