Delta RMP Technical Advisory Committee Meeting

Tuesday, December 13, 2016; 10:00 am – 4:00 pm

LOCATION:

Sunset Maple Room, Sacramento Regional County Sanitation District, 10060 Goethe Road, Sacramento

REMOTE ACCESS:
Phone number: (415) 655-0381; Access Code: 943-326-397#
Screen Sharing Website: https://join.me/sfei-conf-cw1

Agenda

1.	**Introductions and Agenda** Review and agree on agenda and desired outcomes		10:00 Stephen McCord
2.	**Decision: Approve TAC Meeting Summary for 9/20/16 and confirm/set future TAC meeting dates** <u>Scheduled Meetings</u> Nutrient WG: 1/18/17 Pesticide WG: 1/25/17 SC: 1/26/17 Nutrient WG: 2/7/17 Pesticides WG: 2/28/17 TAC: 3/14/17 SC: 5/3/17 <u>Proposed Meetings</u> Please check your calendar in advance! TAC: Tuesday, 6/13/17 <u>Desired outcome</u>: ● Approve meeting summary ● Confirm existing TAC meeting dates ● Set the date for future meetings	Draft TAC meeting summary from 9/20/16	10:05 Stephen McCord

3.	**Information: Steering Committee Update** TAC co-Chairs will summarize the outcomes of the recent joint SC-TAC meeting including the decisions and action items. At the meeting, a few major regulatory drivers were identified: the Nutrient Research Plan, Pyrethroids TMDL, and MeHg TMDL. ASC will present a matrix showing how these major drivers relate to the Delta RMP assessment questions. <u>Desired Outcome:</u> ● Inform TAC regarding SC decisions and activities. ● Feedback on crosswalk between major drivers and assessment questions.	Draft SC Meeting Summary from 10/18/16	10:15 Joe Domagalski Stephen McCord Philip Trowbridge
4.	**Information: Technical Subcommittee Updates** ● **Mercury** ● **Pesticides** ● **Nutrients** Representatives from each of the technical subcommittees will report-out on recent meetings and activities. <u>Desired outcome:</u> ● Inform TAC of subcommittee activity and recommendations	None	11:00 Hg and Pesticides: Stephen McCord Nutrients: Janis Cooke
	Lunch		12:00
5.	**Decision: Responses to the initial External Review Report** <u>Desired outcome:</u> ● Feedback on draft responses ● Agreement to share the draft responses, as amended if necessary, with the Planning Subcommittee	Draft responses to panel questions	12:45 Philip Trowbridge
	Short Break		2:30
6.	**Decision: Review new ideas for projects to propose for SEP funding** <u>Desired Outcome</u>: Recommendation as to whether the proposed studies meet the eligibility criteria and should be added to the list of proposed SEP projects.	Memo re: Proposed Delta RMP Projects Eligible for SEP Funding	2:45 Patrick Morris Selina Cole

7.	**Information: Discuss process for re-confirming TAC members and co-chairs** <u>Desired Outcome</u>: ● Inform TAC on process for re-confirming members and chairs	Memo re: Membership terms	3:15 Philip Trowbridge
8.	**Information: Status of Deliverables and Action Items** <u>Desired outcomes</u>: ● Inform TAC about the status of RMP deliverables. ● Review action items from today's meeting.	Delta RMP Stoplight reports	3:45 Philip Trowbridge

9.	**Updates and wrap-up**
	● Report out on Science Enterprise Workshop (Nov. 1-2) and what it means for the DRMP
	● Plan agenda items for future meetings
	● Address "parking lot" items, as time permits:
	  ● SEP / 401 funding ideas
	  ● Initial experience of Hg monitoring
	  ● Pathogens study updates
	  ● Field trip to monitoring stations
	  ● Input on proposed Delta Research Station
			3:55
			Stephen McCord
			Joe Domagalski

10.	**Adjourn**		4:00

MATERIALS FOR ITEM 5

Response to Review Panel Comments from the Technical Advisory Committee

The Panel made many excellent points about the DRMP monitoring design. Responses to Review Panel comments and questions about the monitoring design and the Program in general are provided below. Some comments can be addressed by providing additional background information that was not previously communicated or available to the panel. Other comments are appreciated as valuable feedback and will be considered by the program as the long-term monitoring design is further developed.

Responses to Fundamental Questions and Comments on the Monitoring Design

The reviewers' major critiques of the Monitoring Design Summary (MDS) were (1) the lack of quantitative design and analysis details and (2) poor linkage between monitoring and management decisions. There are multiple references to these criticisms so the main points have been paraphrased here for simplicity.

Lack of Quantitative Design and Analysis Details. The reviewers commented that the MDS lacked details on:

- *Statistical models to be used for analysis;*
- *Analytical protocols to be used to estimate contaminant concentrations over larger areas or periods, or of processes that management action might affect; and*
- *The measure of "reliability", not only for estimates at a given place and time but for expanded inference in time and space.*

Poor Linkage to Management Decisions. The reviewers recommended that the monitoring designs should:

- *Explain how each important estimate can lead to management actions, either on its own or as part of a more general assessment of the Delta or a subregion of it;*
- *Describe the protocols that might be used to decide the action; and*
- *Explain why the specified reliability is adequate for these protocols.*

These comments raise fundamental questions about the Delta RMP monitoring designs. As a result of these comments and the External Review in general, the Steering Committee directed the TAC and Pesticide Subcommittee to redesign the pesticide monitoring program in time for the FY18/19 workplan. In October, the committees identified three key management decisions which could be informed by Delta RMP monitoring. Planning is underway to tighten linkages to these decisions and better define design and analysis details for all aspects of the Program. The MDS that was reviewed was written primarily for an internal audience and under budget and time constraints. The reviewers' comments

provide helpful guidance for updating the document for internal and external audiences with more detail, with future critical reviews in mind.

While the Delta RMP will strive to produce data that inform management decisions, the actual regulatory and management decisions happen by necessity outside of the Delta RMP. Regulatory decisions are made by the Water Board and other agencies. This separation prevents the Delta RMP from specifying exactly what decision will be made based on its data. However, through the stakeholder process of the Delta RMP, which includes the Water Board and other agencies, the Program will define the regulatory decision and identify how data collected by the Program will fill a data or information gap. More details on the linkages to management decisions for the current designs are provided in responses from the technical committees.

Better linkage of activities to management questions may also involve the type of systematic planning known as the Data Quality Objectives (DQO) Process (USEPA 2006). The DQO Process is used to establish performance and acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of the study. This could be a key component of the program re-evaluation and re-design. Implementing a DQO planning process would address most of the key criticisms by the panel and provide the program with a sound scientific basis for planning and design, data evaluation, and the required QAQC criteria.

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Responses to Specific Questions and Comments on the Monitoring Design

The Panel cannot be certain that the Monitoring Design is inadequate. It is possible that appropriate summaries could be defined, and that models and methods could be developed by which they could be estimated reliably from this sampling design. Some of this work may have been done in the discussions that led to the design. However, none of this supporting information appears in the MDS.

Supporting information on the rationale for the initial monitoring designs have been provided by the reports from the different technical committees. Nonetheless, the Program is undergoing a review and redesign of the Monitoring Design to demonstrate its adequacy.

The MDS (p. 16) says "Interpretation and reporting methods will be described in a Communications Plan" but they are not.

One of the reviewers' main critiques was that the MDS did not have details on statistical models and analytical protocols to be used for analysis. The Program is committed to adding more of these details to an updated document. The original MDS was prepared under budget and time constraints. Given these constraints and the absence of baseline data for some parameters, it seemed prudent to not prescribe the exact methods for data analysis. Instead, program participants planned to develop the initial interpretation of Delta RMP data collectively in a science-based and collaborative process.

We recommend that the monitoring team include one or more environmental statisticians, employed full-time, to refine the sampling design and develop the methods for data analysis.

We have access to additional statistical expertise and will bring it in as needed to assist with the design development. The level of effort involved will depend on the scope and types of monitoring activities that are being planned.

How well do the "lower", "midrange" and "higher" sampling levels achieve the monitoring goals? … In some cases, the sampling may not be worth doing, because it is not tied to management goals or is too sparse to be useful.

Justifications for the initial monitoring designs have been provided in the responses from the technical committees.

How were the prioritization decisions (shown by stars in Table 4) made?

The recommended design was based on an estimated budget that would be available for monitoring activities.

What logic was invoked to justify the selection of the indicators to be measured?

Justifications for the initial monitoring designs have been provided in the responses from the technical committees.

Initial management questions in the documents were usually in words, not numbers: "is there a problem?", "what is the status?", or "is toxicity too high?" These need to be restated in

measurable terms, usually as means or trends over time or space (including subregions or tributaries, etc.) or both. Even when a numerical quantity is given, as for some water quality objectives, it may refer to a single observation or to an average over a sample size, area or time period which has not been specified.

The high-level management questions for the Delta RMP are "text-based" following the convention of other large monitoring programs, such as the Regional Monitoring Program for Water Quality in San Francisco Bay (see page 7 of the 2016 Multi-Year Plan[1]). The detailed "assessment questions" and subquestions are more amenable to numeric goals. During the review and update of the MDS, the committees will consider whether and how to add numeric targets to any of the assessment questions. The Program will be constrained to numeric targets that have been set by agencies. It would not be helpful for the Delta RMP to set arbitrary numeric goals. Establishing analytical protocols for interpreting the data will also help to remove ambiguity about the assessment questions.

Why sample monthly if bi-monthly or annual samples would be nearly as good, and allow more sites?

This is a question specific to the pesticides and pathogens monitoring designs. For pesticides, the subcommittee originally decided on monitoring fewer sites more frequently to develop a baseline for trend analysis, in parts for the need to better understand temporal variability relative to flow. For pathogens, the monthly frequency was chosen to match the monitoring frequency of the LT2 Program. Please see the responses from the technical committees for more information.

<u>*Earlier Programs*</u>

In what specific ways were former/current monitoring programs "not adequate"? (QAPP, p. 12). Was there a report that evaluated the programs and identified specific deficiencies and made recommendations for improvement? If so, it would be helpful to address how this plan makes up for prior monitoring program deficiencies.

The specific statement referenced is "that data from current monitoring programs ... were not adequate to support a rigorous analysis of the role of contaminants in the POD". This was a conclusion from Johnson, M.L., Werner, I., Teh, S., Loge, F. 2010. Evaluation of chemical, toxicological, and histopathological data to determine their role in the Pelagic Organism Decline. University of California, Davis, California[2]. This report revealed the following major deficiencies:

[1] http://www.sfei.org/documents/2016-rmp-multi-year-plan
[2] http://www.water.ca.gov/iep/docs/contaminant_synthesis_report.pdf

- Gaps in the historical data record. Only a few chemicals had a time series of historical data sufficient to assess their role in the POD. And for the few chemicals with longer time series, there was insufficient sampling during the presumed sensitive January to June period (except for diazinon and chlorpyrifos).
- Data quality issues associated with older data, including detection limits above toxic levels and inadequately preserved samples.
- The difficulty involved in finding, accessing and integrating data from multiple sources.

Recommendations from this report included:

- Develop a long-term water quality monitoring program that includes regionally coordinated water chemistry, toxicity, and histopathology samples and incorporates new and emerging contaminants in a multiple lines-of-evidence assessment approach;
- Develop a conceptual model of the Delta that combines critical physical forcing functions and biological elements of the ecosystem and apply this model to inform decision-making and the adaptive management process;
- Provide for ongoing data integration and interpretation aimed at both scientists and decision-makers;
- Improve data management and integration to provide for more consistent quality control and easier access; and
- Address key research needs such as identification of unknown toxicants, the toxicity of contaminants on invertebrate prey species, improved data mining of historical data, and the role of sediment toxicity, among others.

The Delta RMP was initiated to help address some of these deficiencies as a comprehensive water quality program that would help transform existing piecemeal monitoring into a more efficient, whole-scale system through coordination with other efforts and entities. Associated objectives are to:

- Help standardize data formats and protocols;
- Improved data management systems; and
- Improved access to the wealth of collected data.

However, previous attempts at developing a comprehensive monitoring program for the Delta failed mainly because they were too ambitious. Therefore, the Delta RMP:

- Started small and focused with a few high priorities for participants (mercury, nutrients, pathogens, pesticides), and
- Will need to build partnerships and work with other programs to achieve goals of a more efficient, better-coordinated, more useful monitoring system to address questions on a regional level.

Water Quality Objectives.

What are the time frame definitions for "acute" and "chronic" in the WQO or WQC (QAPP, p. 17)? Many of the samples in the Specific Monitoring Designs are monthly grab samples, so it is not clear that the sampling timeframes are consistent with the evaluation criteria. If they are not, then how is Delta RMP to be used for its primary objective, to assess whether Beneficial Uses are being impaired?

Definitions, methods, and processes to derive the criteria maximum concentrations (CMC, acute criteria) and criteria continuous concentrations (CCC, chronic criteria) for the protection of aquatic life are defined in USEPA scientific water quality criteria guidance documents and summarized in the USEPA Water Quality Standards Handbook (Chapter 3). Aquatic life criteria indicate a time period over which exposure is to be averaged, as well as an upper limit on the average concentration, thereby limiting the duration of exposure to elevated concentrations. For acute criteria, EPA recommends an averaging period of 1 hour. That is, to protect against acute effects, the 1-hour average exposure should not exceed the CMC. For chronic criteria, EPA recommends an averaging period of 4 days. That is, the 4-day average exposure should not exceed the CCC.

The thresholds provided a screening tool to determine if there is a potential problem. Additional study over the time scale of the acute and chronic water quality criteria exposure periods (one hour and four days, respectively) would be required to determine the duration of exceedances of WQOs/WQCs. Follow-up studies may occur under the umbrella of the Delta RMP, but not necessarily. The regulatory agencies and other stakeholders may decide to follow up outside of the program if a threshold is exceeded. The Delta RMP cannot determine exceedance, make decisions about regulatory violations or, or decide whether beneficial uses are being impaired.

<u>*Lab measurements (QAPP p. 48.)*</u>

Is the plan to compare concentrations in water to water quality objectives/criteria or other benchmarks? Are these reporting limits and method detection limits sufficiently below the benchmarks that there is confidence in the quantification of the concentration? … It is not clear from the information provided in QAPP, whether the stated analytical methods are able to accurately detect concentrations at or near the WQO or WQC.

Yes: applicable WQOs/WQCs and other benchmarks are listed in Tables 3.3 – 3.5. (pp.17-24) of the QAPP. MDLs and RLs (Table 4.4.) are sufficiently below lowest reported benchmarks for all constituents for which benchmarks exist.

What are the detection limits/limits of quantification for the analyses (QAPP p. 93)? These limits can be lab specific.

Method Detection Limits are listed in Table 4.4. Although the MDLs are adapted from the labs in this case, the general process is that any contracted lab would need to demonstrate that they are able to meet the QAQC requirements specified in the QAPP

Adaptive Design

QAPP (p. 78) says "Collected data are used to evaluate future data needs and adjust the sampling and analysis plan as needed to optimize data collection in an adaptive manner. The program will be continually adjusted to optimize data collection." There seems to be nothing on how this is to be done.

The adaptive management cycle for the Delta RMP is described in the Program Planning Overview document.

The main value of plots is to convey much information clearly and succinctly, but thought and explanatory text are often needed; ***MDS****, p. 28, contains much information but is uninterpretable (other than high scores for Diuron). Plots on p. 52 are better, but still need summarization of both the messages and their reliability.*

The plot on p.28 served as an example for how to visualize temporal and spatial variability across different pesticides in a single graph. More refined graphs with actual Delta RMP data and more detailed explanations will be developed for the 2-year summary report. The plots on page 52 are shown as an example for how to visualize seasonal variability and long-term trends in nutrient variables. It is from a completed technical report (Novick et al. 2015) that provides the interpretation and additional detail about statistical approaches used.

To clarify the components of variance concept, we assume a design in which each site is visited in each of a set of years. Given this assumption, the key components of variation are (see expanded discussion by Scott Urquhart in chapter 7 in Gitzen et al. 2012):

1) *Spatial: variation among sample units (sites); treated as a random effect in an ANOVA model*

2) *Temporal: how much the state variable varies from year-to-year across all sample units; treated as a random effect*
3) *Space by time interaction: how much the state variable changes across time within a sample unit independent of changes in other sample units*
4) *Error variance*

Partitioning the total variance is expressed as:

$\sigma^2_{Total} = \sigma^2_{site} + \sigma^2_{time} + \sigma^2_{site\ x\ time} + \sigma^2_{error}$

To estimate trend, we must first assume a model for how the response variable (e.g., indicator value at sample unit i) changes over time. For example, if we assume a simple linear time-trend model for the indicator, y, our model is:

$y_{ij} = \mu + S_i + T_j + \varepsilon_{ij}$

where, y_{ij} = the value of the state variable at site i in year j

S_i = effect of site i; T_j = effect of year j; {j = 1, 2, ... , t}

ε_{ij} = error term; Then our estimation model for a linear trend, assuming a common trend across sample sites, is:

$\hat{y}_{ij} = \beta_0 + \beta_1 j + \varepsilon_{ij}$

where, β_1 estimates trend

$\beta_0 + \beta_1(t+1)/2$ estimates 'status'

The null and alternative hypotheses of interest are, respectively: H0: $E[\beta_1] = 0$; Ha: $E[\beta_1] \neq 0$. That is, to detect trend we test the null hypothesis that no trend is present in the indicator against the alternative hypothesis that a trend is present.

The Delta RMP is already using power analysis to evaluate different monitoring designs. Knowledge of key outcomes of power analyses for mercury and pesticides for other programs (SWAMP, SpoT, BOG) have informed decisions about current design options. Recent ASC report applied power analysis to evaluated ability of current DWR-EMP water quality monitoring to pick up long-term trends in nutrients in different subregions. As authors suggest, best source of information for these types of analyses is from preliminary survey data; it could be said that the Delta RMP is in the stage of doing that type of preliminary data collection.

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References

ASC. 2015. Delta Regional Monitoring Program – Program Planning Overview. Prepared for Delta RMP Steering Committee. goo.gl/jsBLK5

EPA. 1994. Water Quality Standards Handbook Chapter 3: Water Quality Criteria. EPA 823-B-94-005a.

EPA. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA/240/B-06/001.

Johnson, M.L., Werner, I., Teh, S., Loge, F. 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.water.ca.gov/iep/docs/contaminant_synthesis_report.pdf

Novick E, Holleman H, Jabusch T, Sun J, Trowbridge P, and Senn D, Guerin M, Kendall C, Young M, Peek S. 2015. Characterizing and quantifying nutrient sources, sinks and transformations in the Delta: synthesis, modeling, and recommendations for monitoring. San Francisco Estuary Institute, Richmond, CA. http://sfbaynutrients.sfei.org/sites/default/files/Main manuscript.pdf

SFEI. 2016. Regional Monitoring Program for Water Quality in San Francisco Bay, Multi-Year Plan, 2016 Annual Update. San Francisco Estuary Institute, Richmond, CA. Published online: http://www.sfei.org/documents/2016-rmp-multi-year-plan.

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Response to Review Panel Comments from the Mercury Subcommittee

The Panel made many excellent points about the Delta RMP monitoring design. The comments and questions that relate to the mercury monitoring design can be addressed through a more complete summary of the design, its rationale, and the process through which it was developed. A brief overview of the design process and rationale is presented here to address many of the overarching concerns, such as linkage to management actions. Responses to specific Review Panel questions on mercury are then also provided.

Brief Overview of the Mercury Monitoring Design Process and Rationale

A Mercury Subcommittee was formed to develop the mercury monitoring design. The Subcommittee consisted of a Water Board staff member (Janis Cooke) with a lead role in implementation of the Methylmercury TMDL for the Delta, representatives of several other DRMP stakeholder groups, and several leading local mercury experts familiar with the Delta.

The starting point for the design was careful consideration, refinement, and prioritization of the assessment questions articulated by the Steering Committee and Technical Advisory Committee for mercury, resulting in the priorities identified in Table 1 of the Monitoring Design Summary. The top priority questions for this initial phase of monitoring are as follows:

> What are the status and trends in ambient concentrations of methylmercury and total mercury in sport fish and water, particularly in subareas likely to be affected by major existing or new sources (e.g., large-scale restoration projects)?
>
> A. Do trends over time in methylmercury in sport fish vary among Delta subareas?
>
> B. Do trends over time in methylmercury in water vary among Delta subareas?

Maximizing Linkage to Management

The next step was to maximize relevance to management through identification and consideration of the regulatory and management actions that were either in effect or on the horizon (Table 1). The TMDL is the dominant regulatory driver of actions to control mercury in the Delta, establishing water quality goals and directing the various discharger groups to conduct monitoring and take actions to minimize mercury impairment of beneficial uses. Critical information needs related to various elements of the TMDL were identified, and the urgency (timing) of the needs was considered.

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Development of a mercury model for the Delta is an important element of TMDL implementation. In response to TMDL requirements for a control study, the Department of Water Resources (DWR) is leading development of mathematical mercury models for the Delta and Yolo Bypass. The Dynamic Mercury Cycling Model, a well-established mercury model, is being used in the Yolo Bypass, while in the Delta, mercury and other mercury-related algorithms are being added to DWR's existing Delta Simulation Model. The USGS and partners are also working to integrate methylmercury into the CASCaDE model (http://cascade.wr.usgs.gov/) to allow testing of scenarios to better understand how changes to the Delta will affect mercury impairment. The goal of these modeling efforts is to predict the cumulative effect of multiple changes in the Delta and to predict the effectiveness of regulatory requirements within scenarios of climate change and large-scale wetland restoration.

Priority Data Needs

Mercury concentrations in sport fish were established in the TMDL as the crucial measure of impairment, and a tissue-based water quality objective of 0.24 ppm in top predator sport fish was established. Monitoring of sport fish mercury as an index of mercury impairment in the Delta and as a performance measure for the TMDL was identified by the Subcommittee as the top priority data need. Based on extensive past monitoring and many desirable attributes as an indicator species, largemouth bass was specifically identified as the key species for tracking impairment.

The Subcommittee identified aqueous methylmercury concentrations as a second priority of the mercury monitoring program. In contrast to many other aquatic ecosystems, aqueous methylmercury in the Delta has been shown to correlate well with mercury in the food web, including in largemouth bass. The Delta Methylmercury TMDL describes a statistically significant relationship between the annual average concentration of methylmercury in unfiltered water and average mercury in 350 mm largemouth bass when data are organized by subarea (Figure 1). The linkage of aqueous methylmercury concentration to fish mercury concentration provides a connection, essential for management, between methylmercury inputs from various in-Delta pathways (e.g., municipal wastewater, municipal stormwater, agricultural drainage, and wetlands) and impairment of beneficial uses. Because of this linkage, the TMDL established an implementation goal of 0.06 ng/L of unfiltered aqueous methylmercury. Monitoring of aqueous methylmercury is needed to:

1) better quantify the fish-water linkage that is the foundation of the TMDL,
2) support development of a mercury model for the Delta, and
3) support evaluation of the fish data by providing information on processes and trends.

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The Subcommittee then reviewed existing data to evaluate the need for monitoring by the DRMP and to inform decisions on details of the monitoring designs for fish and water.

A lack of data on long-term interannual trends in sport fish mercury was identified as the most critical information gap. With a major control program being implemented, it is imperative to know whether the key indicator of interest is trending up, down, or not all across the Delta.

Significant sport fish monitoring efforts conducted in the Delta over the past 20 years include a one-year survey in 1998 (Davis et al. 2000), the CALFED Mercury Study in 1999 and 2000 (Davis et al. 2003, 2008), the Fish Mercury Project from 2005-2007 (SFEI 2007, Melwani et al. 2009), and monitoring by California's Surface Water Ambient Monitoring Program (SWAMP) in 2011 (Davis et al. 2013). The studies from 1999 and beyond benefitted from robust peer review by national experts in mercury science. The TMDL (CVRWQCB 2010) provided a synthesis of Delta fish data from 1998 to 2007. A Surface Water Ambient Monitoring Program report (Davis et al. 2013) on contaminants in fish from California rivers and streams presented results from sampling in the Delta in 2011 and provided a comparison to past data for the Delta sites. Distinct and persistent spatial patterns have been observed throughout the period of record, most notably higher concentrations on the northern and southern ends of the Delta and lower concentrations in the Central Delta. However, due to the intermittent nature of the sampling that has been performed, variation in the locations sampled, variation in fish availability, and variation in the types of sample collected, time series for evaluating interannual trends in sport fish mercury are weak and inconclusive (Figure 2). While these past efforts have firmly established robust methods for monitoring mercury in Delta sport fish, the methods have not yet been consistently applied in a sustained manner to allow for evaluation of interannual trends.

The Subcommittee identified two priority data needs for ambient water monitoring: 1) contemporaneous sampling with sport fish to better quantify the relationship of water and fish concentrations and 2) collection of input data for the mercury fate models for the Delta. The key existing water datasets are from 2000-2001 and 2003-2006: the studies of Foe et al. (2003, 2008). These studies monitored methylmercury and mercury at multiple sites in the Delta, collecting sub-surface grab samples once every 4-6 weeks. These studies provided a basis for the linkage analysis in the TMDL. However, additional water monitoring is needed to expand and update this relatively limited dataset that is of great importance for implementing the TMDL and developing predictive mercury models.

Sampling Design Options

Fixed station and probabilistic monitoring designs were considered for both fish and water monitoring (Table 2). Budget constraints and linkage to other data collection efforts (such as hydrology and monitoring of other basic water quality

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parameters) led the Subcommittee to favor the fixed station design for the lower funding level scenario.

Sport fish monitoring was the primary driver of the sampling design. For sport fish monitoring, human exposure is the ultimate concern, so locations with angler access are of particular interest (as opposed to an equal interest in the entire aquatic surface area of the Delta). The probabilistic sampling design considered for this scenario was to identify all of the popular fishing locations in the Delta, and to randomly select from this population on an annual basis. The statewide Surface Water Ambient Monitoring Program recently adopted a design of this type for monitoring largemouth bass mercury in a population of 190 reservoirs (Bioaccumulation Oversight Group 2015). The Subcommittee referred to this as a "random draw" approach. This design could generate representative estimates of the mean for the Delta as a whole and for the subareas identified in the TMDL. Disadvantages of this approach would include 1) an inability to link to other data collection efforts that occur at fixed stations, and 2) lower power for detection of interannual trend. The higher funding level design recommended by the Subcommittee included a component of this random draw sampling, with 10 sites sampled per year.

For the lower funding level, however, the Subcommittee recommended focusing on fixed station monitoring. While this approach is less representative of the region, it allows for coordinated data collection at key sites of interest (including sites important for the fate model) and it maximizes power for detection of interannual trend at the selected stations. The Mercury Subcommittee had a strong interest in monitoring at or near sites where other parameters useful for evaluating the mercury data were being collected. Ancillary parameters of interest are flow, temperature, suspended sediment, salinity, nutrients, and organic carbon. A lack of information on within-station interannual variation in concentration was identified as an important data gap that can be addressed with fixed station monitoring. An important advantage of the fixed station approach is that it retains value even at low funding levels such as the six station level that was ultimately approved by the Steering Committee (in contrast, the information yield of the random draw design diminishes more rapidly if only a few stations are sampled each year). The goal of the recommended fish sampling design at the lower funding level is to evaluate interannual trends in mean concentration at each site (11 fish are collected per year at each site to generate an annual mean). A primary aim of the initial fish sampling under the Delta RMP is to establish time series that will provide the estimates of intra- and inter-annual variance that are needed to inform a power analysis to support an optimized long-term design. This power analysis could be done after an initial period of data collection (e.g., 5 years). However, given the importance of fish concentrations as a performance measure for evaluating the effectiveness of the TMDL, the recommended design calls for development of a 10-year dataset, and then re-evaluating the design.

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Responses to Specific Questions and Comments on the Mercury Design

What is the goal of the mercury program?

The assessment questions were clearly identified. In a management context, the goal is to provide a critical performance measure for the TMDL by comparison of fish tissue concentrations to the water quality objective. The water data:
1) provide additional data for evaluation of status relative to the TMDL and water quality objectives;
2) support evaluation of the fish data in understanding processes and trends,
3) test the fish-water linkage advanced that is the foundation of the TMDL, and
4) support development of mercury fate models for the Delta.

However, using sportfish to monitor impacts on MeHg from large restoration projects does not make sense. Large sportfish have fairly large territories/home ranges, so it would be hard to attribute change to a specific restoration action or location. Also, the change would be hard to detect, since large sportfish have higher Hg body burdens that vary more between individual fish. As a result, a small change from a management or restoration action won't stand out. Small, resident fish with small home ranges would reflect such changes more quickly and clearly. Ideally a Before-After-Control-Intervention design could be used.

The comment about sport fish is incorrect. The sport fish species selected for monitoring (largemouth bass) has been shown through extensive monitoring (Davis et al. 2000, 2003, 2008, 2013; SFEI 2007; Melwani et al. 2009) to have small home ranges and to be an excellent indicator of spatial patterns across the Delta. The approach being employed to evaluate change (ANCOVA to generate annual mean length-adjusted concentrations) will likely have ample power, and has the added benefit of being the key indicator of impairment. Prey fish monitoring was also considered, but given a lower priority and could not be accommodated with currently available funds.

The sportfish are sampled annually. Do we know if mercury varies seasonally in sportfish, as it does in smaller fish? If so, then annual samples are unlikely be adequate unless people catch and consume the fish in only one season, or there is a way to adjust for other seasons (without sampling at those times). If mercury in sportfish varies spatially within a subregion, then sampling one location per subregion is unlikely be adequate. This could be a case where the goal is useful but the effort is far short of what is needed, and thus achieves nothing. How will the data be analyzed to compare trends among sites?

Annual sampling of sport fish is widely performed. There is seasonal variation, but sampling in late summer when fish feeding rates are highest, hydrology is relatively consistent, and human fishing activity is greatest is a cost-effective approach to monitoring impairment. Seasonal sampling would greatly increase the cost. Extensive data and analysis support the existence of subregions and the use of index

sites to represent them. Funding is not available to sample multiple sites within subregions. Trends in annual length-adjusted means at each site will be evaluated by regression or nonparametric methods.

The mercury water samples are monthly. What connects them to the fish tissue samples? Are they at the same sites (including Mokelumne River)? Are they to be compared to the water quality (WQ) criterion of 0.06 ng/L of MeHg in unfiltered water (QAPP, p. 24, Table 3.4)? What will a monthly grab sample at 4 sites in the Delta tell you about MeHg status in the entire Delta? How were the number and locations to be sampled determined? What are the flows at these locations? Will all samples be taken under the same tide/flow conditions?

The water samples are collected quarterly, not monthly. The water and fish sites are co-located to support items 2 and 3 in paragraph 1 of the specific responses above. Aqueous concentrations will be compared to the TMDL implementation goal (0.06 ng/L). The water sampling is admittedly limited, but provides useful information for the limited funding available. The number was driven by the budget. The locations were determined based on co-location with fish sampling and co-location with USGS continuous monitoring stations to support model development. Flow information is available. Collecting all samples at the same point in the tidal cycle would be valuable, but prohibitively expensive. Efforts are directed at sampling on ebbing tides at sampling locations most susceptible to tidal influences such as the Sacramento River at Freeport site.

Why is there a low level of fish sampling and a medium level of water sampling? What is the value of the water sampling? How does current fish sampling data relate to previously collected sampling data? If the primary management question is trends over time, are there existing long term data sets that can be built on. The study plan mentions but does not elaborate on these points (MDS, p. 38).

The levels of sampling are basically equivalent (six sites for fish, five sites for water). The fish sites were selected based on extensive prior sampling. However, past sampling has not done much in establishing time series to build on (Davis et al. 2013). The sport fish design will firmly establish time series at index sites for the Delta. The value of water sampling was covered in the first paragraph of the response to "*What is the goal of the mercury program?*" above. Quarterly sampling for water (rather than annual as for sport fish) is needed to illuminate seasonal patterns and to better characterize overall variability in concentrations.

How were the bin lengths for the Largemouth Bass determined (QAPP p. 86)? The Central Valley Basin Plan has water quality objectives (WQO) for fish 150-500 mm TL, and for fish <50mm TL, so the proposal's sampling divisions (200-249, 250-304, 305-407 and > 407 mm) are not consistent with this Plan. Fish Hg will often vary by length of fish (surrogate for age). How will the data be compared to WQO? Will bins be analyzed separately? The sampled fish can be assumed random within bins, but not between them; is the plan to fit a regression of fish Hg against length? Note the Basin

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Plan is specific as to trophic level of fish for the WQO: any alternative predator species should be at the same trophic level.

The bin lengths were chosen to support estimation of length-adjusted means at a size of 350 mm. This approach has been used widely across the state and over the past 15 years in the Delta. Collecting over this range of sizes provides a sound basis for ANCOVA (basically, regression of Hg versus length at each site). The length-adjusted means or a subset of the overall size range can be compared to the WQO.

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References

Bioaccumulation Oversight Group. 2015. Sampling and Analysis Plan for Long-term Monitoring of Bass Lakes and Reservoirs in California. Surface Water Ambient Monitoring Program. California State Water Resources Control Board, Sacramento, CA. http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/lakes_study/bass_lakes_sampling_plan.pdf

CVRWQCB, 2010. Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury. Staff Report for the Central Valley Regional Water Quality Control Board, April. Available: http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/april_2010_hg_tmdl_hearing/apr2010_tmdl_staffrpt_final.pdf

Davis, J.A., M.D. May, G. Ichikawa, and D. Crane. 2000. Contaminant Concentrations in Fish from the Sacramento-San Joaquin Delta and Lower San Joaquin River - 1998. San Francisco Estuary Institute report. Richmond, California. September. Available: http://www.sfei.org/documents/contaminant-concentrations-fish-sacramento-san-joaquin-delta-and-lower-san-joaquin-river

Davis, J.A, B.K. Greenfield, G. Ichikawa and M. Stephenson. 2003. Mercury in Sport Fish from the Delta Region. Final report submitted to the CALFED Bay-Delta Program for the project: An Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed (Task 2A). San Francisco Estuary Institute and Moss Landing Marine Laboratories. Available at: https://mercury.mlml.calstate.edu/reports/2003-reports/

Davis, J.A., B.K. Greenfield, G. Ichikawa, and M. Stephenson. 2008. Mercury in sport fish from the Sacramento–San Joaquin Delta region, California, USA. Science of the Total Environment 391: 66-75.

Davis, J.A., J.R.M. Ross, S.N. Bezalel, J.A. Hunt, G. Ichikawa, A. Bonnema, W.A. Heim, D. Crane, S. Swenson, and C. Lamerdin. 2013. Contaminants in Fish from California Rivers and Streams, 2011. A Report of the Surface Water Ambient Monitoring Program (SWAMP). California State Water Resources Control Board, Sacramento, CA. http://www.waterboards.ca.gov/water_issues/programs/swamp/rivers_study.shtml

Foe, C.G. 2003. Mercury Mass Balance for the Freshwater Sacramento-San Joaquin Delta Estuary. Final report submitted to the CALFED Bay-Delta Program for the project: An Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed (Task 1A). Central Valley Regional Water Quality Control Board, September. Available: https://mercury.mlml.calstate.edu/wp-content/uploads/2008/12/finalrpt-task-1a-1b-foe-final-calfed-hg-report.pdf

Foe, C.G., S. Louie, and D. Bosworth. 2008. Methylmercury Concentrations and Loads in the Central Valley and Freshwater Delta. CALFED Final Report, Task 2. Available: https://mercury.mlml.calstate.edu/wp-content/uploads/2008/10/04_task2mmhg_final.pdf

DRAFT

Hebert, C.E., Keenleyside, K.A., 1995. To normalize or not to normalize? Fat is the question. Environmental Toxicology and Chemistry 14 (5), 801–807.

Melwani, A.R., S.N. Bezalel, J.A. Hunt, J.L. Grenier, G. Ichikawa, W. Heim, A. Bonnema, C. Foe, D.G. Slotton, J.A. Davis. 2009. Spatial trends and impairment assessment of mercury in sport fish in the Sacramento–San Joaquin Delta watershed. Environ. Pollut. 157: 3137-3149.

SFEI. 2007. The Fish Mercury Project: Monitoring and Reducing Methylmercury Exposure in the Bay-Delta Watershed. SFEI Contribution 531. San Francisco Estuary Institute, Oakland, CA. http://www.sfei.org/documents/calfeds-fish-mercury-project

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Table 1.

Mercury Monitoring Regulatory and Management Drivers

Driver	Monitoring Element	Urgency	Notes
TMDL – fish tissue targets monitoring	THg in TL3 and TL4 fish	For Water Board: Long-term (BPA calls for comprehensive monitoring in 2025)	Not assigned to other Delta entities. No season- or flow-based conditions associated with the allocations.
TMDL – open water control study	Aqueous MeHg; other information (e.g., flux from sediment) to support development of a MeHg transport, transformation, and bioaccumulation model	Near-term (by 2018)	Would support major (> $1M) modeling effort by DWR. Model may also inform other control measures. TMDL Phase 1 review after 2018; open water allocation is based on sediment flux
TMDL – NPDES permittee discharge monitoring	Ambient aqueous MeHg as context for discharge monitoring	Near-term. All in-Delta POTWs and Phase I MS4s are currently monitoring their discharges; Phase II MS4 monitoring requirements need to be negotiated with RegBd by summer 2014	Upgraded POTWs and improved analytical methods are portraying lower loads than estimated in the TMDL POTWs have proposed a network of stations.
TMDL – Wetland restoration projects	Ambient aqueous MeHg as context for discharge monitoring. Project-specific fish monitoring. Associated ambient fish monitoring?	Near-term? Need broad baseline for restoration project implementation	Flood control operations are considered an unquantified component of the wetlands load; BPA requires new projects to participate in or conduct control studies; BDCP accepts MeHg impacts of projects as unavoidable
TMDL – Agricultural tailwater	Ambient aqueous MeHg as context for discharge monitoring	Near term. Ongoing control studies at Yolo Wildlife Area, Cosumnes River Preserve, Twitchell Is.; Delta coalition submitted 319(h) grant application for MeHg discharge monitoring (begin in 2015, if approved)	New WDR for Delta coalition does not require MeHg discharge monitoring
TMDL – Dredging	Sediment releases into the water column from dredging activities	Near term. Applies to all new 401 WQ certifications	Dredging activities and activities that reuse dredge material in the Delta should minimize increases in MeHg and inorganic Hg discharges to Delta waterways

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Table 2. Comparison of different fish monitoring design options.

	Decadal Blitz	Annual Random Draw	Annual Index Sites (Low n)	Annual Index Sites (High n)	Hybrid: Index (Low n) + Annual Random
Power to detect Whole-Delta trend	▲	▲▲▲▲	▲▲	▲▲▲	▲▲▲▲
Power to detect Subarea trend	▲	▲▲▲	▲▲	▲▲▲	▲▲▲
Power to detect Site trend	▲	▲▲	▲▲▲	▲▲▲▲	▲▲▲
Infrastructure sustainability	▲	▲▲▲▲	▲▲	▲▲▲▲	▲▲▲▲
Flexible subarea boundaries	▲▲▲▲	▲▲▲▲	▲	▲▲▲	▲▲▲▲
Information flow	▲	▲▲▲▲	▲▲	▲▲▲	▲▲▲▲
Cost per year	$40K ($400K for 40 sites every 10 yr)	$80K ($80K for 10 sites every yr)	$80K ($80K for 10 sites every yr)	$160K ($160K for 20 sites every yr)	$160K ($160K for 20 sites every yr)

Figure 1.

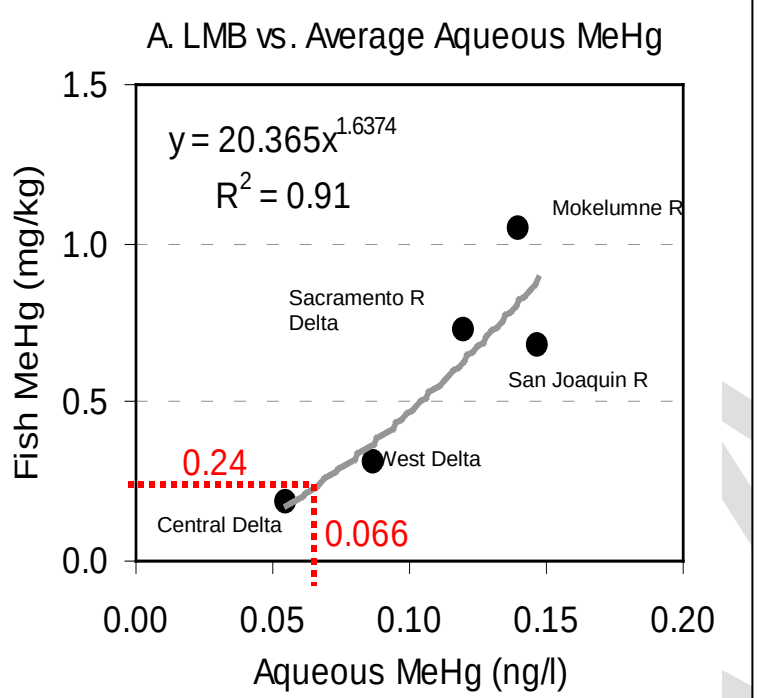
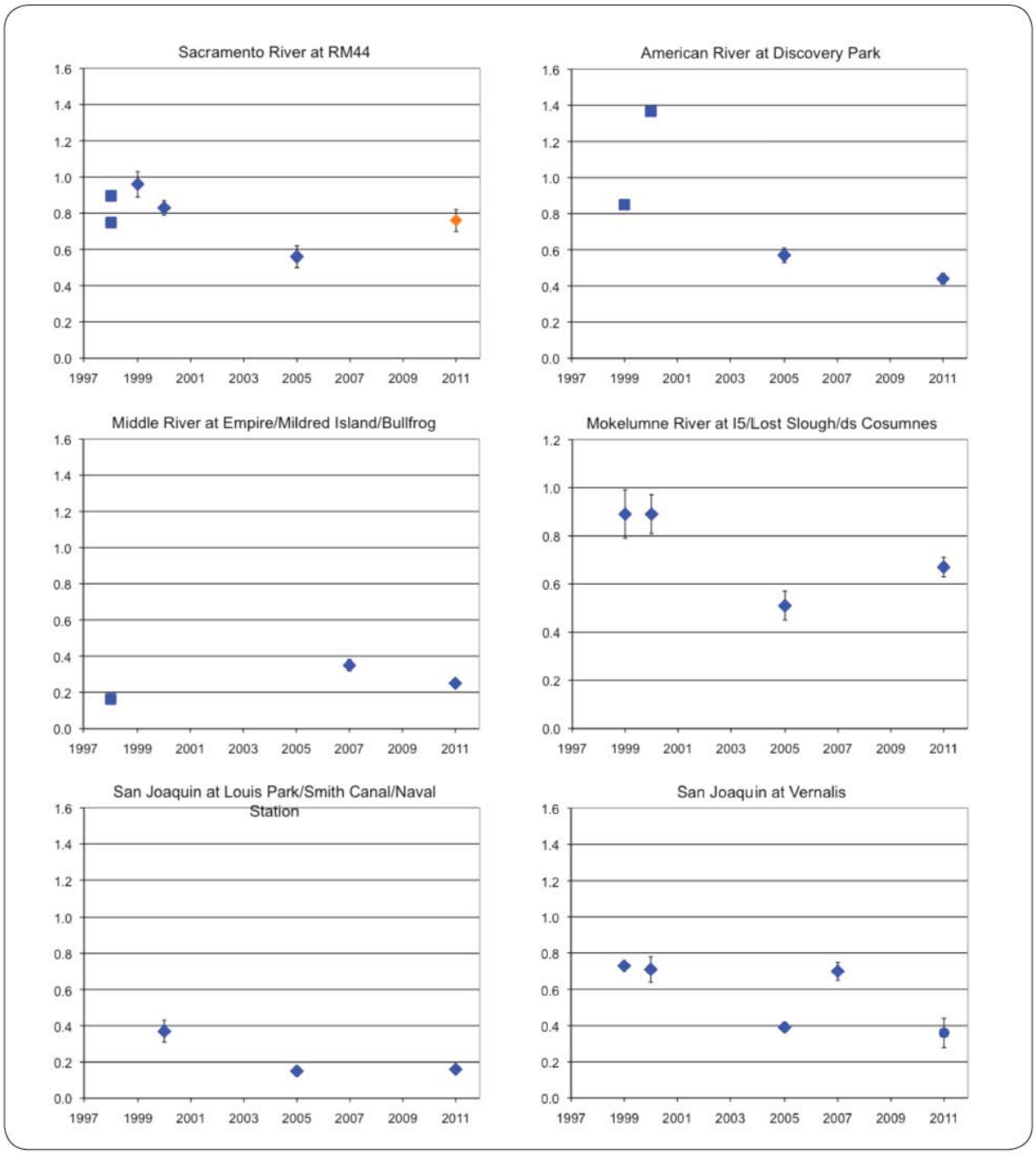


Figure 1. Relationship between Standard 350-mm Largemouth Bass (LMB) mercury and March to October 2000 Unfiltered Aqueous Methylmercury. From TMDL Report 2010, Figure 5.2.

The objective for 350-mm largemouth bass is 0.24 mg/kg.

Locations denote subareas within the legal Delta.

Figure 2. Mercury concentrations in fish for the sites with the best available time series. Largemouth bass shown in blue, smallmouth bass in orange. Diamonds represent averages based on ANCOVA-generated estimates for a size of 350 mm. Squares represent composite samples. Circles represent simple averages for cases where no length correlation was observed. Bars indicate one standard error.



Response to Review Panel Comments on the Nutrients Design from the Nutrients Subcommittee

The Panel made many excellent points about the DRMP monitoring design, and we appreciate the time and effort the Panel put into guiding our future efforts. Our responses to Review Panel comments and questions specific to the nutrients monitoring design are provided below. Most comments can be addressed by providing additional background information that was not previously communicated or available to the panel. Other comments are appreciated as valuable feedback and will be considered by the program as the long-term monitoring design for nutrients is being developed.

An important point that needs clarification is that the Delta RMP has not yet started monitoring for nutrients. All of the work to date has been synthesis of data from other nutrient monitoring programs to identify data gaps and information needs that the future program should address. One of the objectives for FY17/18 is to develop the long-term monitoring design for nutrients, taking into consideration the comments from the External Review, results from data syntheses, and the goals of the Program.

Similarly, the regulatory framework for nutrients in the Delta is still uncertain. The Central Valley Regional Water Quality Control Board is developing a Nutrient Research Plan to determine whether nutrient concentrations cause or contribute to water quality problems in the Delta. The Regional Board will make a decision about nutrient water quality objectives at some point in the future. The nutrient synthesis and studies conducted by the Delta RMP aim to support this decision-making process.

In lieu of a specific regulatory driver, there was consensus to focus initial efforts primarily on synthesis and analysis of existing data and information, and specifically on status and trends and mass balance for nutrients (forms of dissolved and total N and P) and nutrient-associated parameters (chlorophyll, dissolved oxygen). These parameters were identified as the most relevant, based on their significance as indicators relative to the assessment questions, conceptual understanding of biogeochemical processes, and availability and quality of existing data (Figures 1 and 2).

Responses to Specific Questions and Comments on the Nutrients Design

The monitoring program identifies state variables (e.g., indicators) to be measured at sample locations but does not fully explain why these indicators were selected. For example, lab analyses do not assess "pesticides" or "nutrients": they assess particular pesticides and nutrients. Each one added can increase costs, each one ignored can increase risks, and there may be legal requirements. What logic was invoked to justify the selection of the indicators to be measured?

As stated in the introduction, the Delta RMP's nutrient monitoring program has not yet been developed. Nutrient "state variables" to be measured have not yet been specified. The

Monitoring Design Summary (MDS) states that the nutrient *data synthesis* would focus on the following parameters: ammonium (NH_4), nitrate (NO_3), dissolved inorganic nitrogen (DIN), total dissolved nitrogen (TDN), dissolved organic nitrogen (DON), phosphate (PO_4), chlorophyll a (chl-a), and dissolved oxygen (DO).

The nutrient subcommittee recommended focusing on the parameters above because they have been identified as the most relevant for addressing management questions and main issues of concern related to nutrients.

Monitoring design – One of the initial driving questions (p. 44) is "are there important data gaps associated with particular water bodies within the Delta subregions." It seems appropriate to answer this question before designing the sampling plan and locations for the Delta RMP.

We concur and this is the approach being taken by the Delta RMP. A Delta RMP nutrient monitoring planning workshop was held on September 30, 2016. The goals of this workshop were to:

- **Identify** how much of the nutrient monitoring needed to answer the Delta RMP assessment questions is already happening through **existing programs,**
- Identify critical nutrient data **gaps** for the Delta RMP and develop "no regrets" monitoring activities to fill them (beginning in Calendar year 2017), and
- Develop **budget estimates for "no regrets"** monitoring activities to facilitate multi-year budget planning for the Delta RMP multi-year plan

In preparation for the workshop, a background report was produced that summarizes existing nutrient monitoring programs, data gaps, and potential Delta RMP "no regrets" monitoring activities. This report synthesizes information and recommendations gathered in a) interviews with representatives of Delta monitoring and resource management programs, b) updating earlier information gathered on current monitoring efforts in the Delta (Central Valley Monitoring Directory, Jabusch and Gilbreath 2010), and c) conclusions and recommendations from recently completed data syntheses by ASC (Novick et al. 2015, Jabusch et al. 2016) and USGS (Bergamaschi et al., in press).

How are tides, flows, and other hydrodynamic conditions considered in choosing where and when to sample?

This issue will be considered for the development of the monitoring program design. It will depend on the specific question being addressed by the monitoring and the approach taken to answer it. Examples for how these important considerations are being discussed are as follows:

- To the extent possible, any new stations (both continuous and discrete) will be co-located with existing flow stations

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- The California Department of Water Resources (DWR) – Environmental Monitoring Program (EMP) has been collecting monthly data for more than 40 years with consistent timing relative to tides. Since 1975, the sampling times were planned to occur within a one-hour window of the expected occurrence of high tide slack at the sampling location. The EMP can be considered as the core data collection effort for addressing the Delta RMP Status & Trends (S&T) nutrient assessment questions. Any augmentation of the existing station network, for example, to strengthen the statistical power for long-term trend detection or increase spatial coverage, would maintain that consistency of sampling relative to the tide to minimize tidal variation as a factor affecting the long-term dataset.
- One potential Delta RMP activity that was discussed by program participants is to improve estimates of loads from upstream sources at important inflows. Nutrient load estimates for upstream sources are probably biased low, because storm events are not adequately captured. This gap could be filled and prevented from widening through storm sampling to better characterize the hydrograph.
- Additional short-term high frequency sampling to address data needs for hydrological-biogeochemical modeling would be timed for when boundary conditions (inflows and water exports) are changing rapidly.
- High-frequency (HF) data collection cruises have been proposed to understand nutrient transformations and potential internal loading in under-sampled Delta locations. The recommended monitoring cruises would be designed to characterize seasonal changes in flow and water quality and consist of data collection cruises under different flow scenarios.
- A data analysis that involves hydrodynamic modeling is currently underway to help identify temporal and spatial data gaps, in order to inform the future monitoring design. The goal of this analysis is to address the Delta RMP Assessment Question: "Are there important data gaps associated with particular water bodies within the Delta subregions, *relative to the potential for biogeochemical transformations to occur in those places, as inferred by transport time scales, hydrodynamic condition, and the source of the water*" The expected outcome are recommendations for representative sites for trends monitoring, high-frequency mapping sites, and informing biogeochemical models, based on hydrodynamic modeling results.

The MDS (pp. 47-52) shows several ways to display the data, including its variation over time and space. Displays like these are informative, and might help in developing the nutrient monitoring design, or redirect or focus future sampling. However, displays are not a sufficient end point. They do not provide clear criteria for management actions. Such criteria usually need to be numerical estimates, with estimates of reliability. They will arise from comparisons to water quality objectives or other benchmarks of environmental or human health.

We concur with the observation. However, a nutrient assessment framework does not yet exist for the Delta and there are only a few existing water quality objectives or benchmarks that would be appropriate and meaningful in the context of the Delta RMP assessment questions. Examples for meaningful benchmarks are TMDL targets for dissolved oxygen in the lower San Joaquin River (Figure 3, from ASC 2012) or World Health Organization

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(WHO) thresholds of risk associated with potential exposure to cyanotoxins (Table 1, USEPA 2009). Water quality criteria also exist for ammonium and nitrate. However, these criteria are related to toxicity, whereas the primary management concern for these constituents is about their impact on ecosystem productivity and trophic status.

The Delta Stewardship Council's 2013 Delta Plan recommended that the San Francisco and Central Valley Water Board prepare study plans for the development of nutrient objectives in the Delta and Suisun Bay. In response to the Council's recommendation, Water Board staff developed a Strategic Workplan for the Delta that was presented to the Central Valley Water Board in February 2014. This Strategic Work Plan contained a nutrient strategy that included tasks, deliverables and a timeline for developing the research plan. The goal of this project is to develop a Delta Nutrient Research Plan to determine whether nutrient concentrations cause or contribute to water quality problems in the Delta. Completion of the Delta Nutrient Research Plan (by 2018) is expected to lead to the development of a nutrients assessment framework for the Delta.

We recommend that a PhD-level statistician be added to your team to help develop the nutrient monitoring design.

We have access to additional statistical expertise and will bring it in as needed to assist with the design development. The level of effort involved will depend on the scope and types of monitoring activities that are being planned.

Synthesis – An allocation of $435,000 seems high for mostly synthesizing the existing data (MDS, pp. 45-52).

There is agreement among scientists and managers participating in the Delta RMP Monitoring Planning Workshop that a) existing nutrient and nutrient-associated data are underutilized, and b) synthesizing, assessing, and reporting on the wealth of data generated by monitoring agencies could be a valuable function of the Delta RMP. The total annual cost for these activities was estimated at $100 - $500K, or approximately 0.5 – 2.5 FTEs/yr to compile data, perform data analyses, perform modeling, write reports, and interact and coordinate with stakeholder groups, collaborators, and additional technical experts.

However, the $435,000 mentioned above is not the funding level proposed in the MDS to be spent by the Delta RMP on synthesis activities alone (Table 2). This amount includes costs for coordination with related efforts and for developing the monitoring design. It also includes costs of projects that had already been funded through external sources but were expected to provide partial answers to several assessment questions related to concentrations and the mass balance of nutrients and nutrient-associated parameters. The costs listed in the column named **Shortfall (RMP funding needed)** were the funds proposed for the Delta RMP to build on these studies and address additional needs. The total proposed cost to the Delta RMP was $225K.

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Restate Table 1 (Assessment Questions) of Monitoring Design to more specifically address the management questions, monitoring goals, and likelihood of achieving these goals for each constituent. (This recommendation is for the entire design and not specific to the nutrient element.)

We concur with the need to review the assessment questions as they pertain to nutrients. The Nutrient Subcommittee is planning to review the assessment questions for nutrients at an upcoming meeting. The current plan is to discuss whether changes should be made to the assessment questions and their hierarchy that would strengthen the linkage between activities and management questions/drivers. This will be done in the context of linking the parallel efforts of the Delta RMP and the Delta Nutrient Research Plan more closely together and placing more emphasis on evaluating the linkages between nutrients as potential stressors and biological effects (Assessment Question S&T2 in Table 3). The discussion will also review and assess the scope of activities to be undertaken to address remaining data gaps under each assessment question.

References

Aquatic Science Center. 2010. Central Valley Monitoring. Directory. http://www.centralvalleymonitoring.org/ [accessed November 28, 2016].

Aquatic Science Center. 2012. The Pulse of the Delta: Linking Science & Management through Regional Monitoring. Contribution No. 673. Aquatic Science Center, Richmond, CA.

Bennett, W. A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. San Francisco Estuary and Watershed Science 3, http://repositories.cdlib.org/jmie/sfews/vol3/iss2/art1.

Bergamaschi BA, Downing BD, Kraus TEC, Pellerin BA. In review. REVIEW DRAFT: Designing a high frequency nutrient and biogeochemistry monitoring network for the Sacramento-San Joaquin Delta. U.S. Geological Survey Open File Report. U.S. Geological Survey, Reston, Virginia

Dugdale, R.C., Wilkerson, F.P., Hogue, V.E., Marchi, A. 2007. The role of ammonium and nitrate in spring bloom development in San Francisco Bay. Estuarine, Coastal and Shelf Science, V. 73, p. 17-29.

Glibert. P.M., Dugdale, R.C., Parker, A.E., Wilkerson, F., Alexander, J., Blaser, S., Kress, E., Murasko, S. 2012. Elevated ammonium concentrations inhibit total nitrogen uptake and growth, not just nitrate uptake. Poster presentation at Interagency Ecological Program Annual Workshop, April 2012, Folsom, CA.

DRAFT

Jabusch, T, Gilbreath AN. 2009. Current water quality monitoring efforts in the Delta. Prepared for the Central Valley Regional Water Quality Control Board, Aquatic Science Center, Oakland, CA.

Jabusch T, Bresnahan P, Trowbridge P, Wong A, Salomon M, and Senn D. 2015. Summary and Evaluation of Delta Subregions for Nutrient Monitoring and Assessment. San Francisco Estuary Institute, Richmond, CA. http://www.sfei.org/sites/default/files/biblio_files/MainReport-DSP_2016-06-30.pdf

Jassby AD, Van Nieuwenhuyse EE. 2005. Low dissolved oxygen in an estuarine channel (San Joaquin River, California): mechanisms and models based on long-term time series. San Francisco Estuary and Watershed Science, V. 3(2). http://escholarship.org/uc/item/0tb0f19p

Kimmerer, W. J. 2002. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages? Marine Ecology Progress Series 243, p. 39-55.

Kimmerer, W. J. 2006. Response of anchovies dampens effects of the invasive bivalve Corbula amurensis on the San Francisco Estuary foodweb. Marine Ecology Progress Series 324, p. 207-218.

Lehman, P. W., G. Boyer, C. Hall, S. Waller and K. Gehrts. 2005. Distribution and toxicity of a new colonial Microcystis aeruginosa bloom in the San Francisco Bay Estuary, California. Hydrobiologia 541:87-99.

Novick E, Holleman H, Jabusch T, Sun J, Trowbridge P, and Senn D, Guerin M, Kendall C, Young M, Peek S. 2015. Characterizing and quantifying nutrient sources, sinks and transformations in the Delta: synthesis, modeling, and recommendations for monitoring. San Francisco Estuary Institute, Richmond, CA. http://sfbaynutrients.sfei.org/sites/default/files/Main manuscript.pdf

Parker, A.E., V. E. Hogue, F.P. Wilkerson, and R.C. Dugdale. 2012b. The effect of inorganic nitrogen speciation on primary production in the San Francisco Estuary. Estuarine, Coastal and Shelf Science 104-105, p. 91-101.

Thomson, J. R., Kimmerer, W. J., Brown, L. R., Newman, K. B., Mac Nally, R., Bennett, W. A., Feyrer, F., Fleishman, E. 2010. Bayesian change-point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. Ecological Applications 20, p. 1431-1448.

USEPA. 2009. National Lakes Assessment: A Collaborative Survey of the Nation's Lakes. EPA 841-R-09-001. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, D.C.

DRAFT

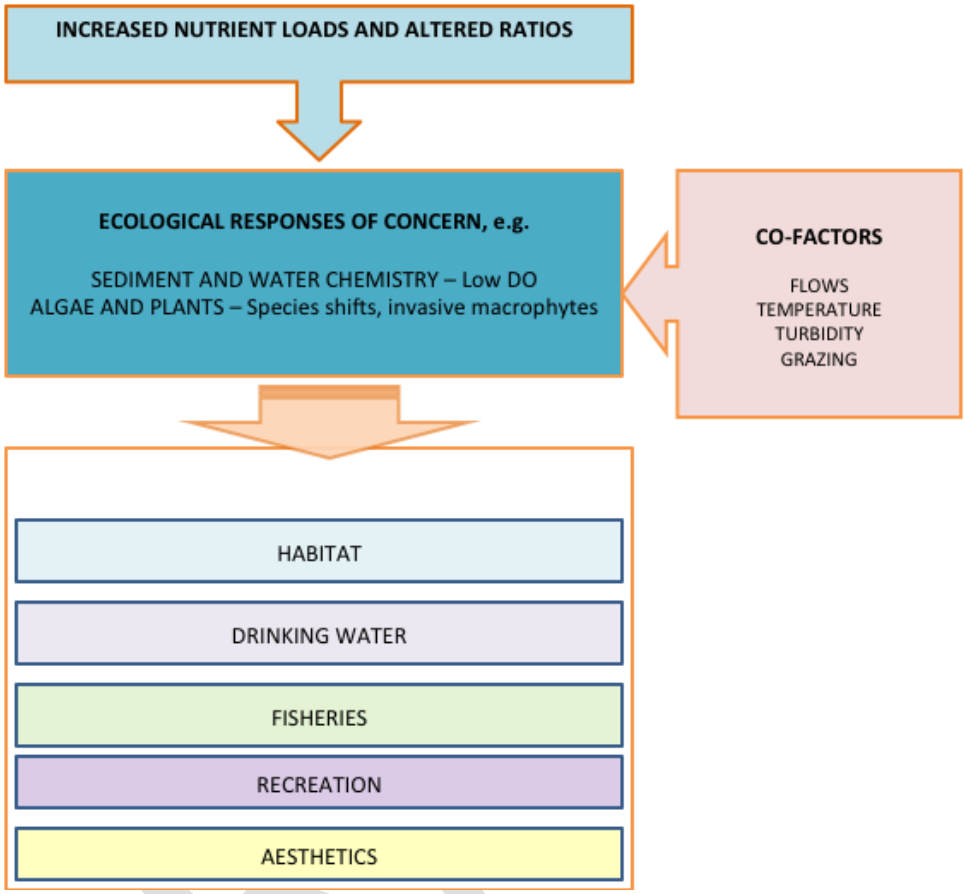

Figure 1. Simplified conceptual framework showing the linkage of nutrients loading, ecological response, co-factors modulating the ecological response, and altered ecological and human services.

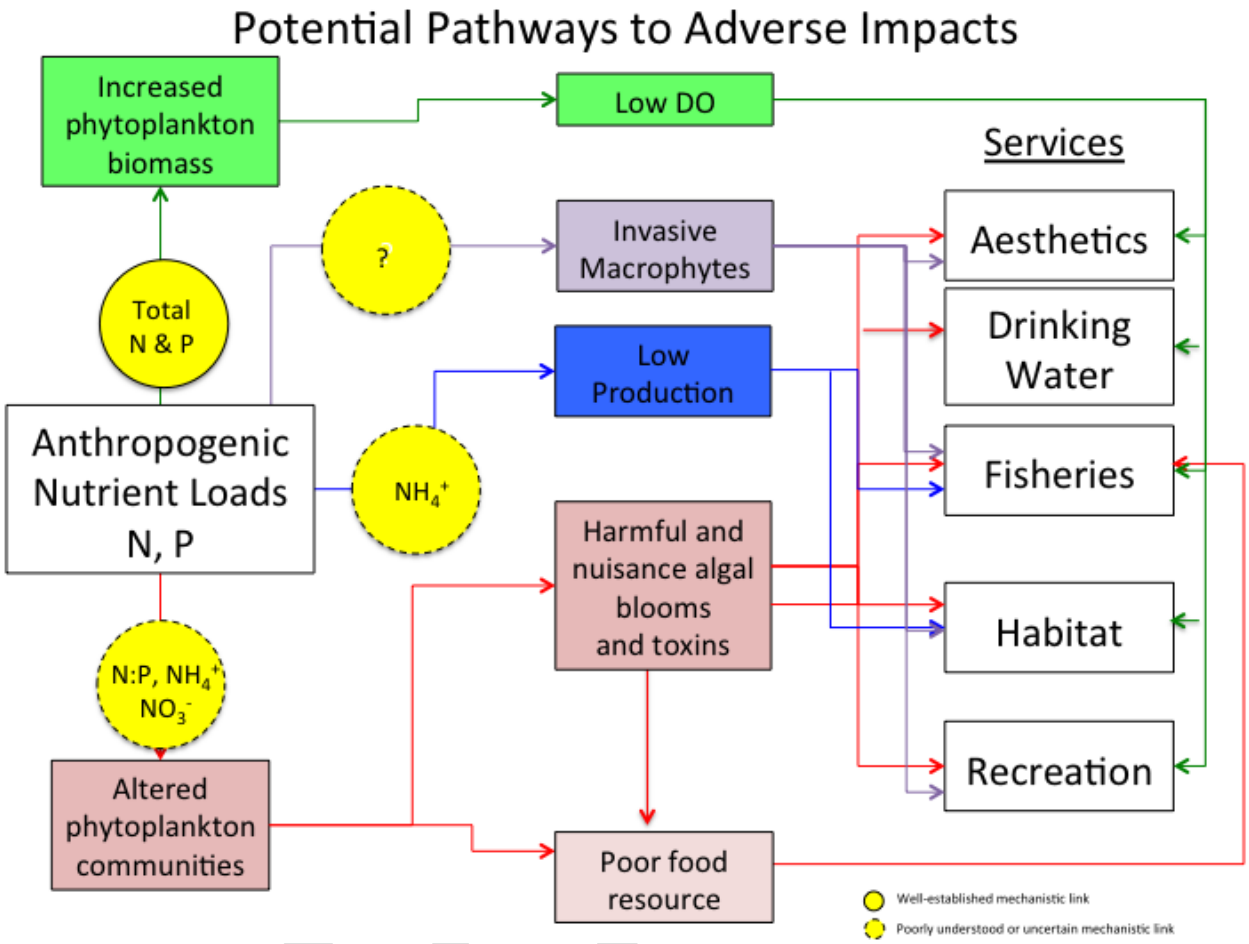

Figure 2. Conceptual diagram of potential pathways from elevated nitrogen and phosphorus loads to adverse impacts on beneficial uses.

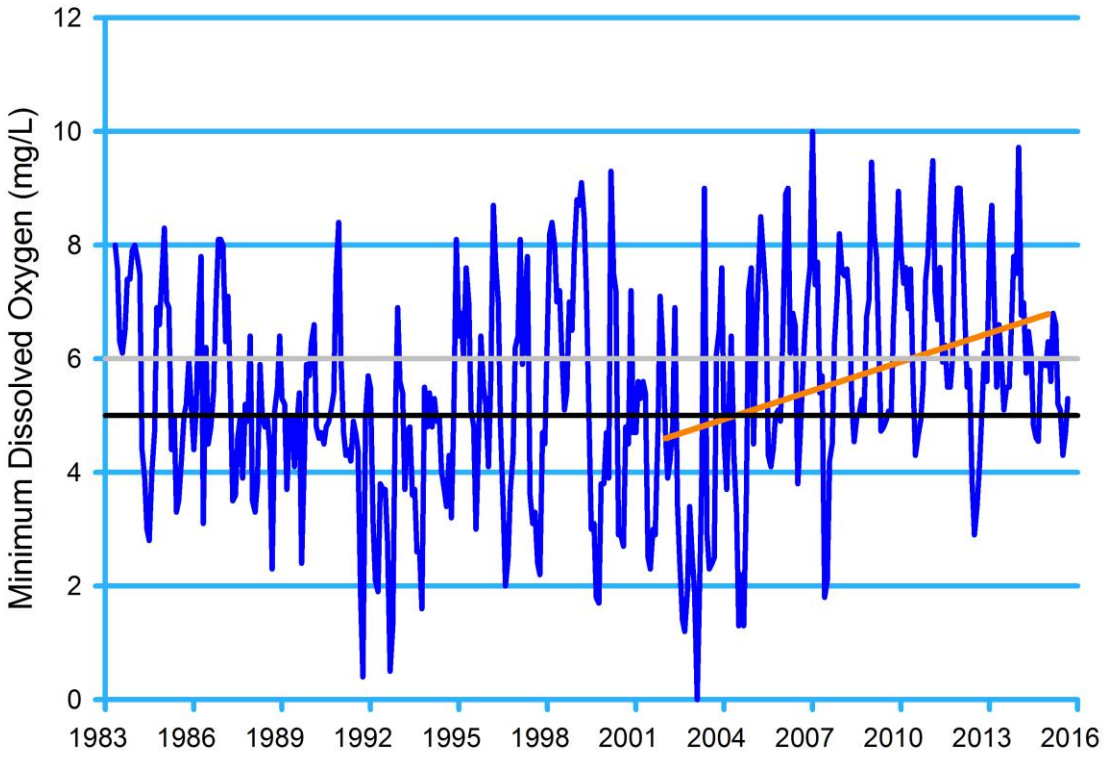

Figure 3. Dissolved Oxygen in the Lower San Joaquin River. ***Example graph and example interpretation***. Low dissolved oxygen in Delta waters pose significant migration barriers to salmon and other migrating fishes. Dissolved oxygen barriers occur in the Stockton Deep Water Ship Channel (DWSC) and on Old and Middle Rivers and have resulted in the establishment of a Total Maximum Daily Load (TMDL) to control low DO in the San Joaquin River. The deepened channel, reduced flows, decomposing algae from upstream, and oxygen-demanding substances from the City of Stockton wastewater treatment plant all contribute to the low DO issue. Seasonal variability of DO is mainly due to seasonal variability in river flow, but fluctuations in river phytoplankton and wastewater effluent also play a role. Dissolved oxygen in the lower San Joaquin River has increased since the early 2000s (see trend line), primarily due to the implementation of algae removal ponds and nitrification treatment by the City of Stockton wastewater treatment plant. However, monthly minimum values continue to fall frequently below the statutory limits of 5 mg/L (December 1 to September 30) and 6 mg/L (October 1 to November 30).

Footnotes: Minimum monthly values of dissolved oxygen measured at the Rough and Ready Island monitoring station in the Stockton DWSC. The Middle River and Old River split off from the mainstem of the San Joaquin River upstream of the DWSC. The orange trend line represents a linear regression of the annual averages of minimum monthly DO concentration 2002 – 2015 vs. time. Data are from the Continuous Multiparameter Monitoring by the IEP Environmental Monitoring Program.

Reference: Jassby & Van Nieuwenhuyse 2005.

Table 1. World Health Organization thresholds of risk associated with potential exposure to cyanotoxins (USEPA 2009).

Indicator (units)	**Low Risk of Exposure**	**Moderate Risk of Exposure**	**High Risk of Exposure**
Cyanobacteria cell counts (#/L)	< 20,000	20,000 - <100,000	≥ 100,000
Microcystin (µg/L)	<10	10 - ≤20	>20

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Table 2.
The following table from the MDS shows the initial cost estimates for steps to develop the nutrient monitoring design. For projects that already have funding from outside the Delta RMP, the cost of the project is shown but is offset by the available outside funding. This table does not include the costs of routine nutrient monitoring. Costs for a longer-term nutrient monitoring will be developed after the monitoring design has been produced.

Task	Cost	Available Funding from non-RMP sources	Shortfall (RMP funding needed)
1. Synthesis and analysis of existing information and data			
a. Synthesize and analyze existing data			
Synthesis of EMP and Nutrient Loads data (ASC-DWR contract)	$82,000	$82,000	$0
Interpretation of stable isotope data (ASC-DWR contract)	$34,000	$34,000	$0
Calibration and interpretation of DSM2 nutrient models (ASC-DWR contract)	$39,000	$39,000	$0
Synthesis of high-frequency sensor data	$70,000	$0	$70,000
Compilation and synthesis of other nutrient datasets from the Delta	$40,000	$0	$40,000
b. Establish meaningful subregions			
Synthesis of Nutrient Data and Analyses to Determine Delta Segments for Nutrient Assessments and Modeling (ASC-DSP contract)	$40,000	$40,000	$0
c. Identify critical data gaps and develop initial recommendations for monitoring design	$50,000	$0	$50,000
2. Coordination			
a. Coordination with the development of the Delta Nutrient Research Plan and related efforts (ASC-DSP contract)	$15,000	$15,000	$0
3. Develop nutrient monitoring design			
a. Define sampling frame (habitats, subareas) b. Data evaluation and reconciliation c. Complete and vet a detailed monitoring and design proposal for nutrients d. Develop mechanisms for systematically compiling, assessing, and reporting data	$65,000	$0	$65,000
Total amount	***$435,000***	***$210,000***	***$225,000***

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Table 3. Delta RMP assessment questions for nutrients. ***Italicized bold-faced questions*** are the highest priority for the initial program.

Type	Core Management Questions	Nutrient Assessment Questions
Status & Trends	IS THERE A PROBLEM OR ARE THERE SIGNS OF A PROBLEM? a. Is water quality currently, or trending towards, adversely affecting beneficial uses of the Delta? b. Which constituents may be impairing beneficial uses in subregions of the Delta? c. Are trends similar or different across different subregions of the Delta?	***ST1. How do concentrations of nutrients (and nutrient-associated parameters) vary spatially and temporally?*** ***A. Are trends similar or different across subregions of the Delta?*** ***B. How are ambient levels and trends affected by variability in climate, hydrology, and ecology?*** ***C. Are there important data gaps associated with particular water bodies within the Delta subregions?*** ST2. What is the current status of the Delta ecosystem as influenced by nutrients? A. What is the current ecosystem status of habitat types in different types of Delta waterways, and how are the conditions related to nutrients?
Sources, Pathways, Loadings & Processes	WHICH SOURCES AND PROCESSES ARE MOST IMPORTANT TO UNDERSTAND AND QUANTIFY? a. Which sources, pathways, loadings, and processes (e.g., transformations, bioaccumulation) contribute most to identified problems? b. What is the magnitude of each source and/or pathway (e.g., municipal wastewater, atmospheric deposition)? c. What are the magnitudes of internal sources and/or pathways (e.g. benthic flux) and sinks in the Delta?	***SPLP1. Which sources, pathways, and processes contribute most to observed levels of nutrients?*** ***A. How have nutrient or nutrient-related source controls and water management actions changed ambient levels of nutrients and nutrient-associated parameters?*** ***B. What are the loads from tributaries to the Delta?*** ***C. What are the sources and loads of nutrients within the Delta?*** ***D. What role do internal sources play in influencing observed nutrient levels?*** ***E. Which factors in the Delta influence the effects of nutrients?*** ***F. What are the types and sources of nutrient sinks within the Delta?*** ***G. What are the types and magnitudes of nutrient exports from the Delta to Suisun Bay and water intakes for the State and Federal Water Projects?***
Forecasting Scenarios	a. How do ambient water quality conditions respond to different management scenarios b. What constituent loads can the Delta assimilate without impairment of beneficial uses? c. What is the likelihood that the Delta will be water quality-impaired in the future?	FS1. How will ambient water quality conditions respond to potential or planned future source control actions, restoration projects, and water resource management changes?

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Response to Review Panel Comments on the Pesticides Design from the Pesticides Subcommittee

The Panel made many excellent points about the DRMP monitoring design. Responses to Review Panel comments and questions specific to the pesticides monitoring design are provided below. Some comments can be addressed by providing additional background information that was not previously communicated or available to the panel. Other comments are appreciated as valuable feedback and will be considered by the program as the long-term monitoring design for pesticides is further developed. One of the objectives for FY17/18 is to develop the long-term monitoring design for pesticides, taking into consideration the comments from the External Review, results from the first two years, and the goals of the Program.

Responses to Specific Questions and Comments on the Pesticides Design

At present it is proposed to conduct "Pesticide-focused TIEs for samples with > 50% reduction in the organism response compared to the lab control treatment (not to exceed 20% of samples or $40,000)" (MDS p. 21). What criteria led to these numbers?

The decision of when to conduct a TIE is a Steering Committee decision. TIEs cannot be performed on all samples with observed toxicity because financial resources are limited for the RMP and management thresholds like this are necessary (e.g., in the first year of sampling, there were 20 samples with significant toxicity based on one or several endpoints). At the outset of the program, the Pesticide Subcommittee decided to follow other programs which have utilized the >50% threshold as the trigger level for when to conduct a TIE. This criterion ensures that the most toxic samples, those with an observed effect greater than 50%, will be evaluated to help narrow down the possible sources such as metals or organophosphate pesticides. Conducting TIEs on samples with less of an observed effect often results in the toxicity not being persistent for the duration of the multiple manipulations and the results being inconclusive due to toxicity being lost. The decision about whether to conduct a TIE when a sample exceeds the trigger level is made case-by-case by a subcommittee of the TAC. During the first year of sampling, one TIE was triggered that was ended early and inconclusive, as the toxic effect was not reproduced.

The toxicity tests use "EPA, 2002, Appendix H" (QAPP, p. 61, it should be "2002a"). It is an old t-test (its formal pre-tests are not useful). How the test is to be used (what action it might lead to), and how reliable it should be (a function of sample sizes and variances) are not clearly

discussed. (The aims and meaning of the measurement quality objectives column in Table 4.10 is not clear.)

The EPA acute toxicity testing manual explains the process to test for meeting data assumptions of normality and equal variance. The initial goals and measurement quality objectives for toxicity monitoring of the Delta RMP are related to evaluating Status and Trends, which are very similar and complementary to those of the statewide Surface Water Ambient Monitoring Program (SWAMP). Therefore, the Delta RMP has adapted the scientifically vetted approach used by the SWAMP for individual toxicity testing analysis. (It should also be noted that the discussion about the most appropriate statistical test has not been unequivocally resolved. Some pesticide subcommittee members are recommending the Test of Significant Toxicity with the argument that it would provide more statistical rigor).

Delta RMP data are expected to contribute to an information basis for assessing conditions at a regional scale and fill prioritized data gaps. There is a continuing discussion about how the Delta RMP should interface with regulators and other managers outside the program and the issue still needs to be resolved, especially with regards to follow-up on any observations. However, results are not "actioned" on within the Program. Regulatory and management decisions (e.g. defining an exceedance and a follow-up to an observed exceedance, determining beneficial use impairments, etc.) may involve participants but do occur outside of the Delta RMP. The key contribution of the Delta RMP is in providing a shared dataset and serving as a forum for joint-fact finding and consensus building. The goal is broadly described in the Communications Plan goal as to develop the interpretation and potential recommendations for management in a science-based and collaborative process.

The plan is not clear about methods for sampling sediments. The QAPP has no information on sediment collection or analysis.

a. *Is the Stream Pollutions Trends Monitoring Program (SPoT) collection, toxicity testing and chemistry of sediments considered part of the Delta RMP?*

No. SPoT is a separate statewide water quality monitoring program that focuses on toxicity and concentrations of stream-borne contaminants in sediments with the goals to:

1. Determine long-term trends in stream contaminant concentrations statewide;
2. Relate water quality indicators to land-use characteristics; and

3. Establish a network of sites throughout the state to serve as a backbone for collaboration with local, regional, & federal monitoring programs.

The SpoT Delta RMP will benefit by utilizing the information generated by the SPoT program. Leveraging resources between the two programs is beneficial.

b. Where are those sample locations?

SPoT sampling locations were shown on the map on page 24 of the Monitoring Design Summary and listed in the table of monitoring locations following the map on pages 25 and 26. These locations can vary according to SPoT program priorities. Current sites are:

Mokelumne River @ New Hope

San Joaquin @Vernalis

Marsh Creek @ East Cypress Crossing

American River @Discovery Park

c. A yearly grab sample seems very limited - what is known about the spatial distribution of pesticides in sediment, or their seasonal variation?

Effectively, not all locations are only sampled yearly as the comment suggests.

However, sediment chemical composition and toxicity does not typically change rapidly over time. Five years of data were evaluated to determine variability in toxicity (2008-2012). Statistical analysis was conducted at selected SPoT sites (called "variability" sites) to assess the temporal and spatial variability of toxicity and contamination. The results indicated that samples collected once per year were representative of spatial and temporal variability within the selected watersheds, and the results varied depending on the magnitude of toxicity and contamination.

Pages 46 & 47 of this report includes power analysis:

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/workplans/spot_%20fourteen_rpt.pdf

Based on the variability of toxicity test results measured once per year for the past five years, it can take an average of 3 to 4 years to observe a 25% change in toxicity. Parameters

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that are more variable, such as total pyrethroids, can take 5 to 9 years to observe a 25% change. Power analysis conducted on the data from the variability sites demonstrated that trends could be detected more quickly by sampling the sites multiple times per year. It is predicted that sampling three times per year at the variability sites could detect trends in toxicity and bifenthrin concentrations in an average of two years. In collaboration with DPR, SPoT now samples 4 sites 4 times per year to assess reductions in toxicity and pyrethroid pesticides associated with recent DPR revisions to pyrethroid label recommendations for use in urban settings. These 4 sites have replaced the "variability" sites and are now called "intensive" sites.

d. *What will the estimated concentrations be compared to in order to evaluate the presence and degree of sediment toxicity?*
e. *There are no standards, criteria, or objectives for the prevalence of current use pesticides in sediment, so what would be done with this information?*

The information gleaned from SpoT will be used to help understand the risk level and to assist as baseline information in future monitoring. The general information is that the data would be obtained and used to evaluate the overarching management question: Is there a problem or are there signs of a problem? Results will also help inform future monitoring needs and whether adaptive changes to the monitoring design are needed (e.g., should there be additional sediment monitoring to address Delta RMP management questions? Which constituents? When? Where? How often?)

Evaluation of SpoT data within the context of the Delta RMP will draw from data evaluation procedures and analyses performed by the SpoT. However, more detailed discussions on the approach for how to assess the “risk” level within the Delta RMP contact and feedback to the Delta RMP design are still pending, i.e. the degree to which SpoT data evaluation approaches can be directly adapted or would require modification.

In SPoT evaluations, for example, amphipod survival is compared to individual chemical threshold values (also referred to as benchmarks) to determine which chemical occurred at concentrations that could cause toxicity. These toxicity benchmark concentrations are assembled from various sources. Where possible, median lethal concentrations (LC50s) derived from spiked sediment toxicity studies using *H. azteca* were used to evaluate chemistry data. Median lethal concentrations are preferable because they are derived from exposure experiments with single chemicals. The probable effects concentration (PEC) sediment quality guidelines (MacDonald et al. 1990) were used when spiked-sediment LC50s were not available. Probable effects concentrations are consensus-based guidelines that were developed from other empirically-derived sediment quality guideline values.

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These benchmarks identify concentrations above which adverse effects to benthic invertebrates are expected.

f. The map on p. 26 of MDS shows there are existing sediment and/or water toxicity test locations in the Delta that have known toxicity (at least within the vague categories). Can these locations be used as negative and positive controls, respectively?

The best approach in toxicity testing for a negative control is the use of standard laboratory control water to compare with the site water. Reference toxicant tests are performed as a positive control test. This is the approach that has been utilized in ambient toxicity testing for over three decades.

Some water samples are scheduled and others triggered by events. If these are to be combined over time, how will they be analyzed? Presumably "event" times have special characteristics, and wet ones are different from dry ones. (This is a question, not a criticism of taking the two types of samples.) It seems that monthly samples are not taken when "events" occur. In that case, why are the "event" sites different from the regular sites?

All data will be treated in the analyses as monthly samples. “Event” times represent five time periods that were selected because they were considered by the pesticide subcommittee as the most critical points or windows in time over the course of the year to evaluate temporal and spatial variability of pesticides and their effects. The pesticide subcommittee selected these five “event” times to be monitored at a minimum, if there is insufficient funding for monthly monitoring at all proposed sites. The selected “event” times include two wet-weather event types and three dry-season periods. The wet-weather event types are: (1) first flush and (2) one additional significant winter storm after first flush has occurred. The three dry-season sampling events are: (1) early spring, (2) 1st irrigation season sampling (late spring/ early summer), and (3) 2nd irrigation season sampling (late spring/ early summer).

“Event” sites were selected to increase the spatial coverage of monitoring. Ideally, these sites would also be monitored monthly. The proposed “events–only” sampling at these sites (5x/year instead of 12x/year) represents a compromise driven by budget considerations. This option is currently not implemented. The pesticides monitoring is currently only funded for the five “regular” or baseline sites. At these regular sites, monthly samples in the wet season are scheduled to capture the wet-weather events.

In the analyses, samples may be binned into periods representing different event times for comparison. For example, results from wet events may be pooled from all years and compared to data collected during dry periods.

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QAPP p. 30. Are the same sites used for both pesticide analyses and toxicity testing?

Yes. The initial monitoring design combines chemical analysis and toxicity testing on all samples for all sites.

More detail on toxicity tests is needed.

The Delta RMP uses water toxicity tests that are common across numerous ambient monitoring programs, including the SWAMP and other regional monitoring programs. The Delta RMP uses the three–species freshwater tests typically used for toxicity testing of receiving waters (EPA 2002a and b) using a fish (fathead minnow, *Pimephales promelas*), a cladoceran (*Ceriodaphnia dubia*), and a green alga (*Selenastrum capricornutum*). Recently (i.e. November 2016), toxicity testing with a second invertebrate, the amphipod *Hyalella* azteca, was added to increase the response range to potential toxicants. The testing approach includes acute (i.e., survival) and chronic (i.e. growth and reproduction) endpoints:

- *Selenastrum capricornutum* (growth)
- *Ceriodaphnia dubia* (survival and reproduction)
- *Hyalella azteca* (survival)
- *Pimephales promelas* (larval survival and biomass)

Each test has specific strengths, weaknesses, and sensitivity to toxic constituents. *H. azteca* was added to the standard three species because it is most sensitive to low levels of pyrethroid pesticides. *Ceriodaphnia* are more sensitive to the presence of organophosphorus (OP) pesticides. Herbicide toxicity is detectable by testing with *Selenastrum*. Fish toxicity (represented by *Pimephales promelas*) is an important management concern in the Delta. In the selection of the test species and endpoints, the pesticides subcommittee considered the response range to potential toxicants, relevance of the test organisms, costs, feasibility, and potential test interferences and other caveats not related to toxicity.

Additional details can be found in the USEPA freshwater toxicity testing manuals (USEPA 2002a and b) and the Standard Operating Procedures for each test:

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- Initiation of *Selenastrum capricornutum* 96-Hour Chronic Toxicity Test (4th Edition)
- Initiation of *Ceriodaphnia dubia* Chronic Toxicity Test (4th Edition)
- Initiation of *Pimephales promelas* (Fathead Minnow) Chronic Toxicity Test (4th Edition)
- Initiation of *Hyalella azteca* Acute 96-hour Water Column Toxicity Test

This is by far the most expensive program and has the potential to become much more so if new or unknown pesticides become an issue. Yet, at present, we do not know the answer to the basic Table 1 question: "What are the spatial and temporal extents of lethal and sub-lethal toxicity?"

It seems more cost-effective to document the toxicity problem first, by postponing pesticide analyses to pay for toxicity testing over more sites, more widely spread, and during times of year when pesticide use/runoff would be expected to be high. When the sites or areas experiencing toxicity, and the times of the year are known, then samples from these sites and times can be analyzed for the chemicals that might cause that toxicity. This information can then be used to determine source(s), which can then lead to control/management.

a. *What samples sizes will be used, and why?*
b. *In the 2-stage approach above, a decision procedure will be needed to decide which sites and times are candidates for pesticide analysis, and perhaps to choose the pesticides to look for.*
c. *Thresholds, trigger points, and estimates of reliability will be needed, especially if information from different sites or times is to be combined.*
d. *When samples are collected from locations with observed toxicity and analyzed for chemicals, will current use pesticides be the only targets?*
e. *Is there reason also to consider personal care products, PBDEs (flame retardants), pharmaceuticals, legacy pesticides in sediment (e.g., DDT) or Hg as causes or contributors to observed toxicity?*

This comment raises fundamental questions about the Delta RMP monitoring design for current use pesticides and toxicity. They are best addressed as part of the re-evaluation of the pesticides design that is getting underway. The Steering Committee directed the TAC and Pesticide Subcommittee to complete the re-evaluation in time for the FY18/19 workplan. The re-evaluation is in response to the outcomes of the External Review as well as to the needs for reducing the relative proportion of program costs for pesticide monitoring and for bringing the focus on pyrethroid pesticides. This may require aligning the Delta RMP assessment questions more directly with pyrethroid TMDL-related management decisions and evaluating whether there are critical data that the Delta RMP

could generate to inform the Central Valley Pyrethroids TMDL. The outcomes of the re-alignment will inform decisions about data quality criteria to be used, site selection, the list of pesticides to be analyzed, the pros and cons of a toxicity-first approach and a toxicity with paired chemistry approach, and how to best meet the updated data evaluation and information needs.

However, the issues raised here by the panel have been thoroughly discussed during the development of the initial design and the pesticide subcommittee has carefully considered various approaches for addressing them. The resulting design represents a compromise between the best possible technical design for addressing the questions, budget constraints, and data needs of different participants. At the beginning of the design development, the planning budget was uncertain and the plans had to capture a range of effort. Ultimately, a lower cost design was implemented. The following paragraphs will outline some of the pros and cons of various approaches that were considered as well as the rationale for the decisions that had been made about the design.

A key point to resolve during the design development was the question of whether the monitoring should be primarily toxicity based (with follow-up chemical analyses in toxic samples as well as some non-toxic samples as reference), primarily or exclusively chemistry-based, or involve both toxicity testing and chemical analysis on all samples from all sites. Consistent with the comment made here, a toxicity-first design was discussed as the potentially most cost-efficient option to assess whether there is a potential problem. Toxicity testing is an integrative tool, it can determine effects of multiple constituents concurrently, and can help to understand how the combination of pesticide active ingredients (AIs) + AI degradates + formulation "inert" ingredient(s) + their degradation products + any other potential toxicants overlying in the water and sediment (e.g., heavy metals) contribute to toxicity. However, there are also significant caveats to this approach. First, chemical-analytical results are important for evaluating if the observed toxicity might potentially be related to the occurrence of pesticides. Second, there are potential issues with changes in sample chemistry and obtaining representative results, if samples are not immediately processed and analyzed. Third, some of the program participants required chemical results for compliance reporting purposes. (Compliance reporting requirements have since changed and this may no longer be necessary. This will be evaluated in the development of the new monitoring design.) Based on these considerations, it was decided to perform toxicity testing and chemical analysis on all samples from all sites.

As pointed out in the comments, there is a possibility of impacts from other contaminant classes and there were also extensive discussions about the range of potential chemicals that should be considered as potential sources of toxicity. The linkage of toxicity testing to pesticides monitoring does not indicate a presumption that pesticides are the sole cause of toxicity in the Delta. However, current use pesticides were identified as a management priority for the program to focus on. Reasons include: 1) available information suggests that currently used insecticides and herbicides are the cause for most of the toxicity observed in the Delta (e.g., Central Valley Regional Water Board 2007, Hoogeweg et al.

2011, Johnson et al. 2010, Kuivila and Foe 1995, Lundberg & Laurenson 2012, Markewicz et al. 2012, State Water Resources Control Board 2010, State Water Resources Control Board et al. 2008, Werner et al. 2010, Weston et al. 2012, Weston et al. 2005, Weston & Lydy 2010); 2) pesticide regulatory mechanisms are already established in statute; and 3) management actions can be readily implemented for pesticides if they are determined to be the cause of toxicity. Thus, toxicity testing is primarily being used as tool to assist in the monitoring of pesticides. If other toxicants are determined to potentially contribute more to toxicity than expected, alternate priority constituents may be proposed to the Steering Committee for consideration. Future plans are likely to include monitoring of Chemicals of Emerging Concern (CECs) as a new program element. Potential coordination opportunities between monitoring for pesticides/toxicity and CECs can be investigated at that time.

Monitoring and assessment of the state of the Delta is based on a sample of the study area—that is, not all possible locations are sampled and indicator values measured. Therefore, the ability to use the sample data to draw inferences about unmonitored sites is a key part of sample site selection. This has several components. One is to use models of flow, transport and degradation to help estimate values up- or down-stream of monitored sites. The five pesticide sampling sites may allow crucial areas to be estimated this way (but they are likely to be small and no methods are given).

There are two broad categories of environmental monitoring programs—design-based and model-based. Both require that the target population and the sample frame be clearly defined in order to avoid the potential for confounding arising from changing frame errors. Those programs that use design-based inference use the selection probabilities of the sample units to calculate an estimate for the statistical population and provide estimates of uncertainty. In contrast, programs that use model-based inference assume an a priori statistical model for the distribution of indicator values and do not require a probability based sample design.

Why are sites for monthly pesticide samples all near the edge of the Delta if these are not informative about interior sites? (Pages 24 and 38 of the MDS lists reasons for site choices but they are vague.) How would one decide whether the proposed design is better than one with half as many times and twice as many sites? The QAPP aims to ensure that results from individual (site, time) samples meet reliability criteria: how are these determined? How would one decide whether to relax some of them so as to add more sites or times, or tighten others due to health risks?

These comments raise fundamental questions about the Delta RMP monitoring design for current use pesticides and toxicity. As a result of these comments and the External Review in general, the Steering Committee directed the TAC and Pesticide Subcommittee to redesign the monitoring program in time for the FY18/19 workplan.

Initial site selection and other design considerations were based on subcommittee member knowledge of important sources; what is known about where toxicity might occur and be detectable; spatial and temporal variability in pesticide concentrations based on the existing monitoring data; important influencing factors of loads and concentrations, such as

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flows and tides; etc. The subcommittee decided on initially monitoring fewer sites more frequently to develop a baseline for trend analysis, potentially identifying pesticide sources to the Delta, and in part for the need to better understand temporal variability relative to flow. The need to also characterize the interior Delta was discussed. However, flows in the interior Delta are more difficult to characterize and there were time and budget constraints for dealing with these challenges, and a feasible compromise was necessary to get the monitoring started in a timely way. The selected sites are critical integrator and/or representative indicator sites representing the most important sources to the inner Delta:

1. Sacramento R @ Hood: terminus site for the Sacramento River watershed, the largest tributary to the Delta
2. Sacramento R @ Vernalis: terminus site for the Sacramento River watershed, the second-largest to the Delta
3. San Joaquin River @ Buckley Cove: on the mainstem Sacramento River, below the influence of the Stockton urban area
4. Mokelumne R @ New Hope Rd: represents the most important tributary influences (Mokelumne and Cosumnes Rivers) at the eastside boundary
5. Ulatis Creek @ Brown Road: represents agricultural and urban influences in the North Delta discharging to the ecologically significant Cache/Prospect Slough complex.

The sites were selected in thoughtful discussions by the Pesticide Subcommittee based on their expert knowledge of previous studies and monitoring results from pesticide and toxicity research and monitoring conducted in the Delta. A review and documentation of the existing knowledge, literature base, and data source on which these decisions were formed was beyond the scope of the initial design effort.

The rationale behind selecting the peripheral sites initially was to develop a good characterization of the spatial and temporal variations in contributions to the inner Delta first. Interior Delta sampling locations were intended to be included in future work plans after a 1-2 year baseline was established for these integrator sites.

We concur that an alternative sampling design could be based on modeling or probabilistic surveys and the committees will consider these alternatives for the redesign. Both of these options have the advantage of covering more of the surface area of the Delta and being more amenable to analytical techniques to optimize data quality objectives, sampling locations, and frequency. A probabilistic design was discussed as an option for monitoring the interior of the Delta in the next program phase, once the spatial and temporal variability of contributions from important sources to the inner Delta would be better characterized. Next planned steps in the re-design are expected to involve a re-evaluation of the assessment questions (and their linkage to monitoring questions). When completed, decisions on the best monitoring design to address the new or refined questions can be made.

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<u>*Data products*</u>

a. *The vague categories used (non-toxic, some, moderate and high: MDS p. 26, 27) are not useful.*

Proposed data products will be re-evaluated, based on the outcomes of the re-design, refined assessment questions, and pending decisions on thresholds to be used for comparison.

The pie charts referred to here are shown as an example for a potential format to communicate complex toxicity data to a non-expert audience. The pie charts and categories are those used by the SWAMP and the California Water Quality Monitoring Council's MyWaterQuality Portals for assessment and graphical display of toxicity data. Some program participants consider them as useful for summarizing toxicity data for managers. However, the committees haven't reached consensus on what would constitute useful data products and this issue needs to be resolved as part of the re-design process.

However,

b. *The main value of plots is to convey much information clearly and succinctly, but thought and explanatory text are often needed;* ***MDS****, p. 28, contains much information but is uninterpretable (other than high scores for Diuron).*

This plot served as an example for how to visualize temporal and spatial variability across different pesticides in a single graph. More refined graphs with actual Delta RMP data and more detailed explanations will be developed for the 2-year summary report.

References

Central Valley Regional Water Board. 2007. Resolution No. R5-2007-0161: Water Board's actions to protect Beneficial Uses of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/resolutions/r5-2007-0161_res.pdf

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EPA. 2002a. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Fourth Edition. EPA-821-R-02-013

EPA. 2002b. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fifth Edition. EPA-821-R-02-012

Hoogeweg CG, Williams WM, Breuer R, Denton D, Rook B, Watry C. 2011. Spatial and Temporal Quantification of Pesticide Loadings to the Sacramento River, San Joaquin River, and Bay-Delta to Guide Risk Assessment for Sensitive Species. CALFED Science Grant #1055. Nov, 2 2011. 293 pp.

Johnson, M.L., Werner, I., Teh, S., Loge, F. 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

Kuivila KM, Foe CG (1995). Concentrations, transport, and biological effects of dormant spray pesticides in the San Francisco Estuary, California. Environmental Toxicology and Chemistry 14: 1141–1150.

Lundberg K, Laurenson B (2012). Summary of 2011/2012 Sacramento stormwater toxicity sampling and analysis. Memorandum to Delia McGrath, City of Sacramento, Ken Ballard, Sacramento County, Vyomini Pandya, SRCSD.

Macdonald, D.D., Ingersoll, C.G., Berger, T.A., 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch Environ Contam Toxicol 39, 20-31.

Markewicz D, Stillway M, Teh S. 2012. Toxicity in California Waters: Central Valley Region. California State Water Resources Control Board, Sacramento, CA. 38 pp.

State Water Resources Control Board. 2010. 2010 Integrated Report (Clean Water Act Section 303(d) List / 305(b) Report). http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtm

State Water Resources Control Board, Central Valley Regional Water Quality Control Board, and San Francisco Bay Regional Water Quality Control 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.

Werner I, Deanovic LA, Markiewicz D, Khamphanh J, Reece CK, Stillway M, Reece C. 2010. Monitoring acute and chronic water column toxicity in the northern Sacramento-San

DRAFT

Joaquin Estuary, California, USA, using the euryhaline amphipod, *Hyalella azteca*: 2006-2007. Environmental Toxicology and Chemistry 29(10): 2190–2199.

Weston D, Poynton HC, Wellborn G, Lydy M. 2012. Variation in contaminant sensitivity among *Hyalella azteca* from different sources. Society of Environmental Toxicology and Chemistry North America 33rd Annual Meeting. Long Beach, CA, SETAC.

Weston DP, Holmes RW, You J, Lydy MJ. 2005. Aquatic toxicity due to residential use of pyrethroid pesticides. Environmental Science and Technology, V. 39, p. 9778–9784.

Weston DP, Lydy MJ. 2010. Urban and Agricultural Sources of Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California. Environmental Science & Technology, 44(5): 1833-1840.

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Table 1. Summary of Delta RMP Pesticide Monitoring (implemented in FY15-17).

Component	Water Sampling
Design	"Bare Bones" 5 baseline sites
Frequency	Monthly (captures 2 wet events: first flush and 2nd significant winter storm)
Toxicity	All samples
Chemistry	All samples
Pesticide-focused TIEs	Up to 20% of samples found ≥50% toxic for at least one endpoint (not to exceed $40,000)

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MATERIALS FOR ITEM 6

Draft for TAC Review

DATE: December 6, 2016

TO: Delta RMP Steering Committee

FROM: Philip Trowbridge, Selina Cole, and Patrick Morris

RE: Proposed Delta RMP Projects Eligible for SEP Funding

Requested Action

Proposed Delta RMP projects that could be eligible for SEP funding is shown in Table 1. Short descriptions of each project are provided after the table. If the Steering Committee approves, these projects will be immediately available as SEP options during penalty settlement negotiations.

Background

Introduction

On February 19, 2016, the Central Valley Water Board approved a resolution that made the RMP an authorized Supplemental Environmental Project (SEP) funds administrator (Attachment A). Therefore, for an enforcement action against a discharger, the discharger has the option to direct up to half of the penalty to the Delta RMP as a SEP.

As part of settlement negotiations for discretionary ACL settlements (ACLs) and non-discretionary ACLs (minimum mandatory penalties) , the Central Valley Water Board will direct dischargers to projects eligible for SEP funding, including the projects that have been vetted by the Delta RMP, as options during the ACL settlement negotiations.

Requirements for Delta RMP Projects to be Eligible for SEP Funding

The State Water Resources Control Board SEP Policy requires a nexus between the violation and the SEP. There is a general nexus between the Delta RMP and violations in the Delta and Central Valley because the Delta RMP monitors water bodies that are potentially affected by violations in the Delta and in the watershed draining to the Delta. If necessary, studies with a more specific nexus to the violation (e.g., geographical) could be identified through the RMP planning process.

The SEP Policy requires that the SEP must "go above and beyond" other applicable obligations of the discharger that proposes to satisfy a part of its monetary penalty with a SEP. Therefore, SEP funds must be used to implement only those elements of the Program that would not otherwise be implemented through the base funding for the Program.

Eligible RMP projects for SEP funding are monitoring or special studies that have been reviewed and recommended by RMP Technical Advisory Committee and approved by the Steering Committee, but not funded. The Steering Committee will maintain a list of eligible projects that can be used by the Water Board during settlement negotiations. The list will reflect the priority un-funded science needs of the Delta RMP at that time and is subject to change by the Steering Committee at any time.

Table 1. Proposed Delta RMP Projects for SEP Funding

Project	Budget Range	Oversight Group
Assessment of Wetland and Stream Extent in the California Delta through Implementation of Regionally Focused Wetland Status and Trends Program	$30,100	TAC

DRAFT

Study Description for Supplemental Environmental Project Funds

Title: Assessment of Wetland and Stream Extent in the California Delta through Implementation of Regionally Focused Wetland Status and Trends Program

Study Budget

SCCWRP and its subcontractors: $30,100

Overview:

Understanding extent and distribution is the first step in managing surface water and groundwater resources, including streams and wetlands. Such information allows assessment of the relationship between resource extent and condition and associated stressors; which, in turn allows for development of informed management measures to protect habitat, water quality, and water supply. Unfortunately, California currently lacks the ability to accurately report on wetland extent, distribution, and trends on a regular basis. This makes it impossible to reliably answer questions about how much wetlands are in California, and whether state regulatory and non-regulatory programs are successful in helping to meet the stated goal of "no net loss" and "long-term net gain" of wetlands. The principal challenge to accurate assessment and effective monitoring over time is the expense of comprehensive mapping; conservative estimates predict comprehensive mapping of California's wetland resources would cost at least $8.4 million. Probabilistic mapping can provide a cost-effective alternative for monitoring aquatic resource extent and distribution. Under a probabilistic program, detailed wetland maps are produced for a set of random plots, placed across the entire state. Information from these plots is extrapolated to provide statewide estimates of extent and distribution. These plots can then become the basis for probabilistic monitoring and assessment programs.

In September 2012, the Southern California Coastal Water Research Project (SCCWRP) released a report entitled, *Technical Design for a Status & Trends Monitoring Program to Evaluate Extent and Distribution of Aquatic Resources in California* (SCCWRP Technical Report #706) that provides a set of recommendations for implementation of a probabilistic mapping program. This report was funded by a grant from USEPA through the California Natural Resources Agency, was coordinated through a diverse technical advisory committee, and was ultimately reviewed and supported by the California Wetlands Monitoring Workgroup (CWMW).

Proposed Project

This project would involve implementation of the established status and trends (S&T) protocols in the Delta RMP study area. Based on the size of the study area, approximately 50 - 4 km^2 plots would be selected from the statewide sample draw (which has already been completed). All aquatic and upland features within each plot would be mapped in order to provide for a statistically based assessment of the stream and wetland extent in the entire Delta RMP study area. In addition to the mapped sample plots, we would produce estimates of linear distance of streams, wetland area (by wetland class) and

associations with adjacent land use. This information can then be used to support additional water quality assessment and management, both in the California Delta and statewide. There are many pending and expected policy decisions coming up that will require knowledge of status and trends of wetlands in the delta. This methodology could serve as the catalyst to converting that decision making process from a political and opinion-based one to a data driven one.

Basic Study Cost and Breakdown

Mapping: $12,500

- All wetlands and streams in plots will be mapped using the California Aquatic Resources Inventory (CARI) standards and classification system, modified for use in the Status and Trends program. Mapping cost = $250/plot for 50 plots

Data management and QA: $5,600

- Maps will be subject to the data quality and metadata standards established in the S&T protocol documents. Data products will be uploaded to BIOS and EcoAtlas upon completion.

Groundtruthing: $4,500

- Approximately 5% of the mapped plots will be randomly selected for groundtruthing (approximately 3 plots). For each plot a team of at least two individuals will spend up to one day in the field verifying mapped resources on the ground. Groundtruthing cost = $1,500/plot for 3 plots.

Project management and reporting: $7,500

- The project management team will coordinate with the RMP on presentation, status updates, and final reports.

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MATERIALS FOR ITEM 7

DATE: December 6, 2016

TO: Delta RMP Steering Committee and Technical Advisory Committee

FROM: Philip Trowbridge

RE: Recommendation for Steering Committee and TAC member terms

At the October 18, 2016, joint meeting of the Steering Committee and the Technical Review Committee, there was discussion about terms for members of the Delta RMP committees and chairs. I took an action item to "Work with the Coordinating Committee to establish when terms will start and end for SC members, TAC members, and TAC co-chairs." This memo describes my recommendation.

After re-reading the Charter, I believe that the Delta RMP should not consider members to have defined terms. Members can serve indefinitely with the support of their participant group (see pages 11 and 17). The Charter calls for the members for the SC and TAC to be "explicitly reconfirmed" every 2 years. I interpret this to mean that the committees should review the roster for accuracy and completeness at least every 2 years. I recommend that this step be taken each year when the committees revisit the Charter at the joint meeting. The charter was approved in July 2016 with the full rosters included. The next time the rosters need to be explicitly confirmed is October 2017. However, changes can be made to the roster at any time.

For the co-chair positions, the Charter states that the SC will select or re-affirm the co-chairs once per year and that the TAC will select co-chairs for a two-year term, subject to approval by the SC (see pages 11 and 19). The co-chairs can serve indefinitely with support of the committees. At the January 2017 meeting, the SC should select or reaffirm the SC co-chairs since it has been more than a year since the last vote on this issue. The SC should also discuss the issue of the TAC co-chairs since the current chairs were appointed by the SC, not the TAC.

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MATERIALS FOR ITEM 8

Delta RMP Deliverables Scorecard Report

Key to Status Colors:
Green indicates greater than 90 days until the deliverable is due.
Yellow indicates a deliverable due within 90 days.
Red indicates a deliverable that is overdue.

Project	Primary	Deliverable	Assigned To	Due Date	Status	Comments
Delta RMP (FY14/15)	Pathogens Monitoring	Set up contracts with BioVir and Eurofins	Thomas Jabusch	04/06/15	Complete	
Delta RMP (FY14/15)	Data Management	Prepare QAPP for FY14/15	Thomas Jabusch	04/15/15	Complete	QAPP completed and sent to SWAMP QAO for review.
Delta RMP (FY14/15)	Pesticide/Toxicity Monitoring	Set up contract with USGS for pesticide analyses	Thomas Jabusch	04/30/15	Complete	
Delta RMP (FY14/15)	Pesticide/Toxicity Monitoring	Arrange for UCD/ATL to participate in SCCWRP Interlaboratory Calibration Study	Thomas Jabusch	04/30/15	Complete	APHL will participate in the study without funding from the Delta RMP.
Delta RMP (FY14/15)	Nutrient Synthesis	Set up contract with USGS for synthesis of high-frequency sensor data	Thomas Jabusch	05/15/15	Complete	
Delta RMP (FY14/15)	Program Management	Revised Monitoring Design	Thomas Jabusch	05/22/15	Complete	The Monitoring Design has been revised and was sent to the TAC and SC on 6/8/15 for review.
Delta RMP (FY14/15)	Program Management	FY15-16 Annual Program Workplan	Philip Trowbridge	05/22/15	Complete	FY15/16 Budget and Workplan sent to SC on 6/9/15.
Delta RMP (FY14/15)	Program Management	Framework for Interpretation of Monitoring Results	Thomas Jabusch	05/22/15	Complete	An outline for the Communications Plan was included in the revised Monitoring Design sent on 6/8/15 and will be discussed at the 6/16/15 SC meeting.
Delta RMP (FY14/15)	Program Management	FY15/16 Revenue Projections and Plan for Efficiently Invoicing Participants	Philip Trowbridge	05/22/15	Complete	
Delta RMP (FY14/15)	Program Management	Quarterly financial reports	Lawrence Leung	05/31/15	Complete	
Delta RMP (FY14/15)	Program Management	System for tracking deliverables and action items	Philip Trowbridge	05/31/15	Complete	For June SC meeting
Delta RMP (FY14/15)	Data Management	Set up templates and EDD reports for the pesticide/toxicity and pathogen laboratories	Amy Franz	05/31/15	Complete	EDDs for pathogens labs have been created. EDDs for pesticide/toxicity labs has been deferred to FY15/16.
Delta RMP (FY14/15)	Pesticide/Toxicity Monitoring	Collect two rounds of samples and analyze the samples for pesticides and toxicity	Contractors	06/30/15	Complete	This task has been deferred to FY15/16 workplan.
Delta RMP (FY14/15)	Nutrient Synthesis	Final report on high-frequency sensor data nutrient synthesis	Brian Bergamashi	12/31/15	Complete	USGS draft report was presented to TAC for review. Report was revised based on internal USGS comments. Revised report was sent to TRC and SC in October 2016 with a deadline of 11/1/16 for comments. No comments were received. On 11/8/16, the Nutrient Subcommittee agreed that the report should be considered "done" for the Delta RMP.
Delta RMP (FY14/15)	Pathogens Monitoring	Pathogens Year 1 Final report	Contractors	06/30/16	Complete	Summary memo provided to TAC.

Project	Primary	Deliverable	Assigned To	Due Date	Status	Comments
Delta RMP (FY15/16)	Program Management	Supplemental Budget Request to analyze split samples for CUPs	Thomas Jabusch	08/31/15	Complete	
Delta RMP (FY15/16)	Program Management	Prop 1 Application	Jennifer Sun	09/16/15	Complete	An application for 2 years of mercury monitoring ($640k) was submitted in response to the DFW solicitation.
Delta RMP (FY15/16)	Governance	TAC Meeting #1 and Summary	Thomas Jabusch	09/30/15	Complete	
Delta RMP (FY15/16)	Communications	Communications Plan	Thomas Jabusch	09/30/15	Complete	The draft Communications Plan and Program Planning Outline were sent to the TAC on 9/17/15 and the Steering Committee on 10/15/15.
Delta RMP (FY15/16)	Governance	Steering Committee Meeting #1 and Summary	Philip Trowbridge	10/30/15	Complete	
Delta RMP (FY15/16)	Governance	TAC Meeting #2 and Summary	Thomas Jabusch	12/31/15	Complete	
Delta RMP (FY15/16)	Governance	Steering Committee Meeting #2 and Summary	Philip Trowbridge	01/31/16	Complete	
Delta RMP (FY15/16)	Communications	Communications Product (The Charter)	Meg Sedlak	01/31/16	Complete	Charter was approved at 7/20/16 meeting.
Delta RMP (FY15/16)	Program Management	MOU for financial management and invoicing	Philip Trowbridge	03/31/16	Complete	MOU was discussed at the 4/25/16 SC meeting. The SC recommended changing the document to be a contract template for entities that need a contract to pay their fees. The MOU was sent to those entities to consider for a template.
Delta RMP (FY15/16)	Governance	TAC Meeting #3 and Summary	Thomas Jabusch	03/31/16	Complete	
Delta RMP (FY15/16)	Governance	Steering Committee Meeting #3 and Summary	Philip Trowbridge	04/29/16	Complete	
Delta RMP (FY15/16)	Nutrients Synthesis	Nutrient Synthesis - Preparation of a memorandum summarizing recommendations for FY16/17	Thomas Jabusch	04/30/16	Complete	A draft of the report will be prepared by April 30, 2016 so that the recommendations can be considered for funding in the FY16/17 Workplan. The final report will be completed by June 30, 2016.
Delta RMP (FY15/16)	Program Management	FY16/17 Annual Workplan and Budget	Philip Trowbridge	05/13/16	Complete	Draft in May 2016. Final by June 30, 2016.
Delta RMP (FY15/16)	Governance	Steering Committee Meeting #4 and Summary	Philip Trowbridge	06/30/16	Complete	
Delta RMP (FY15/16)	Governance	TAC Meeting #4 and Summary	Thomas Jabusch	06/30/16	Complete	
Delta RMP (FY15/16)	Quality Assurance	QAPP Update	Thomas Jabusch	06/30/16	Complete	The QAPP was revised to reflect the addition of mercury monitoring. QAPP was approved by SC in July 2016. State and SWAMP QAOs have re-confirmed their approval. All that remains to be done is to collect all signature, which is delayed due to summer vacation schedules.
Delta RMP (FY15/16)	Pathogens Study - Year 1	Data Management of Year 1 Pathogens Data	Amy Franz	07/31/16	Complete	Data from BioVir and Eurofins has been uploaded to SFEI's RDC database; it takes approximately 2 weeks for it to be loaded into CEDEN.
Delta RMP (FY15/16)	Pathogens Study - Year 1	Quality Assurance Report on Year 1 Pathogens Data	Don Yee	09/30/16	Complete	QAO report. The report is on the agenda for the 9/20/16 TAC meeting.
Delta RMP (FY15/16)	CUP Monitoring	Field Sampling Report for FY15/16 CUP Monitoring	Ila Shimabuku	09/30/16	Complete	On agenda for 9/20/16 TAC meeting
Delta RMP (FY15/16)	Nutrients Synthesis	Nutrient Synthesis - Convene 2-day workshop with expert panel in October 2016.	Thomas Jabusch	10/31/16	Complete	Workshop convened on 9/30/16.

Project	Primary	Deliverable	Assigned To	Due Date	Status	Comments
Delta RMP (FY15/16)	CUP Monitoring	Data Management of FY15/16 CUP Data	Amy Franz	12/31/16		Pesticide, toxicity, copper, carbon, SSC. Labs: USGS and UCD and a second pesticide lab to be named later. Data need to be uploaded to CEDEN by 2/1/17.
Delta RMP (FY15/16)	CUP Monitoring	Quality Assurance Report for FY15/16 CUP Monitoring	Don Yee	12/31/16		
Delta RMP (FY15/16)	Nutrients Synthesis	Nutrient Synthesis - Based on workshop, prepare draft report summarizing recommendations for on-going monitoring plan development. Draft 12/31/2016. Final 3/31/2017	Thomas Jabusch	12/31/16	Complete	
Delta RMP (FY15/16)	CUP Monitoring	Annual Monitoring Report for FY15/16 CUP Monitoring	Thomas Jabusch	02/28/17		Data need to be uploaded to CEDEN by 2/1/17.
Delta RMP (FY15/16)	Pathogens Study - Year 2	Sample Collection and Data Management of Year 2 Pathogens Data	Amy Franz	07/31/17		Data from BioVir and Eurofins. Formatting, transcribing field collection information, performing QA/QC review, and uploading field and analytical results to SFEI's RDC database and replicating to CEDEN.
Delta RMP (FY15/16)	Pathogens Study - Year 2	Quality Assurance Report on Year 2 Pathogens Data	Don Yee	07/31/17		QAO report. Funded from Data Management budget.
Delta RMP (FY16/17)	Governance	Steering Committee Meeting #1 and Summary	Meg Sedlak	07/20/16	Complete	SC draft minutes sent to group for comments.
Delta RMP (FY16/17)	Program Management	Completion of the MOA	Philip Trowbridge	09/01/16	Complete	MOA was completed and used as a bilateral agreement between ASC and Regional San.
Delta RMP (FY16/17)	Program Management	Proposal for Prop 1 Funding	Meg Sedlak	09/21/16	Complete	Prop 1 Hg proposal submitted.
Delta RMP (FY16/17)	Governance	TAC Meeting #1 and Summary	Philip Trowbridge	09/21/16	Complete	
Delta RMP (FY16/17)	Governance	Financial Subcommittee report and conference call	Philip Trowbridge	09/29/16	Complete	Report delivered on 9/26. Conference call held on 9/29.
Delta RMP (FY16/17)	Governance	Steering Committee Meeting #2 and Summary	Philip Trowbridge	10/18/16	Complete	
Delta RMP (FY16/17)	Nutrients Synthesis	7A1.2 Synthesis Report - compile additional data and information	Thomas Jabusch	10/31/16	Complete	Compiled all of the following: IEP-EMP data report (ASC) - done; DSP report (ASC) - done; Delta RMP Sensor Synthesis (USGS); WRTDS/GAMA results (USEPA/ASC)
Delta RMP (FY16/17)	Nutrients Synthesis	7B2.1 Modeling and Synthesis of Modeling Results - Convene nutrient subcommittee in-person meeting or conference call	Thomas Jabusch	11/16/16	Complete	Call completed on 11/08/16
Delta RMP (FY16/17)	Nutrients Synthesis	7B2.2 Modeling and Synthesis of Modeling Results - Select appropriate model and design experiments	Thomas Jabusch	11/30/16		By 11/30/16: Final design of analyses to be performed
Delta RMP (FY16/17)	Governance	TAC Meeting #2 and Summary	Thomas Jabusch	12/19/16		
Delta RMP (FY16/17)	Program Management	Updated Multi-Year Plan	Philip Trowbridge	12/30/16		
Delta RMP (FY16/17)	Governance	Financial Subcommittee report and conference call	Philip Trowbridge	01/05/17		Next report should add a column to separate deliverables/outcomes from outputs in the work completed summary. Also, prepare for rolling over left-over funds at the end of each fiscal year, starting 6/30/17.
Delta RMP (FY16/17)	Governance	Steering Committee Meeting #3 and Summary	Philip Trowbridge	01/26/17		

Project	Primary	Deliverable	Assigned To	Due Date	Status	Comments
Delta RMP (FY16/17)	Nutrients Synthesis	7A1.1 Synthesis Report - Additional data analyses	Thomas Jabusch	01/31/17		Downloaded most recent IEP-EMP data through FY15. Contacted EMP to inquire about availability of FY16 data. By 1/31/16: All analyses should be complete
Delta RMP (FY16/17)	Program Management	FY17/18 Annual Workplan and Budget	Philip Trowbridge	02/10/17		Early draft for Finance Subcommittee by 2/10/17. Draft for SC by 4/30/17. Final by 6/30/16.
Delta RMP (FY16/17)	Program Management	Updated Monitoring Design	Philip Trowbridge	02/15/17		
Delta RMP (FY16/17)	Nutrients Synthesis	7A1.3 Synthesis Report - Prepare synthesis report	Thomas Jabusch	02/28/17		By 2/28/16: Draft outline with example write-ups/graphs/maps to Nutrient Subcommittee/TAC; By 3/31/16: Comments due; By 5/31/17: Draft report to Nutrient Subcommittee/TAC; By 6/30/17: Comments due; By 7/31/17: Final technical report to SC.
Delta RMP (FY16/17)	Governance	TAC Meeting #3 and Summary	Thomas Jabusch	03/15/17		
Delta RMP (FY16/17)	Governance	Steering Committee Meeting #4 and Summary	Philip Trowbridge	04/12/17		
Delta RMP (FY16/17)	Nutrients Synthesis	7B2.3 Modeling and Synthesis of Modeling Results - Run simulations	Marianne Guerin	04/30/17		By 4/30/16: Final model simulation results and output
Delta RMP (FY16/17)	Nutrients Synthesis	7B2.4 Nutrients - Analyze and synthesize model output data	Thomas Jabusch	05/04/17		By 5/4/16: Draft outline to Nutrient Subcommittee/TAC; By
Delta RMP (FY16/17)	Nutrients Synthesis	7C3.1 Nutrients- Statistical Modeling	Thomas Jabusch	05/31/17		Held Nutrient subcommittee meeting/call (same meeting/call as in Task 2) on 11/8.16. The group decided to postpone this task. All subsequent deadlines are shown as "TBD". By TBD: All additional statistical modeling complete; By TBD: Draft outline to Nutrient Subcommittee/TAC; By TBD: Comments due; By 5/31/17: Draft report to Nutrient Subcommittee/TAC; By 6/30/17: Comments due; By 7/31/17: Final technical report to SC.
Delta RMP (FY16/17)	Governance	TAC Meeting #4 and Summary	Thomas Jabusch	06/14/17		
Delta RMP (FY16/17)	Quality Assurance	QAPP Update	Thomas Jabusch	06/14/17		
Delta RMP (FY16/17)	Communications	Technical Workshop / summary memorandum of findings	Philip Trowbridge	06/30/17		Purpose of workshop TBD
Delta RMP (FY16/17)	CUP Monitoring	6. Field Sampling Report for FY16/17 CUP Monitoring	Philip Trowbridge	09/29/17		
Delta RMP (FY16/17)	CUP Monitoring	6. Data Management of FY16/17 CUP Data	Amy Franz	12/31/17		
Delta RMP (FY16/17)	CUP Monitoring	6. Quality Assurance Report for FY16/17 CUP Monitoring	Don Yee	12/31/17		
Delta RMP (FY16/17)	CUP Monitoring	6. Permit Compliance Data for ILRP	Amy Franz	02/01/18		
Delta RMP (FY16/17)	CUP Monitoring	6. Annual Monitoring Report for FY16/17 CUP Monitoring	Thomas Jabusch	02/28/18		
Delta RMP (FY16/17)	Mercury	8. Mercury YR1 report summarizing fish and water analyses	Thomas Jabusch	12/03/18		

Delta RMP Action Items

Key to Status Colors:
Green indicates greater than 90 days until the deliverable is due.
Yellow indicates a deliverable is due within 90 days.
Red indicates a deliverable that is overdue.

	Primary	Meeting Date	Deliverable	Assigned To	Due Date	Status	Comments
1	SC Action Items 10/18/2016	10/18/16	Schedule call to discuss flowchart	Selina Cole	01/26/17		This group would include Regional Board staff (Adam Laputz), State Board staff (Greg Gearheart, Rich Breuer), USEPA (Debra Denton), and representatives of POTWs (Debbie Webster), stormwater (Karen Ashby), and agriculture (Bruce Houdesheldt as placeholder pending follow-up discussion within the group).
2	SC Action Items 10/18/2016	10/18/16	Work with the Coordinating Committee to establish when terms will start and end for SC members, TAC members, and TAC co-chairs.	Philip Trowbridge	01/26/17		Process memo prepared and presented to TAC on 12/13/16.
3	SC Action Items 10/18/2016	10/18/16	Schedule a SC agenda item to discuss whether the TAC should continue to have two appointed co-chairs	Philip Trowbridge	01/26/17		Process memo prepared and presented to TAC on 12/13/16.
4	SC Action Items 10/18/2016	10/18/16	Distribute Word version of the SC-approved Charter document to the TAC	Thomas Jabusch	10/21/16	Complete	
5	SC Action Items 10/18/2016	10/18/16	Send additional specific changes and edits to the charter to Phil Trowbridge	TAC members	11/18/16	Complete	Comments were received from CVCWA.
6	SC Action Items 10/18/2016	10/18/16	Bring Charter with additional edits to the SC for approval	Philip Trowbridge	01/26/17		
7	SC Action Items 10/18/2016	10/18/16	Develop a matrix that shows the intersect between the 3 major drivers (NRP, Pyrethroids TMDL, MeHg TMDL) and the Delta RMP assessment questions	Philip Trowbridge	01/26/17		
8	SC Action Items 10/18/2016	10/18/16	Look into “pooling” multiple settlements into one larger Supplemental Environmental Project	Patrick Morris	01/26/17		
9	SC Action Items 10/18/2016	10/18/16	Send comments on USGS report to Joe Domagalski	Steering Committee	11/01/16	Complete	Comment period expired without any comments received.
10	TAC Action Items from 9/20/2016	09/20/16	Send Nutrient Sensor Synthesis Report including reconciled comments to TAC and SC	Joe Domagalski	10/11/16	Complete	
11	TAC Action Items from 9/20/2016	09/20/16	Modify the slides for the proposed process for pesticide prioritization before including them in the Oct 18 SC/TAC meeting agenda package or sending them to the Pesticides Subcommittee	Stephen McCord	10/04/16	Complete	
12	TAC Action Items from 9/20/2016	09/20/16	Send Doodle poll for first Pesticides Subcommittee Meeting	Thomas Jabusch	09/22/16	Complete	
13	TAC Action Items from 9/20/2016	09/20/16	Add a cover page to the toxicity report that explains how it fits into the overall reporting plan	Thomas Jabusch	12/06/16	Complete	This update has been noted and will be completed when the FY15/16 CUP Report is formatted.
14	TAC Action Items from 9/20/2016	09/20/16	Send comments on management drivers table and Section 7B (TAC) of the approved Delta RMP Charter to Phil Trowbridge	TAC members	10/04/16	Complete	

	Primary	Meeting Date	Deliverable	Assigned To	Due Date	Status	Comments
15	TAC Action Items from 9/20/2016	09/20/16	Prepare slides about the TAC roles and responsibilities in the Charter and share them with the TAC for review before the October 18 meeting	Stephen McCord	10/17/16	Complete	
16	SC Action Items 07/20/2016	07/20/16	Send an invite to SC for January 26, 2017 meeting	Meg Sedlak	09/01/16	Complete	
17	SC Action Items 07/20/2016	07/20/16	Include page numbers in the agenda indicating location of agenda items, add blank pages between items in the agenda package.	Meg Sedlak	10/03/16	Complete	
18	SC Action Items 07/20/2016	07/20/16	Accept Charter track changes sent to SC and incorporate language modifications requested. Place final version in google drive under foundational documents.	Philip Trowbridge	08/17/16	Complete	
19	SC Action Items 07/20/2016	07/20/16	Send TAC the final version of the Charter before the 10/18/16 meeting.	Meg Sedlak	09/30/16	Complete	
20	SC Action Items 07/20/2016	07/20/16	ASC and Finance Subcommittee will meet to determine a way to provide the level of information requested. ASC will provide a cost estimate for any extra work associated with the increased reporting.	Meg Sedlak	10/03/16	Complete	This meeting took place immediately following the SC meeting. For future financial reports, ASC will use the same format as was developed for the Q2 report but also add the hours billed by each staff member for each task from the invoices.
21	SC Action Items 07/20/2016	07/20/16	Send out Management Driver table to SC and TAC	Meg Sedlak	09/30/16	Complete	
22	SC Action Items 07/20/2016	07/20/16	Add an agenda item to the October 18th Joint meeting agenda to discuss TAC comments on the Charter.	Meg Sedlak	09/30/16	Complete	
23	SC Action Items 07/20/2016	07/20/16	Table for TAC roster needs to be updated to reflect the composition indicated in the charter (e.g. resource agencies). Greg Gearheart and Jeff Stuart requested that they be added to the TAC mailing list as they seek to find TAC representatives.	Thomas Jabusch	09/30/16	Complete	
24	SC Action Items 07/20/2016	07/20/16	Develop a list of SEP projects that can be discussed at the MYP meeting.	Adam Laputz	09/30/16	Complete	
25	TAC Action Items from 6/14/2015	06/14/16	TAC needs to provide comments on QAPP by June 30th, 2016	TAC members	06/30/16	Complete	
26	TAC Action Items from 6/14/2016	06/14/16	ASC to confirm chlorophyll measurements conducted as part of FY16/17 Hg project are conducted using standardized procedures (e.g., SWAMP methods). TAC would like results to be comparable among other agencies.	Thomas Jabusch	07/01/16	Complete	
27	TAC Action Items from 6/14/2016	06/14/16	ASC to schedule meeting for the nutrient planning meeting (Day 1)	Thomas Jabusch	06/22/16	Complete	Doodle poll sent and possible dates identified.
28	TAC Action Items from 6/14/2016	06/14/16	Revise workshop description; send to nutrient subcommittee; send to TAC by July 1; and include in agenda package for SC meeting.	Thomas Jabusch	06/21/16	Complete	
29	TAC Action Items from 6/14/2016	06/14/16	For the FY16/17 nutrient synthesis task, Janis Cook requested that a clear explanation of EOF be included.	Thomas Jabusch	02/28/17		
30	TAC Action Items from 6/14/2016	06/14/16	TAC requested that minutes be more concise if possilbe	Thomas Jabusch	09/13/16	Complete	
31	TAC Action Items from 6/14/2016	06/14/16	Send out list of representatives on TAC and subcommittees	Thomas Jabusch	06/28/16	Complete	
32	TAC Action Items from 6/14/2016	06/14/16	Prepare a table of changes to the QAPP and send out the revised QAPP to TAC for approval by the end of the month. Indicate revision number (Rev 2).	Thomas Jabusch	06/21/16	Complete	

	Primary	Meeting Date	Deliverable	Assigned To	Due Date	Status	Comments
33	TAC Action Items from 6/14/2016	06/14/16	Co-chair report to SC should be prepared by 6/30/2016 and sent to TAC for comment. TAC comments need to be received by July 6th so the report can appear in SC agenda package.	Stephen McCord	06/22/16	Complete	
34	TAC Action Items from 6/14/2016	06/14/16	Post pdfs of presentations from June 14 meeting on TAC google drive	Thomas Jabusch	06/20/16	Complete	
35	SC Action Items 04/25/2016	04/25/16	SC members will provide ASC with comments on the Charter	Group	05/05/16	Complete	
36	SC Action Items 04/25/2016	04/25/16	Add an agenda item for the July SC meeting to discuss fees for FY17/18.	Meg Sedlak	07/20/16	Complete	
37	SC Action Items 04/25/2016	04/25/16	Work with Linda Dorn and Dave Tamayo to review the MOA to determine how they can adapt it to be a contract template for use by their respective organizations.	Philip Trowbridge	06/30/16	Complete	Sacramento County will extend the existing contract. Regional San will develop a multi-year MOU.
38	SC Action Items 04/25/2016	04/25/16	Val Connor will organize a Finance Subcommittee (members include Dalia Fadh, Mike Wackman, Linda Dorn, and Adam Laputz, only 3 needed for quorum). The Finance Committee will address questions such as: is the program as cost-efficient as possible?; what format and information is needed for the financial memorandums?; Are there places where the budget assumptions are flawed?; is the program on the right track financially?	Val Connor	07/20/16	Complete	
39	SC Action Items 04/25/2016	04/25/16	Incorporate edits from Debbie Webster and Linda Dorn on the December SC meeting minutes and then distribute the draft minutes back to the SC for review.	Thomas Jabusch	05/05/16	Complete	
40	SC Action Items 04/25/2016	04/25/16	Prepare a short summary of Delta RMP preliminary monitoring results/activities for the July SC agenda package.	Stephen McCord	07/20/16	Complete	
41	SC Action Items 04/25/2016	04/25/16	Revise the FY16/17 Detailed Workplan as follows: Table 1 to reflect the changes in FY16/17 revenue approved at the 4/25/16 meeting; and the last paragraph of the pathogens study description to reflect the allocation of funding for pathogens trigger studies to the FY15/16 budget.	Meg Sedlak	06/01/16	Complete	
42	SC Action Items 04/25/2016	04/25/16	Revise the Charter with edits from SC members (at the meeting and in writing) particularly regarding the Coordination Committee, Finance Committee, Revenue Committee, use of contingency funds, adding/changing members, financial management, and minimum balance for Reserve funds.	Meg Sedlak	07/20/16	Complete	
43	SC Action Items 04/25/2016	04/25/16	Report back to the SC in July as to whether additional funds, besides the extra $20,000 added to the FY15/16 budget, are needed for pathogens trigger studies.	Brian Lauerson	07/20/16	Complete	According to LWA, additional funds are not needed at this time.
44	SC Action Items 04/25/2016	04/25/16	Send meeting invitations for the next SC meetings on July 20, 2016 and October 18, 2016.	Thomas Jabusch	05/05/16	Complete	
45	SC Action Items 04/25/2016	04/25/16	Add an agenda item to July SC meeting regarding the Hyallela workshop being organized by Regional Board.	Meg Sedlak	07/20/16	Complete	
46	TAC Action Items from 3/30/15	03/30/16	Confirm that the Delta RMP website is up to date	Selina Cole	06/14/16	Complete	
47	TAC Action Items from 3/30/15	03/30/16	Send out to the TAC the consensus-based option for FY16/17 studies	Meg Sedlak	04/01/16	Complete	
48	TAC Action Items from 3/30/15	03/30/16	Revise scope of work for nutrient study for FY16/17 and send back to TAC	Thomas Jabusch	04/14/16	Complete	
49	TAC Action Items from 3/30/15	03/30/16	Trouble-shoot PDF printing problems at Regional San (Agenda package does not print correctly)	Meg	04/14/16	Complete	

	Primary	Meeting Date	Deliverable	Assigned To	Due Date	Status	Comments
50	SC Action Items from 12/18/15	12/18/15	Update table of upcoming management decisions and send back out to the SC →Delete Central Valley Diuron TMDL from table →Check status of State Water Board's proposed NNE policy for inland waters and updated as necessary →Change NNE-Delta to Delta Nutrient Research Plan	Meg Sedlak	04/25/16	Complete	
51	SC Action Items from 12/18/15	12/18/15	Respond to the SC's questions regarding how "risk potential" would be determined for prioritizing target current use pesticides for monitoring	TAC members	04/25/16	Complete	On March TAC agenda
52	SC Action Items from 12/18/15	12/18/15	Develop a Cost Allocation Schedule for SC approval that divides the $948,000 revenue target for FY16/17 between the Participant Groups	Meg Sedlak	04/25/16	Complete	Prepared and discussed with SC co-chairs
53	SC Action Items from 12/18/15	12/18/15	Recruit an appropriate representative to fill the new stormwater seat on the SC	Stephanie Hiestand	04/25/16	Complete	Brendan Ferry has agreed to serve
54	SC Action Items from 12/18/15	12/18/15	Finalize meeting summary from December 18, 2015	Thomas Jabusch	04/25/16	Complete	
55	SC Action Items from 12/18/15	12/18/15	Arrange a call between Greg Gearheart and ASC data management staff regarding State Board data management policies, CD3, and the Estuaries Portal	Meg Sedlak	04/25/16	Complete	
56	SC Action Items from 12/18/15	12/18/15	Follow up with TMDL staff about federal requirements so that compliance data issues for Vernalis compliance point can be resolved	Adam Laputz	04/25/16	Complete	RB staff coordinated with coalitions and labs re pesticide data.
57	SC Action Items from 12/18/15	12/18/15	Arrange a call between Adam Laputz, Greg Gearhart, and Tom Mumley to discuss coordination between the RMPs.	Meg Sedlak	04/25/16	Complete	
58	SC Action Items from 12/18/15	12/18/15	Discuss whether there is any value in testing bivalve samples collected by the Bay RMP for parameters of interest to the Delta RMP	TAC members	04/25/16	Complete	This task was deleted because it was not deemed relevant after a conference call between RB2 and RB5.
59	SC Action Items from 12/18/15	12/18/15	Schedule a call of the External Review Planning Subcommittee in January. Participants: Linda Dorn, Adam Laputz, Dave Tamayo, Val Connor, David Cory, Gregg Erickson, Sam Harader, Stephen McCord, and Joe Domagalski.	Philip Trowbridge	12/31/15	Complete	
60	SC Action Items from 12/18/15	12/18/15	Send doodle poll for an alternate date, set next meeting date, reserve room, and send invitations to the SC	Meg Sedlak	01/15/16	Complete	
61	SC Action Items 12/18/15	12/18/15	Patrick and Selina to prepare informational factsheet for Stormwater Phase II reps explaining the value of the program.	Patrick Morris	08/01/16	Complete	Fact sheet prepared by LWA.