October 1, 1999

Regional Monitoring and Assessment Strategy

Version 1.0

Regional Water Quality Control Board
San Francisco Bay Region

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INTRODUCTION: WHAT THIS STRATEGY ENDORSES

The Regional Monitoring and Assessment Strategy (Strategy) is intended to move the Region forward in terms of solving difficult water quality problems that remain despite substantial reductions in pollution from municipal and industrial wastewater treatment plants over the past 25 years. During this period, the Regional Board has used a weight-of-evidence approach based on various chemical, toxicological, and microbiological measurements to assess the attainment of beneficial uses of waterbodies in this Region. These measurements have supported policy directives that have reduced pollutant discharges, but they are not necessarily direct assessments or indicators of beneficial uses.

Through implementation of the Strategy, the aim is to bring attention to and ultimately implement solutions to remaining regional water quality problems by identifying and addressing their true root causes. The Strategy will also assist in the creation of realistic water quality and habitat goals for watersheds that consider the physical constraints of urbanization and fabricated stream modifications. Concurrently, the Strategy will identify areas that exhibit exceptional water quality and high quality habitat, and will provide a scientific basis for protection of such regionally significant resources.

Several new concepts are proposed in this Strategy, the purpose of which is to improve the technical content of the Regional Board's biennial 305(b) water quality assessment report and 303(d) list of impaired waterbodies. The Strategy establishes a rotating basin approach, focused initially on pilot watersheds, which will eventually result in the comprehensive assessment of surface and ground waters in the San Francisco Bay Region, consistent with the long-term goal of the U.S. Environmental Protection Agency (EPA). Implementation of the Strategy will be iterative and require considerable resources. Therefore, it is anticipated to be implemented in phases, allowing for adaptive management, and Regional Board staff has obtained partial funding for the initial phase through a USEPA 104(b)(3) grant. This approach is consistent with many other states, which have adopted a rotating basin monitoring and assessment strategy (e.g., South Carolina).

Regional Board staff has begun working with stakeholders to establish a systematic approach to assessing attainment or impairment of beneficial uses of the Region's waterbodies, incorporating certain types of biological and physical measurements that may not have been applied in the past. In September 1997, EPA published revised guidelines for the 305(b) water quality assessment reports, which provide the foundation for the Board's assessments of this Region's waterbodies. In these guidelines, it is noted that 31 states currently have comprehensive biological monitoring programs in streams in wadeable rivers, not including California. One of the elements of the Strategy is to initiate a comprehensive biological monitoring program in this Region patterned after other successful efforts.

In addition to revised federal guidance on water quality assessments, we recognize an unprecedented opportunity to draw upon newly gained expertise to improve the technical content of the Regional Board's policies and regulatory actions. Many monitoring efforts are underway throughout the San Francisco Bay Region that may provide assessment techniques that go beyond the latest EPA guidance, especially in the science of stream channel morphology.

The Strategy endorses the following approaches to monitoring and assessment:

- Use of bioassessment data and physical measurements (e.g., channel morphology), in addition to chemical, microbiological, and toxicological data, to inform Regional Board decisions, policies and regulatory actions, for instance to evaluate beneficial use attainment and/or impairment;
- Use of scientifically valid data generated by volunteer monitoring groups to inform Regional Board decisions, policies and regulatory actions;
- Region-wide coordination of consistent monitoring and assessment efforts and protocols to generate comparable data;
- Coordinated approach to collection of stream data for pollutants identified as impairing San Francisco Bay and its tributaries;
- Strategic site selection and sampling in watersheds, based on changes in the landscape or stream channel, in order to demonstrate water quality/habitat changes related to land and water use, and justify subsequent local or regional policymaking;
- Pilot-scale implementation in selected watersheds in recognition of limited resources and the need for adaptive management;
- Use of impervious surface coverage and flow characteristics in watersheds to assist in establishing relevant reference conditions for biocriteria or physical criteria;
- Enhancement of the waterbody classification scheme in the Basin Plan based on factors such as stream order, gradient, channel form, flow characteristics, and imperviousness, for instance to support appropriate reference conditions; and
- Coordination with ongoing monitoring and assessment efforts at the national level (e.g., EPA's Reach File Version 3 or RF3), at the statewide level (e.g., California Aquatic Bioassessment Workgroup), and in adjacent Regions (e.g., Central Coast Region).

The above approaches will be integrated into a recognized network of monitoring and assessment in the watersheds of the Region, and information generated at these monitoring locations will be used in various Regional Board reports, policies, decisions, and regulatory actions, such as:

- 305(b) Water Quality Assessment Report and the 303(d) List of Impaired Waterbodies;

- Appropriate updates to Chapter 2 of the Basin Plan, which describes waterbodies and associated designated beneficial uses, existing and potential;
- Appropriate updates to Chapter 3 of the Basin Plan, which describes numeric and narrative water quality objectives intended to protect the beneficial uses described in Chapter 2, examples of which include chemical concentrations, reference conditions or ranges for biocriteria or physical criteria, and site-specific objectives;
- Appropriate updates to Chapter 4 of the Basin Plan, which describes the plans of implementation to achieve protection of existing beneficial uses and attainment of potential beneficial uses and appropriate water quality objectives;
- Appropriate updates to Chapter 5 of the Basin Plan, which describes plans and policies besides the Basin Plan that direct Regional Board actions or clarify the Regional Board's intent; and
- Appropriate updates to Chapter 6 of the Basin Plan, which describes significant surveillance and monitoring programs used by the Regional Board to satisfy its requirements under the federal Clean Water Act and the state's Porter-Cologne Water Quality Control Act.

An early product of the Strategy will be guidelines for how the Regional Board will use and evaluate various water quality and habitat data in their 305(b) assessment and for the 303(d) list, rooted in EPA's 305(b) guidelines. In recognition of the challenge of assessing over 300 water bodies in the Region, the Regional Board staff anticipates the need to encourage data collection by partners throughout the Region. The guidelines will ensure that data used in the 305(b) assessment is collected using established, peer-reviewed protocols. Concurrently, the guidelines will provide assurance to the data collectors specifically how the information will be interpreted and applied in the regulatory framework. The guidelines will also describe general expectations of responsible agencies when determinations of use impairment have been made.

In the past decade, monitoring of the Estuary and associated Baylands has accelerated in quality and quantity, leading to better decision-making in many forums. During this period, monitoring in the Region's watersheds has not moved forward at a comparable pace. The limited information from the watersheds indicate room for water quality and habitat improvement, but there are also studies that suggest the presence of exceptional native fish assemblages in tributaries to the Estuary. Therefore, while the Strategy includes the Estuary and its associated Baylands, it will initially emphasize establishment of a regional, ambient monitoring network in the watersheds. In addition to applicable water quality parameters in the Basin Plan, this regional monitoring will include bioassessment and channel morphology measurements, and data collection by qualified citizen monitoring groups.

CONTINUOUS IMPROVEMENT OF REGIONAL BOARD POLICIES AND REGULATORY ACTIONS

The purpose of the Strategy is to improve the technical content of the Regional Board's policies and regulatory actions. In order to meet its regulatory obligations, the Regional Board needs improvement and coordination of monitoring and assessment of waterbodies in the San Francisco Bay Region. The Strategy will ultimately broaden the range of information used by the Regional Board to assess waterbodies, and will better engage technical and local entities in the definition of water quality goals for specific waterbodies. This information will better guide decision-making in the following areas:

305(b) Water Quality Assessment and 303(d) List of Impaired Waterbodies

Under Section 305(b) of the Clean Water Act (CWA), every two years the Regional Board is required to assess the condition of the Region's waterbodies relative to the attainment of federal water quality standards, defined below. Under Section 303(d), the Regional Board must prepare a list of waterbodies that are not meeting standards, and in cases where a numeric standard is not met and technology-based effluent limits have been established on point sources, develop total maximum daily loads (TMDLs) for specific pollutants and waterbodies. Information and data generated under the Strategy will be used in the Regional Board's biennial Water Quality Assessment (305(b) report), the 303(d) list of impaired waterbodies, development of TMDLs for waterbodies and pollutants listed under 303(d), amendments to the Basin Plan where appropriate, and assessment of point and nonpoint sources and effectiveness of management measures. It will also be used to define issues, set regional priorities, and evaluate effectiveness of actions within the region-wide Watershed Management Initiative.

Basin Plan, Beneficial Uses, and State Water Quality Objectives

The San Francisco Bay Water Quality Control Plan (Basin Plan) establishes a program of water quality control for the watersheds that drain to San Francisco Bay, Tomales Bay, and from the coastal portions of Marin, San Francisco and San Mateo counties. The Basin Plan contains a list of this Region's waterbodies classified according to their names, watersheds, designated beneficial uses for those waterbodies, numeric and narrative water quality objectives (WQOs) required to attain certain beneficial uses, and an implementation plan for waterbodies to attain uses and WQOs. Information generated under the Strategy will be used to revise and update the list of waterbodies and their beneficial use designations, WQOs, and regulatory implementation plans.

Federal Water Quality Standards

Water quality standards for a given waterbody, as defined under the federal Clean Water Act (CWA), consist of the designated beneficial uses, any water quality criteria adopted as State WQOs required to attain those uses, and the State's antidegradation policy, which requires maintenance of the level of water quality in state waters that currently attain uses and WQOs (State Board Resolution No. 68-16). The biennial 305(b) report pertains to assessment of waterbodies with regard to applicable water quality standards. The waterbodies listed under CWA Section 303(d) are those that are not attaining water quality standards, as defined in this paragraph.

Environmental Indicators of Beneficial Use Attainment/Impairment

Environmental indicators are used by agencies to determine whether beneficial uses are being attained in a given waterbody. The Strategy will enable the consideration of physical, chemical, and biological data, where appropriate, in the monitoring and assessment of waterbodies relative to water quality standards, defined above. Biological data include microbiological and toxicological data, which have been used in the past by the Regional Board to make regulatory decisions, but also ecological data such as biological indices based on rapid bioassessment protocols, which have not been considered in past 305(b) assessments. Similarly, certain physical measurements of waterbodies, such as stream flow frequency and intensity, stream channel width-to-depth ratios, stream substrate conditions, and canopy cover, may be effective assessment tools, but these types of data have not been used in past 305(b) reports.

Under the Strategy, the various data will be integrated into a "weight-of-evidence" approach. The data will be weighted based on factors such as how direct the measurement is of a beneficial use, how much uncertainty there is in the measurement, how recurrent the measurements are that suggest impairment, and how much of the different types of data indicate impairment. In order to generate useful data for this approach, however, protocols for these environmental indicators must be established so that data are comparable region-wide. Because the information generated is expected to be substantial, an information management plan must be developed and implemented at the Regional Board.

Regional Monitoring and Assessment Strategy

Improvement of Regional Board policies and regulatory actions will occur by coordinating existing regional and local monitoring efforts, establishing and maintaining an advisory group or groups, identifying environmental indicators and establishing protocols, establishing an information management plan, conducting pilot scale implementation project(s), and ultimately

full implementation. A revised Strategy may be prepared based on the results of the pilot scale implementation project and review by the advisory group(s).

The Regional Monitoring and Assessment Strategy has three areas of focus:

- Monitoring and Assessment of the segments of San Francisco Estuary, currently performed by the Regional Monitoring Program (RMP);

- Monitoring and Assessment of waterbodies tributary to the Bays and Ocean, with respect to attainment of water quality standards (including beneficial uses, applicable water quality objectives, and the State's antidegradation policy); and

- Monitoring and Assessment of loads of pollutants of concern from the watersheds to the Bays and Ocean.

CURRENT MONITORING AND ASSESSMENT EFFORTS

Several monitoring efforts at local and regional scales are being implemented around the San Francisco Bay Region, but coordination of these efforts needs to be improved. There is widespread support for incorporation of information from various sources into Regional Board policies and regulatory actions, but the data collection and reporting needs to be standardized and linked for regional consistency. Presently, there is an opportunity to direct these monitoring efforts toward a common goal - to have regional regulatory assessment reports and the Basin Plan reflect current information and provide regulatory incentive for watershed protection and/or improvement efforts. Initial regional monitoring may identify sources of impairment, or alternatively it may begin to answer watershed management questions and suggest further monitoring at finer scales to identify sources of impairment. Source identification will in turn lead to consideration of land or water management options that will address the impairments and improve water resource quality.

There are seven main program efforts that are essential to include in the Strategy, listed in Table 1 of Appendix A. Other efforts at local levels, such as coordinated resource management plans (CRMPs) and efforts led by the Natural Resources Conservation Service (NRCS), will be integrated using the coordination available under the seven program efforts. An additional opportunity identified at the bottom of Table 1 is regional coordination of Flood Management Agencies, for instance to coordinate flow data collection and streamline flood maintenance permitting procedures.

Also included in Table 1 of Appendix A is a column describing "strategic elements" of the various monitoring and assessment efforts, which are elements that increase the probability of success. Data collection throughout the Region is desirable because it does not unduly expose one or a few entities to liability. Technical advisory panels are important to ensure that scientific information and expertise are incorporated into decision-making. Integration of multiple regulatory programs is necessary to accomplish successful watershed management, and these include wastewater and stormwater permits under NPDES (CWA Section 402), water quality certification for wetland fill (CWA Section 401) including permits for flood management activities, the state and federal endangered species acts, the Long Term Management Strategy for dredge material disposal (LTMS), the Nonpoint Source Management Program (non-NPDES), and various watershed management initiatives (WMI) around the Region. If the Strategy is implemented in an equitable, coordinated manner, and is scientifically sound, then the Regional Board's 305(b) and 303(d) actions are expected to gain more widespread acceptance, and provide useful regulatory incentives for local programs to address our remaining water quality challenges.

Appendix A provides brief descriptions of the program efforts listed in Table 1, and their relationship to the Strategy.

STRATEGY COMPONENTS AND RELATED TASKS

The Regional Monitoring and Assessment Strategy is heuristic, and as such, it is anticipated that each component will provide feedback to the others as information is gathered and hypotheses are tested. For example, conceptual schemes for classifying waterbodies will have to be tested using physical, chemical, and biological data to determine their suitability for establishing reference conditions for certain physical and biological parameters. Reference conditions are described from an aggregate of data best acquired from multiple sites with similar physical dimensions, represent minimally impaired conditions, and provide an estimate of natural variability in biological condition and habitat quality[1]. The San Francisco Bay Region is located in a physiographic region and an ecoregion that both extend well north and south of its statutory boundary, and therefore, establishment of reference conditions will not be limited by this boundary.

The diagram of Figure 1 depicts the relationship of environmental indicators, waterbody classification, and "benchmarks," which are numeric thresholds or ranges that signal impairment of a beneficial use. The following Strategy components and related tasks will move forward in tandem as different indicators, benchmarks, classification schemes, and potential pilot watersheds are explored, analyzed, and evaluated. Eventually, several pilot watersheds around the Region

[1] EPA, 1997. Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates: Supplement, p. 3-27.

will be the focus of the next round of 305(b) and 303(d) efforts, implementing the recommendations of the following tasks, currently estimated to be completed by February 2001.

Regional Board 305(b) and 303(d) Guidelines

An early product of the Strategy will be guidelines for how the Regional Board will use and evaluate various water quality and habitat data in their 305(b) assessment and for the 303(d) list. The recently revised EPA guidelines on 305(b) assessments, dated September 1997, will serve as the basis for organizing the Regional Board's guidelines, and will be incorporated by reference wherever feasible. If and when EPA updates these guidelines, the Regional Board's guidelines will be adapted as appropriate.

The guidelines will describe specific environmental indicators to be used by the Regional Board to assess attainment of uses. The minimum data quality and quantity requirements will be outlined for these environmental indicators based on definitions in federal guidance and the scientific literature. These requirements will clarify if data are satisfactory to be used for assessment if a waterbody exceeds a benchmark. The guidelines will be periodically updated because the Strategy encourages the collection of data to support development of biocriteria and physical criteria – environmental indicators that presently do not have benchmarks for the San Francisco Bay Region. The Strategy commits the Regional Board to consider development of biocriteria and physical criteria based on data collected in the next few years.

The guidelines will ensure that qualified personnel using established peer-reviewed protocols collect data used in the 305(b) assessment. Concurrently, the guidelines will provide assurance to the data collectors specifically how the information will be interpreted and applied in the regulatory framework. The guidelines will also generally describe expectations of responsible agencies when determinations of use impairment have been made. These general expectations will be refined as updates of the guidelines are completed based on new information.

An important task in the development of the guidelines is to identify environmental indicators and establish protocols for their measurement. A list of environmental indicators is essential for assessing attainment of beneficial uses. Environmental indicators can be physical, chemical, and/or biological parameters specifically applied to certain uses, numeric thresholds or ranges, and the type of waterbody. Some indicators may be waterbody-specific, i.e., for urban creeks, rural creeks, intertidal zones, lakes, reservoirs, wetlands, and estuaries. Some indicators may have quantifiable endpoints that can be compared to benchmarks to assess attainment of uses (i.e., water quality objectives or biocriteria), while others may not. For those indicators that do, the different types of waterbodies may need different reference ranges or benchmarks against which to evaluate waterbody data.

At present, some benchmarks for environmental indicators are more certain or fixed than others, yet even for the more certain, fixed benchmarks, there are data quality and quantity issues to resolve. Minimum data requirements and protocols for the environmental indicators need to be more explicitly characterized. The minimum data requirements will be used to determine whether there is adequate quality and quantity of data for assessing beneficial use attainment or impairment. Protocols will guide the collection of data and ensure consistency between different monitoring programs in the Region.

Numeric and narrative water quality objectives (WQOs) in Chapter 3 of the Basin Plan provide examples of certain, fixed benchmarks for environmental indicators that are used in the water quality assessment process, but many of these WQOs are chemical concentrations that are indirect measurements of beneficial use attainment. As such, past determinations of impairment of aquatic life uses have been inferred based on national water quality criteria developed under ideal conditions in research laboratories, and not based on direct measurements of the affected biota in the streams. Figure 2 is a decision flow chart that depicts an approach to assessing monitoring data, in which direct measurements, if available, could supersede indirect measurements such as chemical concentrations. For instance, in cases where numeric WQOs are not met in a waterbody, but evidence exists that the applicable beneficial use is being attained, say through a more direct measurement of that use, then a determination of impairment can be deferred pending more study, or a site-specific WQO can be considered by the Regional Board for that waterbody. Conversely, if "indirect" parameters such as chemicals suggest attainment, but the more direct bioassessment data indicate impairment relative to established criteria, then a determination of impairment can be made.

Other states such as Illinois have been successful in establishing assessment methods for the 305(b) report that incorporate a weight-of-evidence approach[2]. Though not directly applicable to the 305(b) process, California successfully implemented a weight-of-evidence approach in the Bay Protection and Toxic Cleanup Program through the definition of "toxic hotspots.[3]" In a weight-of-evidence approach, relative importance of environmental indicators is determined based on factors such as how direct the measurement is of a beneficial use, how recurrent the measurements are that suggest impairment, and how much uncertainty is associated with the measurement in the specific waterbody. In Illinois, different waterbodies are assessed to determine if various uses are fully supported, partially supported (minor or moderate), or non-supported. Their flowchart approach allows assessments of the aquatic life uses to be completed based on water chemistry data alone, as is presently done in the San Francisco Bay Region. However, if bioassessment data are available that suggest uses are fully supported while the water data indicate non-support, then a determination of "partial/minor" is made. This determination

[2] EPA, 1997. Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates: Supplement, Appendix J, Example Description of State Assessment Methods, Illinois, p. 26-32.

[3] SFRWQCB, 1999. Bay Protection and Toxic Cleanup Program, Final Regional Toxic Hot Spot Cleanup Plan, San Francisco Bay Region, March 1999, p. 6-7.

reflects that the more direct measure, the bioassessment data, is a relatively better indicator of whether the aquatic life use is supported.

PROJECTED TASKS AND SCHEDULE

COMPONENT: REGIONAL BOARD 305(B) AND 303(D) GUIDELINES

Task	Estimated Completion Date
Establish Technical Advisory Committee	Oct. 1999
Draft 305(b) and 303(d) Guidelines	June 2000
Final 305(b) and 303(d) Guidelines	Sept. 2000
Application of Guidelines in 305(b)/303(d) Action	Feb. 2001

Classification Scheme for Waterbodies

The Basin Plan presently classifies waterbodies according to their names and groups them by drainage basins. Positive aspects of this system include its simplicity, its geographic reference, and its general classification of waterbodies (e.g., creek, reservoir, or bay). Past 305(b) water quality assessments have been based mostly on chemical, certain physical (e.g., temperature or turbidity), or microbiological water quality objectives, which have been applicable at generalized levels of "freshwater" or inland surface waters, and "saltwater" or enclosed bays, estuaries, and the ocean.

If future waterbody assessments are to be based on certain other physical and ecological measurements, however, benchmarks associated with these environmental indicators may need to be based on regional conditions more specific than "freshwater" and "saltwater." In its recent 305(b) guidance, EPA states that "a classification system that organizes waterbodies into groups with similar ecological characteristics is required to develop meaningful reference conditions.[4]" During the pilot phases of this Strategy, different classification schemes will be explored. Ultimately, a refined classification scheme should allow different reaches or tributaries in a watershed to be easily described using terms such as "urban (e.g., 25-50% impervious)" and/or "lower order (e.g., 1st to 3rd)." Physical data collected from pilot watersheds should be used to suggest distinct stream reaches within a watershed that may exhibit different levels of beneficial use support. Such distinctions will facilitate targeted management actions at the local level, based on a new regional, informational context.

[4] EPA, 1997. Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates: Supplement, p. 3-28.

Assessment of waterbodies with respect to biocriteria or certain physical criteria will necessitate establishment of reference conditions. Under EPA guidance, compliance with biocriteria is based on comparing appropriate biological metrics with a relatively undisturbed reference condition[5]. Based on existing data from the California Aquatic Bioassessment Workgroup for the Coastal Eco-region, reference conditions for first to third order streams is likely to be different than higher order streams on the Bay plain[6]. Under this system, a creek with an urbanized watershed would have a different benchmark than the same order of creek with a watershed that is mostly open space, reflecting the constraints of urbanization on biological integrity[7]. Data on urban creeks from around the Region will need to be collected and analyzed to ascertain appropriate benchmarks for biocriteria, estimated to take several years. Similarly, perennial creeks will have different physical and biological characteristics than intermittent or ephemeral creeks, and the biocriteria and certain physical criteria developed under this Strategy for these different types of waterbodies will reflect these differences. Many waterbodies in the Bay Area include relatively undeveloped headwater areas that become densely urbanized as they approach the Bay. Different reference conditions and benchmarks should apply to the different reaches of these waterbodies.

As data on creeks and watersheds from around the Region are collected, opportunities will arise to analyze data with respect to the degree and type of urbanization or agricultural development in a given watershed. As discussed below, impervious surface coverage in a watershed can be a measure of urbanization, and biological and physical data on streams can be grouped according to how much imperviousness is upstream of a given monitoring location. A number of studies completed in the last decade suggest that waterbodies can be classified according to the degree of urbanization or agricultural development upstream in the watershed, and goals of physical, chemical and biological integrity set according to this constraint[8]. Under the Strategy, the traditional approach to establishing reference conditions will be pursued, but exploration of alternative forms of reference conditions, for instance a fourth-order channelized urban creek, will be encouraged. In its 305(b) guidelines, EPA "recogniz(es) that pristine habitats are rare," and "resource managers must decide on an acceptable level of disturbance to represent an achievable or existing reference condition[9]."

In order to accommodate a range of reference conditions for specific types of waterbodies (e.g., first to third order creeks vs. fourth order and above, or urban vs. rural creeks), or within a single waterbody, the Basin Plan waterbody classification scheme will need to be expanded. For example, different biocriteria will likely apply for intermittent creeks with urbanized watersheds versus perennial creeks that drain predominantly open space areas. Certain physical and biological benchmarks should be established based on reference conditions, from a relative framework where waterbodies with similar watershed and flow characteristics are compared to common thresholds to assess use attainment or impairment. Similar to the 305(b) assessment

[5] Ibid.
[6] CDFG, 1999. An Index of Biological Integrity for First to Third Order Russian River Tributary Streams.
[7] Schueler, 1994. The Importance of Imperviousness. Watershed Protection Techniques. 1(3): 100-111.
[8] Ibid., and Schueler, 1995. The Peculiarities of Perviousness. Watershed Protection Techniques. 2(1): 233-239.
[9] EPA, 1997.

report itself, establishment of benchmarks will be iterative, based on collection and updates of information from the Region's watersheds.

PROJECTED TASKS AND SCHEDULE

COMPONENT: CLASSIFICATION SCHEME FOR WATERBODIES

Task	Estimated Completion Date
Identify Options for Classification	Nov. 1999
Draft Report on Preferred Classification Scheme	June 2000
Final Report on Preferred Classification Scheme	Sept. 2000

Information Management Plan

Because data and information management is critical to the success of this regional Strategy, another early task in the Strategy is to establish an information management plan (IMP). This plan will be based on review of existing capabilities (hardware/software, geographic information system) and identification of new opportunities. Of particular importance are geographic linkages of various data sets, and accessibility to information by decision-makers, technical staff, agency staff, and the general public. An important component of the plan will be ensuring that resources are dedicated to upkeep and maintenance of the information management system. This effort should be coordinated with the anticipated Statewide Monitoring and Assessment Strategy, if the latter effort is funded and organized on a statewide level.

The IMP will be important for the Regional Board to meet its obligations for the 305(b) water quality assessment. The Regional Board is required to use the GeoWBS (geographic waterbody system), a nationwide database operated by EPA, for the biennial 305(b) report. Under the IMP, the GeoWBS will be refined for this Region, and linked to local efforts. The IMP will enable the Regional Board to meet expectations for better documentation of 305(b) and 303(d) reporting and listing decisions, and will provide a linkage to the national GeoWBS database. As a result of this linkage, public access to administrative records, regulatory actions, and environmental data will be greatly enhanced. As opportunities to link with the national database are pursued, other linkages will be sought to efforts such as SFEI's EcoAtlas and RMP database, Central Coast Regional Board CCAMP and ambient monitoring databases, the Information Center for the Environment (ICE) at UC Davis, CalWater, and USGS NAWQA databases. These linkages will be sought as dictated by availability of resources.

PROJECTED TASKS AND SCHEDULE

COMPONENT: INFORMATION MANAGEMENT PLAN

Task	Estimated Completion Date
Identify Options for Database and GIS Approach	Nov. 1999
Select Information Management Scheme	Jan. 2000
Apply Information Management Plan for Pilot Watersheds	Ongoing

Pilot Watersheds

Implementation of the Strategy will be phased, due to the large number of waterbodies around the Region. Almost 300 distinct waterbodies are identified in the Basin Plan, and this list is not considered complete. For the next 305(b) report, the Strategy will be implemented on a pilot scale for selected watersheds. A set of environmental indicators will be developed, based on the Basin Plan and in collaboration with current monitoring and assessment efforts, discussed above and in Appendix A. An information management plan will also be established. Data will be screened for quality, compiled, data gaps identified, and preliminary assessments conducted. The pilots will be used to define preliminary reference ranges or thresholds, refine the Strategy, further evaluate resource needs for implementation, and to develop a schedule for ongoing implementation.

The pilot watersheds will be the primary focus for the next 305(b) report and 303(d) list of impaired waterbodies. As the Strategy is refined, the focus will be rotated to different watersheds around the Region, in consultation with stakeholders, for improvement of future 305(b) reports and 303(d) lists. The rotating approach is necessary because we do not expect that the Regional Board or partner agencies will have sufficient resources to apply the new monitoring and assessment tools in all watersheds at the same time. Furthermore, this phased approach allows for adaptive management of these tools as we learn from experience.

Selection of the pilot watersheds will be stakeholder-driven. Local governments, citizen monitoring groups, and scientists are in the best position to recommend pilot watersheds to the Regional Board, because of their knowledge of current monitoring and assessment efforts. The next Section of the Strategy, "Watershed Management Priorities," describes the suggested elements of information collection for pilot watersheds.

The phased monitoring and assessment information will be used to suggest regional priorities for water quality protection and improvement, and to implement the appropriate TMDLs for protection of the beneficial uses of the Bay, its tributaries, and coastal watersheds. This

information will also be used to amend as appropriate the Chapter 4 Implementation Plan of the Basin Plan.

PROJECTED TASKS AND SCHEDULE

COMPONENT: PILOT WATERSHEDS

Task	Estimated Completion Date
Establish Preliminary List of Pilot Watersheds	Oct.-Nov. 1999
Establish Monitoring Programs for Pilot Watersheds	Feb. 2000
Conduct Preliminary Assessments of Pilot Watersheds, Applying Selected Environmental Indicators and Waterbody Classification Scheme [305(b) Report]	Feb. 2001
Select Second Round of Pilot Watersheds	Apr. 2001

WATERSHED MANAGEMENT PRIORITIES

This Section of the Strategy highlights the Regional Board's priorities for monitoring and assessment, as they relate to watershed management in urban and rural areas draining to San Francisco Bay, Tomales Bay, the Pacific Ocean, and their tributaries. As such, this section provides guidance for monitoring and assessment programs in rotating pilot watersheds for the 305(b) assessment reports. To implement the Strategy, data collection efforts in pilot watersheds will need to respond to the topic headings in this Section. A pilot watershed should provide affirmative answers to the following questions:

- Will the watershed be mapped and the basic characteristics of the lands and drainage network described? Are different land uses and impervious surface coverage quantified?
- Does the monitoring program allow for the estimation of loads of pollutants of concern to San Francisco Bay, Tomales Bay or their tributaries? Will it facilitate the identification of sources and pathways for these pollutants?
- Does the monitoring program build upon and integrate existing monitoring and assessment efforts?
- Does the monitoring program test hypotheses of cause and effect with respect to water quality and/or habitat?
- Does the pilot watershed include an observation watershed? If not, does the monitoring program go beyond baseline monitoring and apply finer-scale analyses in strategic locations to

refine regulatory assessments, based on techniques developed in recognized observation watersheds?

For individual pilot watersheds, "no" answers to the above questions may be justified, but would warrant a review of the proposed monitoring program, because of inconsistency with the Strategy.

Observation Watersheds

Watershed analysis can be conducted at a wide variety of scales. Scientific analysis and research occurs at the finer spatial and temporal scales, while regulatory assessments tend to occur at coarser scales. If regulatory assessments are made that contain considerable uncertainty, then uncertainty can be reduced through application of finer scales of analysis, and regulatory assessments adjusted as appropriate.

The Strategy recognizes that rigorous scientific analysis of all watersheds in the Region is not economically feasible, and that regulatory assessments must still be conducted every other year. These regulatory assessments will continue to include considerable uncertainty unless there is an organized structure of scientific data collection and analysis to refine regulatory findings of beneficial use attainment and/or impairment.

Through implementation of the Strategy, three scales of watershed analysis will be established and recognized. At the broadest scale, all watersheds in the Region should eventually contain a relatively coarse, baseline monitoring program. The elements of this baseline monitoring program should be defined soon after the first iteration of the 305(b) assessment report, currently estimated to be completed by February, 2001. The most recent 305(b) assessment and 303(d) list of impaired waterbodies provide the current baseline monitoring program to which the first round of pilot watersheds will respond.

At the finest scale, a limited number of "observation watersheds" should be established for intensive, ongoing monitoring and empirical observations. These observation watersheds are necessary to develop and calibrate simulation models, develop field methods, train monitoring staff, evaluate BMPs, and track changes in ambient conditions. The observation watersheds should be strategically located throughout the Region, in order to capture a reasonable range of rainfall patterns and rural vs. urban watersheds. Due to the episodic nature of many environmental indicators in streams, especially associated with storm events, ongoing empirical observations at finer spatial and temporal scales are essential for the Strategy to achieve its purpose of improved technical content.

The third scale of watershed analysis is between the coarsest and finest scales, and associated with the pilot watersheds that are assessed using the rotating basin approach. As knowledge of this Region's watersheds grows through time, the findings from the observation watersheds should be extrapolated to pilot watersheds of each 305(b) assessment report, every other year, in order to refine assessments based on coarser scales of analysis. By implementing this adaptive approach, over time the water quality assessments will improve in technical content and become more useful in justifying regional policymaking to protect water quality.

Watershed Characterization and Mapping

In order to improve the technical content of the 305(b) assessment for streams, all watersheds in the Region need to be characterized. Enhancement of the Basin Plan's waterbody classification scheme will not be possible without basic characterization of the lands and drainage networks associated with each watershed. This basic characterization should be the first information collected in pilot watersheds for the upcoming 305(b) assessment.

Examples of basic characteristics are channel types, land use distribution, extent and type of riparian vegetation, number of impoundments and instream barriers, bridge crossings and culverts, locations of point source discharges, and upstream imperviousness. Basic characteristics of the watershed will suggest hypotheses regarding reach or tributary classification. Similarly, changes or gradients in the characteristics may suggest hypotheses regarding causes of any observed beneficial use impairment. Basic watershed characteristics should be mapped to facilitate presentation and analysis. Mapping approaches should be coordinated with the information management plan, to ensure data compatibility between pilot watershed efforts.

Sources, Pathways and Loadings

The assessment of loads of pollutants of concern to the Bay and Ocean is a focus of the Strategy. This aspect of the Strategy is essential for the development of meaningful load allocations to sources in various TMDLs. Loading approximations for various pollutants suggest that storm water runoff is a major source. Techniques for estimating loading are presently evolving, since loads of pollutants in storm water runoff are often episodic in nature. For the development of TMDLs, accurate pollutant mass budgets are needed for identifying pollutant sources and establishing wasteload and load allocations. Protocols for estimating pollutant loads will be included in the Regional Board 305(b) and 303(d) guidelines.

The Sources, Pathways, and Loadings workgroup of the RMP produced a draft report dated July 8, 1999, describing a strategy for satisfying certain management objectives of the RMP. These objectives relate directly to the third focus of this Strategy listed above – providing a functional

connection between the RMP and efforts to identify, eliminate, and prevent sources of pollution. The tasks recommended in this technical report are incorporated by reference into the Strategy.

Integration of Current Monitoring and Assessment Efforts

Integration of existing efforts is an important goal of the Implementation Plan of the Strategy. This integration will occur by focusing on a limited number of watersheds throughout the Region for each 305(b) report in a phased manner, creating stronger regional consistency over time. Internally, Regional Board staff has formed the Monitoring and Assessment Integration Team, composed of staff involved in different monitoring efforts, ranging from federal water quality databases to local creek stewardship groups.

Regional Board requirements under 305(b) and 303(d) provide an incentive for various existing monitoring and assessment efforts to adhere to regional standardized protocols, so that water quality regulatory decisions are based on consistent scientific information. In the last ten years, different monitoring and assessment efforts around the Region have advanced scientific knowledge of the Region's waterbodies along different lines of expertise (e.g., aquatic bioassessment, hydrogeomorphic analyses, tissue residue analyses, sediment toxicity, toxicity identification evaluations [TIEs], geographic information systems [GIS], organization and training of citizens for monitoring, etc.). Today there is an unprecedented opportunity for the Regional Board to draw on this newly gained expertise to fulfill its regulatory obligations and improve the technical content of its policies and regulatory actions.

Monitoring to Establish Cause and Effect

The Strategy prefers approaches to monitoring which test hypotheses about water quality responses to land use and watershed protection decisions. Such approaches allow monitoring information to provide feedback on the effectiveness of watershed protection policies, and concurrently to suggest changes in land use management that would improve water quality and beneficial uses. For a particular waterbody, example questions to be answered by monitoring efforts include:

- Is water quality and habitat improving? Getting worse? What are some of the possible reasons for the improvement or decline? What additional monitoring could help identify causes of water quality effects?
- Has implementation of certain best management practices (BMPs) in the watershed improved the physical, chemical, or biological integrity of the waterbody?

- Have land use changes or decisions resulted in detectable improvement or degradation in water quality of downstream waterbodies?
- Do local subdivision codes and zoning ordinances appear to encourage watershed protection? If water quality is impaired or declining, could changes in local codes and ordinances reverse the trend?

The first questions relate to status and trends monitoring, which should lead to cause and effect determinations. Trend data suggest hypotheses that can be tested by applying finer scales of analysis. Once likely cause and effect connections are identified, and BMPs or land use changes are subsequently implemented, the status and trends monitoring will show whether such control efforts are successful.

In order to test hypotheses regarding cause and effect, and begin to address questions such as those above, the Strategy will need established environmental indicators of physical, chemical, and biological integrity. At present, the Basin Plan contains some applicable chemical and microbiological indicators. The Strategy encourages development of a greater range of indicators to better address questions of physical and biological integrity.

At the national level, there is not universal agreement on how to assess water quality. One view is that water quality assessment should be done by a national statistical design with prescribed rules for the location and timing of sampling and uniform methods for analyses. A contrasting view is that each hydrologic system requires a custom-designed assessment that is based on its unique hydrologic features and human influences. As pointed out by USGS in its National Water Quality Assessment (NAWQA) program design, national statistical designs are best suited for monitoring large-scale water quality conditions that are persistent over time, but fall short in assessing short-lived conditions or explaining causes and effects[10]. The Strategy identifies monitoring as a tool to test hypotheses about cause and effect in order to suggest management decisions that will improve water quality and habitat conditions. Custom-designed assessment approaches are preferred for this reason, but also because monitoring site selection by statistical design can pose challenges regarding access to private property.

Recognize Imperviousness

Imperviousness, or the impervious surface coverage in a watershed, is important information for water quality assessment from two perspectives: (1) establishment of reasonable water quality and habitat goals for waterbodies with urbanized watersheds; and (2) identification of beneficial use impairment attributable to increases in impervious surface coverage, leading to implementation of

[10] U.S. Geological Survey, 1995. Design of the National Water Quality Assessment Program: Occurrence and Distribution of Water Quality Conditions. USGS Circular 1112.

appropriate mitigation measures. The first perspective conveys the importance of imperviousness in establishing useful benchmarks for various biocriteria and physical criteria, and implies that the waterbody classification scheme of the Basin Plan consider upstream imperviousness. In establishing attainable benchmarks for biocriteria, it may be desirable to utilize and clearly define terms such as "urban creeks" and "rural creeks" based on impervious surface coverage in the watershed.

With regard to the second perspective, there may be no stronger forcing mechanism in the Region's watersheds than the effect of imperviousness on highly variable streamflow patterns, flooding hazards, pollutant conveyance and loading, groundwater recharge and its relation to stream discharge, and anthropogenic (human-caused) sedimentation. These five conditions, in turn, exhibit adverse effects on beneficial uses such as cold freshwater habitat (COLD), ocean, sport and commercial fishing (COMM), water contact recreation (REC1), estuarine habitat (EST), fish migration and spawning (MIGR and SPAWN), preservation of rare and endangered species (RARE), and municipal domestic supply (MUN), to name a few examples.

Technical studies by organizations such as the Center for Watershed Protection have demonstrated a cause and effect relationship between impervious surface coverage in a watershed and the existing and potential biological health of a stream, as measured by various biological indices, based on review of studies throughout the nation[11]. In other words, the best possible aquatic biological community, in terms of biodiversity and abundance of organisms, is ultimately limited by the amount of impervious surface coverage in its surrounding watershed.

The strong correlation of imperviousness with the biological potential of a waterbody underscores its significance in establishing benchmarks for biocriteria, and perhaps for how watersheds and/or waterbodies are classified in the Basin Plan. In addition to flow characteristics, the determination of the appropriate benchmark for biological criteria in a given stream, compared to the appropriate reference condition, should account for the percent of the upstream watershed that is impervious. In this way, urban creeks will not be unrealistically compared to open space creeks in determining the attainment of the appropriate water quality standard pursuant to Section 305(b). Based on EPA's definition of biocriteria, the urban creek is still compared to the same reference condition as a non-urban creek with similar physical characteristics. But the non-urban creek may need to attain an "excellent" rating to support its aquatic life use (e.g., fish spawning), while the urban creek may only need to attain a "fair" rating, after considering the bioassessment and channel morphology data from defined urban creeks around this Region.

In certain agricultural developments, for instance vineyards, shallow ground water is typically routed off sites through networks of underdrains. As a result, storm water from these sites is moved quickly into adjacent streams much like that from paved urban areas. Although this runoff may not contain the pollutant levels of urban runoff, it leads to other impacts such as those

[11] Schueler, 1994, and Schueler, 1995.

described below for imperviousness. For these reasons, certain agricultural developments in watersheds should be considered analogous to impervious cover, and mitigation measures should be developed to address their impacts to water quality and beneficial uses.

Imperviousness Impacts and Mitigation

The correlation of biological indices with imperviousness is a reflection of the numerous impacts that imperviousness produces in stream systems. Imperviousness in a watershed facilitates the transport of pollutants to creeks and the Bay. Pollutants associated with vehicles and other atmospheric deposition are hastened to waters of the State by concrete, asphalt, and rooftops in the watershed. As a result of restricting infiltration into the groundwater, imperviousness alters the natural hydrograph of a watershed, sometimes eliminating perennial flows, and creating flashier, intermittent streams with higher peak flows. The higher peak flows, in turn, may cause downcutting of stream channels or bank erosion, and subsequent anthropogenic sedimentation. Sedimentation of streams adversely affects various aquatic organisms and life stages of sensitive fish species. In summary, impervious surfaces in a watershed introduce multiple stressors on aquatic ecosystems. Consequently, efforts to improve the physical, chemical, and biological integrity of the nation's waters, the goal of the Clean Water Act, must explicitly address imperviousness.

Although imperviousness limits the health of aquatic ecosystems, a number of tools are available to mitigate the adverse effects of imperviousness on beneficial uses. For example, many communities throughout the nation have established land development requirements that provide buffers around streams (riparian habitat corridors), leading to greater abundance and diversity of plants and animals. Swales and retention ponds in urban landscapes can increase groundwater infiltration and reduce pollutant levels in runoff. In many cases, alteration of certain local building and planning codes may significantly reduce the impacts of imperviousness on a watershed scale[12]. In instances where imperviousness is clearly impairing beneficial uses, such mitigation measures may ultimately become requirements of watershed management plans developed to protect and enhance those uses.

CONCLUSION

The Regional Board aims to improve decision-making by working with stakeholders to establish a systematic approach to developing its policies and regulatory actions, incorporating biological and physical measurements in addition to the traditional reliance on chemical measurements. Improved assessment techniques and reports will help to better focus program implementation on

[12] Center for Watershed Protection, 1998. Better Site Design: A Handbook for Changing Development Rules in Your Community.

water quality problems that remain in this Region. The following water quality problems are examples of what regional monitoring and assessment, and subsequent program implementation, are intended to address:

- Water pollution from vehicles and atmospheric deposition
- Water pollution specific to various land uses in a watershed
- Water pollution from various agricultural sources
- Pathogens in recreational waters
- Fish and shellfish contamination by bioaccumulative substances
- Aquatic habitat degradation
- Riparian habitat degradation
- Wetland habitat degradation
- Barriers to fish migration
- Increased stream temperatures
- Special status aquatic species
- Anthropogenic sedimentation
- Increased flooding hazards
- Streambank Instability

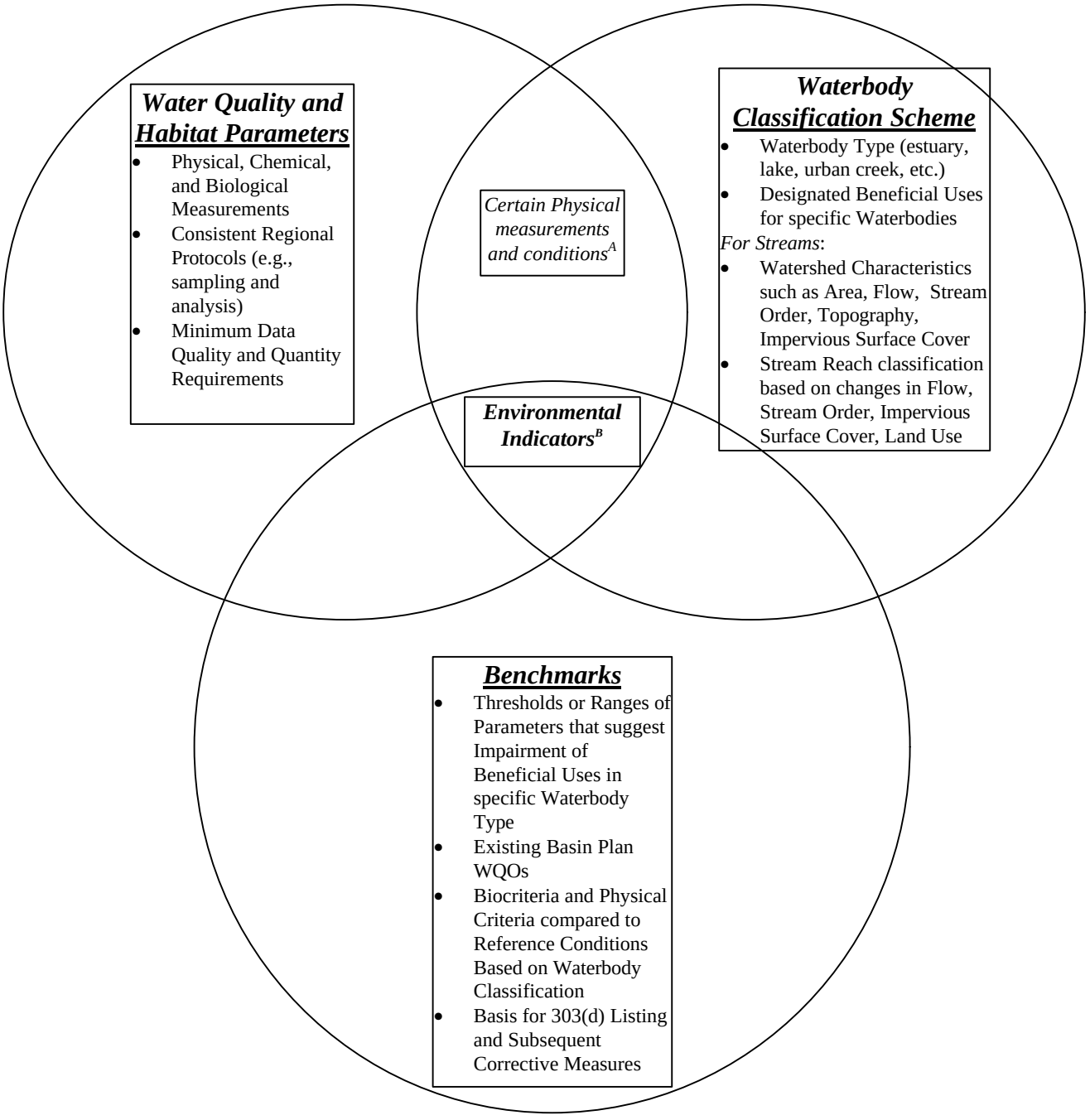
Through implementation of the Strategy, the aim is to bring attention to and ultimately implement solutions to remaining regional water quality problems by identifying and addressing their true root causes. Carefully planned monitoring in the Region's watersheds will demonstrate linkages between beneficial use impairments and the land and water use decisions or factors that cause or contribute to them. Demonstration of these linkages is necessary to justify any Regional Board policies or actions that will move the Region forward in terms of solving remaining water quality and habitat problems. With its regional context, the Strategy will also assist in the creation of realistic water quality and habitat goals for watersheds that consider the physical constraints of urbanization and fabricated stream modifications. Concurrently, the Strategy will identify areas that exhibit exceptional water quality and high quality habitat, and will provide a scientific basis for protection of such regionally significant resources.

Successful implementation of solutions to remaining water quality problems will require cooperation among many entities that traditionally may have not worked together. The Regional Board recognizes that solutions to many of the remaining water quality problems in our Region are dependent on actions that fall outside of the Board's regulatory authority. The ways we develop our communities, through land use planning and management, have profound effects on beneficial uses and flood management. The conditions of waterbodies are influenced by

management of open space areas (e.g., grazing, recreation, or agriculture) as well as through the introduction of impervious surfaces or agricultural underdrain systems and the many resulting effects. Site development requirements at the local level can translate to impervious surface construction that exacerbates flooding and beneficial use impairment of streams. Open space management decisions such as intensive recreational use or cattle grazing can also result in beneficial use impairment and incremental increases in flooding risk.

Land use decisions and requirements are under the jurisdictions of many agencies such as planning departments, public works departments, park districts, flood control districts, and stormwater agencies. Solutions to many remaining water quality challenges will not be possible without active cooperation between the Regional Board, these public agencies, and a number of private entities. The Strategy provides a basis for such a partnership, allowing for extensive public input and adaptive management based on what we collectively learn about the Region's watersheds and the Bay. Information collected and synthesized under the Strategy will provide a basis for changing the way we develop and manage our communities, for the benefit of the state's waters and all of the people, fish and wildlife that use them.

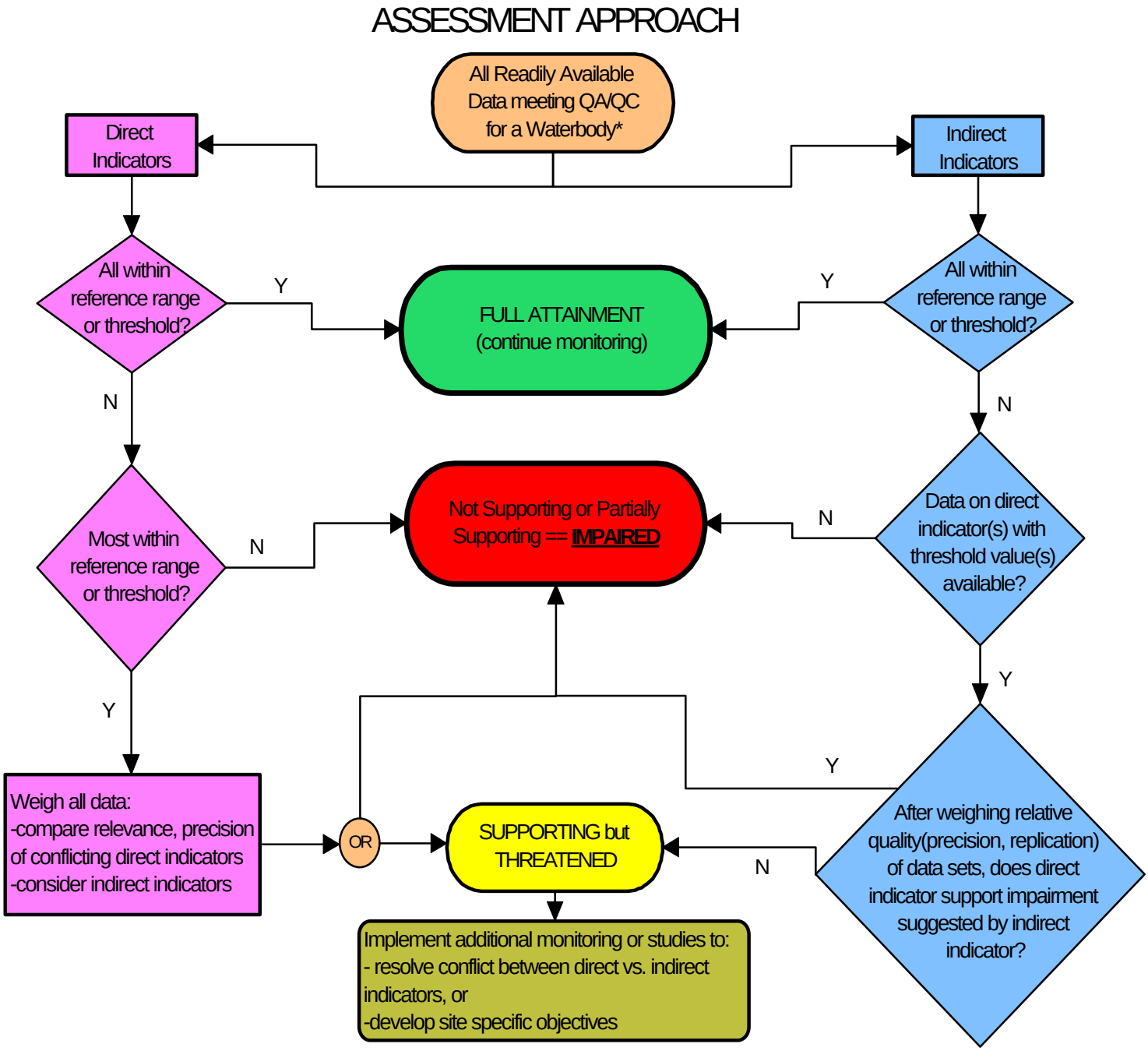
FIGURE 1 – ENVIRONMENTAL INDICATORS: COMPOSITES OF PARAMETERS, WATERBODY CLASSIFICATION, AND BENCHMARKS



A Physical measurements of streams or watersheds, such as streamflow, degree of channelization, stream order, gradient, number of impoundments, upstream imperviousness, etc., can aid in classifying streams and stream reaches, and developing the appropriate indicators for the different reaches or tributaries.

B Environmental indicators for various waterbodies consist of the measured parameter, the beneficial use that is being protected, the waterbody type, and the threshold or range that signals impairment of the specific use in the specific waterbody type. For example, chemical concentrations of copper to protect aquatic life in saltwater waterbodies (estuaries) will differ from copper concentrations to protect drinking water supplies in streams, reservoirs and ground water basins.

FIGURE 2



*Data collected at another waterbody may used in the assessment of a different waterbody if there is good reason to believe those data are representative of other similar waterbodies.

APPENDIX A

CURRENT MONITORING AND ASSESSMENT EFFORTS

1. Regional Monitoring Program (RMP)

The Strategy should include the Regional Monitoring Program for Trace Substances (RMP). The RMP is focused on the main Bay segments and is funded by the major dischargers and dredgers in the Region. San Francisco Estuary Institute (SFEI) administers the program, and produces annual data reports on various trace metals and organics, supplemented by special studies on subjects such as toxicity or phytoplankton. In 1998, after five years of data collection using advanced analytical techniques, the Regional Board used data from this regional effort to refine the 303(d) list of impaired waterbodies, with regard to Bay segments. This cooperative effort provides a successful multi-agency model that the Strategy can build on. It also generates water quality information for the Bay that suggests priorities for pollutant reductions from the surrounding watershed. An objective of the Strategy is to link watershed monitoring to this aspect of the RMP, which should eventually generate mass loading estimates from the watershed in support of TMDL development for pollutants that impair the beneficial uses of the Bay.

The design of the RMP is currently under review, and several workgroups are completing reports in key areas such as pesticides, metals sources and loadings, fish contamination, sediment contamination and chlorinated hydrocarbons. Under guidance from the RMP Steering Committee and Technical Review Committee, reports from these workgroups will be synthesized, and priorities will be set for trend monitoring and special studies. The RMP monitoring plan will be modified to incorporate the recommendations from the RMP review process, estimated to be implemented by 2002. Consistent with the Strategy, this review process is an important opportunity to align bay and watershed monitoring efforts to support key management decisions, thereby improving the technical content of Regional Board policies and regulatory actions.

2. Santa Clara Basin Watershed Management Initiative (SCBWMI)

The SCBWMI is a pilot effort initiated by Board staff in 1996, whose participants include a broad range of stakeholders. The SCBWMI is presently drafting a watershed assessment report on certain watersheds that drain to South San Francisco Bay. Stakeholders are establishing environmental indicators and monitoring parameters and protocols. This stakeholder-driven process will generate watershed assessment findings that will contribute to the regional effort of the Strategy, and provide an opportunity to examine existing watershed monitoring data in the context of beneficial use assessment. In the context of the Strategy, this effort is a *de facto* "pilot project."

3. Watershed Assessment Resource Center (Volunteer Monitoring)

In late 1998, the Friends of the Estuary initiated an effort to establish the Watershed Assessment Resource Center (WARC) beginning in July 1999, with an aim to provide consistent technical information and advice to various volunteer monitoring groups focused on creeks around this Region. Both the Regional Board and the Bay Area Stormwater Management Agencies Association (BASMAA) have shown a commitment to enabling volunteer monitoring programs and using their data to inform decision-making processes. To inform the Regional Board's processes, described above under

"Continuous Improvement of Regional Board Policies and Regulatory Actions," regional coordination of volunteer monitoring activities is a high priority. The San Francisco Estuary Volunteer Monitoring Steering Committee is pursuing a partnership with BASMAA to clearly define the roles of volunteer monitoring groups and storm water agencies. In the context of the Strategy, the WARC will play a vital role in the translation of volunteer monitoring data to regional water quality decision-making.

4. BASMAA Regional Monitoring Strategy (BRMS)

The BRMS was recently developed by BASMAA in cooperation with the Regional Board to increase the efficiency and usefulness of monitoring conducted by individual storm water programs. The BASMAA Board formally adopted the BRMS in February 1998. The BASMAA Board has approved the support document for the Strategy as a final document, though not formally adopted. The BRMS strategic objectives are intended to provide a manageable number of issues on which to focus storm water monitoring resources. The current Strategic Objectives are:

1. Design and initiate a survey of impacts of storm water on beneficial uses
2. Research loads to San Francisco Bay of storm water pollutants
3. Evaluate effectiveness of storm water pollution control Best Management Practices (BMPs)

Note that the first two strategic objectives correspond directly to the three areas of focus for the Strategy, listed above. Also, Objective 1 is considered the highest priority of the three, and will focus on the development of environmental indicators and associated monitoring parameters and protocols.

The BRMS is in its early stages, and studies to support its Strategic Objectives may appear disparate at this time. Nevertheless, BASMAA expects the Annual Status Reports to evolve from a series of snapshots of individual studies into a clearer representation of regional storm water issues as these studies are analyzed and synthesized over time. The Strategy should build on the regional management and coordination structure achieved by the BRMS and link it to other existing efforts. For instance, in order to carry out the CWA mandate of TMDL development for several pollutants of concern in the Bay, there needs to be a linkage between the BRMS, to estimate pollutant loads from urban runoff or storm water sources, and the RMP, which measures pollutant levels in the Bay's water, sediment, and biological tissues. Implementation of the BRMS is expected to include an inventory and assessment of urban watersheds throughout the Region.

5. Watersheds Science Approach (WSA)

The Watersheds Science Approach (WSA), version 3.0, was published in September 1998 by SFEI, who is overseeing several pilot efforts on watersheds around the Bay Area such as Wildcat Creek in Contra Costa County, Miller Creek in Marin County, and Permanente Creek in Santa Clara County. This approach was originally published in December 1996, and continually improved since that time, in order to develop a "regional approach of watershed science...needed to coordinate among the various efforts of government to

assess and report on the health of the watersheds." The approach attempts to integrate "individual scientific disciplines that contribute to a better understanding of the physical, biological, and social relations among terrestrial and aquatic environments." The WSA includes a recommendation that the historical ecology of a watershed is needed to understand the relative influences of natural processes and human operations on watershed conditions.

The WSA recognizes that characterization of watersheds around the Region is presently conducted in a fragmented, uncoordinated manner, and through pilot efforts has begun to establish standardized protocols that will be comparable region-wide. The comparability will increase as more pilot efforts are successfully implemented. The Strategy will incorporate these valuable studies and highlight WSA analyses that show promise for better decision-making with regard to beneficial use protection and improvement.

The WSA establishes certain watershed terminology in its Appendix III that may be helpful to develop regional consistency in use of terms. Scientific classification of watershed reaches is based on surface flow patterns, movement of sediment, and geomorphic form. Classification of watersheds is based on the order (1st, 2nd, 3rd, etc.) of channel, connectedness to the estuary, and the degree or kind of management, such as whether there are reservoirs, storm drains, concrete channels, or water imports/exports.

The watershed and reach classification systems in the WSA are not easily translated to the waterbody classification system of the Basin Plan, which is based on waterbody names. However, the WSA classification information will promote the understanding of basic watershed functions and the establishment of regional reference conditions, or realistic goals or mandates for a specific watershed.

6. Bay Area Stream Protection Policy

The Regional Board has begun development of a Bay Area Stream Protection Policy. The first phase is the development of a comprehensive policy, including a technical framework for linking qualitative beneficial uses to relatively quantitative stream functions (i.e., physical environmental indicators). It will also include recommendations for protecting the beneficial uses, and recommended management practices for minimizing impacts to streams and stream corridors. The policy will be developed in coordination with stakeholders, and an advisory group of local experts will be identified to support development of interim products. Expected outcomes include:

1. A summary of existing literature on beneficial uses and stream functions;
2. a document linking beneficial uses to stream functions specific to the Bay Area;
3. development of criteria (i.e., recommendations) for best management practices to protect beneficial uses;
4. a document outlining criteria (i.e., recommendations) for protection of beneficial uses of streams specific to the Bay Area.

There is considerable overlap in the scope of the Stream Protection Policy and the Strategy. Both efforts seek to link the Regional Board's mission to protect beneficial uses with quantitative parameters, such as environmental indicators and stream functions, which include physical, chemical, and biological measurements. Physical and ecological measurements, in particular, represent new types of information to be considered by the Regional Board in its 305(b) water quality assessment and 303(d) listing of impaired waterbodies.

7. California Aquatic Bioassessment Workgroup (CABW)

The mission of the CABW is to promote the use of biological information in the evaluation of the integrity of aquatic systems. A major component of the evaluation of biological integrity is the use of Rapid Bioassessment Protocols (RBPs). Rapid Bioassessment Protocols (as defined by the U.S. Environmental Protection Agency) provide a useful, cost-effective method for identifying impacts and sensitive aquatic habitats, and for monitoring the effectiveness of watershed restoration programs.

The California Aquatic Bioassessment Workgroup was formed in 1994 to coordinate scientific and policy-making efforts towards implementing aquatic bioassessment in California. Members of the CABW consist of biologists from universities, consulting firms and industry, and representatives of state and federal agencies responsible for assessing, monitoring and protecting the biological integrity of surface waters. Through its Steering Committee and annual meetings, CABW participants develop objectives and strategies for implementing aquatic bioassessment in California.

Specific objectives of the CABW include:

1. Apply consistent, sound methodological approaches to aquatic bioassessment by:
- defining and testing sets of procedures for sampling aquatic communities;
- establishing reference conditions;
- developing quality assurance and quality control procedures;
- advancing analytical procedures, such as effective use of appropriate metrics and indices; and
- coordinating and cooperating with each other and other monitoring partners to reduce duplication of effort and expand bioassessment opportunities.

2. Provide a mentor and support network concerning technical and professional issues for workgroup participants.

3. Facilitate communication by:
- enhancing interagency cooperation;
- providing an electronics communication platform;
- disseminating pertinent technical literature; and
- promoting discussion of findings and bioassessment issues.

4. Promote the incorporation of usable quality-controlled data gathered by volunteer monitoring groups into agency bioassessment programs.

The CABW is sponsored by the Department of Fish and Game, the State Water Resources Control Board, and the U.S. Environmental Protection Agency.

8. Other Monitoring and Assessment Efforts

Other Monitoring and Assessment Efforts to be integrated into the Strategy include data from the Bay Protection Toxic Cleanup Program for characterization and cleanup of toxic hot spots (BPTCP), the Long Term Management Strategy for dredge material disposal (LTMS), the Toxic Substance Monitoring Program of pollutant levels in fish and other aquatic organisms in fresh water systems, the Mussel Watch Program for accumulation of pollutants using resident and transplanted bivalves, the Comprehensive Monitoring, Assessment and Research Program (CMARP) under CALFED, various flood management agencies' monitoring of flow and sediment, numerous research-level studies conducted by the U.S. Geological Survey (USGS) such as the National Water Quality Assessment (NAWQA), the National Oceanic and Atmospheric Administration (NOAA), and local universities. Monitoring information from the Sacramento River Watershed Program will support estimates of pollutant loading from outside of this Region. The recently completed Baylands Ecosystem Habitat Goals report, dated March 1999, contains monitoring recommendations that may be valuable in assessing beneficial use attainment and impairment in the wetlands associated with certain waterbodies. The Coastal Confluences Ambient Monitoring Program (CCAMP), led by the Central Coast Regional Board (Region 3), provides a model for organizing ambient monitoring in this Region, and is an important effort with which the RMAS should be closely linked.

9. Regional Coordination of Flood Management Agencies

Regional Coordination of Flood Management Agencies is desirable for the Strategy to achieve its purpose. Presently, such coordination has not formally occurred, although a comparable committee exists under BASMAA, composed of representatives of some flood management agencies of the Region. This committee, known as the Operational Permits Committee, has met intermittently to strategize for the 404/401 permitting process, particularly with respect to performing maintenance of engineered flood control channels, which includes removal of sediment and vegetation from waters of the state. These maintenance practices, once considered routine, have been recently questioned due to impacts on natural resources, and consequently, 404/401 permitting has become a difficult and lengthy process. The second phase of the Bay Area Stream Protection Policy endeavors to streamline this permitting process for the benefit of both public safety and natural resources.

A critical parameter for regional monitoring is water quantity per unit time, or flow. Flow strongly influences such processes as pollutant loading and transport, aquatic habitat integrity, erosion of streambanks, anadromous fish migration, and flooding hazards. Until the late 1980s, the U.S. Geological Survey operated stream gauging stations throughout the Region, providing daily flow measurements at several locations along major

watercourses. Since USGS funding for this program was terminated last decade, some flood management agencies have continued to collect flow and sediment information from the USGS and other gauging stations for the purpose of managing flood hazards. For this reason, flood management agencies are a likely partner in the region-wide standardization and coordination of flow and sediment monitoring.

TABLE 1 - EXISTING EFFORTS TO INTEGRATE INTO THE STRATEGY

EXISTING PROGRAM EFFORT	MAIN AGENCIES & ENTITIES	STRATEGIC ELEMENTS
Regional Monitoring Program for Trace Substances (RMP)	SFEI, RWQCB, BADA (larger point source municipal dischargers), Medium and Small POTWs, Industries, Dredging Interests, BASMAA	• Region-wide coordination of Bay data collection • Technical Advisory Panels • Use of Data to conduct Waterbody Assessments • Regional data collection does not unduly expose one or few entities to liability
Watershed Management Initiative, Santa Clara Basin (SCBWMI)	RWQCB, USEPA, Cities, County, Water District, Non-governmental Organizations (NGOs)	• Stakeholder-Driven Process • Coordination on basin level • Integration of several programmatic elements (NPDES point source, urban runoff, 401 wq cert., ESA)
Watershed Assessment Resource Center (WARC - formerly Volunteer Monitoring Center)	RWQCB, Friends of the Estuary, BASMAA reps., NGOs	• Region-wide Coordination • Systematic incorporation of citizen-based monitoring efforts
BASMAA Regional Monitoring Strategy (BRMS)	RWQCB, BASMAA Monitoring Committee, NGOs	• Region-wide Coordination (almost?) • Opportunity to use information collected to conduct Waterbody Assessments [305(b) reports] • Opportunity to provide information on pollutant loading for Bay TMDLs • Use of impervious cover and other watershed alterations to establish defensible reference conditions
SFEI Watersheds Science Approach (WSA)	SFEI, NGOs	• Science-based approach to watershed assessment • Detailed suggestions on hydrogeomorphic indicators (i.e., physical parameters) and historical ecology
Bay Area Stream Protection Policy - Component 1	RWQCB, SWRCB, USEPA (thus far) FY 1999-2000 104(b)(3) grant	• Linkage of beneficial uses with stream functions • Recommendations for protecting stream beneficial uses
California Aquatic Bioassessment Workgroup (CABW)	CDFG, USEPA, SWRCB, RWQCB, Universities, NGOs	• Statewide coordination and linkage with universities and citizen monitoring • Detailed suggestions on biological indicators (i.e., biological measurements in streams)
BASMAA Operational Permits Committee[14] Bay Area Stream Protection Policy - Component 2	Flood Management Agencies SWRCB, RWQCB	• Regionally consistent collection of flow data • Regional coordination of permitting for O&M activities

[14] The Operational Permits Committee of BASMAA may provide a forum, but the committee has not considered its role in the Strategy at this time.

APPENDIX B

GLOSSARY OF TERMS

TERM	DEFINITION
Antidegradation	Refers to actions taken to maintain existing uses and the level of water quality necessary to protect those uses in the Nation's waters.
Benchmark	A threshold or range of a specific water quality or habitat parameter that signals impairment of a beneficial use.
Beneficial Use	Regulatory definitions of the resources, services, and qualities of specific waterbodies that are the ultimate goals of protecting and achieving high water quality (e.g., commercial and sport fishing, swimming, aquatic life protection, drinking water supply, etc.).
Bioassessment	A tool for evaluating the biological integrity of a waterbody and its watershed, using surveys of the organisms living in the waterbody.
Biocriteria	Threshold levels or regulatory guidelines based on the premise that the condition of biota inhabiting waterbodies provides a useful baseline measure of water resource quality.
Environmental Indicator	A composite of a water quality or habitat parameter and its benchmark pertaining to a specific beneficial use and waterbody type (e.g., chemical concentration of copper in a freshwater waterbody that is protective of the waterbody's aquatic life).
Heuristic	Stimulating interest as a means of furthering investigation.
Physical Criteria	Threshold levels or regulatory guidelines based on the premise that the physical dimensions and characteristics of stream channels provide a useful baseline measure of water resource quality.
Reach	Segments of a stream, defined as the length of the stream channel between landmarks, such as confluences, bridges, culverts, or other changes in the landscape (e.g., dams, change in land use, etc.).
Reference Conditions	An aggregate of data best acquired from multiple sites with similar physical dimensions, representing minimally impaired conditions, and providing an estimate of natural variability in biological condition and habitat quality.
Water Quality Objective	Numeric thresholds or narrative descriptions of water quality used by the State to define appropriate levels of environmental quality and to control activities that can adversely affect aquatic systems.

Water Quality Standard	For a specific waterbody, the federal standard includes the designated beneficial uses, any water quality criteria adopted as State water quality objectives (WQOs) required to attain those uses, and the State's antidegradation policy, which requires maintenance of the level of water quality in state waters that currently attain uses and WQOs (State Board Resolution No. 68-16). The 305(b) report assesses waterbodies with respect to the federal standard.
Watershed	Lands that drain to a common place. As physical systems, watersheds consist of hillslopes, valleys, and drainage networks.