Review of San Diego County MS4 Monitoring Program

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Prepared for: San Diego Regional Water Quality Control Board
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Task Overview

The San Diego Regional Water Quality Control Board (SDRWQCB) tasked Tetra Tech, Inc., (Tetra Tech) with the following:

1. Review the San Diego County Copermittees' existing monitoring program and proposed changes (Copermittee Monitoring Program) as provided in the Report of Waste Discharge (ROWD) for comparison with the recommendations in the Model Monitoring Program for Municipal Separate Storm Sewer Systems in Southern California (Model Monitoring Program, or MMP). Specifically, the ROWD monitoring elements were to be assessed to determine how well they answer the five core management questions and how closely they match the specific monitoring program design recommendations presented by the MMP. The analysis was also to determine if the proposed monitoring information is sufficient and defensible statistically.

   As a component of this analysis, Tetra Tech was specifically asked to respond to the following questions:

   - How will reduction in monitoring frequency from monitoring three wet-weather events every year to monitoring two wet-weather events every other year affect the ability to use the data to make statistically sound conclusions and to identify significant differences between watersheds or years?

   - How likely is it that the Copermittees' proposed Temporary Watershed Assessment Stations will provide useful data that can be used to make statistically sound conclusions, given the limited scope of the monitoring proposed for these stations? Are the proposed locations of the TWAS and the rationale for those locations adequate to answer the MMP core management questions they are designed to answer?

2. If appropriate, and in coordination with the SDRWQCB, identify a suite of recommendations that could improve the Copermittees' proposed monitoring program but were not specifically included in the ROWD. As part of this effort, Tetra Tech was also to review the Copermittees' recently completed Baseline Long-Term Effectiveness Assessment, San Diego Stormwater Copermittees Jurisdictional Urban Runoff Management Program (LTE) report to identify all interrelated recommendations. All recommendations identified were to be designed to ensure consistency of the Copermittees' monitoring program with the MMP.

This report presents a review and evaluation of the San Diego County Copermittees' monitoring program, both in its current state (CSD 2005a) and relative to a series of recommended changes (CSD 2005b). The report is organized into four sections: (1) brief overview of the MMP, (2) brief overview of the Copermittees' current monitoring program and proposed changes, (3) broad recommendations for the Copermittee Monitoring Program, and (4) detailed analysis of current and proposed monitoring program adherence to the MMP. Summarized findings are presented in both Sections 3 and 4; the detailed statistical analysis of the two primary questions posed by the SDRWQCB is presented in Appendix A.

The following materials were provided to support these tasks:

- San Diego Municipal Stormwater Copermittees Report of Waste Discharge, monitoring sections (August 2005)
- 2003–2004 Urban Runoff Monitoring Final Report (January 2005)
- 2003–2004 Coastal Storm Drain and Lagoon Monitoring Annual Report
- Model Municipal Program for Municipal Separate Storm Sewer Systems in Southern California, Technical Report No. 419 (August 2004)
- Baseline Long-Term Effectiveness Assessment, San Diego Stormwater Copermittees Jurisdictional Urban Runoff Management Program (Weston Solutions, Inc., et al. 2005)
- Draft 13267 Order (Investigation Order No. R9-2005-0216), which outlines proposed Copermittee monitoring requirements for impaired lagoons and adjacent beaches

1. Overview of Model Monitoring Program

The Model Monitoring Program was developed by the Stormwater Modeling Coalition (SMC 2004) and is designed to address five fundamental management questions, with the goal of achieving a basic degree of comparability across southern California monitoring programs while maintaining individual programs' ability to address local and site-specific concerns. The five core management questions are as follows:

1. Are conditions in receiving waters protective, or likely to be protective, of beneficial uses?
2. What are the extent and magnitude of the potential receiving water problems?
3. What is the relative urban runoff contribution to the receiving water problem(s)?
4. What are the sources to urban runoff that contribute to receiving water problem(s)?
5. Are conditions in receiving waters getting better or worse?

These questions define both a logical sequence of monitoring steps and steps in the evolution of an effective stormwater monitoring system.

The MMP focuses on two beneficial uses common to most urban runoff management programs in the region—human health (recreation) and habitat protection (benthic assemblage, biological integrity). For each of these uses, the model program defines monitoring objectives and study designs. Rather than a completely fixed program, the model program recommends several tools to serve as adaptive triggers for initiating more monitoring effort if an impact is observed or a reduction in monitoring effort if no impact (or potential for impact) is found. These tools include triggers for toxicity identification evaluations, upstream source tracking, a prioritization scheme for special studies, and a computer program for estimating sample size on the basis of statistical power to detect trends.

The model program identifies several types of monitoring stations that could be integral parts of a local program that addresses each of the five key management questions:

- Long-term, fixed, bottom-of-watershed (above-tidal-influence) stations to assess cumulative water quality and aggregate loads, with monitoring based primarily on a mass emissions model including wet weather chemistry and toxicity
- Spatially extensive, perhaps randomly sited or rotating, stations to support statistically valid comparisons across multiple watersheds, and with monitoring based primarily on the Triad approach (chemistry, toxicity, and benthic community) for dry weather sampling and on chemistry and toxicity for wet-weather sampling
- Site-specific stations focused on the status of high-priority inland habitats of concern, with monitoring based primarily on the Triad approach for dry weather sampling and on chemistry and toxicity for wet weather sampling
- High-priority inland body contact recreation areas
- Site-specific stations designed to generate information to support key program goals, such as source prioritization or best management practice (BMP) implementation and evaluation
- Coastal estuarine stations to assess status in these key habitats, with monitoring based primarily on the Triad approach
- Coastal ocean stations to assess stormwater plume impacts, conducted primarily as part of the periodic Bight surveys.

The SMC intends that the model program be used as a template to guide incremental adaptation of local monitoring programs toward the goal of a comprehensive program to address the five core management questions. The SMC recommends that this process be accomplished through the following steps:

1. Evaluate a program’s ability to answer each of the five management questions.
2. Identify critical gaps in knowledge (e.g., inability to document impacts, lack of knowledge about potential sources, absence of trend monitoring component) relevant to each program’s circumstances.
3. Use the monitoring designs in the MMP as a framework for developing monitoring components suited to each program’s circumstances.

2. Current Copermittee Monitoring Program and Proposed Changes

The existing Copermittee Monitoring Program (County of San Diego [CSD] 2005a) is organized around (1) stormwater monitoring, (2) rapid stream biological assessments, and (3) coastal monitoring, including storm drain discharge and ambient bay/lagoon monitoring. The Copermittees also participate in a watershed-based toxic hot spot monitoring program, although it is not specifically a component of the monitoring program. The proposed changes in the

Copermittee Monitoring Program (as outlined in CSD 2005b) are intended to increase consistency with the MMP developed by SMC.

Stormwater Monitoring

Existing Program

There are 11 mass loading stations (MLS) where water samples for chemical analysis, flow metering, and other measurements are taken. A single biological assessment site is collocated with each MLS (also discussed below). The mass loading sites were selected to directly measure pollutant loads being discharged into San Diego's receiving waters by the major watersheds within the San Diego region. Accordingly, the stations are located at the downstream ends of major watersheds, upstream of any tidal influences, but they also meet several other criteria such as accessibility, safety, and suitability for measurements and sampling.

Three storm events per year are captured at each MLS site by grab sampling, channel flow rate is measured, and samples are analyzed for the following characteristics:

- Temperature
- pH
- Specific conductance
- Biochemical oxygen demand
- Oil and grease
- Total coliform
- Fecal coliform
- Enterococcus
- Total and dissolved metals
- Organophosphate pesticides (diazinon, chlorpyrifos)

It should be noted that the last two bullets in the above list (metals and pesticides) were provided in the executive summary but did not appear in the methods section of the final 2003–2004 monitoring report (CSD 2005a). In addition, toxicity testing is performed on the grab samples using three freshwater species—*Ceriodaphnia dubia*, *Hyalella azteca*, and *Selenastrum capricornutum.* Both acute and chronic toxicity values are calculated for each, and results are taken to reflect the potential of instream aquatic life impacts resulting from the stormwater. Control organisms are used to determine the acceptability of the test results.

Data from MLS monitoring have been used for regional water quality assessment by comparing constituent of concern (COC) concentrations across watersheds and by grouping similar watersheds by COC relationships. Comparisons of estimated event mean concentrations (EMCs) with measured EMCs at mass loading stations were also performed to compare watershed areas.

The results contribute to identifying water quality impairments among the watersheds in the region. For example, among the MLS, the Tijuana River has consistently shown the highest concentrations for most of the COCs, particularly those associated with untreated wastewater and highly urbanized land use. This MLS has also had the most consistent toxicity results with respect to *Ceriodaphnia* and *Hyalella*. Other MLS data have documented strong relationships for increasing toxicity with higher amounts of diazinon, total suspended solids (TSS), and dissolved nickel. Some trends have been suggested, including decreasing trends for lead, nickel, and zinc at Tecolote Creek; increasing TSS and turbidity at Agua Hedionda; and decreasing TSS and turbidity at Tecolote Creek and Chollas Creek.

Proposed Changes
Basic frequency of MLS sampling is reduced from annual to biannual (once every 2 years). Copermittees further propose to monitor two storm events and two dry weather events, rather than three storm events, every two years. There are no changes to the MLS with respect to location, constituents analyzed, and association with biological assessment stations. They will be assessed for the current constituent list (see list above).

Temporary Watershed Assessment Stations (TWAS) will be placed farther upstream in the watershed (placed to capture major land use changes and to be immediately downstream of tributaries) and will be temporary in that they will be moved if necessary to help track sources of pollutants to the watershed. Sampling will occur on the same schedule as the MLS and apparently will include two wet-weather events and two non-rain events per sample year. Also, as with the MLS, biological assessments will be associated with the TWAS.

Rapid Stream Biological Assessments

Existing Program
Stream bioassessments (BAs) are conducted to assess the ecological health of the watershed units in San Diego County, using the California Stream Bioassessment Protocol (CSBP) (CSD 2005a, page 3-11), which samples and analyzes populations of benthic macroinvertebrates and assesses the quality and condition of the physical habitat. Using species-specific tolerance values and community species composition, numerical biometric indices are calculated, allowing for comparison of relative habitat health between streams in a region. Over time, this information is used to identify ecological trends and aid analyses of the appropriateness of water quality management programs.

A minimum of 23 monitoring reaches were sampled in each survey, including 3 reference sites per survey. The primary goal for each survey was to sample 2 monitoring reaches in each of the 10 watershed management areas that have stormwater mass loading stations. Of the two monitoring reaches, one was located as far downstream in the watershed as was practicable and the other was located farther upstream in the watershed, but where it was still affected to some degree by urban development. From 2001 to 2004, 9 reference sites and 39 “urban-influenced” sites were sampled. They were intermittently sampled twice a year (May-June and October); some reaches were sampled every sampling period (thus, up to seven times) and some as few as a single time.

Taxonomic identification of samples collected in October 2003 produced 90 taxa from a total of 17,302 individuals. The May 2004 samples produced 104 taxa from 20,012 individuals. The majority of organisms from the urban affected sites were moderately or highly tolerant to stream impairments. Organisms highly intolerant to impairments were encountered infrequently at the urban-influenced sites, but several sites supported highly intolerant organisms. The Index of

Biotic Integrity ratings of the monitoring sites ranged from Very Good to Very Poor in October 2003 and May 2004; IBI scores for the reference sites were always higher than the scores for the urban-influenced sites.

Among watersheds in San Diego County, the Santa Margarita River watershed was the least impaired. The remaining watersheds have substantially greater amounts of urbanization, and the IBI results generally indicate that greater water quality impairment occurs in the lower portions of the watersheds, as the impacts of urban runoff become cumulative. Trend analysis has become possible after more than 3 years of bioassessment. However, macroinvertebrate community quality has not shown any trend toward degradation or improvement.

Proposed Changes

Benthic macroinvertebrate sampling will continue to occur twice a year (late spring and late summer) with the intent of spatial and temporal association with the stormwater and non-stormwater chemistry (MLS, TWAS). Thus, BA will be performed at the same number of locations as previously, but with a reduced frequency on a biannual schedule (once every 2 years).

Coastal Storm Drain Outfall Monitoring Program (CSDM)

Existing Program

The objectives of the current Coastal Storm Drain Monitoring (CSDM) program are as follows:

1. Evaluate the impacts of storm drains on the recreational beneficial uses in coastal receiving waters.
2. Identify and eliminate sources of highly elevated bacteria from coastal storm drains.
3. Develop a coastal water quality database.

Objective 1 supports the first two core management questions (protection of beneficial uses and extent/magnitude of receiving water problems) by collecting total coliform, fecal coliform, and enterococcus data on outfalls and receiving waters during both dry- and wet-weather flows and comparing bacteria levels against water quality objectives for recreation. Activities associated with Objective 2 partially contribute to question 3 (sources of urban runoff receiving water problems) by investigating causes of documented exceedances of water quality standards. Achievement of Objective 3 will result in a database that can be applied to core management question 5 (whether conditions in receiving waters are getting better or worse) through trend analysis.

CSDM sites were selected in 2001 on the basis of storm drains having the greatest potential to adversely affect the bacterial water quality of coastal and lagoon receiving waters. Paired samples (simultaneous storm drain discharge and receiving water samples) are collected monthly during the wet season and every 2 weeks during the dry season at the coastal storm drains and lagoon sites. Water samples are analyzed for total and fecal coliform and for enterococcus indicators. Resulting data are used to characterize use support at the sites at the time of sampling, to identify receiving water exceedances, and to trigger source investigations.

Sampling frequency can also be reduced at sites that exhibit consistently low bacteria levels. Exceedances of public health standards for bacteria are reported to the County Department of Environmental Health, and exceedance of the 95th percentile observations of the previous year's bacteria data (pooled from all CSDM stations) triggers investigation and potential remediation of the source(s) of bacteria in the storm drain catchment area.

The CSDM program has been effective in evaluating the impacts of storm drains on the recreational beneficial uses in coastal and lagoon receiving waters. In 2003–2004, only three samples of the paired sample results (< 1 percent) showed both a storm drain action level exceedance and a receiving water exceedance at coastal locations. Similarly, only 7 of 116 paired lagoon samples (6 percent) exceeded both criteria for lagoons. Data collected during the last two reporting periods indicate comparable results. Although there was not a demonstrated decrease in bacteria levels between the 2002–2003 and 2003–2004 programs, overall bacteria levels at the majority of the sites are currently below action levels. Furthermore, approximately 75 percent of all monitoring locations had no exceedances in the receiving water. In 2003–2004, 15 investigations of 95th percentile exceedances were conducted, resulting in successful and ongoing efforts to correct the source activities. During the most recent permit year, data management and transfer were improved as part of the building of a coastal water quality database. Finally, analysis of lagoon data suggested that the current lagoon program might need to be revised to achieve a better interpretation of (1) bacteria concentrations in lagoons and (2) the effects that storm drains and other MS4 drainages might have on lagoon waters.

<u>Proposed Changes</u>

Coastal Storm Drain Monitoring sites where receiving water samples cannot be collected will be moved to the respective Copermittee's dry-weather monitoring program. Five years of data evaluation have shown that the single sample locations tend to have low levels of bacteria, cannot adequately assess the bacteria inputs to the receiving waters, and do not provide useful data to meet the SMC objectives. Furthermore, none of the single sample sites flow directly into the receiving water. These sites should be treated similarly to dry-weather sites, relying on action level exceedances to trigger IC/ID investigations. Therefore, these monitoring sites will be added to the respective Copermittee dry-weather monitoring program.

Monthly sampling of paired storm drain and receiving waters can adequately assess the bacterial impacts from dry-weather storm drain flows. This represents a reduction of dry-weather sampling frequency from twice monthly. Monthly sampling of both coastal and lagoon sites, during both the dry and wet seasons, appears adequate, according to the Copermittees.

Realignment of the Coastal Storm Drain Monitoring Program will provide a consistent dataset for use in regional data analyses. The Permit requires that the monitoring season start on October 1 and end on September 30. The Copermittees intend to align the CSDM sampling and reporting periods to begin and end in accordance with this time frame. Therefore, the CSDM wet weather season will begin on October 1 and end on April 30, while the dry-weather season will occur May 1 through September 30. Storm drain action levels will be reassessed annually, and the new action levels will start on October 1 of each year. This will provide a coastal dataset that uses dry/wet-weather periods similar to the rest of the Copermittee monitoring programs.

Ambient Bay and Lagoon Monitoring Program (ABLM)

<u>Existing Program</u>

The first phase of the Ambient Bay and Lagoon Monitoring (ABLM) Program (2001–2002) collected data on bay and lagoon sediment characteristics as a basis for the design of an appropriate plan to assess habitat conditions in receiving waters. Following completion of the initial phase, ABLM Program sampling was implemented in 2002–2003 with the following objectives:

1. Assess the overall health of the receiving waters and monitor the impact of urban runoff on ambient receiving water quality.
2. Provide an indication of how aquatic life in the bays and lagoons is affected by pollution.
3. Allow prioritization of outfall areas of coastal embayments for additional investigation in subsequent years.

Objectives 1 and 2 support core management questions 1 and 2 (protection of beneficial uses, extent and magnitude of receiving water problems). If continued through time, the ABLM Program could provide information for trend analysis of bay and lagoon condition (question 5). However, because the program is deliberately biased toward "worst-case" locations (see below), data from the ABLM Program will be of limited utility in addressing core questions 3 and 4 (relative contributions of urban runoff and identification of sources of receiving water problems).

As a result of physical characteristics and depositional patterns within coastal embayments, there are wide variations in sediment characteristics within coastal embayments. Rather than trying to directly measure contaminant loading in the water, the ABLM Program focuses on the receiving water sediments where contaminants are most likely to be found. In the study design phase, the ABLM Program used the association between small grain size, high total organic carbon (TOC) levels, and contaminants to target areas in each of 12 embayments where contaminants were most likely to be found. The three sites in each embayment with the highest ranks for grain size and TOC were assessed in the next phase of the program, which began in July 2003. **Note that the subsequent assessments represent a *worst-case scenario* rather than a representative assessment of the embayment.**

At each bay station, several water quality parameters are measured and sediment samples collected for analysis:

- **In situ water quality**: depth, temperature, DO, pH, and conductivity
- **Sediment chemistry**: top 5 cm analyzed for metals, organochlorine and organophosphate pesticides, PCBs, and PAHs
- **Sediment toxicity**: 10-day static amphipod toxicity test
- **Benthic infauna**: species list, relative abundance, species diversity or richness, Shannon-Wiener Species Diversity Index, and an evaluation of the presence of sensitive and pollutant tolerant species.

Once all the ABLM data were collected, a Triad matrix (sediment chemistry/sediment toxicity/benthic community) was developed representing the combination of sediment chemistry, sediment toxicity, and benthic infauna data. The matrix was used to develop a ranking of the embayments across the County.

Results from the first sampling year (2003–2003) indicate that the mean Effects Range Medium Quotients (ERM-Q, the concentration of each COC divided by its ERM to produce a proportion of the ERM equivalent to the magnitude by which the ERM value is exceeded or not exceeded) were low for all of the 12 coastal embayments, reflecting the low concentrations of metals, PAHs, PCBs, and pesticides. Arsenic, chromium, copper, lead, nickel, and zinc were found above the detection limit at all embayments assessed, but at low concentrations. Concentrations of metals exceeded the Effects Range Low (ERL) in only 12 of the 108 analyses conducted. ERLs of only four metals were exceeded; copper was exceeded most frequently, followed by arsenic , zinc, and lead. In most cases, the ERL was exceeded only slightly, suggesting minimal impacts on the biota from individual COCs. PCBs were not found above the detection limit at any assessed embayment. PAHs were found above the detection limit at only two sites at concentrations at least 10 times lower than their ERLs. These results suggest minimal if any impacts on the biota from PAHs in the sediments of the coastal embayments. Neither of the two pesticides assessed in the ABLM Program (chlorpyrifos and diazinon) was found above the detection limit in sediments from any of the coastal embayments assessed.

Sediment toxicity testing showed that survival of the test organisms varied from 88 percent to 27 percent among the embayments. Mean survival of test organisms exposed to sediments from eight sites assessed in the study was significantly different from control sediment survival: two of these sites had much lower survival rates than the other sites assessed, suggesting elevated sediment toxicity in these embayments.

Groupings of benthic infauna based on various metrics were largely based on physical and hydrologic conditions at the sampling sites.

Monitored embayments were ranked on the basis of sediment chemistry, sediment toxicity, and benthos, but consistent relationships between sediment chemistry, toxicity, and benthic community structure have not yet emerged.

<u>Proposed Changes</u>

Continuation of the ABLM Program to collect 3 years of data will facilitate evaluation of associations between mass loading stations and bays/lagoons. Following 3 years of monitoring, the monitoring design will be adapted by assessing the information/data to evaluate associations between the mass loading stations and the ambient bay and lagoon. If a relationship is observed, the ambient bay and lagoon monitoring program will be linked into the program design as a monitoring element to be conducted with the MLS, TWAS, and BA monitoring and the information/data will be assessed as an additional weight-of-evidence element. However, if a relationship between the mass loading stations and the ambient bay and lagoon program is not observed, the ABLM program will be adapted to conduct special investigations on bays and lagoons.

Additional ABLM data will help document relationships between sediment chemistry, sediment toxicity, and benthic community structure. The Copermittees' 2003–2004 Final Report on monitoring points out that such relationships are weak, based on the initial dataset. This is attributed to both the complex dynamics of coastal estuaries and the limited number of samples. The report suggests that data collected in subsequent years might strengthen these relationships.

The ABLM Program will be suspended in 2006/2007 and 2007/2008, supplanted by regional monitoring associated with the Southern California Bight Program, followed by implementation of a "refined" program in Permit Years 4 and 5. No criteria are presented for the "refined" program.

Toxics Hotspots Monitoring Program

The hot spot monitoring component is composed of parts of other programs whose data will contribute to the Copermittees Monitoring Program. The SDRWQCB and select Copermittees (primarily the City of San Diego) have responsibility for its implementation and oversight, and to date the program has focused largely on San Diego Bay. Therefore, only a brief overview of the objectives, monitoring plan, and findings are provided in this report to provide context to the overall Copermittee Monitoring Program. Furthermore, the Toxic Hotspots Monitoring Program was not evaluated against the MMP.

The *California Bay Protection and Toxic Cleanup Program* (BPTCP) has four major goals: (1) protect existing and future beneficial uses of bay and estuarine waters; (2) identify and characterize toxic hot spots; (3) plan for the prevention and control of further pollution at toxic hot spots; and (4) develop plans for remedial actions of existing toxic hot spots and prevent the creation of new toxic hot spots. The BPTCP designates toxic hot spots as areas within enclosed bays, estuaries, or the ocean where pollutants have accumulated in the water or sediment to levels that might pose a hazard to aquatic life, wildlife, fisheries, or human health; affect beneficial uses; or exceed state adopted water quality or sediment quality objectives. Each RWQCB must complete a toxic hot spot cleanup plan, and the SWRCB must prepare a statewide consolidated toxic hot spot cleanup plan that includes a priority listing of all known toxic hot spots, a description of each toxic hot spot including a characterization of the pollutants present at the site, and an assessment of the most likely source or sources of pollutants.

In 1997 the SDRWQCB completed the Proposed Regional Toxic Hotspot Cleanup Plan, which designates five specific areas as toxic hot spots in San Diego Bay. Based on results of the BCTCP completed in the 1990s, sediments in three locations are contaminated with chemicals, including PAHs, PCBs, chlorinated pesticides, and metals. These sites contain degraded benthic macroinvertebrate communities, and samples from these areas have been demonstrated to be toxic to various marine invertebrate species in laboratory toxicity tests. As a consequence, these sites have been identified as areas having impaired water quality. In response to this contamination, the SDRWQCB has initiated efforts to develop Total Maximum Daily Loads (TMDLs) for these sites to reduce ongoing loadings of contaminants of concern, to minimize benthic community impairment, and to minimize human health and wildlife impacts that might result from accumulation and biomagnification of contaminants in the food web.

A watershed monitoring component of this program was scheduled to begin in early 2005 to collect water quality and resource data in three drainage channels upstream of the identified hot spots.

To determine the potential contribution of upstream stormwater to pollutant levels in San Diego Bay, the City and San Diego County Municipal Copermittees developed an upstream source investigation study looking at contaminant levels in fine grain sediments at several locations along creeks. The data were to be used in support of a spatial assessment of marine sediments at the mouths of Chollas and Paleta Creeks in San Diego Bay. Marine sediment assessment at the mouths of the creeks was conducted for the Regional Water Quality Board Toxic Hot Spot/Total Maximum Daily Load (THS/TMDL) Program.

In 2003 the University of California Marine Pollution Studies Laboratory and others performed a sediment quality assessment study at three locations in San Diego Bay to examine the spatial extent and severity of sediment quality impairment in the study areas in order to provide information for TMDL planning and cleanup efforts. This monitoring has been completed and data review is ongoing.

Unlike the ABLM Program, the hot spots investigation program does attempt to relate Bay sediment hot spots to activities in watershed source areas through some of the abovementioned upstream investigations, additional dry-weather sampling in the watersheds, and the use of a model to calculate the runoff and pollutant concentrations based on land use values in the watershed areas above the hot spots. The model demonstrates that a large amount of sediment is entering San Diego Bay adjacent to the hot spots; however, the fate of the sediment and associated contaminants is difficult to determine because of the complex nature of sediment transport.

To date, studies in the Bay have identified several hot spots of concern, especially for PCBs, PAHs, and metals. Most of these areas are in nearshore locations. Wet- and dry-weather monitoring have identified some constituents at high enough levels to suggest that they might end up in Bay sediments. However, given the short data record and a lack of information regarding sediment and pollutant transport processes in San Diego Bay, it is difficult to predict the fate of sediment and pollutants from upstream urban areas that reach San Diego Bay.

3. Broad Recommendations for the Copermittee Monitoring Program

Overview

Based on a review of existing documentation, the current Copermitee Monitoring Program appears extensive and has provided valuable information concerning the impacts of stormwater on receiving waters. The monitoring program has helped to develop an understanding of wet-weather conditions at the outlets of major watersheds and has established baseline information about the condition of stream benthic communities throughout the region. It has provided important data on the contributions of storm drains to impairment of coastal waters for recreation and on toxic hot spots in the region's bays and lagoons. Monitoring data have provided the foundation for documentation of long-term trends in water quality throughout the County. Evaluation of monitoring data from the program has facilitated preliminary priority ranking of watersheds by pollutant, as well as regional evaluation of constituents of concern and environmental stressors (Weston Solutions, Inc., et al. 2005).

As previously noted, however, one particular objective of this report was to review the Copermittees' current and proposed monitoring plan with respect to the MMP. A thorough analysis shows that the Copermittees' current and proposed monitoring programs do not fully adhere to the MMP and that certain aspects of monitoring could be improved to more effectively address the core questions posed by the MMP. In addition, some changes to the monitoring program recommended in the *Baseline Long-term Effectiveness Assessment* need to be addressed. It should be noted that one major purpose of monitoring is the assessment of program effectiveness, in this case, the evaluation of load reduction efforts underway in the County. Monitoring data can evaluate the success of stormwater BMPs implemented in the watershed, of IC/ID programs aimed at dry-weather discharge, of source abatement or of a TMDL process. In doing so, monitoring data can provide feedback essential to the design and management of load reduction programs, showing what works and what does not. Perhaps most importantly, monitoring can document ultimate compliance with water quality criteria and restoration of aquatic biota. Answers to the five questions posed by the MMP will provide a solid basis for evaluation of load reduction programs. Some recommendations for changes in the Copermitees' monitoring program directed toward improving the ability of monitoring data to help document the effectiveness of pollution control efforts are given below, particularly in the areas of increased attention to identification of sources of urban runoff, collection of watershed land use and source activity data, and trend analysis.

The following broad recommendations are presented to address these issues. Section 4 of this report provides a detailed analysis of the relationship between the current and proposed Copermitees' programs and the MMP, along with specific recommendations in each case.

Finally, note that monitoring activities must always be evaluated with respect to the appropriate objectives. In some cases, the current monitoring program might be adequate to address core question 1 (Are conditions in receiving waters protective, or likely to be protective, of beneficial uses?) but inadequate to fully address question 2 (What are the extent and magnitude of the current or potential receiving water problems?) or question 5 (Are conditions in receiving waters getting better or worse?). Thus, a statement that a monitoring activity meets the MMP for one question does not guarantee that the same activity fully meets the objectives of another core question.

Broad Recommendations

Following are six broad recommendations that, if implemented, will maximize the ability of the Copermittees' monitoring program to address the core questions of the MMP and to evaluate the effectiveness of the region's stormwater management program. Note that although complete alignment with the MMP might not always be achievable in a single step, the foundation for further evolution of the monitoring program toward that ideal should be established in each iteration of the Copermittees' monitoring. This is especially important given that the proposed changes presented in the ROWD could likely remain in effect for the next 5 years.

1. Maximize the utility of the TWAS sites

The proposed TWAS program is a critical addition to the Copermittees' monitoring program, particularly with respect to fully characterizing the magnitude and extent of water quality problems and the process of source identification. As noted in the LTE, the current monitoring programs provide a snapshot of the wet-weather freshwater toxicity, chemical, bacterial, and general physical parameters at the base of each of the 11 watersheds, but they have not been designed to fully assess the magnitude and extent of water quality impacts. Furthermore, the current monitoring programs do not provide the ability to conduct a weight-of-evidence assessment of water quality because the sites are not holistically linked to allow for the most effective spatial and temporal assessment. A refocused monitoring program that includes TWAS sites would provide water quality data that are more spatially and temporally varied. However, the proposed number of TWAS sites might be insufficient to fully achieve this purpose and to fulfill the intended purpose, a systematic plan—one that does not currently appear in the proposed changes—is required. The following is a list of principal recommendations and their corresponding reference points in the detailed analysis in Section 4.

- The number of proposed TWAS sites is limited. The TWAS in the proposed program modifications should be sufficient in number to address extent and magnitude issues effectively and to provide statistically useful information. (1.1 E, 2.1 D, O)
- Site TWAS to improve spatial coverage within monitored watersheds, to monitor previously un-assessed subwatershed areas and to focus on specific areas of concern. TWAS should include BA as third leg of Triad, unless all BA stations are collocated with TWAS sites. (1.1 J; 2.1 A, B; 2.1 F)
- Using TWAS and/or additional temporary, targeted monitoring, isolate subdrainages of particular land use or other characteristics as part of source identification efforts. (3.1 E)
- Locate TWAS carefully and in sufficient numbers to target high-priority areas in monitored watershed and to bracket high-priority inputs. In this application, TWAS stations should remain in place long enough to provide a solid basis for trend detection. (4.1 H)
- Assess the location of water quality samples to address long-term questions of trends in water quality that demonstrate long-term effectiveness of implemented load reduction activities. (LTE, p. ES-8). Because they are intended to be mobile, TWAS could be vital in demonstrating effectiveness of load reduction activities if, for example, TWAS are sited downstream of pollution control activities before and after they are implemented. Good data on watershed land use and source activity are also essential in this regard (see Recommendation 5 below).

2. Improve the focus of the sampling locations and schedules

The MMP generally calls for higher sampling intensity in space and time to fully characterize the magnitude and extent of pollutant emissions and impacts, especially where impacts have been documented by a baseline sampling regime. For some objectives, the current Copermittee Monitoring Program does not fully adhere to the MMP; proposed reductions in sampling frequency will tend to compound this problem. Sampling locations and frequencies should be adjusted to focus more closely on the intent of the MMP. In some cases, this will require increased sampling intensity; to some degree such increases can be offset by reductions in intensity in areas where little or no impacts have been observed (adaptive monitoring). The following is a list of principal recommendations and their corresponding reference points in the detailed analysis in Section 4.

- Broaden both current and future ABLM monitoring to include a more spatially representative assessment beyond the worst-case areas. Worst-case data do not provide a representative picture of the extent of habitat problems. Periodic synoptic surveys, probability-based sampling, or rotating sampling stations encompassing a full range of embayment environments (e.g., different sediment grain size and TOC levels, different exposure to currents and tributary and/or storm drain discharge) would help to provide a more unbiased picture of the extent and magnitude of sediment toxicity and impacts on biota in the bays. (1.3 B, H, 2.3 A)

- At MLS, BA, and CSDM sites where consistent impairments have been documented, add additional sampling in space and time to define spatial extent and magnitude of the problem(s). (2.1 A, D, 2.3 E)
- For the ~25 percent of CSDM sites where some sampling showed exceedance of receiving water criteria or where both samples from drains discharging to the ocean and receiving water samples exceeded relevant thresholds, conduct additional sampling down-current in receiving water to document the extent of the problem. (2.2 A, B, D, 2.3 B)
- Measure indicator bacteria more frequently, especially during the high-use season, both in discharges and instream above/below discharges. Sites should be prioritized by risk, i.e., use intensity and contamination level. Sampling frequency for bacterial indicators should be increased at heavily used beaches or beaches with known or suspected sources of bacteria. (1.1 B, I, 1.2 G, 2.1 B)
- Conduct additional sampling upstream and downstream of recreational impacts and at additional times to determine the persistence and extent of elevated bacteria levels. (2.1 J, K)
- At sites where habitat impairment has been documented, add repeated measurements and additional sampling locations for appropriate Triad components to define the magnitude and spatial extent of the problem. (2.1 P)
- Evaluate MLS and other indicator bacteria data to determine patterns of seasonal variability. If significant seasonality is observed, consider restructuring the bacteria monitoring program to account for seasonal patterns. (2.1 G, 4.1 F)

- Evaluate the need for focused sediment sampling up into the watershed to identify the largest contributors to impacted sediments identified in the receiving estuaries. (LTE, p. 2-50)
- The current monitoring program does not address trends in dry weather flows because sampling locations have not been established for trend evaluation. Refocusing the current monitoring program to establish dry-weather sampling locations based on water quality priorities, loading potential of sources within the watershed and available resources, and conducting sampling and analysis of these locations over a period of time could facilitate trend evaluation for dry-weather flows. (LTE, p. 2-47)

3. Reevaluate the consequences of changes in sampling frequency

The proposed reduction of MLS sampling frequency will reduce the program's ability to document differences between stations and trends over time with statistical confidence; that is, larger differences or changes will be required to conclude that the changes are significant at a given level of confidence. Stormwater monitoring in alternate years risks missing significant transient conditions or events. Furthermore, reducing sampling frequency and skipping years will likely impair the use of monitoring data as feedback in evaluating the effectiveness of land-based pollution control activities (e.g., stormwater treatment, improved management practices). A detailed analysis of some of the statistical implications of the proposed reduction in monitoring frequency is provided in Appendix A. The following is a list of principal recommendations and their corresponding reference points in the detailed analysis in Section 4.

- Maintain the present sampling frequency at MLS that show consistent impairment. (2.1 D, Appendix A)
- Examine the existing database to evaluate sampling frequency required to adequately define temporal/seasonal patterns and adjust frequency accordingly. (2.1 G)
- Evaluate the sampling frequency necessary to characterize annual bacteria loads. (2.1 H, J)
- Increase the sampling intensity (spatial and temporal) at stations where impacts have been consistently observed (2.3 D); apply adaptive monitoring to reduce the sampling intensity where impairments are not observed (e.g., reduced bacteria sampling at some CSDM sites).
- Establish goals for trend analysis, and then conduct power analysis and minimum detectable change analysis to determine the sampling frequency necessary to achieve the goals. Reevaluate the effects of reduced monitoring frequency on trend detection; if current trends change direction, magnitude, or both, the proposed changes in sampling regime will have a significantly reduced sensitivity to detect change. (4.1 B)
- Conduct power analysis and minimum detectable change analysis on the CSDM data in the preliminary trend analysis of the existing dataset as called for in the MMP. (4.2 B, C)
- For the CSDM program, reevaluate the proposed reduction of sampling frequency to monthly, especially with respect to alignment of current sampling schedules with recreational use periods, and consider adjustment to enhance sampling during peak periods. (4.2 G)

4. Give substantially more attention to Questions 3 and 4

After some years of assessment monitoring, it is time to look more systematically at determining the relative urban contributions and the sources of urban runoff that contribute to identified receiving water problems. This appears to be the greatest weakness of the current and proposed Copermittees' monitoring programs with respect to the MMP. Working toward source identification will require additional water quality sampling in some areas, better use of existing data, or both. The following is a list of principal recommendations and their corresponding reference points in the detailed analysis in Section 4.

- Use additional methods such as sanitary surveys, bacterial genotyping, and additional bioassessment at MLS and BA sites to gain additional information on impacts that can contribute to source identification. (3.1 H)
- Pursue upstream source identification of documented water quality impacts at MLS sites using the approaches recommended in section 5.4 of the MMP. (3.1 K)
- Assess the need for focused sampling up into the watershed based on the water quality priority rating and the number and location of sources with likely and unknown source loading ratings. Focused sampling should use a weight-of-evidence approach and co-locate wet- and dry-weather samples, toxicity testing, and bioassessment stations where feasible. (LTE, p. ES-6)
- Use source inventories and "Threats to Water Quality" analysis to guide monitoring efforts (LTE)

- Use TWAS and/or additional targeted monitoring to isolate subdrainages of particular characteristics as part of source identification efforts (3.1 E.)
- Future monitoring under the ABLM Program might include focused sediment sampling up into the watershed to identify which specific subwatersheds and related sources are the

largest contributors to sediments impacts at the outfalls of these watersheds, where potential toxic effects are identified. (LTE, p 2-5)

- Answering the question of "relative" contribution requires knowledge of baseline conditions or a reference (non-urbanized) area for comparison. The current monitoring program does not directly address this question. (LTE, p. 2-48)
- Because the majority of dry-weather flows in San Diego County result mainly from urban runoff, additional dry-weather data will help address Question 4. (LTE, p. 2-48)

5. Collect watershed land use and source activity data

Determining the relative urban runoff contributions and identifying specific sources of urban runoff will require not only highly focused water quality monitoring but also data on land use and source activities in watersheds and stormwater drainage areas. Such activity is almost entirely absent from the current and proposed monitoring programs. The following is a list of principal recommendations and their corresponding reference points in the detailed analysis in Section 4.

- As called for in the Copermittees' recommendations, a larger dataset from the ABLM should be assessed to look for a relationship/linkage between the MLS and the ABLM results. This might require collection of additional land use/source activity data from tributary watersheds. If a relationship is observed, then the ABLM Program should be better integrated into the program design as a monitoring element to be conducted with the MLS, TWAS, and BA. (1.3 G)
- Based on land use, population, and published information (as proposed in Section 5.3.2 of MMP), describe the nature and magnitude of potential sources of inputs from watershed management areas. (3.1 B)
- Evaluate the loads at MLS with respect to land use, population, and other characteristics in watershed management areas using tools such as multiple linear regression, factor analysis, cluster analysis. (3.2 A, B, 3.2 B)
- Use land use modeling, reconnaissance, tracers, and other approaches to assess sources upstream of MLS sites. (2.3 F)
- Collect land use, population, and source activity data from source area draining to each drain to allow analysis relating potential source activities/conditions to observed impacts. (3.2 A)
- Conduct an inventory of potential sources of pollutants involved in documented impacts at ABLM stations. (3.3. B)
- Use existing data, relevant literature, and simple tools to estimate the relative magnitudes of pollutant loads from watershed sources. (3.3 B)
- To fully assess pollutant sources, obtain the following type of information (LTE, p. ES-3):
    - Update and expand inventory to include all of the prioritized sources.
    - Provide geo-spatial information (coordinates) of known prioritized sources.
    - Verify unknown pollutant-specific source loading potential for known prioritized sources.
    - Obtain water quality data specific to the area and scale of the implemented activities.
    - Identify and track pollutant-specific activities.
    - Develop means to quantify and track activities implemented.

- Linkage of BMP implementation in the County to changes in runoff/discharge quality is needed to assess the long-term effectiveness of program implementation. Dry-weather data should be targeted to downstream discharge points of prioritized sources to assess load reductions from BMP implementation. Assessment of dry-weather data should be compiled with BMP implementation data. (LTE, Table ES-1)

6. Improve data tracking, analysis, and reporting

The Copermittees' current monitoring program collects a tremendous amount of data from a variety of sources. The utility of these data can be improved by some changes in how the data are tracked, analyzed, and reported. As a general rule, all data collection and analysis activities should be conducted so that performance characteristics such as precision, accuracy, bias, representativeness, and completeness can be documented and reported. The following is a list of specific recommendations and their corresponding reference points in the detailed analysis in Section 4.

- In both the MLS and CSDM programs, analyze and present absolute indicator bacteria numbers even when water quality standards are not exceeded. (1.2 D; 3.2 F, J)
- Flow and mass data from MLS should be reported and used in the regional assessment. (1.1 G, H, O)
- Use the 95th percentile calculated for each individual storm drain to trigger investigations into the cause of exceedance in that drain. Consider setting a lower threshold as a "red flag" that would note a potential problem in the making and be useful in setting priorities for source investigation. (1.2 J, 3.2 C)
- Additional trend analysis techniques should be explored, such as the nonparametric Mann-Kendall test, which is robust against departures from normality. Trend analysis often needs to account for sources of variability in a time series in addition to an underlying trend. Additional approaches to trend analysis, such as including exogenous variables in a multiple-regression model or using a seasonal nonparametric trend model, should be applied. (4.1 A, C)
- Evaluate data concerning habitat indicators from watershed monitoring stations, and conduct power analyses to refine the monitoring design for trend detection, as called for in the MMP. (4.1 I)
- Use load reduction estimates of BMPs implemented (LTE, p. 5-9) as a gauge of the possible magnitude of change in pollutant loadings anticipated; use such estimates in a minimum detectable change analysis to establish sampling frequency for effective trend monitoring at MLS.

4. **Analysis of Current and Proposed Monitoring Programs' Adherence to MMP**

The following tables compare elements of the Copermittees' existing and proposed monitoring programs with the five core management questions and corresponding criteria and design elements suggested in the MMP. For each question, the comparisons are organized into sections representing the major components of the Copermittee Monitoring Program; stormwater monitoring (mass loading stations [MLS] and stream bioassessment [BA]), coastal storm drain monitoring (CSDM), and ambient bay and lagoon monitoring (ABLM). Criteria and design elements are drawn from specific sections of the MMP, as noted in the second column; in some cases, elements listed in more than one section of the MMP have been combined into a single row.

Information contained in the column labeled “Status” is based on San Diego County Municipal Copermittees 2003–2004 Urban Runoff Monitoring Final Report, the Coastal Storm Drain and Lagoon Monitoring 2003-2004 Annual Report, and the Copermittees’ proposed changes to the existing program. The column labeled “Adherence to MMP” characterizes the extent to which the Copermittees’ current and proposed monitoring programs follow the guidance presented in the MMP. Where adherence is partial or minimal, a brief explanation is given and recommendations are presented in the last column, where appropriate. These recommendations include two types of actions—those that would bring the Copermittees’ program more into line with the MMP and those that would strengthen the overall monitoring program, even if not specifically called for in the MMP.

Once again, the core management questions presented in the MMP are as follows:

- **Question 1:** Are conditions in receiving waters protective, or likely to be protective, of beneficial uses?
- **Question 2:** What is the extent and magnitude of the current or potential receiving water problems?
- **Question 3:** What is the relative urban runoff contribution to the receiving water problem(s)?
- **Question 4:** What are the sources to urban runoff that contribute to receiving water problem(s)?
- **Question 5:** Are conditions in receiving waters getting better or worse?

Questions 1, 2, and 5 are addressed in individual tables. Analysis of Questions 3 and 4 has been combined because they are interrelated aspects of a single strategy. According to the MMP, once monitoring demonstrates the nature, magnitude, and extent of water impacts to receiving waters, decisions about any management responses require information about the source(s) of the problem. The MMP breaks this source identification into two parts. Question 3 begins this process by taking the information from Questions 1 and 2 and beginning to work upstream to better define the overall contribution of urban runoff to receiving water problems. Information on Question 3 is used to prioritize more detailed source identification efforts in Question 4 for only those problems for which urban runoff is a significant contributor.

Table 1.1 Question 1: Are conditions in receiving waters protective, or likely to be protective, of beneficial uses?
Stormwater Monitoring—Mass Loading Stations, Temporary Watershed Assessment Stations, Stream Bioassessment

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.1.1	Two approaches: compliance vs. assessment	Current program and proposed changes move toward a combined compliance and weight-of-evidence assessment approach.	Yes	
B.	4.1.2 5.1.1	Monitor bacterial indicators at high-priority sites selected based on a combination of level of contamination by urban runoff and degree of human body contact use.	MLS stations include sampling for TC, FC, and enterococcus. Proposed TWAS sites may be located to address this element.	Partial MLS sites selected to represent wide areas and measure pollutant loads delivered to receiving waters rather than to evaluate water quality at high-priority sites.	Bacterial indicators should be monitored at sites representing high contamination and high use; proposed TWAS might accomplish this.
C.	4.1.2	Data products: frequent measures of indicators, tables of individual measurements and relevant averages	2003–2004 Report includes individual measurement results.	Partial Current sampling frequency for indicators at MLS is not sufficient to make report of averages or other statistics meaningful.	If (as recommended below) sampling frequency is increased, averages and other appropriate statistics should be included in data products.
D.	4.1.2	Data products: comparisons of bacterial indicator values with relevant standards, highlighting exceedances	2003–2004 Report indicates exceedance of water quality objectives and presents cross-watershed comparisons	Yes	

			in regional assessment		
E.	4.1.3	Use the Triad approach as a basis for monitoring both specific sites of high concern and a set of random watershed sites, at least yearly, and assess overall habitat health by comparing a suite of measurements to relevant reference conditions.	MLS stations monitor pollutant loads (chemistry) and include toxicity testing; stream bioassessment completes the Triad and includes reference sites as well as standard metrics. TWAS will potentially address sites of high concern.	Partial Fixed MLS and BA stations monitor habitat health (although current bioassessment sites are not located with MLS sites). However, lack of random sites impairs conclusions about overall habitat health in watershed.	Collocation of MLS and bioassessment sites and addition of TWAS sites can improve this aspect of monitoring. TWAS should be located to give better and more representative spatial coverage of watershed conditions. The major importance of the TWAS lies in the monitoring of previously un-assessed subwatershed areas. Thus, the key to the utility of TWAS data will be in their location. Scattering TWAS around a watershed could be useful in characterizing watershed health. The statistical utility of the TWAS will be limited by sample number and frequency just as for the MLS.
F.	4.1.3	Use the Triad results to trigger an appropriate set of adaptive follow-up studies intended to better characterize conditions.	Wet weather Toxicity Identification Evaluation (TIE) testing has been conducted on sites with persistent toxicity to identify the causes of toxicity.	Yes.	Recommend a systematic approach to follow-up studies, not only for toxicity but also for pollutant loads measured at MLS. For example, an adaptation of the 95th percentile trigger for bacteria counts in the CSDM Program could be applied to follow up on extremes in event pollutant loads. Recommend continued use of decision framework outlined in Table 5-4 of MMP for interpreting and acting on Triad results.
G.	4.1.3	Data product: Site-by-site summaries, interpretations, and conclusions re: each sampled leg of the Triad	2003–2004 Report includes data summaries and interpretations for chemistry, toxicity testing, and bioassessment for each watershed (MLS and BA stations).	Partial No flow or mass data are reported from MLS.	Flow and mass data from MLS should be reported.

H.	4.1.3	Data product: Comparisons across sites for each leg of the Triad and synthesized results	2003–2004 Report includes a regional assessment comparing data across sites for chemistry, toxicity, and bioassessment using ANOVA, cluster analysis, functional feeding groups, and other approaches.	Partial No flow or mass data are reported from MLS.	Flow and mass data from MLS should be reported and used in the regional assessment.
I.	5.1.1	Monitoring of creeks, streams, and rivers should measure indicator levels (weekly during high-use season) in targeted discharges themselves, as well as upstream and downstream of the discharge, with monitoring prioritized by risk-based reports.	Indicator bacteria levels measured by grab samples 3x/yr at MLS sites.	No No reports of measurement of indicators except 3x/year at MLS.	Indicator bacteria should be measured more frequently, especially during the high-use season, both in discharges and instream above/below discharges. Sites should be prioritized by risk, i.e., use intensity and contamination level.
J.	5.1.2.2	Monitoring stations for assessing habitat conditions at the watershed scale: • **Long-term, fixed, bottom-of-watershed mass emissions stations** to assess cumulative water quality and aggregate loads, with monitoring based primarily on a mass emissions model and including wet-weather chemistry and toxicity • **Spatially extensive, randomly sited or rotating stations to support statistically valid comparisons across multiple watersheds**, and with monitoring based primarily on the Triad approach for dry-weather sampling and on chemistry and toxicity for wet-weather (regional station) sampling • **Site-specific stations** focused on the status of high-priority inland habitats of concern, with	MLS are fixed bottom-of-the-watershed stations to assess cumulative water quality and loads. TWAS are proposed to be spatially extensive, rotating sites to supplement MLS; siting criteria for TWAS include ability to focus on specific locations of concern.	Partial Only fixed station, watershed outlet MLS are in current program. TWAS (including both bacteria, chemistry, and Bioassessment) have potential to characterize spatial and temporal extent.	If sufficient in number, TWAS stations in proposed program modifications should be sited to improve spatial coverage within monitored watersheds and to focus on specific areas of concern. TWAS should include bioassessment as third leg of Triad, unless all BA stations are collocated with TWAS sites. The most defensible approach to assess habitat conditions at the watershed scale is to randomly select a number of reaches every year that would be sampled (a stratified random, rotating-basin schedule). The number of reaches sampled would be based on data quality objectives.

		monitoring based primarily on the Triad approach for dry-weather sampling and on chemistry and toxicity for wet-weather (core station) sampling • **Site-specific stations** designed to generate information to support key program goals, such as source prioritization or BMP implementation and evaluation		of water quality problems, but number of proposed TWAS is limited. Reduction of sampling frequency will weaken characterization of temporal extent of water quality problems. Current/proposed program for BA does not include the replication necessary to quantify uncertainty in watershed-scale assessments.	Three reference sites might or might not be sufficient to estimate unimpaired conditions against which to judge the two urban sites (per watershed). For all future bioassessments using benthic macroinvertebrates in San Diego County, reference condition thresholds developed by Ode et al. (2005) will provide the most defensible foundation for assessing impairment and also circumvents the need to sample the three reference sites. Replication of benthic macroinvertebrate sampling is performed within a reach (CSD 2005a, Section 3); results of these samples would allow calculation of within-reach precision (among riffles). Precision estimates for field sampling would improve understanding of sampling is necessary to be able to detect a meaningful change. Results from the same (repeated) samples can also be used to perform quality control (QC) evaluation of the field sampling.
K.	5.1.2.2	Monitoring within any particular watershed integrated to achieve design efficiencies as well as an overall picture of the watershed	MLS sited near watershed outlets to assess pollutant loading to receiving water. BA stations located in upper and lower watershed to bracket major urban influences. BA sites to be co-located with proposed TWAS sites whenever possible.	Partial The elements of the Triad are separated in space and time. Fixed BA stations do not necessarily give representative picture of watershed biological conditions.	For the purpose of characterizing overall watershed condition and support of designated uses for habitat, consider adding random or rotating BA sites, consistent with TWAS sites. Indicators assessed for BA monitoring are a suite of mostly stressor variables and are not focused on stream or ecosystem response. Recommend making **response** indicators the primary indicators measured and evaluated; base interpretation of reach or watershed conditions on quantitative comparison to regional reference conditions and the impairment/ nonimpairment threshold as developed by

					the CDFG (Ode et al. 2005). Use stressor identification process (SI) (Norton et al. 2002, Suter et al. 2002) to determine which or how many of the stressors (physical, chemical, or hydrologic) are most probably the cause of the biological degradation. Those stressor variables then become the targets for restoration or remediation activities (and the basis of TMDL stressor reduction models).
L.	5.1.2.2	Chemistry and toxicity could be used in wet weather when the bioassessment leg of the Triad is not feasible.	Water chemistry and toxicity measured by MLS, sampled in wet weather.	Yes	
M.	5.1.2.2	Bioassessment could be used in lieu of toxicity tests and chemistry scans where the primary concern is the status of a particular habitat.	BA stations located in upper and lower watershed to bracket major urban influences.	Partial BA sampling sites not always tied to particular habitat of concern.	Bioassessment at TWAS sites should be focused on habitats of concern.
N.	5.1.2.2	**Common constituents**: Trace metals Nutrients Bacteria Pesticides Conventionals PAHs Suspended solids Priority pollutants every 5 years, with Bight Program	MLS sampling includes full suite of conventional, physical, wet chemistry, dissolved and total metals, pesticides, priority pollutants.	Yes	
O.	5.1.2.2	Flow-proportional sampling recommended as most cost-effective approach to accurate load estimation.	Flow is measured at MLS by stage/discharge ratings obtained by USGS methods; flow-proportional samples collected for water chemistry.	Unclear Methods describe flow-proportional sampling, however neither flow nor mass data are reported in available	Flow and mass data should be presented, evaluated, and discussed in reports.

				documents.	
P.	Table 5-3	Monitoring for mass emissions: • Bottom of watershed • 3 storms/year for 3 years, then evaluate by statistical power analysis • Analyze for chemistry, toxicity	MLS located at watershed outlets, sampled for chemistry and toxicity; monitor 3 storms/year. Frequency reduction to 2 storms/year in alternate years is proposed, with arguments supported by power analysis.	Yes	Change in frequency is minimally acceptable from the point of view of Question 1 alone, although monitoring in alternate years risks missing significant transient conditions or events.
Q.	Table 5-3	Monitoring for watershed assessment: • Random or rotating • Triad (dry weather)/chemistry/toxicity (wet weather)	MLS are fixed at watershed outlet; BA stations are fixed in upper and lower watershed areas. TWAS proposed to focus on specific areas of concern and to address unmonitored watershed areas.	Partial Fixed stations do not give broad watershed assessment.	Proposed TWAS should be sited to accommodate breadth of watershed conditions; see comments re: TWAS in item E. Consider adding random or rotating BA sites
R.	Table 5-3	High-priority inland habitat: • High-value habitat either impacted or threatened • 1–2/yr dry weather • Triad	BA stations located as far downstream as practicable and upstream, but still with urban runoff influence. Some attempts to select for high-quality riffle habitat for BA sites. Proposed changes would collocate BA sites to MLS and TWAS sites. Sampled twice a year—once in dry season, once in wet season	Partial No mention of whether high-quality habitats are specifically selected as impacted or threatened; separation of BA from ML sites separates Triad data.	BA sites, especially in TWAS program, should be directed more systematically toward high-value habitat. Collocation of core BA sites with MLS sites will improve Triad monitoring. Quantify uncertainty associated with watershed-scale biological assessments. By taking replicate samples as a matter of sampling routine, at 10% of the locations, randomly selected from the total.

Table 1.2 Question 1: Are conditions in receiving waters protective, or likely to be protective, of beneficial uses?
Coastal Storm Drain Monitoring Program

Criterion/Design Element/Design Issue			**Status**	**Adherence to MMP**	**Recommendations**
A.	4.1.1	Two approaches: compliance vs. assessment	Compliance	Yes	
B.	4.1.2 5.1.1	Monitor at high-priority sites (both high use and elevated levels of indicator bacteria)	Drains selected as having greatest potential to affect water quality. Site selection narrative mentions “number of people using coastal area” as selection criterion, but no data presented on use levels of coastal areas sampled. Lagoons sampled are mostly classified as “infrequent” use.	Partial Inadequate characterization of use level of coastal sampling sites	1. Sample all storm drains discharging to receiving waters or establish knowledge base and rational criteria for selecting “representative” drains. 2. Sample additional drains discharging to high-use areas or justify current sampling locations with respect to use level.
C.	4.1.2	Data product: frequent measures of *E. coli*, fecal coliform, total coliform, enterococcus at high-priority sites	Monthly (wet and dry weather) sampling for TC, FC, enterococcus	Yes	Consider reevaluating use of obsolete indicator groups (total coliform) and explore monitoring for true pathogens like *Cryptosporidium.*
D.	4.1.2	Data product: Comparisons of indicators against relevant standards	Extensive discussion of exceedances in both storm drains and receiving waters	Yes	Analyze and present absolute numbers in addition to frequency of exceedance.
E.	4.1.2	Data product: Summaries of relative degree of contamination at monitored locations	Exceedance rates reported for coastal and lagoon sites;	Partial Frequency of exceedance does not tell full story of degree of contamination.	Analyze and present absolute numbers even when water quality standards are not exceeded.
F.	5.1.1 Table 5-1	Monitoring should measure indicator levels in the discharge itself, as well as upcoast and downcoast.	Paired samples collected where possible; drains not directly discharging to receiving waters moved to dry-weather monitoring program at reduced	Yes	Track and analyze bacteria data from storm drains not flowing into receiving waters consistently with comparable data from storm drains that do discharge into receiving waters. Use these combined data to evaluate relative bacteria contributions

			frequency.		from different source areas and activities, as well as to investigate and remediate illegal connections/illegal discharges.
G.	5.1.1	The highest monitoring frequency of daily to five times per week is targeted at beaches with lifeguards and many potential sources of bacteria, and a lower monitoring frequency (e.g., weekly to monthly) is applied to less heavily used beaches and/or beaches with only a few probable sources.	Monthly frequency used, appropriate to low use levels of lagoon sites, but use level of coastal sites unspecified.	Partial Cannot determine compliance with recommended frequency without additional use data of coastal sites.	Data on frequency of use of coastal beaches should be reported. Sampling frequency for bacterial indicators should be increased at heavily used beaches or beaches with known of suspected sources of bacteria. This type of monitoring is conducted outside the Copermittees' stormwater program by the County Dept. of Health. Sharing and reporting of all relevant data should be improved.
H.	5.1.1	Where the monitoring objective is to determine whether overall conditions constitute a problem, monitoring might focus on the portion of the year that represents the worst-case scenario.	Monthly (wet and dry weather) sampling for TC, FC, enterococcus	Yes	Consider increasing sampling frequency during season(s) characterized by highest levels of indicator bacteria.
I.	5.1.1 Table 5-1	Stormwater agencies should build upon the existing recreational water monitoring programs already implemented by local county health agencies and fill gaps in those programs.	Unknown; no mention of interaction with local health agencies in documents reviewed	No	1. Evaluate CSDM sampling sites against existing/historical health agency sampling sites. 2. Use data from other sources as available. 3. If available, provide analysis of existing data generated and maintained by local health agencies.
J.	5.1.1	Application of adaptive triggers that would initiate upstream source identification studies by stormwater management agencies when receiving water monitoring has identified a receiving water problem.	Uses exceedance of 95^{th} percentile to trigger upstream investigation/ remediation; uses adaptive monitoring diagrams to partition data results.	Yes	Use the 95^{th} percentile calculated for each individual storm drain to trigger investigations into the cause of exceedance in that drain. Consider setting a lower threshold as a "red flag" that would not necessarily trigger a full-scale investigation but would note a potential problem in the making.

Table 1.3 Question 1: Are conditions in receiving waters protective, or likely to be protective, of beneficial uses?
Ambient Bay and Lagoon Monitoring Program

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.1.1	Two approaches: compliance vs. assessment	Assessment	Yes	
B.	5.1.2	Monitoring based primarily on the Triad Approach—bioassessment, chemical, and toxicity data.	Yes; Phase II monitoring includes water quality, sediment chemistry and toxicity, and benthic infauna assessment	Yes	
C.	4.1.3	Use the Triad approach as a basis for monitoring both specific sites of high concern and a set of random watershed sites, at least yearly, and assess overall habitat health by comparing a suite of measurements to relevant reference conditions.	Uses Triad approach to monitor sites of specific concern annually, i.e., worst-case sites based on preliminary assessment of sediment characteristics.	Partial No reference sites monitored (for either chemistry or biology); worst-case site bias does not allow assessment of overall habitat health or level of impairment.	Add bay/lagoon monitoring sites, including: • More representative sites based on probability or systematic designs to permit assessment of overall habitat health • Uncontaminated sites to be used as reference sites for both toxicity and benthic assemblages Improve sharing and reporting of data on bays and lagoons collected by other agencies.
D.	4.1.3	Use the Triad results to trigger an appropriate set of adaptive follow-up studies intended to better characterize conditions.	ABLM Program scheduled to continue for 3 years to facilitate evaluation of associations between mass loading stations and bays/lagoons. Following 3 years of monitoring, the monitoring design will be adapted by assessing the information/data to evaluate associations between the mass loading stations and the ambient bay and lagoon.	Partial No system yet in place for follow-up on areas of concern.	Develop program to respond to areas of concern identified through ABLM, both in bays and lagoons and up into contributing watersheds. This will require data on watershed activities and sources currently not being collected (see questions 3 and 4).

E.	4.1.3	Data product: Site-by-site summaries, interpretations, and conclusions re: each sampled leg of the Triad	Each embayment has own chapter in annual monitoring report, including extensive data reporting, ERM/ERL values.	Yes	
F.	4.1.3	Data product: Comparisons across sites for each leg of the Triad and synthesized results	Cross-watershed comparisons and embayments ranked by Triad matrix for sediment chemistry, toxicity, benthos. Bays ranked by ERM-quotients.	Yes	
G.	5.1.2	Coastal ocean stations to assess stormwater plume impacts, conducted primarily as part of the periodic Bight surveys (regional station).	Monitoring stations focused on presumed worst-case sites based on sediment characteristics.	Minimal No apparent tie-in to plumes, tributary loads, or land sources.	As called for in Copermittees' recommendations, a larger dataset from the ABLM should be assessed to look for a relationship/linkage between the mass loading stations and the ambient bay and lagoon results. This might require collection of additional land use/source activity data from tributary watersheds. If a relationship is observed, the ambient bay and lagoon monitoring program should be better integrated into the program design as a monitoring element to be conducted with the MLS, TWAS, and BA.
H.	5.1.2	Types of regional assessment designs: • **Probability-based designs**, similar to the Bight Program design, in which stations are located randomly to provide the ability to draw statistically valid inferences about an area as a whole, rather than just the site itself. • **Systematic designs**, in which stations are located at set intervals along one or more underlying spatial or conceptual frameworks. • **Early warning designs**, in which stations that are considered to be particularly vulnerable to a particular impact are monitored as "canaries in the coal mine." • **Rotating designs**, in which a different subset of	Phase I: stratified random design to assess bay sediment characteristics to set priorities for Phase II sampling Phase II: fixed-station sampling of worst-case (early-warning) sites	Partial Results are biased toward worst-case sites; no ability to draw inferences about entire system(s).	The current exclusive focus of the ABLM Program on sites likely to be contaminated but not on other sites does not provide a representative view of the status of bay and lagoon sediment habitats with respect to support of beneficial uses. Both current and potential future ABLM monitoring should be broadened to include a more spatially representative assessment beyond the worst-case areas. Worst-case data do not provide a representative picture of the extent of habitat problems. Periodic synoptic surveys, probability-based sampling, or rotating sampling stations encompassing a full range

		stations in sampled during each sampling event, with the goal of sampling the entire set of stations over a certain period.			of embayment environments (e.g., different sediment grain size and TOC levels, different exposure to currents and tributary and/or storm drain discharge) would help provide a more unbiased picture of the extent and magnitude of sediment toxicity and impacts on biota in the bays.
I.	5.1.2	Estuaries and nearshore ocean sites should be located randomly and/or clustered in plumes or downstream of major inputs.	Monitoring sites focused on presumed worst-case sites based on sediment characteristics.	Minimal ABLM sites not deliberately associated with plumes/major inputs or arrayed randomly.	ABLM sites should be broadened to capture the purpose of this design element (see point H).
J.	5.1.2	**Common constituents**: Trace metals Nutrients Bacteria Pesticides Conventionals PAHs Suspended solids Priority pollutants every 5 years, with Bight Program	Water quality: temperature, DO, conductance, turbidity Sediment: metals, pesticides, PCBs, PAHs	Partial Limited monitoring of priority pollutants as of yet; no sampling of bacteria in sediment or water column.	Copermittees should consider monitoring for indicator bacteria in both the water column and sediments. Monitoring of priority pollutants should be conducted unless also done by Bight Program.
K.	5.1.2	**Habitat monitoring** can involve a wide range of methods: • Water chemistry • Sediment chemistry • Aqueous toxicity • Sediment toxicity • Bioaccumulation • Bioassessment • Hydrology	ABLM Program includes monitoring for: Water chemistry Sediment chemistry Sediment toxicity Benthic infauna	Yes	

Table 2.1 Question 2: What are the extent and magnitude of the current or potential receiving water problems?
Stormwater Monitoring——Mass Loading Stations, Temporary Watershed Assessment Stations, Stream Bioassessment

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.2	Broader studies required to characterize the spatial and temporal extent and magnitude of problem(s) found in Q1; foundation for scoping of source identification (Q 3 and 4).	Current program includes single MLS at bottom of watershed and BA stations bracketing urban influences. Proposed revisions to program include TWAS located upstream of MLS. Proposed revisions also include reduction of sampling frequency to 2 events in alternate years.	Partial TWAS (including bacteria, chemistry, and bioassessment) has potential to characterize spatial and temporal extent of water quality problems, but number of proposed TWAS is limited. Reduction of sampling frequency will weaken characterization of temporal extent of water quality problems. Current/proposed program for BA does not include the replication necessary to quantify uncertainty in watershed-scale assessments.	TWAS should be located to give better and more representative spatial coverage of watershed conditions. At sites where impairments have been documented, additional sampling in space and time should be added. Within each watershed, proportionally distribute BA sampling site allocation among additional substrate, e.g., a-upper, b-middle, and c-lower watershed; or 1st, 2nd, and 3rd order stream channel segments; or other. Regardless of the stratification approach, efforts should be made to minimize bias associated with the site selection process. This design would allow statistically defensible statements of watershed condition to be made. Begin taking replicate samples as a matter of sampling routine, at 10% of the BA locations, randomly selected from the total, to quantify variability/uncertainty associated with watershed-scale assessments.
B.	4.2.2	Monitor a suite of bacterial indicators at a spatially and temporally more intensive set of stations around sites, prioritized by risk, to	Current program includes single MLS at bottom of watershed	Partial New TWAS will help with spatial	A sufficient number of TWAS should be located to give better and more representative spatial coverage of

		define the extent of problems; compare indicator levels to relevant marine and freshwater standards to define the relative severity of the problem	where indicators are monitored and compared against water quality standards. Reduction in sampling frequency coupled with additional TWAS sites is proposed.	characterization, but number is limited. Reduction in sampling frequency will not help.	watershed conditions. At sites where exceedances of bacteria standards have been documented, additional sampling around sites and over time should be added.
C.	4.2.2	Data products: • Measures of the spatial extent of bacterial contamination (maps) • Measures of the temporal patterns of bacterial contamination (figures that show temporal patterns, measures of variance) • Measures of the relative magnitude of indicator values over space and time (graphs of concentration over time or by site)	2003–2004 Annual Report includes presentation of raw data, exceedances of relevant standards, time plots, map of exceedance value ratios, and analysis of monitoring results and relationships.	Yes	Representations of data currently collected are adequate; as additional samples are collected around impaired sites, maps and figures will be even more important to convey spatial and temporal patterns.
D.	4.2.3 5.2.2	Monitor specific aspects of the Triad, including adaptive elements such as additional chemistry measurements or TIEs, at a spatially and temporally more intensive set of stations where impacts have been observed to define the extent of problems; compare measurements to relevant marine and freshwater standards to define the relative severity of the problem.	TIEs conducted based on Triad decision matrix. No expansion of spatial or temporal monitoring. Proposed changes in sampling frequency affect all sites, both impacted and nonimpacted. Additional BA sites proposed to be co-located with TWAS sites.	Partial Lack of additional sampling sites, and expanded monitoring of other Triad components does not fully define the extent of the problem(s).	Maintain present sampling frequency at MLS sites that show consistent impairment. Increase spatial and temporal coverage around MLS sites that show consistent impairment. Sufficient numbers of TWAS should be located to give better spatial coverage of problem areas.
E.	4.2.3	Data products: • Measures of the spatial extent of modified communities, chemical contamination, and/or elevated toxicity (maps) • Measures of the temporal patterns of modified communities, chemical contamination, and/or elevated toxicity (figures that show temporal patterns, measures of variance) • Measures of the relative magnitude of indicator values over space and time (graphs of concentration or toxicity over time or by site)	2003–2004 Annual Report includes presentation of raw data, exceedances of relevant standards, time plots, map of exceedance value ratios, and analysis of monitoring results and relationships.	Yes	

F.	Tables 4-1 4-4	One-time or periodic short-term sampling at broader spatial extent (depends on Question 1)	TWAS stations proposed to be spatially extensive, rotating sites to supplement MLS; siting criteria for TWAS include ability to focus on specific locations of concern.	Partial Number of proposed TWAS might not be sufficient to fully characterize spatial extent.	TWAS or other one-time or short-term sampling efforts should be expanded to characterize broad spatial extent of water quality problems.
G.	Table 4-4	Sampling appropriate to define temporal patterns at weekly to seasonal scales.	MLS sampled 3 storms/year; frequency reduction to 2 storms/year in alternate years is proposed.	Minimal Current program might not be adequate to fully characterize seasonal/temporal patterns; proposed reduction in sampling intensity will not improve.	Change in frequency is minimally acceptable for question 1, but probably not for question 2. Reconsider reduction in sampling frequency; examine existing database to evaluate sampling frequency required to adequately define temporal/seasonal patterns and adjust frequency accordingly.
H.	Table 4-5	• Adaptive toxicity testing • Adaptive upstream toxicity testing	TIEs conducted based on Triad decision matrix.	Partial No additional upstream toxicity testing reported.	Adaptive upstream toxicity testing would help lay the foundation for source identification efforts (Q 3 and 4).
I.	5.2.1	Stormwater agency will work with local health departments to determine those high-priority (i.e., combination of human use and contamination) locations where extent and magnitude of a bacteria problem should be defined.	Unknown; no mention of interaction with local health agencies.	No	Evaluate current MLS and proposed TWAS sites against existing/historical health agency sampling sites. Use data from other sources as available.
J.	5.2.1	A monitoring design to establish the extent and magnitude of bacterial contamination must have the ability to determine: • The degree of temporal persistence of a particular receiving water problem • The spatial extent of a particular receiving water problem • The relative severity of a particular receiving water problem, compared to other parts of the	Grab sampling for indicator bacteria 3 events/year at MLS; frequency reduction proposed, addition of TWAS proposed.	No Occasional grab sampling at single site does not allow determination of persistence or extent of bacteria problems.	Conduct additional sampling upstream and downstream and at additional times to determine persistence and extent of elevated bacteria levels.

		Region			
K.	Table 4-4 5.2.1	The monitoring design for this question should include: • The core or regional monitoring assessment site(s) in the location of interest • Measures of bacteria loads, which require flow estimates • Measures of the spatial extent of actual impact in receiving waters, which require an array of upstream/downstream samples in creeks • Measures of temporal persistence or pattern, such as between wet and dry weather, which require at a minimum samples through one calendar year.	Current program includes single MLS at bottom of watershed where flow is measured and indicators are monitored and compared against relevant standards. Additional TWAS proposed to be added. No bacteria loads appear to be calculated or reported from grab samples.	Partial MLS monitoring measures water quality at one point; TWAS sites will expand coverage, but limited in number. No bacteria loading data are reported; 3 grab samples/year unlikely to be sufficient to characterize annual loads. Current and proposed reduced sampling frequency will not provide adequate measure of temporal persistence.	Calculate and report point load for bacteria from sampling events at MLS. Evaluate sampling frequency necessary to characterize annual bacteria loads. Conduct additional sampling upstream and downstream and at additional times to determine persistence and extent of elevated bacteria levels.
L.	5.2.1	Depending on the extent of existing knowledge, design elements might be scaled to fill data gaps. For example, where the spatial extent of contamination is well understood, additional sampling at only a few representative stations might be required to define the temporal extent of contamination. Where the spatial extent is not well understood, a survey of shorter-term but more intensive monitoring at an array of stations might be necessary to define the boundary of contamination during periods when human use and contamination combine to create a high-priority period.	TWAS proposed to improve spatial coverage to fill data gaps.	Partial TWAS can define temporal extent of contamination in cases where spatial extent is well known; could improve understanding of spatial extent through short-term intensive monitoring. However, limited	Proposed TWAS should be sufficient in number and sited appropriately to serve appropriate function in individual watersheds. Add additional BA stations randomly distributed throughout each monitored watershed (stratified random).

				number of TWAS proposed might limit capability. The arrangement of BA locations bracketing the urbanized landscape provides some information to evaluate urban effects on stream conditions but does not contribute to estimating overall watershed conditions.	
M.	5.2.1	Indicators should include the levels and loads of the three main bacterial indicators along with other measures that might add useful information (e.g., stream or channel flow, patterns of human use).	Grab samples collected at MLS and proposed TWAS for three bacterial indicators—total coliform, fecal coliform, and enterococcus.	Partial Loads not reported. Information lacking on patterns of human use in drainage areas.	See comments about bacteria loads in item K. Although use of three main indicators is consistent with MMP, the common bacterial indicators alone might not provide an accurate picture of the extent and magnitude of actual pathogen contamination or risk to human health. Copermittees should consider monitoring for true pathogens like *Cryptosporidium.* Collect data on land use and human activities in drainage areas as foundation for source identification (Q 3 and 4).
N.	Table 5-7	Regular grid throughout high-priority use area—one calendar year to establish basic pattern, then daily within subsample of high-use period. Sample for total coliform or *E. coli*, fecal coliform, enterococcus	Grab samples collected at MLS and proposed TWAS for three bacterial indicators.	Partial Point sampling does not define spatial patterns; MLS stations not tied to high-priority areas for	Conduct sampling for bacterial indicators on grid pattern in high-priority areas at frequency adequate to characterize high-use period.

				recreation.	
O.	5.2.2	Variety of approaches for allocating sites including stratified random, systematic, or rotating designs depending on the specific area to be evaluated and indicators to be measured. Integrate the extent and magnitude designs into design(s) for assessment, which will maximize continuity and cost-efficiency.	TWAS proposed to improve spatial coverage, monitor land use changes, major tributaries.	Partial Number of TWAS sites might limit effectiveness.	Proposed TWAS should be sufficient in number and sited appropriately to address extent and magnitude issues effectively.
P.	5.2.2	Use the Triad approach by adding repeated measurements to characterize temporal persistence, upstream sampling of the Triad components to describe spatial extent, and/or adaptive features such as TIEs or targeted upstream source identification studies to better define the magnitude of the problem	TIEs conducted based on Triad decision matrix. No expansion of spatial or temporal monitoring. Proposed changes in sampling frequency affect all sites, both impacted and nonimpacted.	Partial Lack of additional sampling sites, repeated measurements, and expanded monitoring of other Triad components does not fully define the magnitude of the problem(s).	At sites where contamination has been documented, add repeated measurements and additional sampling location for appropriate Triad components to define spatial extent and magnitude of the problem(s).

Table 2.2 Question 2: What are the extent and magnitude of the current or potential receiving water problems?
Coastal Storm Drain Monitoring Program

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.2	Additional studies required to characterize the full extent and magnitude of problem(s) found in Q1; foundation for scoping of source identification (Q 3 and 4)	CSDM program proposed to continue with changes: • Move CSDM sites that do not discharge into receiving waters into the dry weather. monitoring program • Reduce sampling frequency to monthly. • Reduce sampling frequency at sites with consistently low bacteria counts.	No Other than source identification investigations when bacteria levels exceed receiving water criteria or 95th percentile action levels, no additional sampling to characterize full extent of problem at coastal sites where bacteria exceeded criteria.	For the ~25 percent of CSDM sites where some sampling showed exceedance of receiving water criteria or where both samples from drains discharging to the ocean and receiving water samples exceeded relevant thresholds, conduct additional sampling down-current in receiving water to document the extent of the problem. For drains where bacteria standards are exceeded, link to MLS and TWAS programs to document the extent and magnitude of the problem upstream.
B.	4.2.2	Monitor bacterial indicators at a spatially and temporally more intensive set of stations around sites, prioritized by risk, to define the extent of problems; compare indicator levels to relevant marine and freshwater standards to define the relative severity of the problem.	Sites focus on storm drains having the greatest potential to adversely affect the bacterial water quality of receiving waters. Monitoring results compared against water quality standards and exceedances noted. Contaminated storm drain discharges with sufficient flow to reach the receiving water were assigned the	Partial Current and proposed CSDM programs do not appear to include increased intensity of monitoring around high-priority sites.	For drains and receiving waters where bacteria standards are exceeded, increase sampling intensity (spatial and temporal). For coastal sites, document use level of beach sites and confirm priority of sites by risk. [Use level of coastal sites not presented in available reports.]

			next-highest priority for additional investigation and source elimination.		
C.	4.2.2	Data products: • Measures of the spatial extent of bacterial contamination (maps) • Measures of the temporal patterns of bacterial contamination (figures that show temporal patterns, measures of variance) • Measures of the relative magnitude of indicator values over space and time (graphs of concentration over time or by site)	Map of CSDM sites, tables of bacteria by city and sampling station, report of exceedances in appendices to annual report	Partial Presentations of raw data by site/date and maps of site locations do not show the spatial or temporal extent of bacterial contamination	Present maps showing the spatial and temporal patterns of bacteria levels in drains and receiving waters.
D.	5.2.1	A monitoring design to establish the extent and magnitude of bacterial contamination must have the ability to determine: • The degree of temporal persistence of a particular receiving water problem • The spatial extent of a particular receiving water problem • The relative severity of a particular receiving water problem, compared to other parts of the region.	Receiving water sampled 25 yards down-current from drain discharge where possible.	Partial Raw data and exceedance reports allow comparison of receiving water quality across the region. However, single sampling point and single event sampling in receiving water do not allow determination of spatial extent or temporal persistence of high bacteria levels.	For CSDM sites/receiving waters where repeated exceedances of bacteria standards or thresholds occur, initiate additional down-current sampling points and sample on several successive days to determine extent and persistence of receiving water quality impairment.
E.	5.2.1	The monitoring design should include: • The core or regional monitoring assessment site(s) in the location of interest • Measures of bacteria loads, which require flow estimates	Sites focus on storm drains having the greatest potential to adversely affect the bacterial water quality of receiving waters. Only	Partial Current and proposed CSDM program will	Measure storm drain discharge at time of sampling to estimate bacteria load. Improve spatial/temporal distribution of sampling (see item D).

		• Measures of the spatial extent of actual impact in receiving waters, which require an array of upcoast/downcoast samples, regularly spaced grids, or random arrays on the beach and in bays/estuaries • Measures of temporal persistence or pattern, such as between wet and dry weather, which require at a minimum samples through one calendar year	bacteria counts reported. Receiving water monitoring includes concurrent sampling 25 yd down-current or in mixing zone in front of drain.	focus on drains/receiving waters having demonstrated elevated bacteria counts. However, lack of flow data prevent measurement of bacterial loads and single down-current sample (see item D) limit ability to measure spatial extent or temporal persistence.	
F.	5.2.1	Stormwater agency will work with local health departments to determine those high-priority (i.e., combination of human use and contamination) locations where extent and magnitude of a bacteria problem should be defined.	Initial program design based on elements of the AB 411 Recreational Water Monitoring Program conducted by the County of San Diego Department of Environmental Health.	Partial Program initially designed in consultation with DEH, but no reported cooperation since initial phase.	Work with local health department to document high-priority sites for additional definition of magnitude and extent of bacteria problems; share data from ongoing programs.
G.	Table 5-7	Open-coast beach input(s) of concern: • Spaced array upcoast and downcoast of input of concern • One calendar year to establish basic pattern, then daily within representative periods (e.g., storms, dry weather, dominant current regimes) Enclosed bays and estuaries input(s) of concern Based on nature of problem, either: • Spaced array around input of concern	Current and proposed program samples drain discharge and one point in receiving water monthly, with possible elimination of station based on adaptive triggers of consistently low bacteria counts in both bays and lagoons.	No Single receiving water sample monthly does not represent spatial or temporal patterns in open-coast	Where bacteria levels exceed standards or thresholds: At open-coast beaches, sample additional locations up- and down-current from input of concern. For enclosed bays, estuaries, lagoons, collect samples on a regular grid or random array throughout area of concern. In both types of receiving waters, collect daily samples during periods representing

		• Regular grid throughout area of concern • Random array throughout area of concern • Gradient array down-current of input of concern One calendar year to establish basic pattern, then daily within representative periods (e.g., storms, dry weather, dominant current regimes)		beaches or closed lagoons.	high risk of exposure.

Table 2.3 Question 2: What are the extent and magnitude of the current or potential receiving water problems?
Ambient Bay and Lagoon Monitoring Program

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.2	Additional studies required to characterize the full extent and magnitude of problem(s) found in Q1; foundation for scoping of source identification (Q 3 and 4).	Monitoring stations focused on presumed worst-case sites based on sediment characteristics. Following 3 years of monitoring, the monitoring design will be adapted by assessing the information/data to evaluate associations between the mass loading stations and the ambient bay and lagoon.	Partial Evaluation of associations between MLS and ABLM stations will provide foundation for source identification (Q 3 and 4). However, exclusive focus on presumed worst-case sites does not characterize full extent and magnitude of problem.	ABLM monitoring should be broadened to include a more spatially representative assessment beyond the worst-case areas. Periodic synoptic surveys, probability-based sampling, or rotating sampling stations encompassing a full range of embayment environments (e.g., different sediment grain size and TOC levels, different exposure to currents and tributary and/or storm drain discharge) would help provide a more unbiased picture of the extent and magnitude of sediment toxicity and impacts on biota in the bays. This effort should not divert resources from efforts to fully document magnitude of problem at stations where impacts have been observed.
B.	4.2.3	Monitor specific aspects of the Triad, including adaptive elements such as additional chemistry measurements or TIEs, at a spatially and temporally more intensive set of stations where impacts have been observed; compare measurements to relevant marine and freshwater standards in to define the relative severity of the problem.	Continuing monitoring on the current ABLM schedule/sites is proposed.	Partial ERM-Q evaluated for sediment chemistry allows comparison against standards. However, no changes in spatial or temporal sampling	Increase sampling intensity (spatial and temporal) at stations where impacts have been observed. Apply decision framework in Table 5-4 of MMP for interpreting Triad results and pursuing further actions.

				intensity have been proposed for sites where impacts have been observed.	
C.	4.2.3	Data products: • Measures of the spatial extent of modified communities, chemical contamination, and/or elevated toxicity (maps) • Measures of the temporal patterns of modified communities, chemical contamination, and/or elevated toxicity (figures that show temporal patterns, measures of variance) • Measures of the relative magnitude of indicator values over space and time (graphs of concentration or toxicity over time or by site).	2003–2004 Report includes maps of sampling locations, data on sediment chemistry, toxicity tests, benthic community, and relative rankings of each bay's sediment chemistry, toxicity, and biota.	Partial No maps of chemical contamination, elevated toxicity, or impaired biotic communities presented. No measures of temporal patterns of impacts reported.	Present Triad results on maps to show spatial patterns of sediment impairment across region. Present data and figures on temporal patterns and variability of ABLM results.
D.	5.2.2	Adaptive monitoring and special study responses to a receiving water problem, focused on determining the magnitude, extent, and/or severity of any such problem.	Continuing monitoring on the current ABLM schedule/sites is proposed.	No No special studies or additional monitoring proposed for problem areas.	Increase sampling intensity (spatial and temporal) at stations where impacts have been observed. Apply decision framework in Table 5-4 of MMP for interpreting Triad results and pursuing further actions.
E.	5.2.2	Repeated measurements to characterize temporal persistence, upstream sampling of the Triad components to describe spatial extent, and/or adaptive features such as TIEs or targeted upstream source identification studies to better define the magnitude of the problem	Continuing monitoring on the current ABLM schedule/sites is proposed. Following 3 years of monitoring, the monitoring design will be adapted by assessing the information/data to evaluate associations between the mass loading stations and the ambient bay and lagoon.	No Beyond future reassessment of ABLM design, no additional measurements proposed.	Expand monitoring of Triad components around sites with documented impacts. As soon as possible, document associations between ABLM sites and plumes and/or tributary discharges.
F.	5.2.2	Stations should be located in receiving waters	Monitoring stations	Partial	Expand ABLM to include sites of key

		with key beneficial uses, where significant contamination problems related to urban runoff are known to exist, where the likelihood of such problems is high, in high-value habitats whose continued protection is a high priority, at core mass emissions stations, and at distributed locations that will provide a basis for comparisons between watersheds.	focused on presumed worst-case sites based on sediment characteristics.	Current stations are located where significant contamination problems are likely to exist. However, site selection criteria do not appear to include presence of key beneficial uses or high-value habitats.	beneficial uses, high-value habitat, or known urban runoff sources.
G.	Table 5-4	Use decision framework for interpreting Triad results, e.g., toxicity tests at higher dilutions to better quantify toxicity; use TIE to identify contaminants of concern	Continuing monitoring on the current ABLM schedule/sites is proposed.	Partial No changes in spatial or temporal sampling intensity have been proposed for sites where impacts have been observed.	At sites where impacts have been observed, use decision framework in Table 5-4 of MMP for interpreting Triad results and planning further actions, e.g., toxicity tests at higher dilutions to better quantify toxicity; use TIE to identify contaminants of concern

Table 3.1 Question 3: What is the relative urban runoff contribution to the receiving water problem(s)?
Question 4: What are the sources to urban runoff that contribute to receiving water problem(s)?

Stormwater Monitoring—Mass Loading Stations, Temporary Watershed Assessment Stations, Stream Bioassessment

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.3.2	Using parameters relevant to the nature of the receiving water problem, estimate the proportional contribution of urban runoff at the most downstream point of input to the receiving water, based on a loads study and repeated every several years as needed.	MLS selected to directly measure pollutant loads being discharged into receiving waters by the major watersheds. Water quality problems (Q1) (chemistry, bacterial indicators, toxicity, bioassessment) documented at monitoring stations. Land use, population, and other watershed data reported in 2003–2004 Annual Report	No Most information needed to address Q3 and begin to address Q4 appears to be available, but no analysis of contributions of different sources or urban runoff component is reported. Loads not presented in annual reports.	Evaluate loads at MLS with respect to land use, population, and other characteristics in Watershed Management Areas using tools such as multiple linear regression, factor analysis, and cluster analysis.
B.	4.3.2	Data products: • Description of all potential sources of inputs to the receiving water (maps of potential sources) • Rough estimates of the relative magnitude of loads from all sources (table of concentrations or loads by source) • Rough estimates of the proportional contribution of urban runoff to total loads (pie charts or stacked bar charts).	Background data for Watershed Management Area provided in description of monitoring sites General mention of potential sources of impacts in narrative of each Watershed Management Area	No No systematic analysis or discussion of potential sources of inputs to measured loads or to receiving waters.	Based on land use, population, and published information (as proposed in Section 5.3.2 of MMP), describe nature and magnitude of potential sources of inputs from Watershed Management Areas . Use simple models (e.g., Rational Method) to estimate proportional contributions by different land uses to total loads. Use care in applying wet-weather models to conditions in San Diego County.
C.	4.4.2	Using parameters relevant to the nature of the receiving water problem, prioritize receiving water sites for upstream source identification	Regional Assessment section of 2003–2004 Annual Report provides	No There appears to be no discussion	Use comparative analyses already conducted to prioritize Watershed Management Areas for upstream source

		studies and perform source identification studies at the watershed scale and to a moderate degree of resolution until the appropriate stopping rules are reached.	extensive analysis and documentation of differences and similarities among MLS with respect to chemistry, toxicity, and bioassessment.	of prioritization of MLS sites for upstream source identification efforts, although comparative analysis already conducted is an excellent basis for prioritization.	identification. Perform source identification studies based on priorities.
D.	4.4.2	Data products: • Prioritization of receiving water sites in terms of severity of impact (ranked list of sites) • Description of all potential urban runoff sources of inputs to the higher-priority receiving waters (map of potential sources) • Determination of actual sources of urban runoff and their relative magnitude (table of concentrations and flows by source with estimated levels of confidence) • Quantitative estimates of the loads from urban runoff sources (table of loads by source with estimated levels of confidence)	Extensive comparative analysis of results from MLS sites presented, including tables, graphs.	No Sites have not been ranked by severity of impact. Sources have not been identified or discussed except in very general terms.	Use comparative analyses already conducted to rank MLS sites. Evaluate potential sources as recommended in item B, and present results in tabular and map form.
E.	Table 4-1	Source identification involves targeted, site-specific, one-time special efforts.	MLS monitoring proposed to continue at present sites at reduced frequency; TWAS proposed to fill gaps in Watershed Management Area monitoring.	Minimal Depending on location and number, TWAS could contribute to geographic source identification; however, limited number might impair such effort.	Using TWAS and/or additional temporary, targeted monitoring, isolate subdrainages of particular land use or other characteristics as part of source identification efforts.
F.	5.3.1 5.3.2	Load estimation at a fixed downstream reference point that is in or near the affected receiving water, using expert judgment, visual reconnaissance, land use modeling, empirical tributary monitoring, conservative tracers, and	MLS monitoring proposed to continue at present sites at reduced frequency.	No No source assessment work proposed.	Use land use modeling, reconnaissance, tracers, and other approaches to assess sources upstream of MLS sites.

		the evaluation of existing data to assess sources.			
G.	5.4.1	Use a basic indicator of impact (e.g., bacterial indicator, toxicity) to trace the strength of the impact signal upstream, in either wet or dry weather, combined with more powerful and/or targeted methods (e.g., genetic source identification, TIEs, chemical reconnaissance, physical reconnaissance) to locate the specific source(s) of pollution.	MLS monitoring proposed to continue at present sites at reduced frequency; TWAS proposed to fill gaps in Watershed Management Area monitoring. MLS targeted for TIE testing based upon the Triad Decision Matrix.	Minimal TIE testing identifies sources of toxicity in water at MLS sites, but no geographic or land use analysis by other methods to locate sources of pollutants.	Use methods targeted on indicator(s) of impacts documented at MLS sites in upstream investigations to locate specific sources of pollution.
H.	5.4.1	Detailed source identification involves studies at downstream stations to gain additional insight into the sources of the problem. For bacteria, this might include more traditional sanitary survey methods and/or more sophisticated biological testing. For habitat, this might include toxicity tests with a broader suite of test organisms, TIEs, or more detailed analyses of the pattern of impact in communities or on key organisms.	MLS targeted for TIE testing based on the Triad Decision Matrix.	Partial TIE testing provides insight into chemical sources of toxicity problems. However, no other investigations of this type, such as additional BAs or sanitary surveys, are reported.	Use additional methods such as sanitary surveys, bacterial genotyping, additional bioassessment at MLS and BA sites to gain additional information on impacts that can contribute to source identification.
I.	5.4.1	Detailed source identification involves upstream source tracking and source identification studies that might use a variety of methods.	MLS monitoring proposed to continue at present sites at reduced frequency; TWAS proposed to fill gaps in Watershed Management Area monitoring.	No No detailed source tracking is proposed.	Pursue detailed upstream source tracking as outlined in MMP.
J.	5.4.3	For habitat, monitoring results should be evaluated, using Table 5-4 as guidance, to determine whether the probable source(s) of impact is physical, chemical, or unknown.	MLS targeted for TIE testing based upon the Triad Decision Matrix.	Yes	
K.	5.4.4	Upstream source identification efforts include:	MLS monitoring	Minimal	Upstream source identification of

		1. Evaluation of existing data 2. Visual reconnaissance and observation 3. Empirical tributary monitoring, which involves sampling tributary mouths upstream of the receiving water impact to identify the most likely point(s) of input 4. Sampling, or chemical "fingerprinting" of individual sources, including farther upstream along tributaries, which can include the use of unique and/or conservative tracers	proposed to continue at present sites at reduced frequency; TWAS proposed to fill gaps in WMA monitoring.	Limited number of proposed TWAS unlikely to be sufficient to isolate impacts from tributaries. No additional reconnaissance, sampling, or fingerprinting proposed.	documented water quality impacts at MLS sites should be pursued using approaches recommended in section 5.4 of the MMP.
L.	Tables 5-10 5-11	Use adaptive triggers based on Triad results to prioritize studies to identify potential sources of impacts.	MLS targeted for TIE testing based on the Triad Decision Matrix.	Partial TIE testing does not address all potential sources of impacts.	Use adaptive triggers as outlined in Tables 5-10 and 5-11 to prioritize studies to identify potential sources of impacts.
M.	5.4.4	Use explicit starting and stopping rules for detailed source identification studies. Starting rules are necessary for ensuring that source identification studies, which can be costly and time-consuming, are triggered where and when monitoring data strongly suggest the presence of a persistent problem. Such rules are also needed to focus available resources on the highest-priority problems. Stopping rules are essential for ensuring that source identification studies do not continue indefinitely but end when reasonable and realistic expectations have been met.	Nothing in current or proposed monitoring plan that addresses this issue.	No	Develop and apply starting and stopping rules for detailed source identification studies as described in section 5.4 of MMP.

Table 3.2 Question 3: What is the relative urban runoff contribution to the receiving water problem(s)?
Question 4: What are the sources to urban runoff that contribute to receiving water problem(s)?

Coastal Storm Drain Monitoring Program

Criterion/Design Element/Design Issue			Status[1]	Adherence to MMP	Recommendations
A.	4.3.2	Using parameters relevant to the nature of the receiving water problem, estimate the proportional contribution of urban runoff at the most downstream point of input to the receiving water, based on a loads study and repeated every several years as needed.	CSDM program proposed to continue with changes: • Move CSDM sites that do not discharge into receiving waters into the dry-weather monitoring program • Reduce sampling frequency to monthly Reduce sampling frequency at sites with consistently low bacteria counts. Only bacteria counts reported; no load data.	No No bacteria load data available. No information on land use, population, source activity in drain contributing area presented.	Measure storm drain discharge at time of sampling to estimate bacteria load. Collect land use, population, source activity data from source area draining to each drain to allow analysis relating potential source activities/conditions to observed impacts.
B.	4.3.2	Data products: • Description of all potential sources of inputs to the receiving water (maps of potential sources) • Rough estimates of the relative magnitude of loads from all sources (table of concentrations or loads by source) • Rough estimate of the proportional contribution of urban runoff to total loads (pie charts or stacked bar charts).	No relevant activities reported.	No No information presented on potential sources in contributing areas of monitored drains.	Based on collection of land use, population, and source data from drain source areas, use published information (as proposed in Section 5.3.2 of MMP) to describe nature and magnitude of potential sources of inputs from drain source areas. Use simple models (e.g., Rational Method) to estimate proportional contributions by different land uses to total loads. Use care in applying wet-weather models to conditions in San Diego County. Note: similar analysis done for MLS watersheds could apply to the extent that drainage areas overlap.
C.	4.4.2	Using parameters relevant to the nature of	Extensive data presented	Partial	Set a lower threshold, e.g., pooled 75th

		the receiving water problem, prioritize receiving water sites for upstream source identification studies and perform source identification studies at the watershed scale and to a moderate degree of resolution until the appropriate stopping rules are reached.	on exceedances of bacterial water quality standards. Adaptive monitoring diagrams used to identify drains where elevated bacteria levels from the storm drains might be affecting adjacent receiving waters. 95th percentile bacterial counts used as threshold for upstream source investigation on a case-by-case basis.	Adaptive diagrams used to identify priority drains actually affecting receiving waters. Nearly exclusive reliance on exceedance rather than raw data and use of pooled 95th percentile threshold reduce sensitivity of prioritization.	percentile to prioritize drains for source investigation. Reduce reliance on exceedance frequencies for bacterial indicator data alone; report and analyze actual numbers to help set priorities for upstream source identification studies. Use the 95th percentile calculated for each storm drain to trigger investigations into the cause of exceedance in that drain. Results from a particular drain would be compared against the 95th percentile observation from the last year for that drain, and exceedance would trigger an investigation upstream.
D.	4.4.2	Data products: • Prioritization of receiving water sites in terms of severity of impact (ranked list of sites) • Description of all potential urban runoff sources of inputs to the higher-priority receiving waters (map of potential sources) • Determination of actual sources of urban runoff and their relative magnitude (table of concentrations and flows by source with estimated levels of confidence) • Quantitative estimates of the loads from urban runoff sources (table of loads by source with estimated levels of confidence)	Tables reporting exceedances of bacterial indicator standards by individual CSDM stations.	No No information presented on potential sources of inputs in drain source areas, their relative magnitude, or estimates of loads.	Pursuant to recommendations in items A and B, present data and analyses as suggested in MMP Section 4.4.2.
E.	Table 4-1	Source identification involves targeted, one-time special efforts.	Source identification investigations initiated when bacteria levels exceeded receiving water criteria or 95th percentile action levels.	Partial Source investigations limited to highest observed bacteria levels.	Source investigations should be triggered by lower threshold (see item C).
F.	5.3.1 5.3.2	Load estimation at a fixed downstream reference point, which is in or near the affected receiving water, using expert	Source identification investigations initiated when bacteria levels	No No attempt made to associate general	Evaluate all bacteria data with data collected pursuant to recommendations in items A and B to identify patterns of

		judgment, visual reconnaissance, land use modeling, empirical tributary monitoring, conservative tracers, and the evaluation of existing data to assess sources	exceeded receiving water criteria or 95th percentile action levels.	bacteria levels with characteristics/activities in source area. No effort to generalize results of source investigations is apparent.	sources of indicator bacteria in storm drains. Use judgment, reconnaissance, land use modeling, tracers, etc. to assess sources of bacteria observed at CSDM sites.
G.	5.4.1 5.4.2	Use bacterial indicators to trace the strength of the impact signal upstream, in either wet or dry weather, combined with more powerful and/or targeted methods (e.g., genetic source identification, conceptual model of bacteria dynamics in section 5.4.2, physical reconnaissance) to locate the specific source(s) of pollution.	No relevant activities reported other than individual source investigations triggered by threshold exceedance.	Partial Investigations limited to physical reconnaissance.	Where applicable, use tools and approaches outlined in section 5.4.2 of MMP to conduct more definitive source identifications.
H.	5.4.1	Detailed source identification involves studies at downstream stations to gain additional insight into the sources of the problem. For bacteria, this might include more traditional sanitary survey methods and/or more sophisticated biological testing.	CSDM sampling in receiving water consists of single down-current sample when drain discharges into waterbody. Basic bacterial indicators tested.	Minimal Single sample with basic indicator analysis does not provide additional insight into sources.	Consider more extensive sampling in receiving waters to better characterize impacts. Consider evaluating additional microorganisms or associated tracers and/or bacterial genotyping to obtain better information about sources.
I.	5.4.1	Detailed source identification involves upstream source tracking and source identification studies that might use a variety of methods.	Source identification investigations initiated when bacteria levels exceeded receiving water criteria or 95^{th} percentile action levels.	Partial Source investigations limited to highest observed bacteria levels using physical reconnaissance methods.	Where applicable, use tools and approaches outlined in section 5.4.2 of MMP to conduct more definitive source identifications.
J.	5.4.4	Upstream source identification efforts include: 1. Evaluation of existing data 2. Visual reconnaissance and observation 3. Empirical tributary monitoring, which involves sampling tributary mouths upstream of the receiving water impact to identify the most likely point(s) of input 4. Sampling, or chemical "fingerprinting" of	Source investigations and IC/ID investigations use visual reconnaissance and observation.	Partial Source investigations limited to highest observed bacteria levels.	Use lower threshold to trigger source identification efforts using additional approaches. Evaluate all bacteria data with data collected pursuant to recommendations in items A and B to relate observed patterns of sources of indicator bacteria in storm drains to potential sources and

		individual sources, including further upstream along tributaries, which can include the use of unique and/or conservative tracers.			indicate need for source investigations.
K.	5.4.4	Use explicit starting and stopping rules for detailed source identification studies. Starting rules are necessary for ensuring that source identification studies, which can be costly and time-consuming, are triggered where and when monitoring data strongly suggest the presence of a persistent problem. Such rules are also needed to focus available resources on the highest priority problems. Stopping rules are essential for ensuring that source identification studies do not continue indefinitely but end when reasonable and realistic expectations have been met.	Nothing in current or proposed monitoring plan that addresses this issue.	No	Develop and apply starting and stopping rules for detailed source identification studies as described in section 5.4 of MMP.

Table 3.3 Question 3: What is the relative urban runoff contribution to the receiving water problem(s)?
Question 4: What are the sources to urban runoff that contribute to receiving water problem(s)?

Ambient Bay and Lagoon Monitoring Program

Overall Note: Associations between watershed MLS and ABLM stations are currently not well understood. The Copermittees' proposed program states that results of future monitoring will be used to assess such associations. If a relationship is observed, the ABLM Program will be linked into the program design as a monitoring element to be conducted with the MLS, TWAS, and BA monitoring and the information/data assessed as an additional weight-of-evidence element. Assessment of such associations is essential; effective source identification for impacted ABLM sites cannot be determined with certainty until such associations are defined. However, prioritization of ABLM sites/receiving waters can proceed in a preliminary way. Knowledge of activities in watersheds, combined with data from MLS, TWAS, and CSDM programs, may point to potential sources that are worthy of investigation under the present state of knowledge.

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.4.2	Using parameters relevant to the nature of the receiving water problem, prioritize receiving water sites for upstream source identification studies and perform source identification studies at the watershed scale and to a moderate degree of resolution until the appropriate stopping rules are reached.	2003–2004 Annual Report presents regional assessment including ranking of embayments on sediment chemistry, toxicity, and biological metrics.	Yes	
B.	4.4.2	Data products: • Prioritization of receiving water sites in terms of severity of impact (ranked list of sites) • Description of all potential urban runoff sources of inputs to the higher-priority receiving waters (map of potential sources) • Determination of actual sources of urban runoff and their relative magnitude (table of concentrations and flows by source with estimated levels of confidence) • Quantitative estimates of the loads from urban runoff sources (table of loads by source with estimated levels of confidence).	Embayments ranked on sediment chemistry, toxicity, and biological metrics.	Partial No systematic description of potential or actual sources of toxics in drainage area. No estimates of loads from urban runoff sources.	Pending better understanding of relationships between watershed MLS and ABLM stations, conduct inventory of potential sources of pollutants involved in documented impacts at ABLM stations. Use existing data, relevant literature, and simple tools to estimate relative magnitudes of pollutant loads from watershed sources. Use care in applying wet-weather models to conditions in San Diego County.
C.	Table 4-1	Source identification involves targeted, one-time special efforts.	Nothing in current or proposed monitoring plan	No	Pending better understanding of relationships between watershed MLS and

			that addresses this issue.		ABLM stations.
D.	5.4.1	Use a basic indicator of impact (e.g., bacterial indicator, toxicity) to trace the strength of the impact signal upstream, in wet or dry weather, combined with more powerful and/or targeted methods (e.g., genetic source identification, TIEs, chemical reconnaissance, physical reconnaissance) to locate the specific source(s) of pollution.	Pending future monitoring, linkage of ABLM with MLS, TWAS, and BA monitoring will occur.	No	Pending better understanding of relationships between watershed MLS and ABLM stations.
E.	5.4.1	Detailed source identification involves upstream source tracking and source identification studies that might use a variety of methods.	Nothing in current or proposed monitoring plan that addresses this issue. Pending future monitoring.	No	Pending better understanding of relationships between watershed MLS and ABLM stations.
F.	Tables 5-10 5-11	Use adaptive triggers based on Triad results to prioritize studies to identify potential sources of impacts.	Nothing in current or proposed monitoring plan that addresses this issue. Pending future monitoring.	No	Pending better understanding of relationships between watershed MLS and ABLM stations.
G.	5.4.3	For habitat, monitoring results should be evaluated, using Table 5-4 as guidance, to determine whether the probable source(s) of impact is physical, chemical, or unknown.	Triad data collected and ranked for each ABLM site.	Partial Data exist to use Table 5-4 to assess probable cause of impact. Response must wait for better understanding of watershed/tributary contributions.	Pending better understanding of relationships between watershed MLS and ABLM stations.
H.	5.4.4	Conduct upstream source identification efforts as in Table 3.1, items K and M.	Nothing in current or proposed monitoring plan that addresses this issue. Pending future monitoring.	No	Pending better understanding of relationships between watershed MLS and ABLM stations.

Table 4.1 Question 5: Are conditions in receiving waters getting better or worse?
Stormwater Monitoring—Mass Loading Stations, Temporary Watershed Assessment Stations, Stream Bioassessment

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.5.1 4.5.2 4.5.3	Monitor bacterial and habitat indicators at fixed stations over a number of years to determine, whether levels have increased or decreased compared to historical data and to relevant standards.	Fixed MLS sites directly measure pollutant loads being discharged to receiving waters by the major watersheds. Trend analysis conducted using simple linear regression against time.	Yes	Other trend analysis techniques should be explored, such as the nonparametric Mann-Kendall test, which is robust against departures from normality.
B.	4.5.1	Trend monitoring program should conduct its own site-specific power analyses, after obtaining 3 years of trend data, and revise its monitoring design accordingly based on these results.	Power analysis conducted to address consequences of proposed reduction in monitoring frequency at MLS to compensate for expanded monitoring upstream.	Partial Power analysis conducted to justify reduction in sampling frequency, not to assess current program ability to achieve monitoring/management goals. Interpretation of power analysis is based on the highly uncertain assumption that current observed trends will continue in same direction and at a constant rate into the future.	Establish goals for trend analysis, and then conduct power analysis to determine sampling frequency necessary to achieve the goals. Reevaluate effects of reduced monitoring frequency on trend detection; if current trends change direction, magnitude, or both, the proposed changes in sampling regime will have a significantly reduced sensitivity to detect change.
C.	4.5.1	Analysis of monitoring data should include efforts to quantify sources of variability in monitoring data, with the overall goal of reducing any controllable variability	Data are collected on precipitation for monitored storm events, flow.	No Simple linear regression of constituents of concern against time	Trend analysis often needs to account for other sources of variability in the time series in addition to an underlying trend. Additional approaches to trend

				does not account for other sources of variability.	analysis, such as including exogenous variables in a multiple-regression model or using a seasonal nonparametric trend model, should be applied.
D.	4.5.2 4.5.3	Types of data products: • Graphs of the levels of indicators over time at each station of concern • Periodic statistical power analysis results to confirm the power of the trend monitoring Design	Scatterplots and trend graphs of chemistry data presented in appendix to 2003–2004 Report. Power analysis used to address consequences of proposed reduction in monitoring frequency at MLS.	Yes	
E.	5.5.1	Programs begin trend monitoring for recreational water quality with 10 to 15 weekly samples per year for 3 years and then conduct site-specific power analyses.	MLS sampled 3x/year since 1998 or before.	No Sampling frequency substantially less than recommended.	
F.	5.5.1	Because of high variability in indicator bacteria levels, stratify trend analyses by month, with separate trend analyses for each month.	MLS sampled 3x/year since 1998 or before; reduction in frequency proposed.	No Cannot stratify data with current or proposed sample numbers.	Evaluate MLS and other indicator bacteria data to determine patterns of seasonal variability. If significant seasonality is observed, consider restructuring bacteria monitoring program.
G.	5.5.1	Target a trend monitoring program at one or more of the months in that portion of the year when peak bacteria levels coincide with the period of highest recreational use	MLS sampled 3x/year since 1998 or before; reduction in frequency proposed.	No Neither peak bacteria levels nor high recreational use are mentioned as criteria in sampling at MLS.	As appropriate, evaluate bacteria data base and use intensity information for targeting sampling at MLS sites.
H.	5.5.1 Table 5-12	Trend monitoring to target high-priority use areas and high-priority inputs, and include both loads and concentration, with analysis of trends in inputs, impacts, and the difference between stations upstream and downstream of the discharge	Fixed MLS sites located at bottom of WMA; TWAS proposed to fill gaps in spatial coverage in WMA.	Partial If number and location of TWAS are sufficient, improved spatial coverage could address this element as long as TWAS monitoring is sustained over time.	Locate TWAS carefully in sufficient numbers to target high-priority areas in WMA and to bracket high-priority inputs. In this application, TWAS stations should remain in place long enough to provide a solid basis for trend detection.
I.	5.5.2	Trend monitoring programs for habitat should begin by collecting two or three samples per	MLS sampled 3x/year since 1998 or before;	Partial No information or	Evaluate data concerning habitat indicators from watershed monitoring

		year for 3 years and then use these data to conduct site-specific power analyses to refine the following aspects of the design: • The amount of change expected or desired • The number of samples to be collected per year • The number of years before the expected change is detected	reduction in frequency proposed. BA sites proposed to collocate. TWAS sites proposed to improve spatial coverage.	discussion found concerning trends analysis for habitat—toxicity, bioassessment.	stations and conduct power analyses to refine the monitoring design for trend detection. Select the primary response indicator as biological (e.g., the benthic IBI), perform statistical power analysis to determine the number of samples necessary to detect a specified amount of change in THAT indicator. If the primary reporting units are the 10–12 subwatersheds, randomly distribute that number of sample locations throughout each of the subwatersheds (stratified random). Also, within each subwatershed, proportionally distribute sampling site allocation among additional substrate, e.g., a-upper, b-middle, and c-lower watershed; or 1st, 2nd, and 3rd order stream channel segments; or other. Regardless of the stratification approach, efforts should be made to minimize bias associated with the site selection process.

Table 4.2 Question 5: Are conditions in receiving waters getting better or worse?
Coastal Storm Drain Monitoring Program

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.5.1 4.5.2 4.5.3	Monitor bacterial indicators at fixed stations over a number of years to determine whether levels have increased or decreased compared to historical data and relevant standards.	Fixed sites on storm drains discharging to bays and lagoons since 2001.	Yes	
B.	4.5.1	Trend monitoring program conduct its own site-specific power analyses after obtaining 3 years of trend data, and revise its monitoring design accordingly based on these results.	No relevant material found.	No No power analysis of CSDM data found in available materials.	Conduct power and minimum detectable change analysis on each monitored drain. Conduct preliminary trend analysis on available dataset. Conduct trend analysis on raw data for bacterial indicators, not limited to exceedances.
C.	4.5.1	Analysis of monitoring data should include efforts to quantify sources of variability in monitoring data, with the overall goal of reducing any controllable variability.	Flow is measured at CSDM sites.	No No discussion of variability or sources of variability in data.	Assess variability of dataset from each monitored drain, including evaluation of minimum detectable change. Collect data on important covariates such as flow, precipitation, season, and source activity and evaluate their incorporation into an appropriate trend model.
D.	4.5.2 4.5.3	Types of data products: • Graphs of the levels of indicators over time at each station of concern • Periodic statistical power analysis results to confirm the power of the trend monitoring Design	Results are presented as raw sample data, exceedance of water quality standards, and plotted on adaptive monitoring diagram.	No No presentation or discussion of levels of indicators over time or power analysis.	For each monitored drain and downcoast site, plot levels of indicators over time. Conduct power and minimum detectable change analysis on each monitored drain.
E.	5.5.1	Programs begin trend monitoring for recreational water quality with 10 to 15 weekly samples per year for 3 years and then conduct site-specific power analyses.	Initial prescriptive program design initiated in 2001; Adaptive Sampling Program in 2003. Lagoons monitored since 2002. Samples collected monthly	Yes	

			(wet period) and 2x/mo (dry period). Reduction to all monthly proposed.		
F.	5.5.1	Because of high variability in indicator bacteria levels, stratify trend analyses by month, with separate trend analyses for each month.	See sampling frequencies cited in item E above.	No Sample numbers insufficient to stratify in monthly aggregates.	Evaluate dataset for stratification scheme (e.g., quarterly, seasonal) that will address issue of high variability.
G.	5.5.1	Target a trend monitoring program at one or more of the months in that portion of the year when peak bacteria levels coincide with the period of highest recreational use.	See sampling frequencies cited in item E above.	Partial Recreational use of monitored bays unspecified. Current sampling frequency could partially address this issue; proposed all monthly schedule does not.	Reevaluate proposed reduction of sampling frequency to monthly with respect to this criterion. Reevaluate alignment of current sampling schedules with recreational use periods and consider adjustment to enhance sampling during peak periods. Obtain, analyze, and incorporate monitoring data from local health agencies, as appropriate.
H.	5.5.1 Table 5-12	Trend monitoring to target high-priority use areas and high-priority inputs, and include both loads and concentration, with analysis of trends in inputs, impacts.	Drains selected as having greatest potential to affect water quality. Site selection narrative mentions “number of people using coastal area” as selection criterion, but no data presented on use levels of coastal areas sampled. Lagoons sampled are mostly classified as “infrequent” use.	Partial Inadequate characterization of use level of coastal sampling sites to assess degree of targeting for trend monitoring. No flow or bacteria load data reported.	Document current sampling locations with respect to use level. Target monitoring to high-use, high-input locations. Evaluate both concentrations and loads of indicators.

I.	Table 5-12	Trend monitoring at stations bracketing inputs, upcoast and downcoast locations.	Drains flowing into receiving waters sampled down-current from input.	Partial No trend analysis reported for either input or down-current data.	Conduct trend analysis on input and down-current data from appropriate CSDM sites.

Table 4.3 Question 5: Are conditions in receiving waters getting better or worse?
Ambient Bay and Lagoon Monitoring Program

Overall Note: Because samples (Phase II) have been collected only since 2003, ABLM sampling has not developed a sufficient database for trend analysis. Thus, there is no basis to assess adherence to the MMP. Proposed monitoring includes continuation of ABLM to better assess relationships between watershed contributions/tributary inflows and impacts at ABLM Program sites. The criteria and design elements listed below should be applied at that time and preliminary trend analysis conducted. Note that the recommendation provided in Question 1, Table 1.3, Item C, for more representative sampling in bays and lagoons would apply to the trend analysis considerations as well.

Criterion/Design Element/Design Issue			Status	Adherence to MMP	Recommendations
A.	4.5.1 4.5.2 4.5.3	Monitor habitat indicators at fixed stations over a number of years to determine whether levels have increased or decreased compared to historical data and to relevant standards.	ABLM sites are fixed, worst-case locations to be sampled for Triad evaluation for several years.	Yes, preliminary	Representative sites (both highly ranked by the Triad approach and other less-impacted sites) should be monitored to build an unbiased database suitable for trend analysis. The proposed suspension of the ABLM Program until 2009 might be an unwise interruption of a data collection effort that could be used to address trends in receiving water conditions.
B.	4.5.1	Trend monitoring program conduct its own site-specific power analyses after obtaining 3 years of trend data, and revise its monitoring design accordingly based on these results.			
C.	4.5.1	Analysis of monitoring data should include efforts to quantify sources of variability in monitoring data, with the overall goal of reducing any controllable variability.			
D.	4.5.2 4.5.3	Types of data products: • Graphs of the levels of indicators over time at each station of concern • Periodic statistical power analysis results to confirm the power of the trend monitoring Design			

E.	5.5.2	Trend monitoring programs for habitat should begin by collecting two or three samples per year for 3 years and then use these data to conduct site specific power analyses to refine the following aspects of the design: • The amount of change expected or desired • The number of samples to be collected per year • The number of years before the expected change is detected			
F.	Table 5-13	Trend monitoring to target key habitats and/or downstream of major inputs; sites random or clustered in plumes			

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APPENDIX A

Detailed Statistical Analysis of Proposed Reduced Monitoring Frequency at Mass Loading Stations and Assessment of Proposed Temporary Watershed Assessment Stations

The following is an analysis in response to some of the statistical questions raised concerning proposed changes in the Copermittees' monitoring regime. Note that the importance of these changes—and their impact on the effectiveness of the monitoring program—will tend to be greatest for issues of source identification and evaluation of water quality trends (Questions 3–5) than for assessment monitoring (Questions 1 and 2).

Question: *How will reduction in monitoring frequency from monitoring three wet weather events every year to monitoring two wet weather events every other year affect the ability to use the data to make statistically sound conclusions and to identify significant differences between watersheds or years?*

Point 1: Documenting differences between stations/watersheds. The short answer to this question is that the proposed reduction in MLS sampling frequency will reduce the program's ability to document differences between stations and trends over time with statistical confidence; that is, larger differences or changes will be required to conclude that the changes are significant at a given level of confidence. Although the magnitude might not be huge, the resulting reduction in the sensitivity of the program to detect difference/change is very likely a significant cost that should be recognized and considered against the benefit of allocation of monitoring resources to other activities or programs.

There will in fact be some information cost resulting from the proposed decrease in sampling frequency. Collection of fewer samples means that the estimate of the population concentration will be less precise, variability will be more poorly defined, and differences between groups will be more difficult to confirm. For comparisons between multiple stations or years (e.g., by ANOVA) and for comparisons of two stations or years (e.g., by t-test), it is true that variability does not necessarily increase when n (the number of observations) decreases (as stated in Appendix A of Attachment 3). However, it is certain that degrees of freedom (df, the number of independent pieces of information that go into the estimate of a statistical parameter) will necessarily decrease as n decreases. This means that even for the same data distribution, the critical values of the t statistic (for the t-test) and the F statistic (for ANOVA) will increase with decreasing n, especially at the current small sample size. For example, the critical value of t (the value that the calculated t statistic must equal or exceed to conclude that sample means are not equal) at 4 df (n=6; i.e., two sets of three samples) is 2.776 at α=0.05. The critical value of t at 2 df (n=4; i.e., two sets of two samples) is 4.303. Thus, a larger critical t, and hence a larger difference between means calculated from two samples, will be required to conclude significant difference than for means based on three samples.

This effect is also illustrated in the ANOVA results for total dissolved solids (TDS) and nickel (Ni) shown in the response to question 1 in Appendix A. Although it might be true that reducing n from 3 to 2 has little meaningful effect on resolving differences among the 11 stations, in fact the reduction in sampling frequency has the effect of lowering the ability to significantly differentiate stations with respect to mean TDS. With three sample events, for example, station CC has significantly lower mean TDS than SDC, SR, SLR, PC, and TC stations; with two sample events, it can be concluded only that mean TDS at station CC is lower than mean TDS at stations SDC and TC. For Ni, reducing frequency from three to two events per year eliminates the ability to conclude that any significant differences exist among the monitored stations. Although the differences in mean dissolved Ni concentration among the stations with three sampling events might be only slight and not meaningful, the loss of ability to recognize significant differences between groups must be recognized.

Point 2: Documenting differences between years. Decreasing sampling frequency will have the effect of decreasing the ability to document significant differences in mean COC concentrations between years; larger differences will be required to conclude with statistical confidence that a real difference exists. Again, this loss in sensitivity should be balanced against the benefits of other uses of monitoring resources.

The narrative in Appendix A (question 2) states that the present monitoring program has not been designed to answer the question of differences between years, whether two or three annual storm events are considered. At the present sampling frequency of three events per year, only very large differences between years are likely to be detectable, suggesting that the current MLS program might not adequately address some aspects of question 5 of the MMP.

The above issue notwithstanding, the narrative states that in seeking to determine significant differences between years, "the results would be more dependent on the magnitude of differences between years and the variability of the data within each of the years than the number of storm events sampled." The meaning of this statement in this context is unclear. In any comparison of means between periods, the magnitude of difference and the variability of the data of course play a major role. However, the sensitivity of any means test is also highly dependent on the number of observations, and that sensitivity will decrease with decreasing sample size (see Point 1). It is agreed in principle that at the very low sample sizes (three per year or two per year), the absolute values and variability of the data probably have a larger influence than they would at a higher sampling frequency. It is not believed, however, that this is a particularly strong argument for reducing sample frequency.

Some of the same principles discussed in Point 1 apply to evaluating year-to-year differences. Reducing sampling frequency will have the effect of reducing the sensitivity of the monitoring dataset to detect year-to-year differences by comparing means. The effects of reducing sample frequency from three per year to two per year are evident in the tables comparing pairs of years in Appendix A (pages 5–6). In almost every case, the probability (P) level at $n=2$ is higher than the P level for $n=3$. It is technically true that in no case did a t-test change from non-significant (>0.05) to significant (or vice versa) with a reduction of n. However, there is more information in this comparison than simply the binary choice between $P>0.05$ and $P<0.05$. Note that in some cases, going from $n=3$ to $n=2$ resulted in relatively large increases in the probability of finding a t greater than the calculated value. For example, for the comparison of 2001–2002 with 2002–2003:

Location	Measure	P value for n=3	P value for n=2
CC	Nitrite	0.097	0.408
EC	Dissolved Cd	0.199	0.500
SR	Total Zn	0.463	0.710
TJ	Oil and grease	0.388	0.826

Although not statistically significant, the P values for nitrite and Cd above are suggestive of a difference that might be meaningful and perhaps deserve further investigation or at least close observation in the future. The fact that P values decline substantially with a small increase in n from 2 to 3 is suggestive of differences that might be meaningful, but that low n and high variability are preventing the documentation of statistical significance. Such information might be lost when considering only P < or > 0.05. Furthermore, this pattern is indicative of the cost of reduced sampling frequency.

Instead of focusing on only changes resulting from reducing sampling frequency from 3 to 2 per year, it might be more useful to look at the problem from the other direction and ask the following: What is the magnitude of change desired or expected and what sampling frequency is necessary to detect that change with statistical confidence? To answer this question, in would be valuable to conduct an evaluation of **minimum detectable change** (mdc) with respect to the monitoring program. MDC analysis uses knowledge of a water quality constituent (e.g., variability) to determine how much change must occur for the change to be statistically significant at a given sampling intensity. MDC is calculated based on a critical value of t at the appropriate degrees of freedom, the mean square error (a measure of variability), and the number of observations in each period or watershed (Spooner et al. 1987, Richards and Grabow 2003). MDC analysis can be used to estimate the degree of change detectable in a given situation or to calculate the number of samples required to detect a given level of change. A decision to change sampling frequency in the Copermittees' monitoring program should be based on MDC analysis, as well as on the considerations presented in Appendix A.

It is difficult to assess the effect the proposed change in sampling to alternate years on the ability to make statistical inferences. In an obvious impact, not monitoring over a particular year risks missing or at least delaying information about water quality. The effects of a major but transient event such as a chemical spill, a sewer line break, or construction site erosion could be missed entirely. The net effect on long-term trend analysis is not so clear. In general, most trend analysis techniques require a consistent time series of observations; short monitoring periods and small sample sizes make documentation of trends difficult and uncertain. Skipping years might be considered equivalent to having missing data; excessive levels of missing data might mean that a two-sample test must be used. Furthermore, unless the earlier annual data are re-aggregated, the resulting irregularly spaced observations might require the application of different statistical tools, such as nonparametric trend tests. Even if this is not the case, the period of time required to document a trend or the achievement of a water quality objective will be extended. This might be acceptable if the purpose of the program is only to track a long-term trend. However, reducing sampling frequency and skipping years will likely impair the use of monitoring data as feedback in evaluating the effectiveness of land-based pollution control activities (e.g., stormwater treatment, improved management practices).

The analysis presented in Appendix A shows that reducing sampling frequency extends the time horizon for documenting achievement of a water quality objective by only a few years over a period of many years. Although this analysis is correct as far as it goes, it is based on the assumption that existing trends continue in the same direction at a constant rate into the future. This is a highly uncertain assumption. If the trend changes direction, magnitude, or both, the proposed changes in sampling regime will have a significantly reduced sensitivity to detect the change.

As a final observation, it appears that the current approach to trend analysis is inadequate and that more attention should be given to this important question. The only test for trend reported is simple linear regression of a COC (Y) on time (T). This is not the only approach to trend analysis, nor is it necessarily the best one in every case. There are two major shortcomings.

First, parametric linear regression is an optimal trend analysis tool if Y is linear with respect to T and if the residuals are normally distributed. However, if the data depart even to a small degree from these assumptions, other tests will perform as well or better. The narrative in Appendix A states that the COC data were $\log_{10}$ transformed, but it presents no discussion or evidence that the results of the transformation were satisfactory. It is recommended that other trend analysis techniques be evaluated, such as the nonparametric Mann-Kendall test, which is robust against departures from normality. Especially in situations like this one where numerous trend tests must be repeated, it is often simpler to use a nonparametric test than to evaluate, transform, and interpret back-transformations for numerous datasets to satisfy assumptions of normality.

Second, trend analysis often needs to account for other sources of variability in the time series in addition to an underlying trend. Precipitation or streamflow are examples of exogenous variables that can have strong influences on observed water quality data; removing the variation in Y caused by such exogenous variables can reduce the background "noise" and improve the ability to detect an actual trend. Seasonal effects can also be important. Techniques of trend analysis, such as multiple linear regression with flow or precipitation as an independent variable and the nonparametric Seasonal Kendall test, exist to account for such influences. We recommend that additional approaches to trend analysis be explored.

Richards, R.P. and G.L. Grabow. 2003. Detecting reductions in sediment loads associated with Ohio's Conservation Reserve Enhancement Program. *J. American Water Resource. Assoc.* 39(5): 1261–1268.

Spooner, J., C.J. Jamieson, R.P. Maas, and M.D. Smolen. 1987. Determining Statistically Significant Changes in Water Quality Pollutant Concentrations. *Lake Reserv. Manage.*3: 195–201.

Question: *How likely is it that the Copermittees' proposed Temporary Watershed Assessment Stations will provide useful data that can be used to make statistically sound conclusions, given the limited scope of the monitoring proposed for these stations? Are the proposed locations of the TWAS and the rationale for those locations sufficient to answer the Model Monitoring Program core management questions they are designed to answer?*

Because the TWAS will be sampled in the same manner and at the same frequency as the MLS, data from the TWAS will have a comparable statistical basis in terms of detecting differences between stations and between years. However, the major importance of the TWAS lies in the monitoring of previously unassessed subwatershed areas of the major watersheds. The key to the utility of TWAS data will be in their location. Locating two TWAS above and below a tributary, for example, will certainly help document the significance of that subwatershed as a pollutant source, although the statistical sensitivity will be limited by sample number just as at the mass loading stations. Scattering TWAS around a major watershed at points draining areas of different land use(s) could also be useful in evaluating sources of pollutants and evaluating the urban contribution (Questions 3 and 4). However, again, their ability to document differences between subwatersheds will be limited by sample number just as with the MLS. In this context and with these limitations, the TWAS should be applicable to address core questions 3 and 4 and to supplement data relevant to questions 1 and 2. However, most watersheds appear to be scheduled to receive only one TWAS; without specific information on the siting of these stations relative to land use, drainage, and pollutant sources in the watersheds, it is difficult to conclude that the TWAS will achieve all of their objectives.