Role of Science and Engineering in Decision-Making within California's State and Regional Water Boards

Appendix A

September 2005

APPENDIX A

Projects:

Water Rights:

APPENDIX A – 1

NPDES Permit & Monitoring Program for the City of San Diego's Point Treatment Plant

Role of Science & Engineering in the Decision-Making of the Water Boards (R-9)

Plan, Policy, Program (**where** science is used)	Science & Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to improve)
Permitting. Reissuance of the NPDES permit and monitoring program for the discharge from the City of San Diego's Point treatment plant to the Pacific Ocean. The Regional Board adopted the reissued permit on April 10, 2002.	Biology, chemistry, math, statistics and modeling, bacteriology, and microbiology.	a. <u>Development of tentative effluent and receiving water limitations.</u> Data from regional ocean monitoring studies was evaluated to aid in determining reasonable potential for various constituents to be discharged. Chemistry, math and statistics drove the determinations. A model was used to determine the initial dilution of wastewater to the Pacific Ocean. The initial dilution and the Ocean Plan standards were used in determining tentative concentration and mass emission rate based effluent limitations.	The Southern California Coastal Water Research Project (SCCWRP), a joint powers organization conducting research in marine waters, led multi-agency (including the Regional Board) effort to conduct comprehensive assessments of ocean conditions in the Southern California Bight in 1994, 1998 and 2003. Ongoing studies are planned at five-year intervals. The State Board has provided the Regional Board with a model for determining the initial dilution of ocean outfalls. The "California Ocean Plan" is a statewide	Allocate/provide additional resources to allow development of better documentation for tentative permits that explains the basis and rationale for all permit requirements including monitoring Involve all stakeholders early in the process so they understand the science behind and the rationale for all requirements Improved in-house capability to conduct economic analyses of proposed permit conditions and monitoring requirements/ frequencies.

		Math, statistics and modeling drove the determinations. b. <u>System-wide solids calculations</u>. Equations were developed for determining total solids discharged from the entire City of San Diego's wastewater system. Math, statistics and modeling drove this decision. c. <u>Development of tentative effluent, receiving water and special studies monitoring programs</u>. Data from regional ocean monitoring studies and the Model Monitoring Program developed by SCCWRP were used in preparing tentative influent, effluent and receiving water monitoring and special studies	policy adopted by the State Board. It provides water quality standards and guidance for implementing the standards when preparing discharge permits. The Model Monitoring Program was prepared by SCCWRP, in cooperation with the Southern California coastal Water Boards and large ocean discharging POTWs in the Southern California Bight. The Model Monitoring Program provides a framework for developing effluent, receiving water and special study monitoring programs for the ocean discharges by the City of San Diego, City of Los Angeles, Los Angeles County Sanitation Districts and Orange County Sanitation Districts.	

NPDES Permit & Monitoring Program for the City of San Diego's Point Treatment Plant

Role of Science & Engineering in the Decision-Making of the Water Boards (R-9)

		Specifications were developed for water quality sampling, microbiological sampling, sediment monitoring, fish and invertebrate monitoring, and kelp bed monitoring. Special studies were proposed requiring 1) independent scientific review of the ocean monitoring program, 2) sediment mapping to evaluate impacts on benthic communities, and 3) remote sensing to identify and track fate and transport of the wastewater discharge in the ocean environment. Biology, chemistry, math, statistics and modeling, bacteriology, and microbiology informed the decisions on the tentative monitoring requirements.		

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"Renewal of an NPDES permit for Ventura Water Reclamation Facility (VWRF) and demonstration of enhancement of the Santa Clara River Estuary due to discharge of tertiary effluent"

Role of Science & Engineering in the Decision-Making Processes of the Waterboards (R-4)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendation (how to improve)
"Renewal of NPDES permit **for Ventura Water Reclamation Facility** (VWRF), including studies to determine if enhancement of the Santa Clara River Estuary is occurring due to discharge of tertiary effluent" Due to the more stringent water quality objectives contained in the California Toxics Rule, the City of San Buenaventura's VWRF discharge has not been able to comply with NPDES permit limits for several metals (copper, nickel, lead, zinc). In addition, the Water Quality Control Plan for the Enclosed Bays and Estuaries of California (Resolution 95-84) prohibits the discharge of municipal wastewater to enclosed bays and estuaries unless the Regional Board finds that	The discharger has conducted several studies in order to demonstrate that the San Buenaventura wastewater discharge enhances the Santa Clara River Estuary and does not adversely impact water quality, including: a. Hydrology Modeling to demonstrate that the wastewater discharge replaces historical upstream freshwater diversion losses to the estuary; b. Resident Species study to show that a healthy and appropriate biological community inhabits the estuary; c. Toxicology studies to show that the metals concentrations in the discharge do not produce sediment or water column toxicity in the estuary; d. Metals Translator	In conformance with the Enclosed Bays and Estuaries Policy, the discharger must demonstrate that the discharge of treated wastewater enhances conditions in the estuary. Scientific studies will be used to show that water quality within the estuary is better with the presence of the treated wastewater discharge than it would be without it, and that habitat conditions for aquatic organisms are better as a result of the discharge. If the discharger cannot meet all of the metals criteria derived from the California Toxics Rule, one option is to develop site specific objectives for certain constituents. However, the Regional Board requires scientific evidence that less	The scientific and policy issues arising during the renewal of the NPDES permit are complex and could have significant economic implications for the City of San Buenaventura. The City has relied upon a consultant to produce the scientific studies that will be used to form the basis for a Regional Board decision later this year. The City and Regional Board staff consulted with federal and state resource agency staff to develop an appropriate workplan prior to conducting these scientific studies. Prior to holding a Board hearing, the results of the studies will be reviewed and discussed by a stakeholder committee consisting of resource agencies and other interested parties, including local environmental groups and members of the academic	The Enclosed Bays and Estuaries Policy does not describe a precise method by which enhancement should be demonstrated. It would be useful to establish such a method to ensure consistent application of the policy. The Regional Board does not have the resources to allow for peer-review of the technical merit of proposed scientific studies or evaluation of the data and conclusions from such studies. It would be useful to create an advisory panel for this purpose. The Regional Board also lacks the resources to conduct independent scientific studies in most cases. It would be desirable to have an available source of contract money for

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendation (how to improve)
the wastewater in question would be treated and discharged in such a manner that it would enhance the quality of receiving waters above that which would occur in the absence of the discharge. The City's demonstration of enhancement was conducted twenty years ago, so the Regional Board is requiring verification of this enhancement demonstration using current scientific methods for evaluation. Under Regional Board oversight and with input from resource agencies and other interested parties, the City conducted several scientific studies in the Santa Clara River Estuary and its watershed (Resident Species, Metals Translator, Toxicology, Hydrology Modeling) to	study to support development of appropriate NPDES limits for metals.	stringent effluent limits would be protective for aquatic life and other beneficial uses. Scientific toxicological studies will be used to show that such site specific limits would not produce sediment or water column toxicity within the estuary. According to federal regulation (40 CFR 122.45c), NPDES permit limits must be expressed as total recoverable metals. However, science has shown that because there are chemical differences between discharged effluent and receiving water conditions, changes may occur in the partitioning of metals between total and dissolved forms. A metals translator	community.	such purposes. In some cases, the Regional Board does not possess the specialized technical expertise needed to address certain scientific issues (e.g., we do not have specialists in risk assessment or toxicology). It would be useful to establish a mechanism to allow us to consult with experts in other state, federal or local agencies.

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"Renewal of an NPDES permit for Ventura Water Reclamation Facility (VWRF) and demonstration of enhancement of the Santa Clara River Estuary due to discharge of tertiary effluent"

Role of Science & Engineering in the Decision-Making Processes of the Waterboards (R-4)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendation (how to improve)
guide Regional Board selection of appropriate water quality standards to set NPDES effluent limits for the VWRF discharge and to demonstrate whether the discharge enhances water quality conditions and biological communities within the estuary.		answers the question: What fraction of metal in the effluent will be dissolved in the receiving water body, and therefore bioavailable? This scientifically-derived translator allows for calculation of effluent metals limitations that more accurately reflect probable impacts to aquatic life in the estuary.		

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Power Plant Permitting in Coastal Waters

Role of Science & Engineering n the Decision-Making of the Water Boards (R-3)

Plan, Policy, Program (**where** science is used)	Science - Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to improve)
Power Plant Permitting	Biological assessments, ecological systems (large scale biological), fisheries, DNA analysis, estuarine hydrodynamics, geomorphology, and habitat restoration.	The Central Coast Water Board formed multiple technical workgroups that included over a dozen independent scientists and consulting firms, all paid for via escrow accounts. The dischargers funded the escrow accounts. The independent scientists directed all biological studies, including design, implementation, and interpretation of results. Independent scientists also provide their own interpretations and recommendations to the Board when appropriate. The independent scientists are hired and managed by the Water Board only, and are not connected to the discharger in any way. Water Board staff	Our use of independent scientists and consultants fundamentally changed the way we interpreted power plant impacts and issued power plant permits. This approach is highly effective for bringing detailed, science based information to the Board's decision-making process. It is also expensive and time consuming. This work could not have been done without funding from the dischargers, via an independent escrow account. The Board's normal process is to rely on self-monitoring and	This approach should not be used for most cases. Only the most complex and high priority issues warrant this level of effort, time and resources (we have been using this method for three power plants since 1995). We could improve our process by having a formal policy that authorizes the Boards to require discharger funding for independent scientists when appropriate.

		receive, review, and approve all invoices for the independent scientists.	discharger conducted studies.	

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Watershed-Wide Waste Discharge Requirements for Timber Harvests

Role of Science & Engineering in the Decision-Making of the Water Boards (R-1)

Plan, Policy, Program (**where** science is used)	Science – Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to **improve**)
Watershed-wide WDRs (WWDRs) for timber harvesting. Regulation of timber harvesting activities to address nuisance flooding and sediment impacts from cumulative watershed effects	**Geology, Engineering, Hydrology, Fisheries Biology**	Initially, these sciences were used in the **documentation of the extent and severity of impacts justifying the need for WWDRs.** For the WWDRs, **empirical modeling was used to develop receiving water limitations** to reduce: 1)peak flow frequency and magnitude, and 2)harvest-related landsliding.	This is the first watershed-wide WDRs regulating timber harvest based on scientifically-derived receiving water limitations for nuisance flooding and sediment delivery.	**Foster, promote, fund, and streamline the process to set up blue ribbon science panels** to provide guidance to the RWQCBs on complex scientific issues. The process for developing the WWDRs overall was a long one, and well-supported by reviews and recommendations from blue ribbon science panels. **Monitoring to** support fine-tuning the models to **reduce uncertainty**, and to **independently evaluate effectiveness** of the WWDRs and **support adjustments to the receiving water limitations.**

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Timber Harvest Program
Development of Watershed-wide Waste Discharge Requirements for timber harvest activities in the Elk River and Freshwater Creek watersheds.

Role of Science & Engineering at the Water Boards (R-1)

North Coast Regional Water Board staff developed draft watershed-wide waste discharge requirements (WWDRs) for the Elk River and Freshwater Creek watersheds to address impacts from timber harvest on peak flows (nuisance flooding) and sediment delivery (aggradation with consequent fishery, flooding, and water supply impacts). The scientific basis for the WWDRs, and the science used in developing receiving water limitations are detailed below.

Sediment deliveries to Elk River, Humboldt County, have increased in response to accelerated timber harvesting plan activities and associated ground disturbances over the last two decades, resulting in impacts to water quality conditions documented by residents and Regional Water Board staff. These impacts include:

- stream channel aggradation and consequent loss of fishery habitat and channel capacity,
- increased flooding from higher peak flows and reduced channel capacity,
- taste and odor problems and physical blocking of local water supplies, and
- increased turbidity and suspended solids affecting fishery values and local water supplies.

Inventories and scientific reports were generated and reviewed by science panels to further define the extent of disturbance and develop options for addressing beneficial use impairments and cumulative effects of ground disturbances:

- "Sediment Source Investigation Reduction Plan for the North Fork Elk River Watershed, Humboldt County, California" (Pacific Watershed Associates, 1998).
- Review of "An Analysis of Flooding in Elk River and Freshwater Creek Watershed, Humboldt County, California" (1999) by a CDF-commissioned blue ribbon panel of University of California scientists.
- The North Coast Regional Water Quality Control Board "Staff Report for Proposed Regional Water Board Actions in the North Fork Elk River, Bear Creek, Freshwater Creek, Jordan Creek and Stitz Creek Watersheds" (Sept. 9, 2000)

- The University of California Committee on Cumulative Watershed Effects June 2001 report, "A Scientific Basis for the Prediction of Cumulative Watershed Effects."
- Review of the California Department of Forestry and Fire Protection's application of an empirical peak flow model to establish the annual timber harvesting limitation for Elk River by the Humboldt Watersheds Independent Scientific Review Panel (ISRP) set up by the North Coast Water Board (December 27, 2002).
- Regional Water Board staff's "Preliminary Assessment of Flooding in Lower Elk River" (Patenaude, 2004).
- At the request and under the direction of licensed professionals on the North Coast Water Board staff, scientists at the USDA Forest Service Pacific Southwest Research Station's Redwood Sciences Laboratory in Arcata, CA prepared analyses of Pacific Lumber Company's 1998 sediment inventory reports for Bear Creek and the North Fork Elk River. These analyses, authored by Dr. Leslie Reid, offered simple empirical models to help predict the rates of sediment production from harvested lands.
- ISRP 2002 review of the approach developed by Dr. Reid included recommendations on improving the empirical models to account for differences in landslide potential.

The large body of evidence and the scientific analyses and reviews form the basis for the development of the WWDRs to address timber harvesting activities in these two watersheds so that beneficial uses are restored and nuisance conditions ameliorated.

Two empirical models were used to develop draft receiving water limitations for the WWDRs, both of which are refinements of existing models: *Empirical Peak Flow Reduction Model* and the *Empirical Harvest-Related Landslide Sediment Delivery Reduction Model* (Landslide Reduction Model). The WWDRs are out for a 30-day public review prior to refining and presenting to the North Coast Water Board for consideration in September.

Suggestions to improve science in the decision-making of the RWQCBs:

1. The State should foster, promote, fund, and streamline the process to set up blue ribbon science panels to provide guidance to the RWQCBs on complex scientific issues. One suggestion is to set up a special contract and fund for scientific review panels. The review of products and the recommendations provided by scientific review panels was invaluable to the Water Board staff in

directing our application of science to the regulatory arena. For instance, review of the refined models used to develop receiving water limitations for the WWDRs would be useful in further refinements in the WWDRs.

2. Scientific field data are needed to support science-based efforts, and monitoring is needed to verify and validate conclusions and to independently determine trends and compliance. The North Coast Water Board used available data for its empirical modeling; no new data were collected. In the case of the peak flow modeling, the empirical relationships came from another north coastal stream in the Mendocino area that was much smaller in watershed area than the subject streams and over 70 miles to the south. Local information would reduce uncertainty associated with that model. The landslide model used local data collected by contractors for the discharger, the reliability of which could be improved by more ground-truthing. Adjustments to those models will have to occur, based on changes in the watershed characteristics. While the draft WWDRs include a monitoring program for the discharger, independent data collection and analysis is needed in future adjustments of the receiving water limitations.

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Irrigated Lands Conditional Waiver Program

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to improve)
Irrigated Lands Conditional Waiver Program Central Valley Regional Water Board Order No. R5-2003-0105				
• Review of Coalition/Water District/Individual Watershed Evaluation Reports (WER) or Farm Reports	The scientific disciplines needed for the review of the WER or Farm Reports include analytical chemistry, biology, geology, hydrology, and toxicology.	The information provided in the WER's will be scientifically evaluated to indicate watershed characteristics including some land-use activities and pesticide application patterns that directly or indirectly influence water quality.	The scientific and technical information provided in the WER will be used to develop and evaluate the most appropriate MRPP that should be submitted by the discharger.	The technical ability of dischargers varies significantly with respect to developing WERs. Additionally, verifying the information that is provided is difficult given limited Water Board staff and the lack of adequate GIS resources. Board staff will need to provide additional training to groups and obtain up to date GIS resources.
• Review of Coalition, Water District, or Individual	Evaluation of the MRPP applies scientific disciplines such as analytical	MRPPs are reviewed to consider watershed characteristics, land use patterns, crop and	The MRPP is reviewed to determine the adequacy of the proposed monitoring,	Make changes to MRP requirements based on input from the Technical Issues

Irrigated Lands Conditional Waiver Program

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

Monitoring and Reporting Program Plans (MRPP)	chemistry, biology, environmental chemistry, geology, hydrology, and toxicology	pesticide application information, as well as appropriate laboratory analyses and quality control measures.	evaluate the effects of irrigated agriculture on water bodies, and to make recommendations for changes in the MRPPs.	Committee and its focus groups.
• Review of Annual Monitoring Reports (AMR) from Coalition and Individual Dischargers	Analytical chemistry, biology, geology, hydrology, statistics, and toxicology are some of the scientific disciplines used for the review of AMRs.	Water quality monitoring data are evaluated to determine if correct monitoring and analyses were conducted, and to determine whether Water Quality Objectives are being exceeded.	Review of the AMRs to determine discharger compliance with the waiver, as well as to recommend management plan implementation and/or modifications to the existing MRPP.	AMRs are providing much needed baseline data. If more data were available, or if existing information from other agencies and programs were accessible in one-source database, this effort would be improved. One of the highest priorities is to require more monitoring sites in all areas of the Region and to focus monitoring on high priority issues. Magnitude and duration of measured water quality impact must be expanded.

Irrigated Lands Conditional Waiver Program

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

• Evaluation of Management Practice (MP) Effectiveness	Evaluation of MP Effectiveness utilizes scientific disciplines including biology, geology, hydrology, hydrogeology, and toxicology.	Scientific disciplines are used to evaluate water quality monitoring data as well as visual observations made during inspections on agricultural discharges.	The monitoring data and visual observations will be used to evaluate MP effectiveness and to develop requirements for dischargers to implement a management plan.	There is very limited MP effectiveness information available, with respect to the protection of water quality from agricultural discharges in California. Need to work closely with Grant Program, Watershed Management Iinitiative and Non-Point Source staff to identify needs and priorities.
• Technical Issues Committee (TIC)	Scientific disciplines used in the TIC include analytical chemistry, biology, chemistry, physics, and toxicology.	The TIC meetings inform the various groups by sharing and working through technical issues, such as toxicity and nutrient testing methods and bioassessments.	The TIC has been a valuable tool in presenting technical and up-to-date scientific information on topics such as sediment Toxicity Identification Evaluation.	Continue the TIC and expanding the focus groups as needed as the Program progresses.
• Development of an Environmental Impact Report (EIR)	Many technical disciplines such as geography, geology, hydrology, climatology, statistics, chemistry, and	The scientific data gathered for the existing conditions of the Central Valley water bodies will identify and establish	Review of methods and data sources used to characterize the current surface and groundwater conditions will provide	Evaluate the environmental implications of the Program to avoid or reduce any significant environmental

Irrigated Lands Conditional Waiver Program

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

	toxicology will help identify the existing surface water and groundwater conditions of Central Valley water bodies and the potential impact of the Program on these.	a credible and defensible Irrigated Lands Water Quality Regulatory Program (Program).	the Program with a foundation to evaluate the effectiveness of the program.	impacts.

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Irrigated Lands Conditional Waiver Program

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

The Irrigated Lands Conditional Waiver Program (Program) is designed to protect water quality and to ensure agricultural discharges meet water quality objectives (WQOs). California Water Code Section 13260 requires that any person who is discharging waste, or is proposing to discharge waste that could affect the quality of the waters of the State (Discharger), file a Report of Waste Discharge (RWD) along with a filing fee, in anticipation that the Regional Water Board will prescribe Waste Discharge Requirements (WDRs). The Program provides two alternatives to WDRs for those owners and operators that qualify – a Conditional Waiver for Coalition Groups and a Conditional Waiver for individual Owners and Operators of irrigated lands.

Owners and operators are required to comply with applicable numeric and narrative WQOs. This includes protection of beneficial uses and prevention of nuisances by implementing monitoring and reporting programs, evaluating the effectiveness of management practices where water quality problems occur, and implementation of additional management practices so that WQOs are met.

Currently, the Program requires each Coalition Group or Water District, representing a group of Dischargers, to submit a Watershed Evaluation Report (WER), and to develop a science-based water quality monitoring and reporting program plan (MRPP), which describes the irrigated lands, crops, water bodies, pesticide use activities, identifies monitoring sites, testing methods, detection limits, and sampling frequency for irrigation and wet seasons. Dischargers covered by the Individual Waiver are required to submit a Farm Report in place of the Watershed Evaluation Report. Part of the required monitoring includes testing for toxicity. Three species toxicity testing is performed on water column samples, as well as sediment toxicity testing in various types of water bodies, including agriculture drainages. Monitoring parameters also include pesticides, metals, nutrients, and physical parameters. Monitoring results are compared to applicable WQOs and assessments of management practices are conducted. When there are analytical results that exceed WQOs, in particular for toxicity tests, follow-up monitoring is required. For samples that indicate toxicity, follow-up may include conducting a Toxicity Identification Evaluation (TIE) in order to help determine what chemicals are responsible for the toxicity. Further tests and resampling are required to determine the extent and magnitude of WQO exceedances. Information regarding the exceedances must also be submitted to the Regional Water Board in a timely fashion, so that Dischargers can be appropriately advised regarding the details of resampling or TIEs.

Dischargers are required to submit an Annual Monitoring Report (AMR), which summarizes their monitoring activities, sampling locations, tabulates monitoring results compared to WQOs, and management practices used to address water quality impacts. The AMRs must also include laboratory data sheets, chain of custody documents, and quality assurance/quality control documentation.

To ensure that the MRPPs use standardized procedures that are scientifically sound and defensible, a Technical Issues Committee (TIC), including representatives from coalition groups, growers, agencies and other interested parties, meets to discuss and provide input on technical issues pertaining to monitoring and reporting activities required under the Program. Within the TIC, there are four focus groups (Toxicity Triggers, Sediment Toxicity, Nutrients, and Bioassessment). The TIC and focus groups provides the opportunity to share knowledge and consider new approaches.

In order to determine compliance with the Irrigated Lands Conditional Waiver, the reporting by the Dischargers is evaluated, not only through the AMRs, but also including various other technical reports, such as the Communication Reports, that are required to be submitted when WQOs are exceeded. Additionally, when the exceedance is the result of activities from irrigated agriculture, Dischargers must take action by implementing management practices designed to reduce pollutant loads to surface waters.

To further expand the Program, an Environmental Impact Report (EIR) is being developed. The role of science in the development and ultimate completion of the EIR is critical to establishing a defensible, credible, and effective Program. The science generated in the form of methods and data sources to characterize the effectiveness of current regulatory efforts and surface water and groundwater conditions will provide the Program with a sound foundation to accurately evaluate the future of the program.

Knowledge gained about the techniques and management practices used for agriculture-related irrigation and storm water management activities will be of critical importance in establishing a sound scientific basis for ensuring WQOs are met and beneficial uses are protected under the Program. Additionally, the information received regarding management practices will identify data gaps, effectiveness, and uncertainties, and allow for the evaluation of alternative management actions that will lead to enhanced water quality conditions in water bodies throughout the Central Valley.

A natural outgrowth of the EIR process will be the identification and further expansion of a set of likely indicators and performance measures, able to translate the program goals and objectives into measurable benchmarks for Program success. Indicators and performance measures will provide information on conditions, trends, and significance of activities for scientific evaluation to meet WQOs. Ultimately, the knowledge gained through this iterative process will lead to adaptively managing the current use of the watershed approach to improve overall water quality conditions as they may be affected by agricultural discharges to waters of the State.

APPENDIX A – 6

Total Maximum Daily Load for Pathogens in the New River

Role of Science & Engineering in Decision-Making at the Water Boards (R-7)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to **improve**)
Adoption of Pathogen Total Maximum Daily Loads **(TMDLs) for New River**	Development of TMDL required: a. Source analysis based on field measurements (sampling and analyses based on chemistry) and estimates derived from scientific analysis and literature b. Determination of loading capacity for pathogens c. Assign load and waste load allocations for pollutant loading for all sources d. Develop implementation plan for all sources to achieve water quality standard(s) by specify date.	Science (chemistry, biology, microbiology, human health, environmental engineering) to determine the capacity of pathogens that the river can receive without exceeding water quality objectives. The load capacity establishes the amount of pollutant dischargers, individually or collectively, are permitted to release into the waterbody. Compliance monitoring determines if violations have occurred, WQOs are achieved, or the need for TMDL refinement .	Determining a TMDL requires knowledge of the physical (e.g., flow rates, hydrology, waste water treatments, etc.), chemical (e.g., current pollutant levels, oxygen levels, microbiology, biochemistry), and biological (e.g., human health, microbiology, aquatic biology, etc.) conditions, and the beneficial uses (e.g., habitat for sensitive species, swimmable, fishable) of the receiving waters. This is significantly more complex than the conventional regulation of point and nonpoint sources, and requires a "holistic", watershed approach to regulating and improving water quality.	• Facilitate accessing scientific literature, libraries, etc. (reimbursement for copies and visits). • More resources for sampling, SWAMP, and TMDL contracts. • **Streamline** the State contracting process. • Salary parity to reduce attrition and recruit knowledgeable, skilled staff.

Appendix A - 6

Development of the New River Pathogen TMDL

Role of Science & Engineering in Decision-Making at the Water Boards (R-7)

The New River is located in the southeast part of the Salton Sea Transboundary Watershed; an area dominated by highly productive farmland irrigated with water imported from the Colorado River. The River originates in Mexicali, Mexico, traversing northward approximate 20 miles before crossing the International Boundary. In the United States the New River consists largely of agricultural return flows from the Imperial Valley. It also receives treated disinfected and undisinfected domestic wastewater from nine Imperial Valley wastewater treatment facilities. In Mexico, the River receives agricultural discharges from Mexicali Valley, and partially treated and untreated municipal and industrial wastes from the city of Mexicali. The New River is on California's CWA, Section 303 (d) list because current pathogen loads violate water quality objectives established by the Regional Board to protect the River's beneficial uses.

TMDLs achieve ambient water quality standards (WQSs) by controlling point and nonpoint sources of pollution. Several tasks necessary to develop a TMDL require empirical data, or scientific findings and research. These include: problem statement; numeric target; source analysis; linkage analysis; margin of safety, load and waste-load allocations; monitoring plan, and implementation plan. A CEQA analysis (Environmental Checklist) is also needed to evaluate for environmental impacts for methods of compliance; measures to mitigate impacts; alternative means of compliance to avoid impacts, and cost estimates for compliance (CEGA Guidelines, Section 15187). Independent peer review of the scientific basis of a TMDL by professionals with expertise in the TMDL discipline is also required pursuant to Health and Safety Code, Section 57004.

The New River Pathogen TMDL was developed by a multi-disciplinary team of Regional Board (RB) staff with various expertise and include: environmental, civil and chemical engineers; soil scientists; biologists; geologists, pesticide specialists, and economists. Information also was obtained from scientific literature, and state, federal and local agencies (USEPA, CDFG, USBOR, SWRCB, IID, Farm Bureau, and others). The scientific role of these individuals and agencies in the development of the New River Pathogen TMDL is discussed below.

PEER REVIEW PROCESS

Scientific Peer Review: The New River Pathogen TMDL was peer reviewed pursuant to the California Health and Safety Code Section 57004, to ensure it was scientifically based. Section 57004 of the Health and Safety Code requires that the "scientific basis" and "scientific portions" of a TMDL (i.e., parts of a TMDL premised upon or derived from empirical data or other scientific findings, conclusions or assumptions) under go external peer review by professionals from institutes of higher learning (National Academy of Science, University of California, California State University, etc.) to ensure the TMDL utilizes sound scientific knowledge, methods, and practices. Peer Reviewers for the New River Pathogen TMDL are listed below with their expertise:

- Marylynn V. Yates, Ph.D. Chair, Department of Environmental Sciences, University of California, Riverside; Environmental Microbiology
- Edward R. Atwill, D.V.M., M.P.V.M., Ph.D., School of Veterinary Medicine, UC Davis, Tulare Research Center, Epidemiologist; environmental health, waterborne zoonotic diseases, and infectious disease risk management,
- Jeannie L. Darby, Ph.D., P.E. Professor, Department of Environmental Engineering, University of California, Davis; water quality and treatment.

Stakeholder Peer Review: Several stakeholders were involved in the development of the New River Pathogen TMDL including:

- U.S. members of the Binational Technical Advisory Committee (BTAC) for the New River/Mexicali Sanitation Project;
- Salton Sea Authority (SSA),
- Citizens Congressional Task Force for the New River, and
- City of Calexico.

The Citizens Congressional Task Force for the New River consists of private citizens; federal, state and local government agencies; the University of California Cooperative Extension at Holtville; Imperial Valley College, and non-profit organizations. The U.S. BTAC includes Imperial County; Imperial Irrigation District; International Boundary and Water Commission (IBWC); U.S. Environmental Protection Agency (USEPA), and Regional and State Board staff.

RB staff organized several meetings with stakeholders to facilitate TMDL development. The objective of this outreach was to obtain expert resources, scientific evaluations, knowledge, and recommendations on the TMDL development/implementation process. Stakeholders contributed local knowledge and experience, and their concerns and viewpoints.

PROBLEM STATEMENT

The problem statement provides background information for TMDL development, including violations of WQSs prompting development. Numerous scientific sources were used to develop the problem statement for the New River Pathogen TMDL. These are categorized and discussed below.

Historical Data: Historical data for fecal coliforms and *Escherichia coli* (*E. coli*) collected by IBWC and RB staff in the New River at the International Boundary clearly indicate violations of water quality standards (WQSs) promulgated for the River in the Region's Basin Plan, and Minute No. 264 of the Mexican-American Water Treaty. The magnitude of the violation indicates serious threats to public health and impairment of the River's beneficial uses. These data were used to place the New River on California's CWA 303 (d) list for pathogen impairments, and to develop the problem statement.

Water Quality Standards: Pathogens are present in the New River at concentrations that violate water quality standards established for the River in the Region's basin plan. Water quality standards consist of designated uses (aka beneficial uses in the CWC) and water quality criteria (aka water quality objectives in the CWC). Water quality criteria (objectives) are numeric or narrative water quality characteristics or constituents established to protect designated (beneficial) uses that are derived from rigorous scientific study. Bacteria WQOs for the New River at the International Boundary protect humans from direct and indirect contact with sewage-contaminated water and are based on scientific studies and recommendations from USEPA (USEPA Jan 1986; USEPA May 1986; USEPA Sep 1988; USEPA May 1998).

Hydrogeologic Setting: RB staff characterized the hydrogeologic setting of the New River by reviewing land use maps, Imperial County land use data, and geologic publications. Staff also conducted field inspections, consultations with IID, USGS, and USBR, and collected New River flow data. Soil classifications were obtained from scientific literature (Zimmerman, 1981) using soil descriptions from the Natural Resources Conservation Service.

Biological Setting: RB staff conducted fieldwork, reviewed scientific literature (e.g., Setmire et. al, 1999; Keeney, 2000) and consulted with CDFG, USFWS, and the Salton Sea Authority, to characterize terrestrial and aquatic ecosystems in the New River, Salton Sea, and Imperial Valley agricultural drains. Habitats and species (indigenous and transient) were identified including several federal or state threatened and/or endangered, and the ecological significance of the New River and nearby waters for migrating birds using the Pacific Flyway.

Public Health Hazard: RB staff reviewed available data, scientific publications (DHS 1987, U.S. Department of Health and Human Services 1996), and consulted with Imperial County Health Department and California Department of Health Services, to characterize threats to public health and the potential to contract disease with water contact with the New River.

NUMERIC TARGET

The numeric target identifies in-stream goals for the TMDL that ensure attainment of applicable WQSs. Numeric targets for the New River Pathogen TMDL were selected to attain and maintain basin plan standards for pathogen indicators Fecal Coliforms, E. coli, and Enterococci in the River at the International Boundary and downstream, and to provide a basis for evaluating TMDL success. Targets were based on reasonable levels for protecting human health, scientific literature, monitoring data collected by IBWC and RB staff, and best professional judgment. Targets protect the REC I beneficial use, which has the most stringent water quality objectives (WQOs) for bacteria because it includes water contact activities such as swimming, wading, and fishing. Procedures provided in "*Protocol for Developing Pathogen TMDLS*" (USEPA, 2001) were used for TMDL development. Long term monitoring in progress may result in future refinement of the numeric target, as knowledge of the problem and solution increase with data collection and analysis.

SOURCE ANALYSIS

The source analysis identifies and describes the magnitude and location of all significant point, nonpoint and background sources of a pollutant to a waterbody. Several scientific disciplines contributed to the New River Pathogen TMDL source analysis including: land use, biology, microbiology, environmental health, environmental engineering, hydrology, soil chemistry, and geology.

The source analysis was based on water quality data collected monthly in the New River at the International Boundary from 1975 to 2000 for the Region's USEPA funded

Border Program, and from data collected in 2000 at 16 stations in the River located from the International Boundary to the River's terminus at the Salton Sea, with some stations in major agricultural drains tributary to the River. Water quality sampling was conducted pursuant to a Quality Assurance Project Plan (QAPP) that was reviewed and approved by three senior level RB staff, including the Region's Quality Assurance/Quality Control (QA/QC) Officer (M. Carpio-Obeso, Ph.D., chemistry). Water quality samples were analyzed in the Region 7 laboratory, certified by the California Department of Health Services for inorganic chemistry and microbiology for wastewater analysis. Data collected by IBWC, and photodocumentation from binational monthly tours of the New River in Mexicali, were reviewed.

Watershed data used to quantify bacteria loads from human activities and natural sources are discussed below.

Analysis for Point Sources in the US

Point sources evaluated for the source analysis include:

- Nine wastewater treatment facilities that discharge effluent into the New River pursuant to the National Pollutant Discharge Elimination System (NPDES) program, and
- Nine NPDES Confined Animal Feeding Operations (CAFOs) located within the New River watershed.

Analysis for Nonpoint Sources:

Nonpoint sources evaluated for the source analysis include:

- Data from major agricultural drains in the Alamo River watershed collected in 2000;
- Stormwater runoff draining into the New River from farmland, roads, and Valley communities;
- Urban runoff;
- Natural sources include warm- and cold-blooded wildlife and wind deposition, and
- Point and nonpoint sources from the Mexicali Valley in Mexico.

LINKAGE ANALYSIS

The linkage analysis specifies the critical quantitative link between the applicable WQSs and the TMDL such that the total loading to the New River will result in attainment of the numeric target. The Linkage Analysis for the New River describes the relationship between numeric targets and pathogens sources, and is the analytical basis upon which the load allocations for these sources are based, such that the total loading to the New River will result in attainment of numeric targets. This information is useful to evaluate the degree and duration of required effort, including mitigation options, to achieve WQOs. A one-to-one relationship between load allocations and numeric targets exists for this TMDL.

The Linkage Analysis was developed by analyzing flow and pathogen concentrations in the New River, with pathogen sources in the watershed. This allowed for simple linkages between sources of pathogens, numeric targets, and the total assimilative capacity of the River, which is the highest pathogen load the River can assimilate without exceeding numeric targets. Scientific publications focusing on microbiology and human health were also reviewed (e.g., USEPA 1986; Thomann and Mueller 1987; Pickett 1997; Mancini 1978).

LOAD ALLOCATIONS

USEPA TMDL guidelines (USEPA 1991) define the maximum allowable pollutant load as the total load of a particular pollutant that can be present in a waterbody and still attain and maintain designated beneficial uses. The maximum allowable pollutant load is reduced by a margin of safety. The remainder is allocated to wasteload allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources.

Density-based WLAs for point sources and LAs for nonpoint sources were established using conservative analyses, even for relatively minor loading sources, to ensure attainment of numeric targets, and expressed in terms of fecal coliforms, *E. coli*, and enterococci organisms. Allocations accounted for future growth and possible water transfers, and were expressed as organism density (i.e., number of organisms in a given volume of water) rather than organism mass (i.e., pounds per day) based on scientific literature indicating density is more significant than mass when establishing limits to protect public health and beneficial uses.

TMDLs include a margin of safety (MOS) to account for data uncertainty, growth, critical conditions, and lack of knowledge. Data uncertainty is relatively insignificant for this TMDL given that the relationship between effluent limits and water quality is well documented in scientific literature. To address uncertainty in bacterial die-off and regrowth dynamics, an aggressive monitoring and review plan was implemented to ensure data needed to determine compliance with WQSs or TMDL revision was collected.

IMPLEMENTATION PLAN

The implementation plan for the New River Pathogen TMDL is divided into Phase Phase I and II. Phase 1:

- Requires actions for responsible parties, and recommends actions for other agencies/organizations;
- provides time schedules for actions to be taken;
- requires monitoring and surveillance to determine progress attaining deadlines, milestones, and WQSs;
- identifies a means for TMDL compliance;
- evaluates economic impacts of TMDL implementation, and
- identifies potential funding sources for pollution control.

Monitoring and reporting is critical to the success of this TMDL, and necessary to ascertain compliance with numeric targets, LAs, WLAs, and WQSs; the accuracy of assumptions and hypotheses used to develop the TMDL, and the need to refine TMDL components.

Phase II will be implemented if water quality targets are not achieved in Phase I. Phase II requires further assessment of bacterial contributions from sources not addressed in Phase I, and implementation actions to control these sources. This multi-phased approach allows for immediate control of major pathogen sources while allowing time for monitoring and further scientific study for Phase II planning.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

TMDL development requires a CEQA Checklist pursuant to California Code of Regulations Title 23, section 3777, subdivision (a)(1) through (3); Public Resources Code section 21159, subdivision (a)(1) through (3); and California Code of Regulations Title 14, section 15187, subdivisions (b) and (c)(1) through (3). The CEQA Checklist identifies physical, biological, social and economic factors that might be affected by the proposed project. Where appropriate, the evaluation includes an analysis of feasible reasonably foreseeable mitigation measures identified for those impacts; and an analysis of reasonably foreseeable alternative means of compliance with the requirements of this project, to avoid or eliminate the identified impacts.

Environmental factors evaluated include: Aesthetics, Biological Resources, Hazards & Hazardous Materials, Mineral Resources, Public Services, Utilities/Service Systems, Agriculture Resources, Cultural Resources, Hydrology/Water Quality, Noise, Recreation, Air Quality, Geology/Soils, Land Use/Planning, Population, and Transportation/Traffic. This document also discussed alternatives to the proposed project.

RB biologists completed the CEQA analysis by reviewed technical papers, and consulting with CDFG, USFWS, and other experts, to ensure protection of threatened or endangered species as required by The California Endangered Species Act (Fish and Game Code 2080).

LINKING SCIENCE TO THE DEVELOPMENT OF ENVIRONMENTAL REGULATION

The basin plan amendment process is the mechanism used to include science into the policy making regulatory process.

The basin plan amendment process for a TMDL requires:

- Document preparation
  - Staff report
  - Environmental (CEQA) checklist
  - Draft amendment
  - Draft resolution
- Consulting with agencies with jurisdiction (23 CCR 3778)
- External scientific peer review
- Public notification of RB public hearing (notice of a public hearing/notice of filing) at least 45 days prior to the meeting (23 CCR 3777)
- Responding to public comments (23 CCR 3779; APM p. 30)
- Adoption hearing
- Transmitting two copies of administrative record to SB-basin planning unit for review
- Participating in SB workshop and public meeting
- Filing a Notice of Decision with Secretary of Resources Agency for public posting for at least 30 days
- Review/approval by Office of Administrative Law
- Review/approval by USEPA
- Incorporation of the amendment (TMDL) into the Basin Plan.

Science is incorporated in several of the above processes as discussed in the preceding pages of this report.

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APPENDIX A - 7

Total Maximum Daily Loads for Silt in the Alamo River

Role of Science & Engineering in Decision-Making at the Water Boads (R-7)

Plan, Policy, Program (**where** science is used)	Science – Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to **improve**)
Adoption of Silt Total Maximum Daily Loads **(TMDLs) for Alamo River**	Development of TMDL required: • Source analysis based on field measurements (sampling and analyses based on chemistry) and estimates derived from scientific analysis and literature • Determination of loading capacity for sediments • Assign load and waste load allocations for pollutant loading for all sources • Develop implementation plan for all sources to achieve water quality standard(s) by specific date.	Science (chemistry, biology, microbiology, toxicology, hydrology, statistics, modeling) to determine the capacity of sediments the river can accept without exceeding water quality objectives. The load capacity establishes the amount of sediment dischargers (individually and collectively) are permitted to release into the reservoir. Compliance monitoring determines if violations have occurred, WQSs are achieved, or the need for TMDL refinement.	Determining a TMDL requires knowledge of the physical (e.g., flow rates, hydrology, agricultural practices, etc.), chemical (e.g., current pollutant levels for sediment and pesticides, biochemistry, fate and transport), and biological (e.g., threatened species, toxicology, aquatic biology, etc.) conditions, and the beneficial uses (e.g., habitat for sensitive species, swimmable, fishable) of the receiving waters. TMDL development is significantly more complex than traditional regulation of point and nonpoint sources, and requires a "holistic" watershed approach to regulate and improve water quality.	• Facilitate accessing scientific literature, libraries, etc. (reimbursement for copies and visits). • More resources for sampling, SWAMP, and TMDL contracts. • **Streamline** the State contracting process. • Salary parity to reduce attrition and recruit knowledgeable, skilled staff.

APPENDIX A - 7

Total Maximum Daily Load for Silt in the Alamo River

Role of Science & Engineering at the Water Boards (R-7)

The Alamo River originates in Mexicali, Mexico, flows northward across the International Boundary, then traverses approximately 60 miles of Imperial Valley before discharging into the Salton Sea. The River consists almost entirely of agricultural discharges from the Imperial Valley, and is on California's Clean Water Act (CWA) Section 303 (d) list because current sediment loads violate water quality standards (WQS) contained in the Water Quality Control Plan for the Colorado River Basin Region (a.k.a. Basin Plan).

WQSs consist of beneficial uses, water quality objectives, and related policies based on such uses. The WQOs are either numerical or narrative and are designed to protect the most sensitive beneficial uses. Tables 1 and 2, below, summarize the beneficial uses and water quality objectives addressed by the Alamo River Siltation/Sedimentation TMDL

Table 1: Beneficial Uses Addressed In Sedimentation/Siltation TMDL for Alamo River

Designated Beneficial Uses of Water	Description
Warm Freshwater Habitat (WARM)	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Wildlife Habitat (WILD)	Uses of water that support terrestrial ecosystems including, but not limited to, the preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.
Preservation of Rare, Threatened, and Endangered Species (RARE)	Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under State or Federal law as rare, threatened or endangered.
Water Contact Recreation (REC I)[1]	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs.
Non-Contact Recreation (REC II)	Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Source: California Regional Water Quality Control Plan for the Colorado River Basin Region (CRWQCB 7,1994)

[1] The only known REC I usage is infrequent fishing activity.

Table 2: Summary of WQOs Addressed by Sedimentation/Siltation TMDL for Alamo River

Parameter	Water Quality Objective
Suspended Solids	Discharges of wastes or wastewater shall not contain suspended or settleable solids in concentrations which increase the turbidity of receiving waters, unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in turbidity does not adversely affect beneficial uses.
Sediment	The suspended sediment load and suspended sediment discharge rate to surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Turbidity	Waters shall be free from changes in turbidity that cause nuisance or adversely affect beneficial uses.
Chemical Constituents	No individual chemical or combination of chemicals [e.g., chlorinated pesticides] shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in hazardous chemical concentrations found in bottom sediments or aquatic life.
Biostimulatory Substances	Waters shall not contain biostimulatory substances [e.g., phosphate] in concentrations that produce aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

Source: California Regional Water Quality Control Plan for the Colorado River Basin Region (CRWQCB 7,1994)

For the Alamo River, the most sensitive designated beneficial uses to be addressed in the Sedimentation/Siltation TMDL include: warm freshwater habitat (WARM); wildlife habitat (WILD); preservation of rare, threatened, and endangered species (RARE); and contact and non-contact recreation (REC I and REC II). One of the main scientific challenges faced by the Regional Board regarding the silt impairment was the lack of a numeric objectives for silt in the Basin Plan. The Alamo River Siltation/Sedimentation TMDL bridged that gap. TMDLs are required by the CWA. They are developed and implemented to achieve ambient water quality standards (WQS) by quantifying and controlling point and nonpoint sources of pollution and establish a quantifiable loading that assures compliance with WQS. Several tasks necessary to develop a TMDL require comprehensive scientific study or research to complete. These include: problem statement, numeric target, source analysis, linkage analysis; load allocation, and implementation plan. A CEQA analysis and independent peer review of the scientific components of a TMDL by professionals with expertise in the TMDL discipline are also needed.

The Alamo River Silt TMDL was developed by a multi-disciplinary team of Regional Board staff with a variety of expertise, including: environmental, civil and chemical engineers; soil scientists; biologists; geologists, pesticide specialists, and economists. Information also was obtained from scientific publications, and State, Federal and local agencies (USEPA, CDFG, USBOR, SWRCB, IID, Farm Bureau, and others). The scientific role of these individuals and agencies in the development of the Alamo silt TMDL is provided below.

PEER REVIEW PROCESS

Scientific Peer Review: The Alamo River Silt TMDL was peer reviewed pursuant to the California Health and Safety Code Section 57004, to ensure it was scientifically based. Section 57004 of the Health and Safety Code requires that the "scientific basis" and "scientific portions" of a TMDL (i.e., parts of a TMDL premised upon or derived from empirical data or other scientific findings, conclusions or assumptions) under go external peer review by professionals from institutes of higher learning (National Academy of Science, University of California, California State University, etc.) to ensure the TMDL utilizes sound scientific knowledge, methods, and practices. Peer Reviewers for the Alamo River Silt TMDL are listed below with their expertise.

- Alex Horne, Ph.D., Department of Civil and Environmental Engineering, University of California, Berkeley, Toxicology;
- Ray Krone, Ph.D., Ray B. Krone & Associate, Sedimentation and Hydraulics, and
- Larry Schwankl, Ph.D., PE, LAWR, Department of Civil and Environmental Engineering, University of California, Davis, Hydrology.

Silt TMDL Technical Advisory Committee: Another challenge faced by the Regional Board regarding water quality control policy for silt was that it needed to identify best management practices to effectively implement the policy. The Imperial Valley Sedimentation/Siltation TMDL Technical Advisory Committee (Silt TMDL TAC) was established in December 1998 to advise RB staff with the TMDL development and implementation process. Committee members represented stakeholder agencies, groups or landowners, and provided local knowledge, experience, and the concerns and perspectives of the stakeholder groups. Members of the Sedimentation/Siltation TMDL TAC include:

- Audubon Society/Sierra Club
- Coachella Valley Water District
- Desert Wildlife Unlimited, Inc.
- Farmers from the Imperial Valley
- Imperial County Agricultural Commissioner
- Imperial County Farm Bureau and Imperial Valley Vegetable Growers Association
- Imperial Irrigation District (IID)
- Salton Sea Authority
- Salton Sea Science Subcommittee
- Sonny Bono Salton Sea National Wildlife Refuge
- State Water Resources Control Board (State Board)
- University of California Cooperative Extension, Holtville Field Station
- U.S. Bureau of Reclamation (USBR)
- U.S. Filter Corporation
- U.S. Fish and Wildlife Service

They were instrumental not just in reviewing the technical elements of the TMDL, but they were also key players in identifying and recommending best management practices (BMPs) to attain the goals of the TMDL.

PROBLEM STATEMENT

The problem statement provides background information for TMDL development, including violations of WQSs prompting development. Numerous scientific sources were used to develop the problem statement for the Alamo Silt TMDL. These are categorized and discussed below.

Historical Data: Historical data for the Alamo River collected by IID from 1995 to 1999, and through State Board's Toxics Substances Monitoring (TSM) Program from 1978 to 1999, clearly indicate beneficial uses of the Alamo River are impaired due to excess sediment. These data were the basis for placing the Alamo on California's CWA 303 (d) list for sediment impairments, and used to develop the problem statement.

Water Quality Standards: Sediment concentrations in the Alamo River violate WQSs established for the River in the Region's basin plan. Water quality standards consist of designated uses (a.k.a. beneficial uses in the CWC) and water quality criteria (a.k.a. water quality objectives in the CWC). Water quality criteria (objectives) are numeric or narrative water quality characteristics or constituents established to protect designated (beneficial) uses that are derived from rigorous scientific study (USEPA and others).

Hydrogeologic Setting: RB staff characterized the hydrogeology of the Alamo and surrounding area by reviewing land use maps, Imperial County land use data, and geologic publications. Staff also collected flow data, conducted field inspections, and consulted with IID, USBR, and United States Geological Survey (USGS). Soil classifications were obtained from scientific literature using soil descriptions from the Natural Resources Conservation Service (Zimmerman, 1981).

Biological Setting: RB staff conducted fieldwork, reviewed scientific literature (Setmire et. al, 1999; Keeney, 2000) and consulted with CDFG, USFWS, and the Salton Sea Authority to characterize the terrestrial and aquatic ecosystems of the Alamo River, Salton Sea, and Imperial Valley agricultural drains. Habitats and species (indigenous and transient) were identified, including several federal or state threatened and/or endangered, and the ecological significance of the Alamo and nearby waters for migrating birds using the Pacific Flyway.

Aquatic life and nutrient impacts: RB staff researched scientific literature to document sediment impacts to the aquatic environment (e.g., Muncy et al, 1997), and reviewed studies evaluating nutrient concentrations and impacts to the Salton Sea, and contributions of nutrient bound sediments from the Alamo to the Sea (Federal Water Quality Control Administration, 19780; Holdren, 200; Cagle, 1998; etc.).

Pesticides: Sediment may carry DDT, DDT metabolites or insoluble pesticides (e.g., toxaphene), and pose a significant threat to aquatic and avian communities, and people consuming fish from pesticide laden waters, due to bioaccumulation. To evaluate for impacts to aquatic life from pesticides bound to bottom/suspended sediment, sampling locations were selected in the Alamo for State Board's Toxic Substance Monitoring (TSM) Program. The TSM Program was developed by State Board in 1976 to provide a uniform statewide approach to detect and evaluate the occurrence of toxic substances in surface waters. The program targets water bodies with known or suspected impaired water quality, and evaluates fish and other aquatic life for trace elements, PCBs, and pesticides. CDFG biologists assist to implement the Program by conducting field studies with RB staff to collect fish (or other organisms) at selected sampling locations. Samples are evaluated for toxicity by UC Davis chemists (Larry LeBlanc, Ph.D., and others).

RB staff conducted an extensive literature search to evaluate pesticide impacts on the aquatic environment, human health and biota (e.g., Bennett, 1998;Genium, 1999; Kaloyanova and Mostafo, 1991; Muncy et al, 1979; and several studies by USGS, USFWS, USBR and USEPA), and compared results from the TSM Program with local DDE studies conducted by IID, CDFA, and USGS spanning over fifteen years. Experts on pesticide occurrence in the Alamo were consulted (e.g., Setmire, USGS; Eccles), and scientifically derived action levels issued by the Food and Drug Administration (FDA) and National Academy of Science (NAS) used to determine public health and ecological threats.

NUMERIC TARGET

The numeric target identifies in-stream goals for the TMDL that ensure attainment of applicable WQSs. Numeric targets for the Alamo River Silt TMDL were selected to attain and maintain basin plan standards for total suspended solids (TSS) and turbity, and to provide a basis to evaluate TMDL success. Numeric targets were based on reasonable levels for protecting aquatic life from the direct effects of suspended sediment in the aquatic environment rather than nutrient or pesticide impacts, and relied on scientific literature, monitoring data, and best professional judgment. Water column sediment indicators were selected for numeric targets using EPA's *Protocol for the Development of Sediment TMDLS* (USEPA, 1999b), and considered studies specific to warm water systems (Waters, 1995; Winger, 1981), NAS' recommended TSS concentration to protect aquatic life (based on a literature survey of the direct effects of suspended solids on the life cycle of freshwater fish by the European Inland Fisheries Advisory Council in 1964), and EPA's *Quality Criteria for Water,* which supports NAS' recommended criteria. Long term monitoring in progress may be used to refine the numeric target, as knowledge of the problem and solution increase with data collection and analysis.

SOURCE ANALYSIS

The source analysis identifies and describes the magnitude and location of all significant point, nonpoint and background sources of pollutant to a waterbody. Several scientific disciplines contributed to for the source analysis for this TMDL including: geology, topography, land use, limnology, statistics, hydrology, and soil physics.

The Alamo River source analysis identified and quantified sediment loading to the River from human activities (NPDES discharges, agricultural discharges, drain system maintenance, urban runoff, and wastewater from Mexico), and from natural processes (in-stream erosion, wind deposition and stormwater runoff). RB staff evaluated sediment transport in the Alamo from 1978 to 2001, by measuring TSS and turbidity in water samples collected from downstream reaches. Water quality sampling was conducted pursuant to a Quality Assurance Project Plan (QAPP) that was reviewed and approved by three senior level RB staff, and the Region's Quality Assurance/Quality Control (QA/QC) Officer (M. Carpio-Obeso, Ph.D., chemistry). Water quality samples were analyzed in the Region's laboratory, certified by the California Department of Health Services for microbiology and inorganic chemistry for wastewater analysis. Sediment data from IID (1995-1999), the USBR, and from State Board's TSM Program (1978 to 1999) was also reviewed. Watershed data and methods used to quantify sediment loads from human activities and natural sources are detailed below.

Analysis for Point Sources: Monthly suspended solids load discharged to minor drains was calculated for each point source (i.e., NPDES facilities) by multiplying the facility's reported monthly effluent flow by the reported monthly effluent TSS concentration.

Analysis for Nonpoint Sources: Monthly suspended sediment load in the Alamo at the International Boundary with Mexico was calculated by multiplying monthly average TSS concentration by total monthly flow.

- Monthly flow data for the minor drains was estimated from monthly irrigation water deliveries for areas served by the drains;
- Missing monthly flow data for major drains was estimated using statistical analyses of existing major drains flow data and the irrigation delivery data for areas served by major drains;
- Monthly suspended sediment load for minor drains discharging into the Alamo was determined by multiplying the estimated monthly flow of each minor drain by the average TSS concentration for the minor drains;
- Monthly suspended sediment load for major drains discharging into the Alamo was determined by multiplying the flow of the drain by the TSS concentration for the major drains;
- Potential loads from drain dredging operations was estimated from TSS monitoring data collected by RB staff upstream and downstream of dredging operations, and from flow data from IID;
- Estimated loads from stormwater runoff from farmland and urban areas in the Alamo River watershed was calculated using precipitation data from 1994 through 1999, and a TSS of 150 mg/L for urban runoff (Terrene Institute and USEPA, 1994), and
- The estimated potential cumulative loading from in-stream erosion and wind deposition in the drains was determined by mass balance.

A Regional Board registered civil engineer developed a two-dimensional model for the source analysis. The model also served as a foundation for load allocations (discussed below) and became part of the TMDL administrative record. As such, it was also peer reviewed.

LINKAGE ANALYSIS

The linkage analysis specifies the critical quantitative link between applicable WQSs and the TMDL such that total loading to the Alamo River will result in attainment of the numeric target. The linkage analysis for the Alamo Silt TMDL describes the relationship between the numeric target and sediment sources, and the analytical basis in which the load allocations for these sources are based. The linkage analysis was developed by analyzing the flow and sedimentation regimes in the Alamo River watershed (both relatively stable), with the sediment and water sources in the watershed (both relatively uniform and widespread). These factors allow simple linkages between sources of sediment, numeric targets, and the total assimilative capacity of the Alamo River for sediment. The assimilative capacity is the highest sediment load the River can assimilate without exceeding its numeric targets.

LOAD ALLOCATIONS

USEPA TMDL Guidelines (USEPA, 1991) define the maximum allowable pollutant load as the total load of a particular pollutant in a water body that ensures designated beneficial uses are attained and maintained. The guidelines recommend that the TMDL be reduced by a factor that accounts for uncertainty, the margin of safety, and, when appropriate, an allocation for future growth. The remaining allowable pollutant load is distributed equitably among existing point sources and nonpoint sources of pollution.

Allocations for the Alamo Silt TMDL are based on data analyses that indicate sediment inputs into the Alamo are mainly from agricultural drain discharges, the discharge from Mexico at the International Boundary, and natural sources (in-stream erosion, and wind-deposited sediment). To account for some of the uncertainty in load contributions from the various drains, Regional Board staff divided the Alamo River into six (6) sections for monitoring and assessment. To allocate mass load amongst the drains, the total mass load allocated for the segment was distributed based on the proportion of flow of each drain to the total flow within the segment on a yearly basis. This method of allocation accounts for agricultural acreage served by each drain and promotes watershed-wide implementation of BMPs. Yearly mass load allocations account for monthly fluctuations and data uncertainty.

Load allocations (LAs) are required for all nonpoint sources and wasteload allocations (WLAs) for all point sources. RB staff developed a two-dimensional spreadsheet model described below, to calculate load and waste load allocations for the Alamo River Silt TMDL.

Load Allocations: To determine LAs for nonpoint sources, the Alamo River watershed was divided into seventy-one (71) minor drains and five (5) major drains. Based on the source analysis, ten (10) mg/L of sediment in the Alamo River were allocated to natural sources including wind deposition and erosion, and another 10 mg/l were allocated to the margin of safety. The TSS balance was attributed to loading from minor and major drains. The concentration used to determine the total load allocation for each section was computed by adding the allocation for natural sources to the margin of safety in terms of concentration, and subtracting this sum from the suspended sediment target concentration for the River. Total load allocations for each section (for all drains within a section) was determined by multiplying the total load allocation concentration by the total flow within the section. Load allocations for each drain was determined by multiplying the percent flow by the total section load allocation. The load allocation for the Alamo River at the International Boundary, which is minimal, was also considered in the Source Analysis.

Wasteload Allocations: There are no direct discharges of wastes into the Alamo River from point sources. However, thirteen (13) NPDES facilities have permits to discharge into drains tributary to the River. A wasteload allocation for these facilities equal to twice their current TSS loading rate was used to allow for potential expansion. An additional wasteload allocation of 1000 tons per year was used for future point sources.

The development of LAs and WLAs also considered future water use that could impact suspended sediment concentrations in the Alamo specifically, population expansion, and water transfers between IID and San Diego County Water Authority, Coachella Valley Water District, or Los Angeles Metropolitan Water District.

IMPLEMENTATION PLAN

The Implementation Plan for the Alamo River Silt TMDL was based on a self-determined model of compliance, and allows agricultural dischargers in the watershed to continue to operate under a waiver of waste discharge requirements provided implementation efforts are reasonable. In addition to the best management practices identified and recommended by the Silt TAC, RB staff researched technical papers (e.g., R.E. Sojka, USDA Agricultural Research Service), and consulted with USDA Natural Resources Conservation Service, University of California Cooperative Extension, environmental consultants (e.g., Jones & Stokes Associates), and technical experts with federal, state, and local agencies to develop a list of efficient and cost effective sediment reduction BMPs. Moreover, an Economics Technical Advisory Committee (ETAC) was established to evaluate the costs (i.e., assess potential economic impacts) resulting from the BMPs that were likely to be implemented by farmers.

The Implementation Plan requires farmers to implement best management practices (BMPs) to control the silt coming from their fields and to monitor and report effectiveness of BMPs. It also requires the IID to implement BMPs to control the impacts caused by drain maintenance operations and to monitor and report on impacts and effectiveness of BMPs. The Implementation Plan specifically requires IID to develop a Drain Water Quality Improvement Plan (DWQIP), proposing a program to monitor:

- water quality impacts caused by dredging operations in the drains and the effects of dredging operations in the Alamo River Delta on water quality and the Delta habitat;
- representative water samples from major drains, and a statistically representative number from small drains tributary to the Alamo River, for analysis of flow, TSS, turbidity, and nutrients;
- a statistically representative number of irrigation locations for TSS;
- a statistically representative number of drains at a location sufficiently upstream of the outfalls to the River to provide an indication of silt reduction due to field BMP implementation, and
- sediment impacts from storm events.

A DWQIP and QAPP were developed by IID for review and approval by the RB Executive Officer.

The Implementation Plan also recommends that the Imperial County Farm Bureau (ICFB) implement their "Voluntary Watershed Program" throughout the Valley to address sediment pollution from farmland. Farmers discharging sediment into the Alamo or tributary drains are required to submit and implement water quality improvement plans identifying self-determined sediment control measures, and water quality improvements. An electronic database was developed by the Farm Bureau to accommodate plans submitted by farmers, and reporting requirements to the Regional Board. Implementation monitoring reports from IID and the Farm Bureau are reviewed by RB staff.

The TMDL Implementation Plan also requires RB staff to conduct comprehensive monitoring and surveillance programs throughout the implementation period. A sediment TMDL implementation QAPP and a monitoring plan to monitor turbidity, dissolved oxygen, salinity, temperature, and pH from seven (7) locations on the Alamo River was developed. Monitoring and reporting conducted by RB staff, ID, Farm Bureau and others, is a critical component of TMDL implementation, and required to evaluate compliance with the TMDL numeric target, load and wasteload allocations, and WQSs; the accuracy of assumptions and hypotheses used to develop the TMDL, and the need to refine TMDL.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

TMDL development requires a CEQA Checklist pursuant to the California Code of Regulations Title 23, section 3777, subdivision (a)(1) through (3); Public Resources Code section 21159, subdivision (a)(1) through (3); and California Code of Regulations Title 14, section 15187, subdivisions (b) and (c)(1) through (3). The CEQA Checklist identifies physical, biological, social and economic factors that might be affected by the proposed project. Where appropriate, the evaluation includes an analysis of feasible reasonably foreseeable mitigation measures identified for those impacts; and an analysis of reasonably foreseeable alternative means of compliance with the requirements of this project, to avoid or eliminate the identified impacts. Evaluated environmental factors include: Aesthetics, Biological Resources, Hazards & Hazardous Materials, Mineral Resources, Public Services, Utilities/Service Systems, Agriculture Resources, Cultural Resources, Hydrology/Water Quality, Noise, Recreation, Air Quality, Geology/Soils, Land Use/Planning, Population, and Transportation/Traffic.

RB staff consulted with CDFG to complete the CEQA analysis to ensure protection of threatened or endangered species as required by The California Endangered Species Act (Fish and Game Code 2080). USFWS was also consulted, and other experts.

NATURAL ENVIRONMENT STUDY

The Natural Environmental Study (NES) supplements the CEQA Checklist, and provides biological studies and information needed for environmental documents to satisfy legal requirements of state and federal statutes. The NES documents the biological resources in the project area and assesses impacts from alternative projects on those resources.

To complete the NES for the Alamo River Silt TMDL, RB biologists reviewed technical papers researching habitat, vegetation, and species in the Alamo River and Salton Sea delta. The distribution of plant communities was mapped based on survey information and recent aerial photographs. Environmental impacts to habitat and wildlife were assessed, including: Southern willow scrub, non-native Tamarisk scrub, cismontane alkali marsh, freshwater marsh, mudflats, and open water. Loss of valuable habitat used by sensitive species in the Salton Sea delta due to reduced silt from TMDL implementation, was also evaluated. RB staff consulted with CDFG to complete the NES. USFWS was also consulted as appropriate.

LINKING SCIENCE TO THE DEVELOPMENT OF ENVIRONMENTAL REGULATION

The basin plan amendment process is the mechanism used to include science into the policy making regulatory process.

The basin plan amendment process for a TMDL requires:

- Document preparation
  - Staff report
  - Environmental (CEQA) checklist
  - Draft amendment
  - Draft resolution
- Consulting with agencies with jurisdiction (23 CCR 3778)
- External scientific peer review
- Public notification of RB public hearing (notice of a public hearing/notice of filing) at least 45 days prior to the meeting (23 CCR 3777)
- Responding to public comments (23 CCR 3779; APM p. 30)
- Adoption hearing
- Transmitting two copies of administrative record to SB-basin planning unit for review
- Participating in SB workshop and public meeting
- Filing a Notice of Decision with Secretary of Resources Agency for public posting for at least 30 days
- Review/approval by Office of Administrative Law
- Review/approval by USEPA
- Incorporation of the amendment (TMDL) into the Basin Plan.

Science is incorporated in several of the above processes as discussed in the preceding pages of this report.

APPENDIX A - 8

Total Maximum Daily Load for Nutrients in the Indian Creek Reservoir

Role of Science & Engineering in Decision-Making at the Water Boards (R-6)

Indian Creek Reservoir (ICR) in Alpine County was constructed with the dual purposes of storing tertiary-treated wastewater exported from the Lake Tahoe watershed for irrigation use, and providing a recreational trout fishery. The Lahontan Water Board adopted numeric water quality standards for ICR based on the expected quality of tertiary effluent. The reservoir became eutrophic, and fish kills occurred. ICR was placed on the Clean Water Act Section 303(d) list of impaired waters. This triggered the need for development and adoption of Total Maximum Daily Loads (TMDLs).

In 1989, the South Tahoe Public Utility District (STPUD) diverted wastewater to a new reservoir and began maintaining ICR with fresh water from the West Fork Carson River. Monitoring by STPUD after 1989 showed that, although nutrient levels decreased, phosphorus concentrations remained high, dissolved oxygen depletion continued during the summer months, and eutrophic conditions persisted (including blooms of blue-green algae).

Lahontan Water Board staff completed a preliminary draft TMDL and TMDL implementation program in 1999, based on evaluation of effluent data and ambient water quality data, and on the projected nutrient flushing rates from STPUD's maintenance program for ICR. The 1999 drafts were peer-reviewed by a scientist with expertise in eutrophication problems. Her comments pointed out that:

- the preliminary draft TMDL targets for nutrients, based on existing water quality objectives, were set at levels that would continue to maintain eutrophic conditions

- Water Board staff had not accounted for internal loading of phosphorus to surface waters from the reservoir's sediment

- The proposed implementation program with existing available water rights was inadequate to achieve significant flushing of nutrients from ICR

As a result of the peer review comments, Lahontan Water Board staff undertook a detailed review of the scientific literature on eutrophication and lake restoration, and performed additional TMDL calculations to estimate nutrient loads from external and internal sources.

It was determined that ICR was "phosphorus limited," and that the TMDL should necessarily focus on phosphorus. (That is, reductions in phosphorus loading would reduce the other symptoms of eutrophication.) The additional literature research and calculations resulted in estimates that internal loading from the reservoir's sediment accounted for 76 percent of the total phosphorus load. External sources, including tributary inflow, surface runoff and atmospheric deposition accounted for only 24 percent. Based on this information, the Lahontan Water Board adopted a TMDL strategy that would effectively address the internal phosphorus loads.

Suggestions to improve science in the decision-making of the RWQCB:

1. Scientists at the Regional and State Water Boards need better access to the scientific state-of-knowledge. The State Board should obtain and maintain at least one institutional subscription to a broad-based electronic scientific journal access system such as Ingenta, or institutional electronic subscriptions to a number of key journals selected by staff from the various programs that need access to current scientific information (i.e., planning, monitoring, assessment, TMDL programs). Access to these journals should be available to all technical staff of the State and Regional Boards.

2. State/Regional Board budgets should include routine allocations for purchase of up-to-date scientific reference books and maintenance of adequate library space and cataloging databases. State scientists should not have to subsidize their projects through personal book purchases, go through weeks of red tape to order needed references through current purchasing channels, or find that valuable reference material has been discarded to save space.

3. Staff time should be allowed (and encouraged) for visits to university libraries. Photocopying allowances should be included in budgets. Even if electronic journal subscriptions become available, library visits are still useful to access graduate theses on specific watersheds, and a broader range of reference books. (The nearest university to Region 6's South Lake Tahoe office is over 60 miles away in Reno, Nevada, and out-of-state travel authorization may be required to use its library on state time.)

4. The State Board should resume allowing State/Regional Board scientists to attend professional society conferences in their fields as "training," at least for conferences held in/near California. (Conferences in other states where no out-of-state travel expenses are involved should also be allowed, e.g., conferences on the Nevada side of Lake Tahoe, or in Reno, where employees can stay in California.)

5. Regional Boards are unlikely to have staff with in-depth knowledge of all of the scientific disciplines that may be involved in TMDLs and other types of Regional Board activities. A general process for formal inter-Board consultation, when needed, could be very useful. (Some informal consultation already exists. For example, the TMDL Roundtable is developing a process for "internal scientific peer review" of preliminary draft TMDL products. A more formal process would require baseline allocations of staff time.)

APPENDIX A – 8

Total Maximum Daily Loads for Nutrients in the Indian Creek Reservoir

Role of Science & Engineering in Decision-Making at the Water Boards (R-6)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to improve)
Adoption of Total Maximum Daily Loads **(TMDLs) for Indian Creek Reservoir**	Development of TMDLs required: a. source analysis based on field measurements (sampling and analyses based on chemistry, biochemistry, phycology) and estimates derived from scientific literature b. determination of the loading capacity (LC) for nutrients c. assign waste load allocations for pollutant loading among all sources d. develop an implementation plan for all sources that will achieve water quality standard(s) by a specified time.	Science (chemistry, biology, limnology, phycology) determined the capacity of nutrients that the reservoir can accept without exceeding water quality objectives. The load capacity determines how much dischargers, individually and collectively are permitted to release into the reservoir. The results of compliance monitoring determines whether violations have occurred.	Determining a TMDL requires knowledge of the physical (e.g., flow rates, turnover rates, lake stratification, etc.), chemical (e.g., current pollutant levels, oxygen levels, sediment biochemistry), and biological (e.g., algae, chlorophyll-a, etc.) conditions, and the beneficial uses (e.g., swimmable, potable, fishable) of the receiving waters. This is far more difficult than the traditional regulation of point and nonpoint sources. It requires a "holistic" approach to regulating and improving water quality.	Scientists at the Regional and State Water Boards need better access to the relevant scientific state-of-knowledge. The State Board should obtain and maintain at least one institutional subscription to a broad-based electronic scientific journal access system such as Ingenta, or institutional electronic subscriptions to a number of key journals selected by staff from the various programs that need access to current scientific information (i.e., planning, monitoring, assessment, TMDL programs). (See attached narrative for more suggestions.)

APPENDIX A – 9

Total Maximum Daily Loads for Mercury in Cache and Bear Creeks

Role of Science & Engineering in the Decision-Making Processes of the Water Boards

Plan, Policy, Program (**where** science is used)	Science – Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to improve)
Cache Creek, Bear Creek, and Harley Gulch TMDL for Mercury (Nov 2004) Technical report describes in detail the elements of a total maximum daily load (TMDL) management plan for controlling mercury in the Cache Creek watershed. Total Maximum Daily Loads are required under the CWA for each pollutant affecting an impaired water body appearing on the Clean Water Act Section 303(d) List.	Development of the TMDL required: a. Calculation of water quality targets in the form of concentrations of methylmercury in fish tissue that protect humans and wildlife species eating the fish – relies on biology, risk assessment, and biochemistry. b. Analysis of the sources, including the amount, seasonal variation, and origin of mercury and methylmercury pollutants – relies on field measurements (sampling and analysis based on chemistry), hydrogeology, geochemistry, and statistics.	Calculating the numeric targets: the risk assessment <u>determines</u> the targets that will protect wildlife species. The human health risk assessment <u>informs</u> selection of numerical targets to protect human health (deciding how much fish from Cache Creek people should be able to eat is a scientific and social question that balances the benefits and risks of consuming fish). The load allocations <u>determine</u> how much dischargers, individually and collectively, are permitted to release into a water body.	Determining a TMDL requires knowledge of the physical (e.g., flow and erosion rates, sedimentation rates), chemical (e.g., current mercury levels, forms of mercury), and biological (e.g., fish, shellfish, aquatic plants, habitat types) conditions, and the beneficial uses (e.g., swimmable, potable, fishable) of the receiving waters. Understanding the role of multiple sources of a pollutant and characteristics of a whole watershed is more difficult than the regulation of individual point and nonpoint sources of a pollutant. It requires a "holistic" approach to regulating and improving water quality.	The State currently has 68 water bodies listed as impaired due to mercury. TMDLs have been completed for only a few. The fact that we must reduce levels of methylmercury in the environment is not in question. We lack a thorough scientific understanding of how to most effectively reduce the methylmercury levels, whether by controlling inorganic mercury or interrupting mercury-to-methylmercury production, or increasing methylmercury degradation. We also need better scientific information on how to design and manage restored wetlands so as to minimize

	c. Determination of the source reductions needed to meet water quality targets, including a margin of safety, requires an understanding of the link between methylmercury in fish and total mercury in sediment and relies on biogeochemistry, biology, microbiology, hydrology, statistics, and physics. d. Assign allocations for mercury loads among the sources. e. Develop an implementation plan for all sources that will achieve water quality standard(s) by a specified time – relies on engineering, hydrogeology, physics, and geochemistry.		TMDLs are adopted by amending Regional Water Quality Control (Basin) Plans to add enforceable water quality standards. Amendments to Basin plans are subject to public and scientific peer review.	methylmercury loads. Many of the wetland restoration projects being proposed for the Yolo Bypass and the Sacramento San Joaquin River Delta will be downstream of mercury sources and could increase methylmercury production if improperly designed and managed.

APPENDIX A - 9

TMDL Development for Mercury in Cache and Bear Creeks

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

The **Cache Creek, Bear Creek, and Harley Gulch TMDL for Mercury** (November 2004) is technical staff report that describes a total maximum daily load (TMDL) for mercury in Cache Creek and two of its tributaries. These water bodies are considered impaired because fish and water contain elevated levels of mercury. The TMDL includes: development of numeric water quality targets, assessment of mercury sources and loads, analysis of the linkage between methylmercury concentration in fish and loads in sediment and water, assignment of load allocations, and monitoring and implementation plans. The goal of this TMDL is to lower mercury levels in the Cache Creek watershed such that humans and wildlife that eat fish from the creeks are protected. Also, because Cache Creek is a significant source of mercury to the Sacramento-San Joaquin Delta Estuary, lowering mercury levels in the Cache Creek watershed will help to protect human health and wildlife in the Delta.

The numeric targets for this TMDL are in the form of concentrations of methylmercury in fish tissue. The Basin Plan does not contain water quality objectives for mercury. New targets were developed for the TMDL using biology, risk assessment, and biochemistry. As part of the TMDL approval process, the Regional Board will adopt the targets as site-specific, numeric water quality objectives and amend them into the Basin Plan. The target calculations are based on methods recommended by the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency.

The TMDL incorporated a large amount of field data that included analyses of mercury and methylmercury in fish, water, and sediment. Estimates of existing mercury and methylmercury loads in Cache Creek were based on water data collected by Regional Board Staff and others at seven primary sites, located in each of the main tributaries and reaches of the creek. The water data showed that a significant portion of the mercury load was unrelated to ongoing inputs from upstream inactive mercury mines. Staff designed and conducted several special studies of the creek bed and smaller tributaries to refine the source analysis.

The linkage between the methylmercury fish tissue targets and mercury sources is complicated. Most of the mercury entering the creeks is in inorganic forms. Sediment-dwelling bacteria convert a small portion of the inorganic mercury to methylmercury, which is the most toxic form of mercury in the environment. Factors affecting the formation and degradation of methylmercury include concentration of inorganic mercury, temperature, pH, and availability of oxygen, sulfate, and nutrients. Methylmercury bioaccumulates; that is, concentrations of methylmercury increase in successive levels of the food chain. The degree of bioaccumulation depends on availability, size, and species of prey, and metabolism of the consumer. Understanding the linkage, then, required knowledge of biogeochemistry, biology, microbiology, hydrology, statistics, and physics.

The heart of the linkage was a mathematical relationship between concentrations of methylmercury in water and in fish. This relationship, derived empirically from the field data discussed above, was used to calculate the overall reductions in methylmercury loads needed to attain the water quality targets. The existing loads minus the reduction and minus a margin of safety equaled the acceptable load, which is then allocated among the various sources. The load estimates represented average values. The margin of safety was included to account for both natural variation in loads (range of potential values) and statistical uncertainty in estimating the true average loads.

Assigning load allocations is particularly difficult for a pollutant such as mercury, which undergoes a transformation after leaving the source. With the exception of thermal springs, sources in this watershed (inactive mines and contaminated stream bed sediment) do not discharge methylmercury.

A scientific understanding of the transport and fates of mercury and methylmercury was important in crafting an implementation plan to reduce mercury loads. Given staff's current understanding of the mercury/methylmercury cycle, some factors affecting methylmercury production appear controllable in the Cache Creek watershed, while others do not. The implementation plan seeks to reduce the concentration of mercury in sediment by controlling inputs of concentrated sources of mercury, such as discharge from inactive mine sites. To estimate the efficacy of mine cleanup and other projects to reduce mercury loads, staff utilized their experience in engineering, hydrology, geology, physics, and geochemistry. Levels of methylmercury in fish could decline more quickly if other factors (besides concentration of inorganic mercury) to address methylmercury production were better understood and controllable.

APPENDIX A – 10

Update of Bacteria Objectives Set to Protect Water Contact Recreation and Implementation of Bacteria Objectives in TMDLs

Role of Science & Engineering in Decision-Making Processes at the Waterboards (R-4)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to improve)
Amendments to Los Angeles Water Board Basin Plan, including: a. Update of bacteria objectives set to protect the REC-1 (Water Contact Recreation) beneficial use, b. incorporation of implementation provisions for updated bacteria objectives, and c. incorporation of TMDLs to address bacteria impairments at beaches along Santa Monica Bay. The amendments were a multi-year effort to update our bacteria objectives based on the latest science. This update	Basin Plan contains: a. Multi-part bacteria objectives set to protect REC-1 use. The objectives were based on the most recent national epidemiological studies as well as a landmark local epidemiological study (*attachment 1*) that characterized the health risk associated with swimming in waters contaminated by urban runoff. b. The implementation provisions for the bacteria objectives acknowledge natural sources of	a. Science determined the updated bacteria objectives based on recent and relevant epidemiological studies. b. Science is the basis for potential refinements to the reference system approach used to implement the bacteria objectives. c. Science was used to identify and prioritize sources of bacteria to aid responsible agencies in achieving TMDL requirements. d. Science informed the decision regarding the appropriateness of	In general, amendments to regional basin plans are subject to extensive public review. Additionally, technical aspects of basin plan amendments are subject to peer review through the UC system before adoption by Water Boards. Finally, basin plans and water quality standards are subject to periodic (triennial) review per the federal Clean Water Act and Porter Cologne Water Quality Control Act. For the Santa Monica Bay Bacteria TMDLs, Water Board staff also established a	The scientific field of recreational water quality is rapidly evolving. Nowhere in the world is recreational water quality more important than in California and southern California in particular, where we have world-renowned beaches that are visited by millions of local residents and visitors each year. One of the state's highest priorities has been to protect and improve water quality at these beaches. Because of the importance of clean beaches, there are many other scientific studies underway in California to evaluate

Update of Bacteria Objectives Set to Protect Water Contact Recreation and Implementation of Bacteria Objectives in TMDLs

Role of Science & Engineering in Decision-Making Processes at the Waterboards (R-4)

was made in anticipation of adopting Total Maximum Daily Loads for the world-class beaches along Santa Monica Bay in southern California.	bacteria that may cause exceedances of the bacteria objectives and establish a reference system approach for implementing the bacteria objectives. The reference system approach requires that water quality be at least as good as that at an established reference waterbody or, maintained at existing levels if water quality is better than that of the reference system. A scientific study to evaluate possible differences among potential reference sites and variability within a site is	applying dilution credits when setting TMDL requirements. e. Science is being <u>used to understand</u> bacteria fate and transport during wet weather to <u>inform decisions</u> geared toward optimizing control measures. f. Science <u>determined</u> guidelines for compliance monitoring under the TMDLs including sampling protocols, analytical methods and data analysis and reporting.	technical steering committee made up of key stakeholders with various areas of scientific expertise. The steering committee met frequently (on average every other month) for three years. Additionally, the Water Board solicited the assistance of the Southern California Coastal Water Research Project (SCCWRP) through contracts for some of the scientific studies that formed the basis for, or informed, decisions regarding TMDL development.	emerging analytical methods to more precisely identify sources of bacteria (i.e. human vs. non-human and more specifically whether the source of bacteria is avian, bovine, canine, feline, etc.). Effective source identification methods will accelerate our efforts to target and control sources of bacteria. Another line of research underway in California is to develop more rapid methods for measuring traditionally used fecal indicator bacteria as well as emerging measures of recreational water quality such as viruses. These more rapid methods will

	underway and will support refinements of the reference system approach in the future (*attachment 2*). c. The TMDL characterizes sources of bacteria through a multi-year study comprised of wet-weather monitoring and modeling to identify critical sources of bacteria (from land uses). d. The TMDL requires compliance in the wave wash (i.e. the point at which the freshwater initially mixes with ocean waves) and does not apply any dilution credits based upon a scientific study of			allow the state and county health departments to provide more timely information on water quality to beach-goers and will should improve public health. Nationally, a new series of epidemiological studies are underway to evaluate new objectives (criteria) that are more directly linked to health effects. In addition to these national epidemiological studies, more epidemiological research is needed to determine the health risk associated with non-human sources of bacteria. Current EPA policy requires that the health risk from human and non-

	mixing and dilution conducted at several beaches along Santa Monica Bay (*attachment #*). e. TMDL implementation strategies are being evaluated through wet weather sampling to understand the nature of bacteria loading during wet-weather events (*attachments 3 and 4*).			human sources of bacteria be treated as the same. Finally, more monitoring and modeling work is needed to inform decisions regarding optimal design storms for BMPs and other treatment measures to help responsible agencies implement TMDL requirements in a cost-effective manner.

APPENDIX A – 11

Construction Stormwater Permit Violations (ACL) Moro Hills, CA

Role of Science and Engineering in Decision-Making at the Water Boards (R-4)

Plan, Policy, Program (**where** science is used)	Science-Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to improve)
Enforcement. Imposition of Administrative Civil Liability against developers of the **Moro Hills** (Fieldstone/Chase) **project** in Oceanside for **construction storm water permit violations**. The Regional Board imposed Administrative Civil Liability penalties in the amount of $262,500 on June 8, 2005.	Biology, chemistry, geology/hydrogeology, math/statistics, meteorology, economics.	a. Identification of non-compliance. Science drove the determination. Involved review and interpretation of monitoring and technical reports and inspection results. **Biology**: evaluation/ assessment of stream conditions, assessment of aquatic and plant environments. **Chemistry**: analyses to determine compliance with water quality objectives and limitations. **Hydrogeology**: Assessment of sediment and pollutant transport, stream condition/ function, soil and sediment size. **Math/statistics**: evaluation of rainfall data, days of discharge, water chemistry statistics	The discharger submitted monitoring reports pursuant to requirements of the statewide construction stormwater permit. The discharger was required to submit additional technical reports pursuant to California Water Code Section 13267.	Provide more resources to inspections and other compliance assurance activities. This would result in better documentation of permit violations and support of subsequent field investigations. This would also result in improved water quality sampling and data analysis for evaluation of receiving water quality and stream conditions.

Construction Stormwater Permit Violations (ACL) Moro Hills, CA

Role of Science and Engineering in Decision-Making at the Water Boards (R-4)

Plan, Policy, Program (**where** science is used)	Science-Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to improve)
		Meteorology: Review weather conditions, precipitation patterns. **Engineering**: Review assessment of BMPs, design for sediment basins, channel flow based on particle size, design runoff events. b. Determination of severity of violations & culpability. Science informed the determination. Involved analyzing available information, including discharger submittals in response to investigative orders pursuant to CWC Section 13267. **Biology**: evaluation and assessment of stream conditions, assessment of aquatic and plant environments. **Chemistry**: analysis to determine compliance with water quality objectives and limitations.		

Construction Stormwater Permit Violations (ACL) Moro Hills, CA

Role of Science and Engineering in Decision-Making at the Water Boards (R-4)

Plan, Policy, Program (**where** science is used)	Science-Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to improve)
		Hydrogeology: Assessment of sediment and pollutant transport, stream condition/ function, soil and sediment size. **Math/statistics**: evaluation of rainfall data, days of discharge, water chemistry statistics. **Meteorology**: Review weather conditions, precipitation patterns. **Engineering**: Review/ assessment of BMPs, design for sediment basins, channel flow based on particle size, design runoff events. c. Prepare complaint and basis or foundation for the Order. **Biology**, engineering and hydrogeology were used to evaluate the following statutory factors. The results of this determination informed the decision on amount of liability proposed: • Nature • Circumstance		

APPENDIX A – 11

Construction Stormwater Permit Violations (ACL) Moro Hills, CA

Role of Science and Engineering in Decision-Making at the Water Boards (R-4)

Plan, Policy, Program (**where** science is used)	Science-Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to improve)
		• Extent • Gravity • Susceptibility to cleanup or abatement **Economics and mathematics** were used to evaluate the following statutory factors. The results of this determination informed the decision on amount of liability proposed: • Ability to pay • Efect on ability to continue its business • Voluntary cleanup efforts • Prior history of violations • Degree of culpability • Economic benefit or savings c. <u>Imposition of monetary penalties by the Regional Board.</u> All of the science and engineering cited informed the Regional Board's ultimate decision to impose the monetary penalty.		

APPENDIX A – 12

Adoption of Waste Discharge Prohibitions and CDOs for Sewage Discharges at Eagle Lake

Role of Science & Engineering in Decision-Making at the Water Boards (R-6)

Plan, Policy, Program (**where** science is used)	Science – Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to **improve**)
Adoption of Waste Discharge Prohibitions and Cease & Desist Orders for **sewage discharges at Eagle Lake.**	Based on monitoring data, the RWQCB adopted a prohibition on the discharge of all sewage to individual treatment systems (i.e., septic systems) in the watershed of Eagle Lake.	Science (bacteriology) was used to compare monitoring results from drinking water supply wells to drinking water standards. Science (chemistry) was used to compare monitoring results from Eagle Lake to Basin Plan nutrient objectives.	The communities have received grants to construct modern sewage treatment systems. Construction is partially completed and ongoing.	Ground water investigations should incorporate monitoring wells designed and located for the purpose of delineating and quantifying ground water pollution. (See attached narrative.)

APPENDIX A - 12

Basin Plan Provisions Prohibiting Septic Systems and Enforcement Actions requiring Waste Discharges to Septic Systems to Cease from Spalding Tract and Stones-Bengard Subdivisions, Eagle Lake, Lassen County

Role of Science & Engineering in Decision-Making at the Water Boards (R-6)

The Lahontan Water Board relied on science to make three separate decisions at Eagle Lake: 1) adoption of a **prohibition of waste discharge**, 2) **declaring a public health problem**, and 3) adopting **cease and desist orders (CDOs)** against individuals discharging wastes to ground water.

In 1984, the Lahontan Water Board adopted amendments to its *Water Quality Control Plan for the Lahontan Region* (Basin Plan) for the Eagle Lake Hydrologic Unit. The Regional Board imposed a waste discharge prohibition requiring discharges of waste from septic systems to ground water within the Stones-Bengard Subdivision and the Spalding Tract to cease by September 1989. The Water Board relied primarily on nutrient and lake productivity data to support the prohibition. Contract resources and staff time focused on collecting nutrient and lake productivity data and compiling a preliminary nutrient budget for Eagle Lake. The Water Board contracted with the Department of Water Resources and a private contractor for the water quality data. A Chico State University Research Assistant conducted enumeration and identification of phytoplankton samples. The Lassen National Forest also supported water quality monitoring at Eagle Lake and several years of data had been collected allowing a trend to be established. The Water Board determined that accelerated eutrophication was occurring and since Eagle Lake is a closed basin lake with no outlet, the Board determined reducing nutrient loading was critical in protecting Eagle Lake's unique aquatic habitat (e.g., Eagle Lake trout – a unique subspecies of the rainbow trout, considered for threatened and endangered species listing). In deciding to prohibit discharges from new and existing septic systems at the Spalding Tract and Stones-Bengard subdivisions, the Water Board also relied on housing and planning information provided by Lassen County.

Following adoption of the Basin Plan amendments in 1984, Water Board staff, County Health Department staff and contractors sampled over 100 domestic wells in the two subdivisions for total and fecal coliform and fecal streptococcus bacteria. At two different sampling events, 20 percent of the wells contained fecal coliform concentrations in violation of drinking water standards. The Water Board passed a resolution in 1986 declaring that a public health problem existed within the two subdivisions. This determination, supported by the Lassen County Health Department, assisted the communities in obtaining grants for community sewer systems.

After the registered voters declined to assess fees to pay for the required match for the grants, the Water Board adopted individual cease and desist orders for the more than 900 property owners with existing septic systems. Again, the Water Board relied on the bacteria data in making that decision. Several individuals petitioned the Board's decision and the State Water Board approved funding for additional ground water monitoring. The Department of Water Resources collected samples from several domestic wells and found similar results to the Lahontan Water Board. Approximately 20% of the wells tested contained fecal coliform in concentrations that exceeded the drinking water standard. The State Water Board upheld the Lahontan Water Board's enforcement orders.

The Stones-Bengard Community Services District now has a community sewer system with lined evaporation ponds, and all property owners are connected. At Spalding Tract, construction of a similar system will begin this year.

Suggestion to improve science in the decision-making of the RWQCB:

1. Ground water investigations should incorporate monitoring wells designed and located for the purpose of delineating and quantifying ground water pollution. The available funding for the Eagle Lake studies was not adequate to provide for installing new wells. Therefore, the Water Board had to rely on data collected from individual domestic wells. Since domestic wells were constructed with a variety of methods, including lack of sanitary seals and no screening at discrete ground water depths, the results were criticized by some stakeholders. Better funding for monitoring programs (both surface and ground waters) is therefore essential to support critical water quality protection decisions at the Water Boards.

APPENDIX A – 14

Cleanup of Perchlorate in Groundwater

Role of Science & Engineering in the Decision-Making of the Water Boards (R-3)

Plan, Policy, Program (where science is used)	Science - Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to improve)
Perchlorate in Groundwater	Soil & groundwater chemistry; pollutant fate & transport, hydrogeology, soil & water treatment engineering, health science	For all perchlorate investigation and cleanup cases, the Central Coast Water Board has gathered technical consultants and scientists (engineering, geology, hydrogeology, water purveyors & health experts) to guide decision-making. In our most complex case (Olin/Std Fusee), where more than 1000 domestic, municipal, and agricultural wells have been impacted, Water Board staff helped establish a community advisory group. The group meets monthly with regular Water Board participation to discuss technical issues and obtain public insight. In addition to engineering	The Central Coast Water Board and its staff have been intimately involved with several military base and private responsible party cases where perchlorate has impacted ground water, including domestic, municipal and agricultural wells. In every case, decisions related to pollution investigation & cleanup, wellhead treatment and provisions for replacement water were made after lengthy participation by technical consultants, regulatory & health officials, water purveyors, public advisory groups, special interest organizations, and legal counsel.	For complex or extensive perchlorate contamination cases, where numerous domestic, municipal or agricultural supply wells have been impacted, a more open and transparent process directing remediation activities is recommended. Smaller and less extensive pollution cases may not warrant as broad a public process. Every perchlorate pollution case should involve technical experts and consultants, including engineers, hydrogeologists, soil scientists, chemists, health officials, and various regulatory personnel.

		and hydrogeotechnical assistance, the group has brought in heath officials, toxicologists, Dept of Health Services, Office of Environmental Health Hazard Assessment, USEPA experts, and locals with knowledge & expertise in agricultural, human health, soil science, chemistry, etc. Generally, draft regulatory decisions and direction given to the responsible parties, are presented to the technical consultants, regulatory agencies, the community advisory group and the general public, prior to an final Water Board decision.	Experience has proven that proper regulatory direction on complex groundwater pollution cases is best made with input from appropriate technical, scientific, regulatory, public, and legal expertise. Broad technical & scientific involvement is especially important for perchlorate cases, where regulatory and health goals and levels are not clearly established or available.	

APPENDIX A – 15

Cleanup and Abatement of Copper & Zinc in Sediments in the Peyton Slough

Role of Science & Engineering in Decision-Making Processes in the Water Boards

Plan, Policy, Program (**where** science is used)	Science – Engineering (**what** science is used)	Role in Decision (**how** science is used)	Comment	Recommendations (how to improve)
Sediment in Peyton Slough and the adjacent wetlands have been contaminated with copper and zinc from historic industrial activity. The Regional Water Board is **overseeing cleanup**. In this case the Board adopted **Site Cleanup Requirements.** The cleanup approved by the Board involved the unusual step of relocating the existing stream alignment to uncontaminated land further east, to greatly reduce the risk of further erosion of extensive areas of polluted soil and to **restore tidal wetlands.** This approach required unusual technical considerations, especially involving stream dynamics.	Developing a remediation plan for Peyton Slough required use of a wide range of science disciplines: - Ecology (including biology and botany), chemistry, toxicology, statistics and risk assessments were used to evaluate wetland habitat and slough conditions; - Geology (including hydrogeology and hydrology), and computer modeling were used to understand the interrelation between groundwater and surface water, including preferential pathways for contaminants; and - Hydrology and computer modeling were used to evaluate various project designs including tidal exchange.	The science described here was mostly done by the discharger's consultants and reviewed by Regional Water Board staff. This body of work was the basis for the Board's ultimate approval of this unusual cleanup and its requirement for long-term monitoring after cleanup is complete.	The unusual nature of this cleanup project calls for special long-term oversight. Under the Board's order, the discharger must do comprehensive post-remediation monitoring, and host a meeting annually, including a site walk, for all permitting agencies and the interested public. At the end of years 3, 5, 7, and 10, the discharger must submit reports that include data on hydrology, sedimentation/erosion, vegetation cover, and faunal observations, in addition to water and sediment data. Post remediation monitoring will continue for a minimum of 10 years post construction.	Many water quality impacts result from contact with contaminated sediment and/or soil. The Water Board does not have a comprehensive, accepted soil guidance document to aid staff in making decisions regarding sediment/soil cleanup levels that are protective to groundwater and surface water.

APPENDIX A – 16

Establishing Region-wide Beneficial Uses for Wetlands

Role of Science & Engineering in Decision-Making at the Water Boards (R-6)

Plan, Policy, Program (**where** science is used)	Science – Engineering (**what** science is used)	Role in Decision (**how** science is used)	Commentary	Recommendations (how to **improve**)
Adoption of **region-wide beneficial uses for wetlands**. Establishes the Lahontan Basin Plan beneficial uses for wetlands.	Beneficial uses for wetlands include: a. Water Quality Enhancement (ability of wetlands to remove pollutants from water) b. Flood Water Retention (ability of wetlands to attenuate & retain flood waters)	Science (**chemistry, biology, physics, ecology**) determines the beneficial uses of wetlands. University scientists conducted extensive literature review (to establish the BUs) & survey of wetlands in the Region (to identify location of wetlands).	The Lahontan Region was the first RWQCB in California to acknowledge the unique benefits of wetlands by adopting specific beneficial uses to be protected.	More monitoring is needed to track trends in wetland quality (area, functions, and values) over time. More research is needed to develop numerical chemical and biological water quality standards for wetlands. On-going staff training is needed to ensure that regulatory activities regarding wetlands are based on the best available science.

APPENDIX A - 16

Basin Planning Program: Adoption of Beneficial Uses for Wetlands

Role of Science & Engineering in Decision-Making at the Water Boards (R-6)

The current *Water Quality Control Plan for the Lahontan Region* (Basin Plan) was adopted in 1994 and received final approval from the USEPA in 1995. The revised plan was largely an editorial update of three earlier plans, with some new regulatory language. Regulatory changes included the addition of: (1) new beneficial use categories related to wetland functions; (2) new entries in the plan's beneficial use table (Table 2-1) for about 500 wetlands; (3) a narrative water quality objective for non-degradation of wetland communities and populations; and (4) policy language for protection of wetlands in the plan's implementation chapter (Section 4.9). The new wetlands beneficial uses were Water Quality Enhancement (WQE) and Floodwater Retention (FLD). Definitions of these uses are included in Chapter 2 of the Basin Plan.

Wetlands are considered surface waters of the State of California, and "jurisdictional" wetlands are also waters of the United States. Water quality standards for surface waters have always been applicable to wetlands.

The importance of natural wetland functions in protecting water quality in the Lahontan Region had been recognized earlier in the State Water Board's 1980 *Lake Tahoe Basin Water Quality Plan.* (The regulatory provisions of that plan are now contained in Chapter 5 of the Lahontan Basin Plan.) Scientific studies at Lake Tahoe showed that wetlands and riparian areas (included in the term "Stream Environment Zone" or SEZ) are capable of removing significant amounts of sediment and nutrients from stormwater through mechanical filtration, vegetative uptake of nutrients, and microbial processes such as nitrification-denitrification. Protection and restoration of SEZ functions has been a key provision of an ongoing interagency program aimed at reversing the scientifically documented decline in the clarity of Lake Tahoe.

In the early 1990s, additional staff and contract resources were provided for all of the Regional Water Boards to update their Basin Plans. Lahontan Water Board staff used contract funding for a region-wide wetlands study by University of California, Santa Cruz scientists under the direction of Dr. Robert Curry. The products of the study included:

- wetlands mapping and GIS coverages based on aerial photographs;
- an intensive scientific literature review (involving more than 1,000 references);

- a written report on wetland functions and values, based on the literature review;
- recommendations for beneficial use designations for about 500 specific wetlands, based on field visits;
- a computer database containing the information from the study.

The contract also included provisions for Dr. Curry's group to provide wetlands training to Lahontan Water Board staff. Dr. Curry made a presentation on his study to the Lahontan Water Board at one of the public hearings held prior to adoption of the final revised Basin Plan.

The study recognized that wetlands of arid portions of the Lahontan Region have some unique functions, including improving the quality of saline groundwater through plant evapotranspiration. This process brings salts to the soil surface where they can be removed by wind.

Lahontan Water Board staff used Dr. Curry's study as the basis for recommendations to the Board regarding wetland water quality standards, including specific beneficial uses, in the 1995 Basin Plan. The study was also used, together with staff's experience in SEZ protection in the Lake Tahoe Basin and its knowledge of federal regulations for protection of jurisdictional wetlands, in development of the wetlands policy language in Basin Plan Section 4.9. The Regional Board adopted the changes in 1994.

Suggestions to improve science in the decision-making of the RWQCB:

1. State-of-the-art science continues to demonstrate the importance of wetlands, riparian areas, flood plains, and headwater streams in removing pollutants from stormwater and protecting downstream water quality and beneficial uses. (At the same time, the U.S. Supreme Court's SWANNC decision removed federal protection from "isolated" wetlands, which are widespread throughout the Lahontan Region.) More research and monitoring are needed to develop numerical chemical and biological water quality standards for these waters. The U.S. Environmental Protection Agency's recent (2003) *Elements of a State Water Monitoring and Assessment Program* (referred to as the USEPA's "10 Elements" guidance) requires that states conduct monitoring of <u>all</u> water body types (including streams, rivers, lakes, reservoirs, estuaries, coastal areas, and wetlands) in order to continue receiving Clean Water Act Section 106 grants, which fund a large portion of our core regulatory programs. The State Water

Board's Surface Water Ambient Monitoring Program (SWAMP) has developed a strategy for the needed monitoring, but funds are not currently available to implement it.

2. There is an ongoing need for training of Regional Board staff to ensure that regulatory activities regarding wetlands are based on the best available science.

APPENDIX A – 17

De-designation of Municipal an Domestic Supply (MUN) Beneficial Use

Role of Science & Engineering in Decision-Making at the Water Boards (R-6)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to improve)
De-designation of the municipal and domestic supply **(MUN) beneficial use** for certain saline waters	Per the federal Clean Water Act, de-designation of any beneficial use requires a science-based "Use Attainability Analysis" to show that the designated beneficial use(s) cannot be feasibly attained.	Science (chemistry, engineering treatment technologies) was used to determine that certain saline waters could not feasibly be used for municipal or domestic supply (i.e., drinking water).	De-designation of the beneficial use was necessary to avoid the requirement to develop TMDLs for these water bodies.	In order to recognize the unique characteristics of geothermal and inland saline water bodies, the State Water Board should consider revising its Sources of Drinking Water Policy (or enact a new "natural pollutants" policy) to provide more specific science-based direction regarding the suitability of such waters for the MUN use. (See attached narrative for more details.) Develop aquatic life criteria for such waters. (See attached narrative for more details.)

APPENDIX A - 17

Basin Planning and TMDL Programs
De-designation of MUN use for saline water bodies

Role of Science & Engineering in Decision-Making at the Water Boards (R-6)

In 1988, the State Water Board adopted the Sources of Drinking Water Policy (Resolution 88-63) and directed Regional Water Boards to designate Municipal and Domestic Supply (MUN) beneficial uses for potential drinking water sources within their jurisdictions. The MUN use was subsequently designated for nearly all surface and ground waters of the Lahontan Region. This "blanket designation" was largely a policy decision, with the assumption that water scarcity might make it feasible and desirable to treat and use even poor quality waters at some time in the future. Drinking water standards apply to all surface waters designated for the MUN use under the Basin Plan's narrative water quality objectives for Chemical Constituents and Toxicity.

Surface waters of the Lahontan Region drain to closed inland basins rather than to the ocean. Some of these waters have naturally high concentrations of salts and trace elements such as arsenic, boron, and fluoride. These pollutants come from geothermal or volcanic sources, or from evaporative concentration over geologic time. Due to violations of drinking water standards, a number of Lahontan Region waters with naturally high pollutant concentrations were placed on the Clean Water Act Section 303(d) list of impaired waters. This triggered the need for development and adoption of Total Maximum Daily Loads (TMDLs). (Some waters were also listed due to violations of the stringent arsenic standard in the State Water Board's Inland Surface Waters Plan; that plan and its standards were subsequently invalidated by a court decision.)

After discussions with U.S. Environmental Protection Agency (USEPA) staff, Lahontan Water Board staff determined that TMDLs were not appropriate for "naturally impaired" waters, and instead prepared draft Basin Plan amendments to remove the MUN use from nine water bodies. These waters included geothermal springs, geothermally influenced streams, and ephemeral inland saline lakes. A "Use Attainability Analysis" report meeting USEPA requirements was prepared. The report reviewed available information and data on:

- water quality of the nine water bodies

- criteria for protection of these waters' designated beneficial uses, especially in relation to commonly occurring pollutants such as arsenic

- water quality and beneficial uses of saline and geothermal waters in general

- potential treatment technology for natural pollutants, including desalination and arsenic removal.

In response to the evaluation of the above factors, the Regional Board decided to de-designate the MUN beneficial use from the water bodies.

Suggestions to improve science in the decision-making of the RWQCB:

1. In order to recognize the unique characteristics of geothermal and inland saline water bodies, the State Water Board should consider revising its Sources of Drinking Water Policy (or enact a new "natural pollutants" policy) to provide more specific science-based direction regarding the suitability of such waters for the MUN use. (Most of these water bodies would provide relatively small and/or ephemeral/unpredictable amounts of water, and many have unique ecological and/or recreational values that might take precedence over diversion for MUN uses.)

2. Develop aquatic life criteria for such waters. (EPA's saltwater aquatic life criteria apply to these waters under the California Toxics Rule. However, those criteria were developed using toxicity tests with marine and estuarine organisms, and are not really appropriate for inland saline water bodies.)

APPENDIX A – 18

Total Dissolved Solids/Nitrogen Management Plan

Role of Science & Engineering in the Decision-Making Processes of the Waterboards

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to improve)
Amendment of the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) to incorporate a revised **Total Dissolved Solids/Nitrogen Management Plan** Amendment of the Basin Plan to incorporate revised groundwater subbasin boundaries, revised total dissolved solids (TDS) and nitrate water quality objectives, TDS/nitrogen wasteload allocation for publicly owned treatment works (POTWs).	<u>Groundwater subbasin boundaries</u>: Hydrogeologic studies and geologic data including groundwater level data, fault maps, depth to groundwater data, groundwater quality and groundwater gradient studies <u>TDS/Nitrogen WQOs:</u> Hydrogeologic studies and geologic data including groundwater level data, depth to groundwater data, statistical programs, and GIS mapping software <u>TDS/Nitrogen POTW Wasteload Allocation:</u> a wasteload allocation model was developed and calibrated using	Geology, hydrogeology, statistics and engineering models were used to develop basin boundaries, calculate TDS and nitrate water quality objectives and evaluate groundwater quality potentially impacted by POTW discharges and therefore specify TDS and nitrogen discharge limits for POTWs. The model results were used to determine if further restrictions on TDS and/or nitrogen discharged by POTWs were needed to comply with revised WQOs (Water Code 13241 factors to be evaluated when setting WQOs).	To develop the recommended revisions to the TDS/Nitrogen Management Plan, 22 local agencies formed the Nitrogen-TDS Task Force (Task Force). Agency representatives to the Task Force included scientists and engineers (scientific and technical experts) from their respective agencies. Further, Board staff, including the senior planning staff and the Executive Officer, actively participated in nearly 100 Task Force meetings. As required by the Health and Safety Code, the proposed TDS/Nitrogen Basin	The methods utilized in the revision of the TDS and Nitrogen Management Plan for the Santa Ana River Basin relied heavily on computer models and statistical programs. The use of these scientific and engineering tools is contingent on the availability of sufficient and high quality data. Further, the Regional Board needs access to these computer tools including appropriate software programs and high power computers to run complex computer programs.

	data from 1950 through 1999. Data from 43 rain gauge stations and daily stream flow data from 20 US Geological Survey stations across the upper Santa Ana watershed, TDS and nitrogen data from a number of stations in the watershed, precipitation data, POTW flow and water quality data, and data on soil characteristics were all input into the model. The volume-weighted average of the surface water TDS and nitrogen inputs described above were compared to ground and surface water quality to determine allowable POTW TDS and nitrogen discharge quality.	Based on the model results, only minor revisions to the current TDS and nitrogen wasteload allocations would be needed, and therefore, there would be minimal impacts on the POTWs as a result of the revised TDS and nitrogen WQOs. The science used to re-define basin boundaries, re-calculate TDS and nitrogen WQOs ensured that groundwater quality would be protected, but also that demonstrated the efficacy of increased reclamation activities within the region.	Plan amendment did undergo scientific peer review. The peer reviewer found no flaws with the scientific and engineering components of the amendment. This extensive Basin Plan amendment was approved by the Regional Board and State Board without any negative comments. The Regional Board recognized the rigorous scientific effort that comprised the 8-year long study.	

APPENDIX A - 18

Total Dissolved Solids (TDS)/Nitrogen Management Plan

Role of Science and Engineering in Decision-Making at the Water Boards (R-8)

During the 1995 revision of the Santa Ana Region's Basin Plan, a number of wastewater and water supply agencies expressed concern that the total dissolved solids (TDS)/Nitrogen Management Plan specified in the Basin Plan limited available wastewater reclamation opportunities in this area of rapidly increasing water demand. The fundamental concern raised by the wastewater and water supply agencies was the probable cost of compliance with TDS and nitrogen discharge limits set to protect underlying groundwater quality with respect to TDS and nitrogen. Since the basis for TDS and nitrogen discharge limits are the underlying groundwater TDS and nitrogen water quality objectives (WQOs), the wastewater and water supply agencies believed that the TDS and nitrogen objectives for the various groundwater subbasins should also be reviewed to ensure that they were set correctly based on the best available data and scientific analysis.

In 1996, twenty-two wastewater and water supply agencies, in coordination with Board staff, formed the Nitrogen/TDS Task Force. The Task Force contracted with two consulting firms. Wildermuth Environmental, Inc. (WEI), was responsible for performing the technical analyses and preparing the water quality reports. Risk Sciences was responsible for facilitating the regulatory review and developing consensus among the Task Force participants. As part of the study efforts, the consultants conducted watershed-wide evaluations of TDS and nitrogen that, in 2004, resulted in significant revisions to the Santa Ana Basin Plan. Major revisions and the scientific nature of these revisions to the Basin Plan are summarized below.

1. <u>Revision of Groundwater Management Zone Boundaries</u>
   Using an extensive database of groundwater level data and other hydrogeologic studies performed during the last 50 years, WEI reviewed available geologic data, such as fault maps, depth to bedrock, groundwater elevations and groundwater quality gradients to develop the hydrologically-distinct management zones. Management Zones were identified based on 1) impermeable rock formations that prevent subsurface flow from one area to another, 2) natural gradients that cause groundwater to flow in one direction, but not another; and 3) significant differences in TDS or nitrate-nitrogen concentrations that make it useful to differentiate two or more distinct management zones in order to protect areas with high groundwater quality.

2. Groundwater Subbasins TDS and Nitrate WQOs

   For each of the re-defined groundwater Management Zones, it was necessary to re-compute TDS and nitrate WQOs. Taking into account spatial distribution of wells and water quality data, WEI computed ambient quality using a volume-weighted method utilizing the best available data on water level, water quality and well construction information. To develop the TDS and nitrate WQOs, WEI compiled all available well data and associated well and aquifer information for all wells in the region covering the period of 1954 through 1997. For each well, TDS and nitrate statistics (mean, standard error of the mean) were calculated. Using the water quality statistics and water level data, and taking into consideration Management Zone boundaries, nitrate and TDS water quality contours were drawn and digitized for each Management Zone. In order to evaluate groundwater quality data against hydrological conditions, water level maps for every 2 years since 1950 were also developed and digitized. The Task Force agreed to use the 1973 historical period TDS and nitrate water quality contours and the 1973 water level contours as the benchmark historical time period for setting the TDS and nitrate WQOs.

   To develop volume-weighted estimates of TDS and nitrate in each Management Zone, a rectangular grid was overlain over the entire region. The grids, which were 400 X 400 meters, were created in Fortran and imported into GIS in a consistent format with the Management Zone boundary process described above. For each grid, the volume of storage was determined. Using the TDS and nitrate contours, the TDS and nitrate concentration for each grid was determined and the volume-weighted TDS and nitrate concentration for each grid was calculated. Finally, the TDS and nitrate concentrations for each grid within a Management Zone were summed to calculate the value of TDS and nitrate in each grid cell and the Management Zone as a whole.

3. TDS and Nitrogen Wasteload Allocations for Publicly Owned Treatment Works (POTWs)

   The Task Force recognized that with the proposed revision of subbasin (management zone) boundaries and calculation of new TDS and nitrate-nitrogen water quality objectives, it would be necessary to review the TDS and nitrogen wasteload allocation for POTWs, as well. This review was necessary to ensure that the wasteload allocation for POTWs would ensure compliance with the proposed TDS and nitrate objectives for downstream and underlying management zones, as well as to assure compliance with existing and proposed TDS and nitrogen surface water quality objectives.

WEI also performed the model wasteload allocation analysis for both TDS and nitrogen taking into account all POTW discharges to the Santa Ana River or its tributaries. WEI developed a wasteload allocation model that was calibrated using surface water flow, and TDS and nitrogen data from a number of stations in the watershed. In order to ensure that all hydrological regimes were considered, data from 1950 through 1999 were used in the calibration process. The model took into account the TDS and nitrogen quality of wastewater discharges, overland runoff (based on 1993 land use data), in-stream flows, and groundwater. Precipitation data from 43 rain gauge stations and daily stream flow data from 20 United States Geological Survey (USGS) stations across the upper Santa Ana watershed were collected and put into the model. These data and soil characteristics were used to evaluate the amount of impervious surface, off-stream and in-stream percolation rates, and rising groundwater quality and quantity. The modeling work did not include simulation of the interaction of surface and groundwater and its effects on nitrogen and TDS quality. Rather, the volume-weighted average of the surface water TDS and nitrogen inputs described above were compared to ground and surface water quality. Nitrogen loss through percolation through the vadose zone was factored into this analysis. Three model evaluations were conducted – year 2001 Baseline Plan, year 2010 alternative with assumed wastewater recycling as currently identified in the Basin Plan, and year 2010 alternative with ambitious wastewater recycling plans that were developed by the Task Force.

The modeling results indicated that, for the most part, the existing TDS and nitrogen wasteload allocations for the POTWs would ensure compliance with the re-calculated TDS and nitrate WQOs; therefore, cost impacts to POTWs resulting from the revision of the TDS and nitrogen WQOs would be minimal. Further, increased reclamation activities would not result in degradation of groundwater quality.

In summary, the 8 years of extensive data collection, data evaluation, hydrogeologic investigations and computer modeling resulted in this sweeping Basin Plan amendment that was adopted by the Regional Board, State Board and approved by the Office of Administrative Law without controversy. Further, the required Peer Reviewer of the scientific components of the amendment found no flaws with the scientific approach used to develop the proposed amendment.

APPENDIX A – 19

Diazinon Water Quality Objectives for the Sacramento & Feather Rivers

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to improve)
The Water Quality Control Plan for the Sacramento River and San Joaquin River Basins – Amendments for the Control of Orchard Pesticide Runoff and Diazinon Runoff into the Sacramento and Feather Rivers	Statistics; hydrology; chemistry; agronomy; agricultural engineering; aquatic toxicology; environmental risk assessment; entomology; agricultural economics; analytical chemistry; atmospheric sciences.	**Monitoring** – statistics; aquatic toxicology; hydrology; analytical chemistry are used in determining when to monitor, the type of analysis that will give us the accuracy needed, and how to evaluate and interpret toxicity test results. **Water quality objectives** – statistics; aquatic toxicology; and environmental risk assessment were applied to identify a diazinon level that should not impair the aquatic life beneficial use of surface waters. **TMDL** – statistics; hydrology; chemistry; and atmospheric sciences were used to determine the loading capacity, evaluate the	Regional Water Board staff used a variety of methods to ensure our recommendations had a sound scientific foundation. Many of the suggested management practices were identified from reports prepared by UC Cooperative Extension. The State Water Board's economist provided assistance in developing cost estimates. Scientists at DPR reviewed and commented on pesticide-related issues. The water quality criteria were based largely on work done by scientists at the US EPA and CA Dept. of Fish and Game. Monitoring information was	One area for improvement is in the derivation of water quality criteria. The U.S. EPA methodology provides a sound basis for deriving criteria, but also has limitations. If data are not available for the eight families of aquatic organisms identified, then the methodology cannot be applied. This has made it difficult to derive criteria for other pesticides that could contribute to aquatic life toxicity. Additionally, methodologies for deriving sediment criteria are needed. Pyrethroids have been identified as a replacement for diazinon, but their impact would be seen

		fate and transport of diazinon, and evaluate the pathways of diazinon transport. **Implementation** – agronomy; agricultural engineering; and agricultural economics were applied to the evaluation of various management practices, their feasibility, and the expected change in cost to agricultural operations.	collected collaboratively with scientists from the University of California, Davis, DPR and the US Geological Survey. A stakeholder group with expertise in management practices was consulted. Multiple stakeholder meetings were used to provide critical feedback on the scientific and technical basis of proposals. A formal scientific peer review was conducted of the proposed Basin Plan Amendment.	in the sediment, rather than the water column. These chemicals bind to sediment organic matter. Sediment criteria derivation methods are not readily available, so the Regional Water Board could not easily establish objectives for these replacement pesticides.

APPENDIX A – 19

Diazinon Water Quality Objectives for the Sacramento and Feather Rivers

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

Diazinon is an organophosphorus insecticide that is used for pest control on a variety of crops and has historically been used in and around homes. In the early 1990's. diazinon was identified as a water quality problem in a number of Central Valley waterways, including the Sacramento and Feather Rivers, which were placed on the Clean Water Act Section 303(d) list of impaired water bodies. In developing water quality objectives for diazinon, science played a role in a variety of areas – definition of the problem; assessment of sources; evaluation of alternative numeric objectives; establishment of the total maximum daily load (TMDL); and review of available management practices.

Definition of the Problem – Central Valley Regional Water Board staff were national leaders in adapting the U.S. EPA's three species whole effluent toxicity testing protocols to an ambient water quality monitoring program. In the late 1980's and early 1990's, water samples were collected from dozens of Central Valley streams and rivers. Species of algae, water flea, and fathead minnow (representing three major trophic levels) were placed in those water samples to observe their survival, reproduction, and growth. In waters in which the water flea did not survive (or had low survival), additional tests and investigation suggested that diazinon was a primary contributor to the observed toxicity in many cases. Water quality criteria developed by the Department of Fish and Game, using U.S. EPA methodologies, confirmed that diazinon levels in the Sacramento and Feather Rivers were elevated and were likely responsible, at least in part, for the observed toxicity.

Assessment of the Sources – Once diazinon was identified as a potential problem, the Regional Water Board, U.S. Geological Survey, and the Department of Pesticide Regulation (DPR) designed monitoring studies to evaluate the distribution and timing of diazinon runoff. Pesticide use records maintained by DPR were analyzed to identify likely sources. Monitoring revealed that diazinon runoff primarily occurred in response to rain events during the winter. This time period corresponds with the application of pesticides to dormant orchards for the control of over-wintering insects. Later analysis was refined, by using Geographic Information System (GIS) technology, to assess diazinon use patterns to a relatively small spatial scale (1 square mile). Comparison of GIS crop and diazinon use layers revealed the primary areas and crops (almonds, peaches, prunes) that were contributing to the diazinon runoff problem.

Evaluation of Alternative Numeric Objectives – The primary scientific issues were related to establishing the diazinon level necessary to protect the most sensitive beneficial use of water and evaluating whether that level was attainable. The U.S. EPA methodology is the standard method used to establish water quality criteria for protection of aquatic life. The manufacturers of diazinon proposed an alternative risk assessment methodology. Principles and practices of statistics, aquatic toxicology, and risk assessment were applied in comparing and evaluating the different methods and criteria. The Board had to take into account the potential presence of other pesticides that could act in an additive or synergistic manner with diazinon, as well as potential sublethal (olfactory) impacts of diazinon to salmonids. Application of these scientific principles led to the Board's conclusion that the U.S. EPA methodology should protect aquatic life in the Sacramento and Feather Rivers, whereas the manufacturers' alternative would allow potentially toxic conditions to exist. The attainability of the recommended objective was evaluated as part of the review of available management practices discussed below.

Establishment of the Total Maximum Daily Load – The federal Clean Water Act requires the development of a TMDL for each pollutant-water body pair that has been added to the Section 303(d) list. In establishing the TMDL, the capacity of the Sacramento and Feather Rivers to assimilate diazinon without exceeding the water quality objectives was evaluated. This required analysis of the physical and chemical properties of diazinon; the hydrology of the Sacramento and Feather Rivers; and the fate and transport of diazinon. The analysis suggested that the critical hydrologic conditions for diazinon transport were during rainfall-runoff events. A variable loading capacity was defined, rather than a fixed load limit that might be more appropriate for pollutant impacts during low flow. Aerial transport and deposition pathways were considered in establishing the allocations of the loading capacity. Allocations for non-point sources were done on a watershed basis, which should account for both runoff from fields on which diazinon was applied and runoff from other areas that receive diazinon from aerial deposition and transport. Allocations to point sources took into account background diazinon levels in rainfall.

Review of Available Management Practices – Management practices available to control the diazinon runoff and manage pests in ways that minimize diazinon use were reviewed to assess the feasibility of attaining the proposed objectives and TMDL. GIS and data analysis tools were applied to DPR's pesticide use report database to assess changes in pesticide use patterns and determine what alternatives to diazinon were being used by orchard growers. Agricultural pesticide application practices were evaluated to determine the benefits of new technologies, such as "Smart Sprayers", in comparison to standard practices. Integrated Pest Management (IPM) practices were reviewed to identify potential benefits in reducing diazinon runoff (e.g. scouting for pests to determine whether a pesticide application is needed). Runoff management practices (e.g. cover crops, vegetated buffer strips) were assessed for their feasibility and effectiveness in reducing diazinon loading from fields. The review demonstrated that there are a wide variety of cost-effective and technically feasible approaches to reducing or eliminating diazinon runoff from agricultural fields and meeting the applicable water quality objectives.

APPENDIX A – 20

Site Specific Objectives (SSOs) for Copper and Nickel

Role of Science & Engineering in Decision-Making at the Water Boards (R-2)

Plan, Policy, Program (**where** science is used)	Science – Engineering (**what** science is used)	Role in Decision (**how** science is used)	Comment	Recommendations (how to improve)
The establishment of **site specific objectives for copper and nickel in the Lower South San Francisco Bay** south of the Dumbarton Bridge. This project resolved regulatory issues in several programs, including TMDL, 303(d) Impairment Listing, and NPDES permitting.	The project used a combination of the following sciences: • **Aquatic toxicology**, to assess the impact of copper and nickel to the same species of organisms as for national standards, but using waters from the Lower So. SF Bay rather than laboratory waters. • **Biogeochemistry, hydrodynamic computer modeling** to predict the fate and transport of copper and nickel in their various speciated forms in the Lower So. SF Bay. Samples from about 12 stations over several years provided a valid characterization of the seasonal and annual variability of the system.	The project established revised copper and nickel objectives that were appropriately protective of the Lower So. SF Bay. They were based on site-specific factors as compared to national standards that were more restrictive than needed. This led to two major actions: 1. Removal of copper and nickel from the list of impairing pollutants (303d List) for the Lower So. SF Bay, and 2. Development of achievable and protective permit limits for discharges into the Lower So. SF Bay. The affected dischargers include three major sewage treatment plants–San Jose/Santa Clara, Sunnyvale, and Palo Alto.	The 3 keys to success of this project were: 1. Formation of a broad-based stakeholder group that included environmentalists, to improve communication and consensus building. 2. Creation of Technical Review Committees to provide peer review. These were made up of national experts who reviewed the studies and provided feedback on the approach and methods. The City of San Jose funded an independent expert, chosen by the environmental community, to provide that community with independent advice. As mandated by State law, the results of the investigation received	This project took four years to bring to fruition. As noted in the Comment, it would not have been possible without the funding support of one of the regulated parties (City of San Jose). State or federal funding of scientific studies could facilitate and speed similar processes. Expand the stakeholder process to fully examine implementation issues earlier on and avoid debates during implementation after policies are final.

APPENDIX A – 20

Site Specific Objectives (SSOs) for Copper and Nickel

Role of Science & Engineering in Decision-Making at the Water Boards (R-2)

	• **Risk assessment** principles identified appropriate regulatory strategies. • **Engineering** identified relative significance of Cu and Ni sources and assessed treatment technologies for those sources. • **Ecological science** expertise assessed all available data to determine if there were impacts to the Lower So. SF Bay from copper and nickel, and none were found.		final scientific peer review by the University of California. 3. Solid funding for the scientific studies by the City of San Jose.	

APPENDIX A – 21

Identifying Numerical Water Quality Limits

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to improve)
Numerical water quality limits used in permits, waste discharge requirements, enforcement, and other Board orders and in water quality assessments, are based on water quality objectives in the Water Quality Control Plans (Basin Plans) to protect beneficial uses of water resources. In many cases, there are no Board-adopted numerical limits for particular constituents of concern that are protective of specific beneficial uses of water. The Basin Plan contains a number of narrative water quality objectives, including Chemical	Numerical water quality limits for constituents used in this process are based on **toxicology**, **biochemistry**, **risk assessment**, **biology** (ability to taste or smell a constituent in water; which species are likely to be exposed to a toxic chemical) and in some cases **computer modeling**. Limits for physical characteristics of water, such as pH, temperature, hardness, and turbidity are based on **chemistry** and **physics**. Limits for bacterial and nutrient effects are based on **bacteriology** and **microbiology**. The ability to detect and	Most of the numerical limits used to interpret narrative objectives are **determined** by the scientific disciplines discussed to the left. There are a few (e.g., drinking water MCLs and Notification Levels from the California Department of Health Services) that are **informed** by health-effects related scientific disciplines, but are also influenced by technologic and economic factors such as the ability to deliver drinking water that meets these levels statewide and the ability to quantify these constituents and parameters (also science-based) by a sufficient number of	Water quality limits that apply to a specific permitted waste discharge are updated at the time that the permit or waste discharge requirements are updated; normally on an every 3-, 5- or 10-year basis. Limits used in water quality assessments and enforcement actions are normally selected more frequently. The *Water Quality Goals* database is updated on a regular basis, as staff resources allow, to provide staff with access to the latest water quality limits available. The last update of the database occurred in May 2004.	Increasing the frequency of updating the Water Quality Goals database would provide more current information to staff that use these limits. Increasing the frequency of renewal of Board-adopted permits and waste discharge requirements would allow limits applied to specific regulated discharges to reflect more current science. There are many waste constituents for which there are no available water quality limits or for which limits are not available to protect all beneficial uses of water. Without this information, it is

Identifying Numerical Water Quality Limits

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

Constituents, Toxicity, Tastes & Odors and Pesticides. The Implementation Chapter contains policies and procedures to guide the application of narrative objectives using relevant and appropriate numerical limits published by other agencies and organizations. Regional Water Board staff maintains the *Water Quality Goals* database of these limits to provide easy access for staff, other agencies, the regulated community and the public. Staff has also developed recommended procedures for selection of relevant and appropriate limits from those available for a particular constituent and beneficial use.	quantify these constituents and parameters at appropriate levels is based on **analytical chemistry**. Knowledge of these disciplines also comes into play in selecting the most relevant and appropriate limits from among those available for a particular constituent of concern or water quality parameter to interpret narrative water quality objectives.	analytical laboratories so as to determine water purveyor compliance. Most narrative water quality objectives are worded in a manner that demands a purely scientific application (e.g., "All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.") However, a few are largely determined by technologic factors (e.g., "Total identifiable persistent chlorinated hydrocarbon pesticides shall not be present in the water column at concentrations detectable within the accuracy of analytical	Recommended limit selection procedures (narrative "Selecting Water Quality Goals" at the beginning of the staff report *A Compilation of Water Quality Goals*) foster consistent application of purely risk-based limits that reflect current science and that have been subjected to peer review. These procedures also give a preference for limits developed by other California agencies (e.g. OEHHA, CDFG) over those from other sources (e.g., USEPA), so as to foster consistency within state government. However, the final selection of water quality limits may deviate from these recommended procedures, due	difficult for staff or the Regional Board to adequately regulate the effects of these constituents on water quality. The pace of water quality criteria development by the USEPA is slower than in past decades, due to less funding for this work. Toxicologic and other information developed for pesticide registration is often not available or is insufficient to protect all beneficial uses of water resources. Regulatory mechanisms that mandate development of this information do not exist for the vast majority of chemicals used in commerce and industry. Analytical methods to detect and quantify many constituents used in commerce

		methods approved by the Environmental Protection Agency or the Executive Officer."), however even this is objective is determined by the analytical chemistry and statistical analysis. Due to the specific language of narrative objectives, the selection of relevant and appropriate limits to apply them, in most cases, is **determined** by science. However, in adopting a specific order that contains the numerical limit, the Regional Water Board is also influenced by technologic and economic factors, relating to implementability. In those cases, the selection is **informed** by science.	largely to factors related to implementability for a specific waste discharge and potential challenges from the regulated community.	and industry have not been developed, making regulation through the setting of water quality limits difficult or impossible. In many other cases, analytical methods are not able to detect or quantify constituents at levels that have been calculated to protect against health impacts, especially where cancer risk is involved.

APPENDIX A - 21

Identifying Numerical Water Quality Limits

Role of Science & Engineering in Decision-Making at the Water Boards (R-5)

Numerical water quality limits used in permits, waste discharge requirements, enforcement, and other Board orders and in water quality assessments, are based on water quality objectives adopted by the Regional Board in the applicable Water Quality Control Plans (Basin Plans). The water quality objectives are designed to protect one or more designated beneficial uses of water resources. Water quality objectives come in two forms – numerical and narrative. Numerical objectives exist for only a small number of waste constituents and water quality parameters. Narrative objectives potentially provide protection for all others. Examples of narrative objectives include:

Chemical Constituents

Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.

Tastes and Odors

Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses.

Toxicity

All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.

In 1994 and 1995, the Central Valley Regional Water Board adopted amendments to our two Basin Plans, including the *Policy for Application of Water Quality Objectives* that, in part, formalized a mechanism that had been used by the Regional Board to apply narrative objectives for many years:

> To evaluate compliance with the narrative water quality objectives, the Regional Water Board considers, on a case-by-case basis, relevant numerical criteria and guidelines developed and/or published by other agencies and organizations. In considering such criteria, the Board evaluates whether the specific numerical criteria, which are available through these sources and through other information supplied to the Board, are relevant and appropriate to the situation at hand and, therefore, should be used in determining compliance with the narrative objective.

This technique provides relevant numerical limits for constituents and parameters which lack numerical water quality objectives. To assist dischargers and other interested parties, the Regional Water Board staff has compiled many of these numerical water quality criteria from other appropriate agencies and organizations in the Central Valley Regional Water Board's staff report, *A Compilation of Water Quality Goals*. This staff report is updated regularly to reflect changes in these numerical criteria.

The first edition of *Water Quality Goals* was published in July 1985. The report is currently in its 13th edition and is available on the Regional Water Board's web site.[1] In April 2003, the *Water Quality Goals* staff report was made available to staff of the State and Regional Water Boards via a searchable intranet database[2] containing over 820 chemical constituents and water quality parameters. Currently, the database contains California and U.S. EPA drinking water standards, limits protective of human health from water and/or aquatic organism consumption, limits protective of freshwater and saltwater aquatic life, limits protective of nuisance conditions such as adverse tastes and odors, and limits protective of sensitive crops. Sources of these limits include the California Department of Health Services, the Office of Environmental Health Hazard Assessment, the Department of Fish & Game, the State Water Resources Control Board, the U.S. Environmental Protection Agency, the National Academy of Sciences, the Food and Agriculture Organization of the United Nations, as well as selected references from the peer reviewed scientific literature. The database includes descriptions of each of these limits, reference information, and direct links to primary on-line sources. Current limits and proposed changes to limits are identified, along with adoption dates, whether human health limits are based on cancer or reproductive toxicity, risk-assessment assumptions that were used to translate dose-based limits into concentrations in water, chemical synonyms and CAS Registry numbers. Footnotes are included that qualify how the limits were derived and provide potential limitations on their use.

Recommendations on how to select among available numerical limits are included at the beginning of the *Water Quality Goals* staff report. This information includes a description of the assumptions used to derive each type of limit and their applicability to the protection of beneficial uses of groundwater and surface water resources. Two algorithms are presented to help staff identify appropriate limits for Central Valley groundwater and inland surface waters. The algorithms are based on a set of guiding principles:

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1 http://www.waterboards.ca.gov/centralvalley/available_documents/wq_goals/

2 http://r5web.swrcb.ca.gov/General_Info/WQ_search1.jsp

- Use purely risk-based limits, rather risk management-based limits, when available;
- Match exposure and other assumptions used to derive the limits to the beneficial uses being protected in the water resource;
- Use limits developed and/or published by California agencies when available;
- Use limits that reflect peer reviewed science; and
- Use limits that reflect current science.

The assumptions used to derive risk management-based limits (e.g., drinking water MCLs) may not be applicable or appropriate to the protection of raw water resources, as defined by the specific language of the narrative water quality objective. Exposure pathways, types of species and water characteristics used to derive the limits should be relevant to the beneficial uses being protected. Consistency in the use of limits within state government should be encouraged and enhanced.

Training has been and will continue to be provided to State and Regional Water Board staff throughout the State on the use of these tools via the Water Board Training Academy.

Staff uses the *Water Quality Goals* report and database to identify water quality limits in tentative orders that will either be proposed to the Board for adoption or will be signed by the Executive Officer. Findings in these orders or the attached information sheet explain why a selected limit is relevant and appropriate to the narrative objective being applied or the beneficial use being protected. Identified limits are also used for water quality assessments and to interpret assessments performed by others.

Where proposed limits are or become controversial or where inconsistencies with earlier decisions are raised, the original sources of the limits and experts in other agencies may be consulted to provide clarification and additional guidance. The results of this consultation are often documented in findings or the information sheet for tentative orders being considered by the Board or EO. Staff-selected limits that form the basis of water quality objectives, other amendments to the Basin Plan or other rulemaking are subjected to the normal Water Board peer review process. All items that goes before the Board for consideration, including the water quality limits that staff have selected, are subject to notice, public review and comment.

This method allows current, peer reviewed science to be used in setting numerical water quality limits. Staff does not need to have a numerical water quality objective adopted by the Board via the lengthy Basin Plan amendment process to be able to use limits based on the most recent science. A good example is the use of U.S. EPA's *National Ambient Water Quality Criteria for Ammonia* to apply the narrative toxicity objective in the derivation of NPDES permit limitations. These criteria for the protection of freshwater aquatic life were revised four times between 1984 and 1999, as new information became available on how ammonia toxicity varies with water pH and temperature and the presence or absence of salmonids and/or early stages of aquatic life. It was not necessary to have the Regional Water Board adopt a new water quality objective (a process that can take one and one-half to two years) each time the criteria were revised, allowing rapid application of the latest scientific information. This method of interpreting water quality objectives has been upheld by the State Water Board and has been approved by U.S. EPA for translating narrative water quality standards pursuant to the federal Clean Water Act.

APPENDIX A – 22

Pilot Project for *in situ* Groundwater Remediation for Chrome-6+

Role of Science & Engineering in Decision Making at the Water Boards

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendations (how to improve)
In-situ **Groundwater Remediation Pilot Test Project**, PG&E Compressor Station, Hinkley	State-of-the art hydrogeology and biology were used to design a remediation pilot project.	Science (**biology, chemistry**) were used to screen potential treatment methods. Science and engineering (**hydrogeology, microbiology, physics, climatology, mathematics, and soil mechanics**) were used to design the treatment and monitoring systems.	An *in-situ* (i.e., underground) treatment system is desired because existing technology for above-ground treatment poses the potential for aerial drift of mist that may contain chrome-6. An *in-situ* (i.e., underground) treatment system should eliminate this potential health risk. (Inhalation of chrome-6 is far more toxic than by ingestion.)	

APPENDIX A - 22

In-situ Remediation Pilot Test Project PG&E Compressor Station, Hinkley

Role of Science & Engineering in Decision-Making at the Water Boards (R-6)

The In-situ Remediation Pilot Test Project (Project) is located at the Pacific Gas and Electric Company (PG&E) Compressor Station in Hinkley, California. The purpose of the project is to evaluate the effectiveness of in-situ (below ground) remediation of hexavalent chromium [Cr(VI)]. The project's goal is to reduce Cr(VI) in groundwater to trivalent chromium [Cr(III)]. Groundwater beneath the site has been adversely impacted by discharges of chromium-enriched effluent from the compressor station that percolated from evaporation ponds. The Project will provide information that will be used to design a full-scale remediation system for achieving cleanup goals and restoring the aquifer. Testing will take place in the groundwaters of the Middle Mojave River Valley Ground Water Basin for approximately six months.

The Project includes two major elements: 1) injection of food-grade, biological reagents to ground water, and 2) extraction of ground water downgradient to spread the reagents. Following bench-scale testing in the laboratory, two reagents, sodium lactate and emulsified vegetable oil (EVO), were selected for the pilot study. When injected into the aquifer, the reagents will be consumed by naturally-occurring microbes. The microbes in turn will consume oxygen in groundwater, creating an anaerobic environment. This condition will prompt Cr(VI) to reduce to Cr(III). As Cr(III) precipitates and adheres to the soil matrix, Cr(VI) (and therefore total chromium Cr(T)) will decrease in concentration in groundwater. This project will determine the number of injections and areal extent affected by injections needed to reduce Cr(T) concentrations to meet water quality goals.

The project includes a tracer test using potassium bromide to monitor groundwater flow rates before (and possibly during) the pilot test at each of the two test cells. Potassium bromide, a salt, will be injected to groundwater at an initial concentration of 500 mg/L. It will be immediately diluted to 100 to 150 mg/L by adding distilled water at four times the bromide dose. Tracer monitoring will be conducted by using a bromide ion-specific probe and collection of samples for confirmatory testing at the laboratory. The tracer is expected to disperse in the aquifer to concentrations meeting water quality standards at the test cell boundaries.

The project will take place at two test cells of similar design, measuring 80 x 40 feet. The sodium lactate will be tested in one cell, and EVO tested in the other. The test cells consist of an upgradient injection well or wells and a downgradient extraction well. At least four monitoring wells will be placed between the injection and extraction wells; several lateral monitoring wells are also included in the design. The two cells will be located approximately 1,000 feet apart, so that there is no mixing of the two reagents.

A different pilot study approach will take place at each cell, due to the nature of the substances and the way in which each is expected to act in groundwater. The lactate pilot study, using a "recirculation approach," will take place on the compressor station property. A sodium lactate solution will be continuously added to the aquifer at a concentration of 200 to 250 mg/L at two injection wells. The downgradient extraction well will spread lactate in the downgradient direction. The EVO pilot study uses a "passive approach" during the first three months and changes to a "recirculation approach" during the last three months. EVO, mixed to a 4 to 5% solution, will be added to one injection well at a contaminated property across the street from the compressor station. Since EVO is less soluble and lasts longer than lactate, it will be injected "semi-continuously" into the aquifer at a rate of three times a week. Three months after the study begins, pumping will be initiated at a downgradient extraction well. This action will spread the EVO over a larger area within aquifer, promoting bioremediation of Cr(VI).

Three documents have been prepared to ensure the success of the project. A Pilot Test Operation and Monitoring Plan (O&M Plan) has been developed for the operation and performance evaluation of the pilot test system. A Sampling and Analysis Plan (S&A Plan) describes sampling procedures and monitoring details to evaluate the reactions and results of the project. A Contingency Plan has been prepared should the reagents migrate to the test cell boundaries due to incomplete reactions. The Contingency Plan describes triggers that are in place if reagents are detected at or above specific concentrations in outlying monitoring wells. Pumps within the monitoring wells will extract groundwater-containing reagents and re-inject it upgradient.

The Discharger will describe project implementation and results in a report following the conclusion of the pilot study. The report will state whether either of the biological reagents in the pilot study was viable for implementation in a full-scale remediation project of the chromium plume in the future.

The Lahontan Regional Board assumed the lead agency role for the project under the California Environmental Quality Act (CEQA). Regional Board staff prepared an Initial Study/Checklist in accordance with Title 14, California Code of Regulations. Injection of biological food-grade reagents to groundwater had the to potential to impact water quality by increasing the total organic carbon content, mobilizing certain metals/metalloids from soil to groundwater, and creating gases. The potential hazards of the projects to the public and the environment were mitigated by preparation of the O&M Plan, S&A Plan, and a Contingency Plan. Based on the Initial Study/Checklist, Regional Board staff prepared and distributed for public comment a Mitigated Negative Declaration indicating that the project will not have a significant adverse effect on the environment. After addressing and incorporating public comments, the Regional Board adopted the Mitigated Negative Declaration at a public hearing.

In addition, the Regional Board adopted Waste Discharge Requirements and a Monitoring and Reporting Program (M&R Program) for the project at a public hearing. Water quality will be protected by ensuring that the discharge conforms will all requirements, conditions, and provisions set forth in the requirements and in the M&R Program. The long-term benefit of the project will result in removal of chromium from groundwater, and therefore, be consistent with state policies for maintaining high quality of waters in California.

APPENDIX A -23

"Use of Science in Evaluating the Fate and Transport of the Fuel Oxygenates Methyl Tertiary Butyl Ether and Tertiary Butyl Alcohol in Groundwater"

Role of Science & Engineering in Decision-Making at the Waterboards (R-4)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Commentary	Recommendation (how to improve)
Modeling MTBE at leaking underground fuel tank (LUFT) sites ("Analytical Model Applications") for understanding the contaminant behavior in the subsurface and developing a screening methodology to prioritize investigative and remedial actions at these sites in accordance with the State Water Resources Control Board's Final Draft Guidelines for Investigation and Cleanup of MTBE and other oxygenates ("Final Draft Guidelines"). In addition, the Analytical Model Applications were valuable aides in low risk case closure (e.g., no further action [NFA])	Contains: a. Analytical Modeling; b. Statistics; c. Hydrogeology (e.g., TOC, F_{OC}, K_{OC}, K_{ow}, soil moisture content, hydraulic conductivity, gradient, and direction, etc); d. Soil stratigraphy; e. Contaminant chemistry (e.g., surface area, surface charge, surface-site density, surface functional groups); f. Contaminant-matrix interactions (e.g., sorption, adsorption kinetics, adsorption capacity, etc) ; g. Contaminant chemical and	a. Science (contaminant chemistry and chemical and physical characteristics) determine how the chemical will partition among the different phases; b. Science (soil stratigraphy and geology) assists in setting a range of groundwater velocity and dispersivity values as input parameters for calculating contaminant fate and transport; c. Science (hydrogeology, chemistry, and analytical contaminant	a. Mainstream analytical models were used to provide an analytical solution for bi-dimensional flow in a horizontal aquifer; b. Analytical groundwater transport models have seen wide application for this purpose, and experience has shown such models can produce reliable results when site conditions in the plume area are relatively uniform (ASTM, 1995); c. The analytical models provide, through the Microsoft Excel spreadsheet environment, a process for site-specific data	a. Application of the analytical models to regional LUFT sites to generate useful region-specific statistics and shed light on the underlying system dynamics and processes; b. Comparison of model forecasts and realizations with predictions generated by other comparable industry standard models; c. Model validation and refinement through comparison to actual site data as additional site-specific information is gathered and become available;

decision-making where residual contaminants are left in place. Comparison of the Analytical Model Applications' contaminant concentration predictions to other environmental screening levels (e.g., USEPA's PRGs, MCLs, RWQCB-SF's ESLs, Cal-EPA's CHHSLs, $DAF_{5\text{-}20}$, etc) provides useful risk-based analysis for NFA sites.	physical characteristics (e.g., vapor pressure, Henry's Law Constant, etc); h. Contaminant phase partitioning; i. Advection; j. Dispersion; k. Diffusion; l. Natural attenuation; m. First order degradation rate constant; n. Fate and transport of contaminant in groundwater.	groundwater fate and transport modeling) derives contaminant plume length and travel time predictions and forecasts; d. Contaminant plume length and travel time from the source area to a pre-determined or pre-assigned receptor is used to prioritize investigative and remedial action at LUFT sites in accordance with the "Final Draft Guidelines." e. Science (statistics) assists to analyze the concentration distribution data for investigative and remedial strategy.	calibration and prediction; d. The models provide consistent and conservative model forecasts based on solute transport equations that incorporate groundwater velocity, dispersivity, source concentration (or mass flux), and degradation, etc. e. Statistical analysis for data is widely accepted in the scientific community.	d. Similarly, uncertainties in model predictions may be decreased through the availability and input of additional site-specific data. e. Statistical methods can be used to improve our knowledge of data distribution and further our decision for data collection, type, and focus for investigative and remedial strategy

APPENDIX A – 24

Projects: Regional Monitoring Program (RMP)

Role of Science & Engineering at the Water Boards (R-2)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Comment	Recommendations (how to improve)
The **Regional Monitoring Program (RMP)** is a discharger-funded program to provide data and assessment on the impact of waste discharges to San Francisco Bay. It serves to determine the effectiveness of the Regional Water Board's regulatory programs for pollution sources such as sewage treatment plants, industries, stormwater, and dredging. The RMP is carried out by the San Francisco Estuary Institute (SFEI), an independent, non-profit scientific organization with headquarters in Oakland. Its governing board includes the Regional Water Board, waste dischargers, and environmentalists.	The RMP as carried out by SFEI makes use of all relevant science, including aquatic chemistry, toxicology, analytical chemistry, and aquatic biology. The RMP monitors contaminant concentrations in water, sediment, and fish and shellfish tissue in the San Francisco Bay and its tributaries. The science is world-class, conducted by a staff that includes eight people with doctorates, and many others with advanced scientific degrees. The RMP staff would do credit to a major university.	The RMP is used to measure and assess the significance of contaminants on the Bay-Delta system. It is the major tool used by the Regional Water Board to determine which pollutants should be listed as impairing, how pollutant concentrations are changing over time, and whether monitoring intensity should be increased or decreased. A special feature of the RMP is that data is not simply generated and reported; it is interpreted in understandable language in annual reports called Pulse of the Estuary. This greatly enhances its value to all stakeholders.	The RMP was created by the Regional Water Board as a means to more efficiently monitor receiving water. In return for being relieved of the requirement to monitor conditions around each discharge site, the dischargers agreed to fund a comprehensive baywide program. The RMP and its implementing agency, SFEI, are models for how to carry out integrated, cost-effective monitoring for waters that receive waste discharges. The science is first class, the results are accepted as credible by all stakeholders, and the funding is essentially permanent.	The RMP could be bettered by extending it, or at least the overall approach, to the full Delta and other water bodies. There are three distinctive elements to use as models: 1. Ongoing, stable funding from the discharger community: 2. Oversight that includes all stakeholders to promote acceptance of results: and, 3. First class science, using highly qualified, permanent staff.

APPENDIX A – 25

Remediation: Restoration of Cargill Salt Ponds

Role of Science & Engineering in Decision-Making at the Water Boards (R-2)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Comment	Recommendations (how to improve)
Environmentally safe discharge of water from salt ponds The initial phase of restoration of former Cargill salt production ponds in the South San Francisco Bay includes release to the Bay of salt pond water that has salinity in excess of Bay water	The water release project has three main elements: Hydrodynamic modeling of likely impacts, especially regarding salinity-based toxicity. This work was done by consultants with the special expertise needed, with peer review from experts at Stanford; Designing a water release program to minimize such impacts; and Monitoring the project to find and correct problems. This element proved to be critically important.	The release of salt pond water with salinity in excess of natural background is being regulated by the Regional Water Board under Waste Discharge Requirements. Those requirements, and the monitoring and adaptive management developed for the project, made full use of the best available science.	Hypersaline environments do <u>not</u> follow conventional expectations for physical or biological behavior. Even so, problems were miminized by using the best available scientific expertise in this highly specialized field. Salinity impacts in the pond water releases have been successfully managed, and initial problems with low dissolved oxygen in receiving waters have mostly been resolved.	This project would have been easier had a project like this been done before and assessed the impacts. The Regional Water Board, Cargill, and the public and private consultants involved are now the experts. The experiences from this first salt pond water release are being used in the restoration of other salt ponds in the Bay.

APPENDIX A – 26

Remediation Projects: Preventing Vapor Intrusion at Cleanup Sites

Role of Science & Engineering in Decision-Making at the Water Boards (R-2)

Plan, Policy, Program (where science is used)	Science – Engineering (what science is used)	Role in Decision (how science is used)	Comment	Recommendations (how to improve)
Preventing vapor intrusion at cleanup sites Site cleanup programs (UST, SLIC, DOD) In regulating soil and groundwater polluted by volatile chemicals, the Regional Water Board has become aware of the need to prevent the intrusion of vapors into living spaces. The development of environmental screening levels for indoor vapors can dramatically streamline the cleanup process.	Assessing potential health impacts of vapor intrusion from soil or groundwater contamination requires an understanding of: - Physical and chemical properties of contaminants and soil matrices - Behavior of contaminants in groundwater and the vadose zone - Building foundation construction as it affects vapor migration - Thermodynamics and the behavior of gases in indoor air - Contaminant toxicity to humans and exposure assumptions for indoor air contaminants	The Regional Water Board used its understanding of these parameters to define environmental screening levels (ESLs) where needed. The ESLs include the risk of vapor intrusion, to include screening levels for groundwater, soil gas, and indoor air. Use of the ESLs has allowed us to focus our attention on the highest-threat sites and reduce our efforts at lower-threat sites.	The Regional Water Board uses ESLs to rapidly assess the vapor intrusion potential at sites contaminated with volatile organic chemicals (VOCs). Board staff also collaborated with USEPA staff to assess vapor intrusion at targeted Superfund sites. Using groundwater screening levels, Board staff targeted 15 sites with significant vapor intrusion potential. The Board required those responsible for cleanup to assess soil gas VOC concentrations and, where in excess of screening levels, to proceed with indoor air sampling.	In a small number of cases, Board staff discovered that soil gas concentrations of VOCs correlated better with historic high groundwater concentrations as compared to current groundwater concentrations. Board staff are still evaluating data from the 15 targeted sites and will fine tune the screening algorithm based on this data and other results.

APPENDIX A - 27

Huntington Beach Bacterial Pollution Problem

Role of Science and Engineering in Decision-Making at the State Water Boards (R-8)

In the summer of 1999 the Orange County Health Care Agency (OCHCA) closed several miles of Huntington State and City Beach due to high concentrations of total and fecal coliform bacteria and enterococcus bacteria found at many of their routine beach monitoring sampling stations along this section of shoreline. These high concentrations of bacteria exceeded State body contact recreation standards and water quality standards adopted by the Regional Board for the protection of the body contact recreation beneficial use of the Pacific Ocean. In response to this pollution problem, the Regional Board's Executive Officer issued an order pursuant to Section 13267 of the California Water Code, requiring the Orange County Sanitation District (OCSD), the County of Orange, and several coastal cities to submit a plan, subject to the EO's approval, to investigate the cause(s) of the beach pollution and control sources of bacteria that were causing or contributing to the violations of water quality standards. In response, OCSD established the Huntington Beach Technical Advisory Committee (HBTAC) that included Regional Board staff and members from the USGS, Scripps Institute of Oceanography, UCI, USC, UCSB, and many other research institutions and organizations. The committee was also open to the public and received input from many different environmental organizations and their consultants.

The main task of the HBTAC was to develop and implement an investigation plan to determine the source and cause of the beach pollution. The HBTAC used the scientific method and peer review to develop a hypothesis, develop a statistically significant sampling and analysis plan to test the hypothesis, and then start the process over again to test different hypotheses, once a hypothesis was proved wrong.

The HBTAC used the scientific method to test a hypothesis and eliminate suspected sources of the beach pollution, if the hypothesis proved to be incorrect. For example, when the beach pollution started, the first suspected source in many people's minds was the OCSD ocean outfall discharging 180 MGD of primary and secondary undisinfected wastewater into the ocean approximately 5 miles off shore. The HBTAC proposed to test the hypothesis that the OCSD outfall was the source of the beach pollution and then proceeded to complete a very thorough investigation of water quality, ocean currents, and sediment quality that included the collection of hundreds of thousands of samples for analysis combined with continuous monitoring recorders in the ocean. A team of scientists analyzed the data, and the conclusion was that the OCSD discharge was not the source, because there were areas between the outfall discharge and the shoreline where no bacteria were found in the ocean, implying that the source is a land-based source and not the offshore discharge. The National Water Research Institute also had a peer review panel of scientific experts in oceanography and wastewater review the investigation plan, the data, the scientific analysis of the data, and the conclusions in accordance with the standard scientific method.

Comments by the peer review panel were then addressed in subsequent phases of the investigation. To date there have been 5 phases to this investigation following these procedures. There are still many people who question the use of "science" in this investigation because they do not agree with the scientific conclusion that the OCSD discharge is not the cause of the beach pollution. However, none of the scientific evidence collected by the scientists conducting the investigation could demonstrate how the OCSD discharge causes the beach pollution when the bacteria disappear between the discharge point and the beach. OCSD even went so far as to initiate disinfection of its discharge to ensure the discharge met the body contact recreation standards at the edge of the zone of initial dilution, which is within a few hundred feet of the discharge point. Some people still claim the OCSD discharge is the source of beach pollution despite the physical evidence demonstrating that the bacteria from the discharge do not reach shore.

The following is a summary of the hypotheses tested:

1. OCSD's offshore discharge is the source/cause of the bacterial pollution.
2. The AES power plant thermal discharge is drawing the OCSD wastewater plume towards shore and causing the pollution.
3. OCSD's sewers onshore are the source.
4. Huntington Beach's leaking sewers are the source.
5. The AES Power Plant discharge is the source.
6. Urban runoff is the source.
7. The State Park bathrooms are leaking and that is the source.
8. Birds are the source.

A bibliography of peer reviewed reports, journal articles, and papers that have been produced to document the results of the 4 years of scientific investigations would exceed 3 pages. In summary, the Regional Board, the County of Orange, OCSD, USGS, Scripps Institute of Oceanography, UCI, USC, UCLA, and others conducted numerous investigations, or hired consultants and researchers, to collect data, evaluate the collected data, and to test the hypotheses summarized above.

APPENDIX A - 28

Water Right Permitting Activities

Role of Science and Engineering in Decision-Making of the State Water Board

The Division of Water Rights undertakes a variety of **water right permitting** activities. Following the adoption of the Water Commission Act of 1913, the State legislature determined that anyone who seeks to appropriate water from surface streams or subterranean streams following through known and definite channels in the State of California must acquire a water right permit.

The water right permitting process is a three-step process. First, someone who seeks a water right must file an application with the State Water Board. The State Water Board reviews the application, and if it is acceptable, the State Water Board issues a permit. A water right permit gives the permit holder the authorization from the State Water Board to develop a water supply project. Any permit issued by the State Water Board will include as permit conditions, a project development schedule. The permittee must develop his proposed project diligently and in accordance with the permitted schedule. One the permittee has constructed the project and has put water to beneficial use, the State Water Board conducts a filed inspection to confirm that the permittee has complied will all conditions of the permit. The State Water Board also determines how much water was actually put to reasonable and beneficial use under the permit in accordance with the conditions of the permit. The State Water Board then issues a water right license for that amount of water.

In its review of a water right application, the State Water Board is statutorily required to make certain findings and to consider certain impacts of the project being proposed. First, the State Water Board must determine that there is unappropriated water available to supply the project. The State Water Board must determine that approval of the proposed project will not injure any other legal user of water. In addition, the State Water Board must consider the impacts of issuing a permit on water quality, fish and wildlife and other public trust uses, and on the public interest. Other water users and the public are notified of any pending application and are allowed to file protests against the proposed water supply project for any of the aforementioned reasons.

Before issuing a permit, the State Water Board must also comply with the California Environmental Quality Act (CEQA) and must disclose the expected effect of the project on the environment. For most water right applications, the State Water Board is the lead agency under CEQA and must conduct the review.

In the process of making the required findings under the Water Code and under CEQA, the State Water Board reviews all scientific information which it has available. This information typically includes precipitation data, water use data, biological and archeological surveys, and studies on fisheries, invertebrates and other species. For some projects, either because they are in biologically sensitive areas or because they are in areas where there is significant use and limited supplies, the State Water Board may have much more information available. The State Water Board may also require that scientific studies be conducted in order to be able to make the required findings. Therefore science informs the State Water Board's water right actions and, conversely, the State Water Board's actions drive the production of scientific information.

Most modern water right permits contain conditions to protect the environment. These conditions may be developed to address things such as impacts to fish as a result of temperature variations resulting from the project (see, for example, condition 1 of State Water Board Water Right Order 90-5, requiring that temperatures below Shasta Dam be monitored and that temperatures to protect salmonids be maintained at specific compliance points), impacts to groundwater recharge (see, for example, condition 8 of Water Right Decision 1627, prohibiting the storage of water in a reservoir in the Pismo Creek Watershed in San Luis Obispo County unless rainfall in the watershed exceeds specified amounts), and impacts to water quality (see conditions 14-16 of Water Right Decision 1643, requiring that the Delta Wetlands Project be operated in such a manner as to not adversely affect drinking water quality through the production of disinfection byproduct precursors or salinity in the western Delta). In arriving at these conditions, the State Water Board considers all scientific information available to it, including studies that it requires to be conducted under its water rights, water quality and public trust authorities.

The State Water Board currently has a number of pending water right applications to divert water from the Russian River stream system. There are a number of factors that affect the salmonid fishery on the Russian River and other coastal streams. These factors include water flow and temperature, the condition of spawning and rearing habitat (shade, cover, presence of deep pools, etc), fish passage, predation, ocean harvest, toxics and other pollutants, and food supply. Of these factors, the ones that are most controllable by the State Water Board are streamflow (within the limits of natural hydrologic variation), including ensuring that adequate flows are provided to "cue" fish migration, and fish passage (i.e., on-stream dams). The State Water Board, in cooperation with the California Department of Fish and Game (DFG) and the National Marine Fisheries Service, has developed draft guidelines to protect salmonids in the Russian River and other northern California coastal watersheds from the impacts of water diversions. Scientists from the University of California participated in the development of the draft guidelines. The State Water Board is in the process of developing a policy document to inform current pending water right applicants as well as any potential water right applicants of the conditions that are necessary to protect anadromous fisheries in the Russian River and the other coastal streams. The proposed policy document will also be peer reviewed.

In the case of the Russian River, the State Water Board benefits from the scientific studies conducted by the DFG, NMFS, and the Sonoma County Water Agency. However, many water right actions are requested on creeks, streams and rivers that have not been studied extensively.

Recommendations:

1) The State Water Board and the public would benefit significantly if certain scientific relationships were better understood, particularly the effect of flow diversions and dam construction on geomorphology, and the degree to which certain factors like flow, water temperature, pollutants, food web interactions, and introduced species.

2) Because the Board is tasked with balancing competing beneficial uses of water, it would benefit from more information on how water supply and quality affects crop production, industrial processes, and other uses of water, including drinking.

APPENDIX A - 29

Water Quality Certifications for Hydropower Projects (FERC Re -licensing)

Role of Science and Engineering in Decision-Making at the State Water Board

The Division of Water Rights issues Water Quality Certifications for Hydropower Projects subject to licensing decisions by the Federal Energy Regulatory Commission (FERC). The Clean Water Act requires that every applicant for a federal license or permit to conduct an activity that may result in a discharge into navigable water provide the licensing or permitting federal agency with certification that the project will be in compliance with specified provisions of the Clean Water Act, including water quality standards and implementation plans promulgated under the Clean Water Act. In California, the State Water Board is responsible for issuing the required water quality certification. Because protection of the instream beneficial uses identified in Basin Plans adopted by the California Regional Water Quality Control Boards and approved by the State Water Board requires the maintenance of adequate stream flows as well as limitations on the discharge of waste, this responsibility is primarily within the State Water Board's Division of Water Rights.

FERC relicensing of a hydropower is essentially an investigation to determine if a project should continue to operate on a public river and, if so, what conditions are necessary to protect the river, mitigate project impacts, and enhance the river's resources. The FERC offers two processes for a hydropower operator to acquire a new license. The first is called the traditional approach. The second approach is referred to as the alternative approach. Flow charts showing both processes are available at http://www.ferc.gov/industries/hydropower/gen-info/workflow.pdf. Both processes offer significant opportunities for participation by agencies with authority over natural resources.

Hydropower projects fall into three categories: (1) "storage" projects impound water behind a dam, forming a reservoir and generate power when releases from the dam is run through turbines in a powerhouse located near the base of the dam; (2) "run of the river" projects typically use relatively low dams where the amount of water running through the powerhouse is determined by the water flowing in a river or alternatively involve the diversion of all or most of the flow in a river through a series of penstocks which discharge the water past turbines and back into the river; (3) "pumped storage projects" use off-peak electricity to pump water from a lower reservoir to an upper reservoir. During periods of high electrical demand, water is released back into the lower reservoir to generate electricity.

The dams and powerhouse operations that are a necessary element of hydropower plants cause direct environmental impacts. The impacts of a particular project depends many factors, such as the location of the dam, the design of the facility, and steps taken to modify the operation of the facility. Changing the operation of a hydropower facility can reduce impacts of hydropower facilities on such things as stream flow, water quality, fish passage, cultural resources, and recreation.

Hydropower facilities have the potential to dewater entire stream reaches. Peaking power operations can cause downstream stretches to alternate between no water and surges of water that cause scouring and cause deposition of sediments downstream. In addition, varying the depth of water can strand fish and wildlife. Varying streamflows also disrupt flow triggers that affect the migration of anadromous fish. Storage of water behind a dam can warm waters, further degrading habitat conditions for cold water fishes. Dam operations can also affect the amount of dissolved gases in the river.

The State Water Board consults with the FERC, the hydropower facility owner, other state local and federal agencies, and the public in formal facilitated stakeholder meetings to review the potential impacts to the environment and to the energy production. The State Water Board, in fulfilling its water quality certification authorities, has broad authority to require scientific studies to determine the effects of power project operations on water quality, including the physical parameters of flow and temperature. The State Water Board also uses the results of these studies to inform its decisions. For instance, in the case of Pacific Gas and Electric Company's Rock Creek-Cresta project on the North Fork of the Feather River, the State Water Board's involvement resulted in:

- Adoption of an ecosystem approach that includes streamflow regimes to balance sediment transport and channel bed material mobilization and distribution, which contribute to diverse aquatic and riparian habitat.

- Construction of several trout spawning habitat projects to improve trout habitat.

- Improvement of riparian habitat by better managing cattle grazing, including improved cattle fencing and an extensive cattle grazing rotation program.

- Implementation of real-time water quality monitoring and establishment of a method to secure improvements if necessary.

- Establishment of a standing Ecological Resources Committee made up of resource agencies and public interest groups to ensure the interests of all stakeholders are represented on a continuing basis.

The State Water Board's activities also drive science when it requires that these studies be conducted. In the case of the Rock Creek-Cresta Project, a settlement agreement between PG&E, the State Water Board and other parties included the creation of the Collaborative Natural Resource Stewardship Program, a program that is restoring trout fisheries and improving aquatic and riparian habitat and recreation use conditions for the river's future health. In 2003, Pacific Gas and Electric Company continued its ongoing studies of water temperature conditions and other elements of its extensive stream ecology monitoring program. PG&E applied the 2002 monitoring results to adjust the new streamflow regime to better benefit amphibians. These adaptive management adjustments were developed collaboratively with the Ecological Resources Committee of river stakeholders established in 2000.

A water quality certification issued by the State Water Board must be based on the best information available at the time that the State Water Board makes its decision. Environmental quality is a function of many interrelated factors. How these factors affect the environment individually and in combination is not well understood.

Recommendation: The water board's decisions could be improved if these processes as well as the life stages of the species that utilize the rivers under study were better understood.

APPENDIX A – 30

Water Rights Under the Bay Delta Plan

Role of Science and Engineering in Decision-Making at the State Water Board

The Bay-Delta Plan is a water quality control plan. The plan identifies the beneficial uses of the waters of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, includes numeric and narrative objectives to protect those beneficial uses, and specifies a program of implementing the objectives. The Bay-Delta Plan supplements the other water quality control plans that cover the Bay-Delta Estuary; together they include all necessary elements of water quality control plans in accordance with State and federal requirements.

The Bay-Delta Plan was first adopted in 1978 and was last amended in 1995. It is currently under review by the State Water Board. The plan contains flow and flow-dependent water quality objectives to protect the beneficial uses of the Delta and the Suisun Marsh. Salinity objectives protect beneficial uses from saltwater intrusion and agricultural drainage. Dissolved oxygen objectives protect fish, primarily salmonids, from impediments to migration that result from low oxygen levels in the lower San Joaquin River. In addition, operational objectives protect the beneficial uses of the Delta from adverse impacts of operating the California Department of Water Resources' (DWR) State Water Project and the U.S. Bureau of Reclamation's (USBR) Central Valley Project (water projects).

Because the flow objectives can only be met through the control of water diversions, the plan is implemented through conditions applied to water right permits, including those held by the DWR, USBR, and others. The State Water Board's Division of Water Rights administers these water rights permits. Conditions that can be met through non-flow actions are also implemented through water quality actions taken by the Central Valley Regional Water Quality Control Board and the San Francisco Bay Regional Water Quality Control Board. The plan is adopted under both the State Porter-Cologne Water Quality Control Act and the federal Clean Water Act. Those parts of the plan that are adopted under the Clean Water Act must be approved by the U.S. Environmental Protection Agency.

The flow objectives apply to the San Joaquin and Sacramento Rivers and to the outflow of the Delta. These conditions affect operations of the State's Oroville Reservoir and the federal government's Shasta, Folsom, and New Melones Reservoirs and to a lesser extent the federal government's Friant Reservoir. Permits issued to other water users who divert water from the Delta watershed are also subject to conditions to protect flow and water quality in the Delta. The permits of some permit holders contain flow requirements similar to and coordinated with the flow requirements in the DWR and USBR's permits.

The plan contains operational requirements that affect only the State and federal projects, due to their unique role in controlling the hydrodynamics of the Delta. For instance, the plan contains an objective that controls the number of days that the USBR's Cross Channel Gates must be closed to prevent migrating salmonids from straying into the Central Delta, where mortality is higher than it is in the main channel of the Sacramento River. Other operational objectives specify how much water may be pumped from the Delta as a percentage of river flows. These objectives protect both salmonids and Delta smelt, which are protected under the Endangered Species Act. Because exports by the State and federal water projects are a function of flow, flow objectives also affect operations of the State's Harvey O.Banks Pumping Plant and the federal government's Tracy pumping plant.

Salinity in the Delta comes from two primary sources, depending on location. Salinity in the western Delta, where the State and federal water projects' pumps are located, is affected by seawater intrusion from the San Francisco Bay. Salinity in the southern Delta is the result of hydrodynamics in the Delta, local discharges by Delta farmers, and drainage from the San Joaquin Rivers. In order to provide drinking water that meets federal Environmental Protection Agency drinking water standards, to provide adequate salinity conditions for crop production, and to provide appropriate salinity habitat for fish and wildlife species, the plan specifies salinities that must be met at certain locations in the Delta.

Dissolved oxygen levels in the San Joaquin River are affected by the bathymetry of the river, by diversions within the Delta, and by discharges of municipal wastewater and agricultural drainage that contains nitrogen that encourages the proliferation and growth of algae in the slow-moving shallow parts of the lower San Joaquin River. When these algae flow into the deep ship water channel at the Port of Stockton, they sink and die, consuming oxygen in the river. Low oxygen levels impede fish passage. Wastewater discharges by from the City of Stockton's Municipal Wastewater Treatment Plant further affect the levels of dissolved oxygen in the river. This portion of the river is tidal in nature, with limited mixing. As a result, oxygen levels tend to remain low.

The State Water Board is informed by science when it sets objectives in the Bay-Delta Plan. The flow objectives are intended to ensure that adequate fresh water is provided to repel salinity from San Francisco Bay. They also provide adequate water levels in the Delta to ensure that appropriate habitat is provided for fish and wildlife and for Delta agriculture. When they release water from upstream reservoirs and by limit exports, water users also incidentally help meet salinity and dissolved oxygen requirements.

Appropriate objectives to achieve these protections are determined using hydrologic, hydrodynamic, water quality, and fishery models. The current version of the plan is based on 72 years of precipitation data for the Central Valley. Fishery and wildlife needs are based on numerous studies to assess factors that affect protected and other species. Scientific research on issues such as land use, fate of return flows from agricultural irrigation, the effects of irrigation water and soil salinities on crop production, food preferences of fish and wildlife species, food-web interactions, particle tracking, geomorphology, the effects of introduced species on native species, the effect of water temperature variations on life stages of various fishes, the effect of fish entrainment, salmonid migration, and numerous other topics have informed the State Water Board in its activities to set appropriate objectives.

The State Water Board also drives science as a result of its planning activities in the Delta. The Bay-Delta Plan includes a requirement for ongoing studies to provide physical, chemical and biological data to determine compliance with the water quality objectives in the plan, to evaluate the response of the aquatic habitat and organisms to the objectives, and to increase understanding of the large-scale characteristics and functions of the Delta estuary ecosystem to better predict system-wide responses to management options. These studies are conducted under the direction of the Interagency Ecological Program, of which the State Water Board is a participant. Other studies are conducted under the direction of the CalFed Science Program, the San Francisco Estuary Institute's San Francisco Estuary Regional Monitoring Program (RMP) and monitoring efforts conducted by other agencies. These ongoing studies are used to inform current and future reviews of the Bay-Delta Plan.