Draft Guidance for Management Questions 2 and 3

The following material provides draft guidance for the design and implementation of monitoring efforts to address Management Questions 2 and 3. Subsequent material will be developed to address Management Questions 1, 4, and 5. It has not yet been decided which portions of this guidance will be contained in the MRP itself or in a companion guidance document.

The Management Questions are:

QUESTION No.1: Are conditions in waters of the State that receive agricultural drainage or are affected by other irrigated agriculture activities within Coalition Group boundaries protective, or likely to be protective, of beneficial uses?

QUESTION No.2: What is the magnitude and extent of current or potential water quality problems in waters of the State that receive agricultural drainage or are affected by other irrigated agriculture activities within Coalition Group boundaries, as determined using monitoring information?

QUESTION No.3: What are the contributing source(s) from irrigated agriculture to the water quality problems in waters of the State that receive agricultural drainage or are affected by other irrigated agriculture activities within Coalition Group boundaries?

QUESTION No.4: What are the management practices that are being implemented to reduce the impacts of irrigated agriculture on waters of the State within the Coalition Group boundaries and where are they being applied?

QUESTION No.5: Are conditions in waters of the State within Coalition Group boundaries getting better or worse through implementation of management practices?

Management Question 2: What is the magnitude and extent of water quality problems?

[The following presumes that information is available from assessment studies conducted under Management Question 1. Tables 1 and 2 illustrate a suggested framework for evaluating and ranking assessment monitoring results.]

This question corresponds to the question on the flowchart in Figure 1 related to the relative priorities of the impacted area. This information is necessary for assessing the relative severity or importance of different problems, ranking and targeting source identification efforts, and planning management actions such as source control or reduction efforts. It is important to stress that any such ranking is not meant to remove or replace regulatory requirements for the development of management plans or other actions. Rather, answers to Management Question 2 are intended to assist in developing timelines, scoping source identification studies and BMP implementation, and otherwise matching the scale and timing of monitoring and management actions to the severity of water quality problems.

In most cases, assessment monitoring designs to answer Management Question 1 will include only representative sites (defined in the guidance for Management Question 1 as downstream integrator sites, stratified randomized designs, or upstream sites specifically allocated to different cropping conditions). Thus, once a receiving water problem is found, data from these sites will most often be insufficient to characterize the full extent and magnitude of the problem and additional studies will normally be called for. This is because information about the severity of a problem is useful for prioritization before proceeding with some corrective action. Impacts that cause more extreme effects, cover large areas, or extend over long periods of time typically require more immediate attention. Impacts that cause less extreme, more localized, and or more sporadic effects can be dealt with on a longer timeline and/or with less intensive efforts.

In some cases, the extent, magnitude, and/or severity of a receiving water problem will be immediately apparent from the assessment monitoring data obtained under Management Question 1. In such cases, for example, high levels of toxicity in multiple test species, especially in areas of biological significance, or obvious kills of resident species in the receiving water that extend over several contiguous monitoring sites, source identification work should begin promptly. In addition, lower levels of toxicity that persist at the same sampling sites over multiple monitoring events should also be a high priority for source identification work.

In other cases, broader sampling to assess spatial and temporal extent will be required, usually as special studies that, as opposed to routine monitoring, have explicit starting and ending dates. However, it may be necessary for such studies to extend over multiple years to adequately capture signals from pesticides that are only intermittently used. Thus, magnitude and extent studies focused on different types of impacts or constituents may require different timeframes depending on the characteristics of the problem being focused on. In some situations, where the problem is complex and/or covers a large area, addressing Management Question 2 will involve regional studies that require the cooperative efforts of several entities. It may be useful, especially during initial monitoring for magnitude and extent, to adjust data quality objectives to accommodate the rapid collection of larger amounts of data. For example, test kits and other methods can provide useful indications of the presence and relative magnitude of contamination that could help to focus further studies, even without achieving the lower levels of detection required for other types of monitoring.

In addition to the spatial and temporal extent of a receiving water problem, additional studies may help to characterize the relative severity of the problem. Toxicity tests at different dilutions may better quantify the degree of toxicity, while toxicity tests on different test organisms may provide greater insight into the breadth of toxic impacts. Body burden data from animals exposed to water and/or sediment from impacted sites may indicate whether and to what degree contaminants are being accumulated. Similarly, laboratory bioaccumulation experiments, chemical analysis of sediment pore water, and pore water toxicity tests can furnish insight into the possible mechanisms of bioaccumulation.

Finally, impacts may be judged more severe or significant if they directly affect more highly valued resources. For example, impacts on species listed as endangered or threatened under the Endangered Species Act (ESA), on highly valued recreational or commercial species, or on species with key ecological roles are likely to be considered more important, and higher priorities, than impacts in areas or on species without these concerns.

In summary, monitoring and/or data analysis to establish the extent and magnitude of receiving water impacts may include:

- The routine monitoring sites(s) in the area of interest

- Estimates of the relative magnitude of toxicity or chemical exceedance, which may require additional toxicity tests at different dilutions and/or with different test organisms
- Measures of the spatial extent of actual impact in receiving waters, which may require an array of upstream / downstream samples, regularly spaced grids, or random arrays
- Measures of the temporal persistence or pattern of receiving water impact, such as between dry and wet weather, or different crop cycles, which may require sampling over multiple seasons or years
- Field and/or laboratory studies to characterize the potential for bioaccumulation and the pathways this might occur
- Documentation of whether impacts overlap or affect listed species, highly valued recreational or commercial species, or species with key ecological roles. Such documentation may necessarily be less quantitative than that for the previous items in this list

Management Question 3: What are the contributing sources from agriculture?

This question corresponds to the portions of the flowchart in Figure 1 related to the identification of sources and the prioritization of inputs. Once monitoring or other studies demonstrate that there is a current impact to receiving waters (Management Question 1) and describe the problem's extent and magnitude (Management Question 2), decisions about any management responses depend on information about the source(s) of the problem. Gathering this information can be envisioned as a two-step process. The purpose of this two-step process is to prioritize more detailed source identification efforts at only those problems for which agricultural discharges are a significant contributor.

The first step is an estimation of the relative importance of the agricultural contribution to the receiving water problem. Based on this estimate, source identification will proceed either as a regional collaborative effort that involves other sources (e.g., urban runoff) or as an independent effort conducted by one or more of the agricultural coalitions.

Are agricultural sources significant?

It is important to clarify that defining the overall contribution of agricultural discharges is not intended in any way to diminish or replace regulatory requirements to reduce contaminant inputs to the maximum extent practicable. It is rather intended to help determine when additional, more detailed and extensive, source identification efforts should be conducted independently by a coalition or its members, with the goal of ensuring that the full burden of source identification work not be shifted to the agricultural sector where action by them would not contribute significantly to solving the larger problem.

The decision-making framework (Figure 1) assumes that, if agricultural discharges contribute only a very small percentage to the receiving water problem, then there would be no need for a coalition or its members to **independently** carry out substantial source identification efforts in addition to those activities usually carried out under the waiver. (In such cases, regional collaborative efforts involving other sources should be implemented.) This first-cut estimation, therefore, requires only minimal resolution appropriate to a scoping study and including at least a rough estimate of the identity and magnitude of the non-agricultural contributions.

In many situations, aggregate estimates of the non-agricultural contribution, rather than source-by-source estimates, may be adequate and may already be available from previous characterization and/or monitoring studies. While a variety of methods may be suited to deriving this first-cut estimation, they should include all readily available quantitative information, use at least simple mass-balance estimates or models, clearly state all underlying assumptions and/or algorithms, and quantify uncertainties to the greatest extent possible, especially where the agricultural contribution is near the 5 – 10% threshold. For example, if the agricultural contribution is small (i.e., less than 5% of the cumulative load), there would probably be no need to refine the estimate any further because large variability does not change the answer to the question; agricultural discharge is still a small contribution. In contrast, if the agricultural contribution is 10% +/- 15%, there would be a need to refine the estimate to determine whether and to what extent to proceed to the more detailed source identification work. Thus, monitoring designs for this issue might proceed through multiple iterations to develop:

- Description of all potential sources of inputs to the receiving water
- Rough estimates of the relative magnitude of loads from all sources
- Rough estimate of the proportional contribution of agricultural discharges to total loads

It is important to emphasize that this 5 – 10% threshold is intended as a guideline only in situations where the source of a receiving water problem is not known. Where the source(s) of such problems are known, then relevant permit conditions related to source reduction and cleanup would come into play. As emphasized above, this threshold is not intended to diminish or replace permit requirements to reduce contaminant inputs to the maximum extent practicable or other regulations or legal requirements.

What are the sources from agriculture?

Only if agricultural discharges are found to contribute significantly (i.e., more than 5 – 10% of loads) to receiving water problems would a coalition or its members be required to take the lead on conducting further source identification studies at greater resolution. Such studies would be intended to provide more detailed information about the nature, location, and quantity of inputs to the higher-priority receiving waters identified in Management Question 2. This information can help refine receiving water monitoring, improve fundamental understanding of agricultural discharge contamination processes, and help guide management actions intended to reduce sources and their attendant impacts. It can also help focus trend monitoring under Management Question 5 on those parameters that are potentially most responsive to agricultural source reduction efforts.

In the context of Management Question 3, “sources” can refer to two types of sources. The first is identification of the specific chemical(s) responsible for observed impacts, while the second is identification of the specific locations or agricultural practices responsible for releasing, mobilizing, or concentrating such chemicals.

The identification of specific pollutants responsible for impacts may involve data mining, statistical, biological, and/or chemical methods, such as:

- Investigation of available data from pesticide use reports, flow and discharge patterns, crop types, and specific agricultural practices, combined with chemical concentration data, to pinpoint the most likely cause(s) of impact
- Statistical analysis of the strength of correlations between individual chemicals and biological endpoints (e.g., toxicity, benthic community condition)

- Gradient analysis that uses samples taken at various distances from an impact to examine patterns in chemical concentrations and biological responses. The concentrations of presumed causative agents should decrease as biological effects decrease
- Toxicity Identification Evaluation (TIE), a toxicological method for determining the cause of impairments. Water or sediment samples are manipulated chemically or physically to remove classes of chemicals or render them biologically unavailable. Following the manipulations, biological tests are performed to determine if toxicity has been removed. In general, TIEs are most effective where strong toxicity signals have been observed
- Bioavailability studies to determine if chemical contaminants are present but not biologically available to cause toxicity or other biological effects. For sediments, chemical and toxicological measurements of pore water can determine the availability of sediment contaminants. Metal compounds may be naturally bound up in the sediment and rendered unavailable by the presence of sulfides. Measurement of acid volatile sulfides and simultaneously extracted metals analysis can be conducted to determine if sufficient sulfides are present to bind the observed metals. Similarly, organic compounds can be tightly bound to sediments. Solid phase microextraction (SPME) or laboratory desorption experiments can be used to identify which organics are available to animals

Source tracking to identify the likely location(s) and/or activities identified contaminants are coming from typically follows either a systematic or branching design template. In the systematic design template, all inputs, or a representative sample of all inputs, are sampled and quantified or ranked in terms of their relative contribution. In the branching design template, a contamination signal is followed upstream, with a decision being made at each branch point about which branch to continue following upstream, based on the strength of the signal in each tributary input. However, there are aspects of agricultural practices and discharges that make it impractical to always apply these standard approaches to source identification. [further explanation and description of alternatives].

There are several categories of sources likely to be encountered, each of which requires a somewhat different approach to source identification.

Crop-specific pesticides. Examples of constituents in this category include chlorpyrifos used for dormant spraying on almond orchards in March / April (??) and on alfalfa in April / May (??). Appropriate steps for this category of inputs include:

- Contact the agricultural commissioner to request pesticide use reports for a specific crop(s) and/or a specific period. There may or may not be a record of use for the pesticide being investigated. It is also important to recognize that the use reports are only a first step, are not all inclusive, and do not account for discharge patterns that have a large effect on the potential for downstream impact
- Contact growers who grow the crop or use the pesticide to verify use patterns and discuss the problem and ways to address it. For example, most of the chlorpyrifos use is on a couple of specific crops within a well-defined time period, e.g., dormant spray and alfalfa
- Verify that people comply with the regulatory requirements from DPR (in terms of applications)
- Determine the discharge pattern(s) for the period(s) of interest. Note that discharge can change daily and that it can be hard to pin sources down to individual growers.
- Surveys may be needed to help interpret the implications of the discharge patterns
- Identify who has used it (if possible) and contact the specific growers. However, it may only be possible to identify users/sources to categorical levels

Broadly distributed, non-pesticide, particle-bound constituents such as metals. Examples of constituents in this category include lead, XXX, YYY. Appropriate steps for this category of inputs include:

- Determine whether the constituent is a high priority constituent (see above)
- Use a desktop audit, combined with toxicity testing (see next bullet) to determine which beneficial uses are being impacted. Prioritize attention on where beneficial uses are being impacted
- Test the assumption that the majority of the constituent is particle bound, by obtaining a sample using a pole to prevent disrupting the sediments in the creek bottom and filter the sample. Analyses for total and dissolved fractions would allow you to determine if the lead is sediment bound. However, we know that the partitioning of metals is complicated and that metals move back and forth from bound to dissolved phases
- Based on the assumption that most of the constituent is in the particulate phase, sediment toxicity tests, combined with sediment TIEs, could help partition the sediment-related toxicity into higher- and lower-priority components. For example, if the majority of toxicity is due to pyrethroids, then this could provide a basis for identifying the non-agricultural constituent as a lower priority input
- Determine whether the sediment-bound constituent is entering the system and moving downstream through the system or is simply being resuspended by high flows from sediments already in the system
- If the constituent is entering the system, figure out where this is coming from, perhaps with isotope studies, but this would be very costly
- Determine if the constituent stems from legacy applications. If so, there should be an "early out" in the process, unless erosion control practices useful for other constituents would also be useful for the constituent

Legacy pesticides. Examples of constituents in this category include DDT/DDE, XXX, and YYY. Appropriate steps for this category of inputs include:

- Assume it is not currently being applied, since it is a legacy compound
- Since it appears everywhere and does not appear to have highly localized sources, use gradient analysis to test this assumption
- If the constituent is most commonly associated with sediments, improve understanding of how the constituent is mobilized and moves through the system, e.g., whether it is moving from fields to channels and how this happens. For example, flooding lands to drive salt further down in the soil brings in water with sediment loads that include DDT/DDE that remains on the fields after they dry out
- Conduct simple mass balance modeling, as have been done for mercury in the San Francisco Bay area, to set some rough boundary conditions on the size of the problem and the potential for addressing it
- Sediment control may be the best option to address this parameter and this provides an opportunity to deal at the same time with other sediment-related issues. Solutions should look at the entire drainage system, not just at the level of individual fields

Valley-wide constituents from natural sources. Examples of constituents in this category include salinity, XXX, and YYY. Appropriate steps for this category of inputs include:

- Evaluate existing information on sources and distribution

- Estimate incremental change due to agriculture with a straightforward comparison of input vs. output levels
- Evaluate the priority level

Secondary or cumulative effects. Indicators in this category are not directly discharged by agriculture but instead are indirect or cumulative effects of agricultural activities. Examples of constituents in this category include dissolved oxygen, XXX, and YYY. Appropriate steps for this category of indicators include:

- Document spatial and/or temporal patterns that may affect the measurement of magnitude, extent, and trends
- Develop causal model that is more relevant than the usual upstream – downstream source identification model
- Identify precursors or causal inputs and determine if these should be measured
- Develop "source" identification measurement plan based on the above

Prioritizing source identification efforts

Criteria for further prioritizing source identification work could include the following factors: Refer to Table 3

- The severity of the problem, for example the degree of toxicity [use quantitative toxicity metric based on persistence over time, amount of toxicity, breadth across multiple test organisms?]
- The type of pollutant(s) involved (e.g., highly toxic pesticides vs. nutrients, pollutants with numeric Basin Plan objectives vs. those without such objectives)
- The potential for human health risk
- The potential for aquatic health risk
- Whether listed species, highly valued recreational or commercial species, or species filling key ecological roles are impacted or at risk of impact
- Whether the constituent is applied by agriculture
- Whether the constituent is mobilized or concentrated by agriculture
- Whether the constituent is a legacy pollutant
- Whether the problem occurs during dry and/or wet weather, since dry weather problems may be more easily dealt with
- Regulations and other legal mechanisms that require source identification and/or control
- Stakeholder involvement such as watershed group planning priorities

The wide variety of specific situations likely to be encountered makes it infeasible to recommend a standard study design for Management Question 3. However, in general, monitoring and/or data analysis to estimate the potential agricultural contribution to a receiving water problem could include:

- Validated expert judgment
- Visual reconnaissance and observation
- Land use modeling
- Mass balance modeling
- Calculations of estimated toxicity to assess whether observed levels are high enough to be likely contributors to toxicity

- TIEs to determine whether toxicity is due to the class of constituents of concern (e.g., metals vs. pyrethroids)
- Empirical tributary monitoring
- The use of unique and/or conservative tracers
- Evaluation of existing data, particularly comparisons of contrasting times and/or places

Management Question 4: What are the management practices used to reduce impacts?

[To be completed. Related to elements in flowchart (Figure 1) that focus on whether BMPs are possible and on which ones are being implemented.]

Discussion notes:

There are three general levels of BMP: outreach and education; better housekeeping practices such as pesticide application and storage; structural BMPs such as settling basins and other runoff/erosion control devices.

Some criteria for addressing BMPs might include:

- Does the BMP address the problem?
- BMPs should be based on the body of knowledge of what we know about what is already being done to address this problem, with new efforts incremental to, rather than duplicative of, existing efforts
- BMP options should start with the less expensive, easiest methods to implement and progress to the more expensive and complicated methods
- Cost and efficiency should be compared with the urgency and severity of the issue
- Apply the most appropriate criteria for implementing BMPs (i.e. Identify whether toxicity events are caused by agriculture) and include efforts to improve information about sources as needed

Management Question 5: Are conditions getting better or worse?

[To be completed. Related to elements in flowchart (Figure 1) that focus on whether targets are being met.]

Discussion notes:

Targets specific to each receiving water problem and/or BMP should be defined. These should be as quantitative as possible and as specific as possible in terms of location and time period. Targets can include water quality parameters, levels of effort, degree of use of particular practices, etc. However, targets should ultimately be defined in terms of measures of water quality and/or related beneficial uses.

Monitoring should be based on a design appropriate to the type of target being assessed. Types of designs to be considered include:

- Surveys of agricultural practices
- Measurements immediately downstream of representative sources
- Experimental designs that include both control and source sites, measured both before and after the source control “treatment” has been applied

Table 1. A decision framework for interpreting assessment results and prioritizing source identification. Possible conclusions and actions/decisions are intended as general guidance, dependent on the specific monitoring results found and the actual relationships among chemistry, toxicity, and benthic data. Benthic component probably not relevant to most ag sites and should be deleted?

	Chemistry	Toxicity	Benthic Alteration	Example Conclusions	Example Actions or Decisions
1.	Persistent exceedance of water quality objectives	Evidence of toxicity	Indications of alteration	Strong evidence of pollution-induced degradation	Toxicity tests at higher dilutions to better quantify toxicity Use magnitude, breadth, and persistence of toxicity to further prioritize Use TIE to identify contaminants of concern, based on TIE metric Initiate source identification as a high priority
2.	No persistent exceedances of water quality objectives	No evidence of toxicity	No indications of alteration	No evidence of current pollution-induced degradation Potentially harmful pollutants not yet concentrated enough to cause visible impact	No immediate action necessary Conduct periodic broad scans for new and/or potentially harmful pollutants
3.	Persistent exceedance of water quality objectives	No evidence of toxicity	No indications of alteration	Contaminants are not bioavailable Test organisms not sensitive to problem pollutants	TIE would not provide useful information with no evidence of toxicity Continue monitoring for toxic and benthic impacts Consider whether different or additional test organisms should be evaluated Initiate source identification (i.e., location) as a medium priority
4.	No persistent exceedances of water quality objectives	Evidence of toxicity	No indications of alteration	Unmeasured contaminant(s) or conditions have the potential to cause degradation Pollutant causing toxicity at very low levels Synergistic effects of multiple chemicals at low levels causing toxicity	Recheck chemical analyses and evaluate detection limits relative to reported toxic levels Use magnitude, breadth, and persistence of toxicity to further prioritize Consider additional advanced chemical analyses Toxicity tests at higher dilutions to better quantify toxicity Use TIE to identify contaminants of concern, based on TIE metric Initiate source identification (i.e. type of pollutant) as a medium priority

	Chemistry	Toxicity	Benthic Alteration	Example Conclusions	Example Actions or Decisions
5.	No persistent exceedances of water quality objectives	No evidence of toxicity	Indications of alteration	Alteration may be due to physical impacts, not toxic contamination Test organisms not sensitive to problem pollutants Synergistic effects of multiple chemicals at low levels causing toxicity	No action necessary due to toxic chemicals Initiate upstream source identification (for physical sources) as a high priority Consider whether different or additional test organisms should be evaluated
6.	Persistent exceedance of water quality objectives	Evidence of toxicity	No indications of alteration	Toxic contaminants are bioavailable, but in situ effects are not demonstrable Benthic analysis not sensitive enough to detect impact Potentially harmful pollutants not yet concentrated enough to change community	Determine if chemical and toxicity tests indicate persistent degradation Recheck benthic analyses; consider additional data analyses Toxicity tests at higher dilutions to better quantify toxicity Use magnitude, breadth, and persistence of toxicity to further prioritize If recheck indicates benthic alteration, perform TIE to identify contaminants of concern, based on TIE metric Initiate upstream source identification as a high priority If recheck shows no effect, use TIE to identify contaminants of concern, based on TIE metric Initiate upstream source identification as a medium priority
7.	No persistent exceedances of water quality objectives	Evidence of toxicity	Indications of alteration	Unmeasured toxic contaminants are causing degradation Pollutant causing toxicity at very low levels Synergistic effects of multiple chemicals at low levels causing toxicity Benthic impact due to habitat disturbance, not toxicity	Recheck chemical analyses and consider additional advanced analyses Toxicity tests at higher dilutions to better quantify toxicity Use magnitude, breadth, and persistence of toxicity to further prioritize Use TIE to identify contaminants of concern, based on TIE metric Initiate upstream source identification as a high priority Consider potential role of physical habitat disturbance

	Chemistry	Toxicity	Benthic Alteration	Example Conclusions	Example Actions or Decisions
8.	Exceedance of water quality objectives	No evidence of toxicity	Indications of alteration	Test organisms not sensitive to problem pollutants Benthic impact due to habitat disturbance, not toxicity	TIE would not provide useful information with no evidence of toxicity Initiate upstream source identification as a high priority Consider whether different or additional test organisms should be evaluated Consider potential role of physical habitat disturbance Initiate source identification as a medium priority

Table 2. Definitions of the thresholds for action in Table 1, the Triad interpretation framework, designed to initiate further adaptive studies to identify potential sources of impact. Benthic component probably not relevant to most ag sites and should be deleted?

Possible prioritization threshold in Table 1	Definition of threshold
Persistent exceedance of water quality objectives	Exceedance of relevant Basin Plan or ILP triggers (in Basin Plan by reference) by 20% for 3 sampling periods [We need a way to rank ALL exceedances when more than one occurs within a three year period]
Evidence of toxicity	High score, in relation to other stations, on metric that combines magnitude and persistence of toxicity observed over an entire year (see Appendix 5: TIE Metric)
Evidence of benthic alteration	Index score that indicates substantially degraded community

Table 3 Summary of source identification priorities, based on combinations of the chemical, toxicity, and benthic components of the triad approach. "Yes" and "No" refer to whether or not data from each component exceeded the triggers described in Table B. Benthic component probably not relevant to most ag sites and should be deleted?

Table A Row	Triad Component	Yes	No	Source ID Priority
1	chemistry	X		
	toxicity	X		
	benthos	X		High
2	chemistry		X	
	toxicity		X	
	benthos		X	None
3	chemistry	X		
	toxicity		X	
	benthos		X	Medium[1]
4	chemistry		X	
	toxicity	X		
	benthos		X	Medium
5	chemistry		X	
	toxicity		X	
	benthos	X		High (for physical components)
6	chemistry	X		
	toxicity	X		
	benthos		X	Medium
7	chemistry		X	
	toxicity	X		
	benthos	X		High
8	chemistry	X		
	toxicity		X	
	benthos	X		High

[1] If further testing indicates appropriate and sensitive enough toxicity tests were used and analytical results suggest pollutant is not bioavailable.

Figure 1. Flow chart of monitoring and evaluation steps focused primarily on source identification efforts.