Role of Science and Engineering in Decision-Making Within the State and Regional Water Boards

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Acronyms and Terms

ACL	Administrative Civil Liabilities
Anadromous	Migrating from the sea to fresh water to spawn
Benthic	Collection of organisms living on or in sea or lake bottoms
BU	Beneficial Use, 28 BUs of water have been defined by the State and Regional Boards (Table 2 p. 40).
CAO	Cleanup and Abatement Order
CDO	Cease and Desist Order
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CTR	California Toxics Rule
CWA	Clean Water Act
GAMA	Groundwater Ambient Monitoring and Assessment
RCRA	Resource Conservation and Recovery Act
RWQCB	Regional Water Quality Control Board, nine such regions are established in California
SCCWRP	Southern California Coastal Waters Research Project
SFEI	San Francisco Estuary Institute
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
UAA	Use Attainability Analysis, determines if a beneficial use can be attained
WDR	Waste Discharge Requirements, “permit” conditions under Porter-Cologne
WQO	Water Quality Objective, the State’s version of the federal water quality standard

Executive Summary

The primary purpose of State Water Resources Control Board and the nine Regional Water Quality Control Boards is to preserve and protect the beneficial uses of all waters of the State. This includes all ground water, more than 1.6 million acres of lakes, 211,000 miles of rivers and streams, more than 1.3 million acres of bays and estuaries, 1,609 miles of coastline, and the first three miles of ocean off of our coastline. The California Legislature found that "activities and factors which may affect the quality of the waters of the State shall be regulated to attain the highest water quality that is reasonable . . . (and) that the state must protect the quality of waters in the state from degradation inside or outside the boundaries of the state." How we use water, or expect to use water in the future determines its beneficial uses. A designated beneficial use determines the quality of water that must be maintained for that use. Protecting water quality and preventing degradation in order to preserve beneficial uses of water relies heavily on science and engineering. Protecting water quality also depends on an equitable system for allocating water resources, which is carried out by the State Water Resources Control Board's water rights program. This report discusses the role of science and engineering (technology) in decision-making at the water boards in implementing federal and state laws along with their implementing regulations, and water board plans and policies.

Laws, Plans, and Policies

There are four laws, fourteen water quality control plans, and eighteen formal State Board policies that govern the activities of the water boards. Two laws, the federal Clean Water Act and the California Water Quality Control Act (Porter-Cologne), are summarized with respect to the authorities and responsibilities delegated to the water boards. The Ocean Plan is briefly reviewed to illustrate the water quality objectives (criteria) used to protect ocean water quality, how permit conditions for effluent discharges are determined, and how to monitor for compliance with permit conditions. The Bay-Delta Plan is discussed in the context of water rights. The Plan contains flow and flow-dependent objectives to protect the beneficial uses of the Delta and Suisun Marsh from salinity. The flows necessary to achieve these protections are determined using hydrologic, hydrodynamic, water quality, and fishery models. Because the flow objectives can only be met through the control of water diversions, the plan is implemented through flow conditions applied to diversions granted in water right permits. These permits have wide-ranging impacts on major water projects and reservoirs that divert or release water flowing to the Bay-Delta.

The Porter-Cologne requirement for Regional Boards to prepare Basin Plans is discussed. Basin Plans must: designate existing and potential beneficial uses of surface and ground waters; include water quality objectives that establish limits or levels for pollutants that are protective of beneficial uses; and contain implementation programs with a description of the actions necessary to achieve the water quality objectives. Because each of these components is based on science and engineering and Basin Plans are regulatory in nature, they must undergo external scientific peer review.

The Porter-Cologne Water Quality Control Act requires the State Board to formulate and adopt policy for water quality control. Four of the 18 policies adopted to-date that strongly affect the science and engineering used in decision-making are discussed in the report. The *"Policy for Implementation of the Toxic Standards for Inland Surface Waters, Enclosed Bays and Estuaries in California"* contains water quality criteria adopted by U.S. EPA for California (the California Toxics Rule). These criteria, along with the technical procedures, algorithms, and statistics contained in the policy document, are used to establish permitted effluent discharge limits. The mandate of the Legislature to "protect the quality of waters in the state from degradation" takes form in the State Board's anti-degradation policy, *"Policy with Respect to Maintaining the High Quality of Waters in California."* The federal anti-degradation policy applies only to surface waters, while the State policy includes groundwaters. The impact of both policies occurs whenever a water quality objective or standard is proposed for change. Any proposed change must undergo an anti-degradation analysis that includes scientific determinations of the potential degradation that could occur, an engineering analysis to determine what technologies could be used to minimize any degradation, and social and economic analyses of any benefits that would accrue to the people of the State if a small amount of degradation is allowed.

The federal Clean Water Act requires each state to identify waters within their borders that are not attaining water quality standards or objectives. The process for identifying and listing impaired waters is contained in the State's *"Water Control Policy for Developing California's (federal) Clean Water Act Section 303(d) List."* The policy document provides detailed guidance on the review and evaluation of field measurements, data, and information used to decide which water bodies can be placed on, or removed from the 303(d) list. Determining whether a water body or a river/stream segment meets any one of eight listing criteria relies heavily on science.

The significance of a water body, stream, or river segment being placed on the §303(d) list of impaired water bodies is that a total maximum daily load (TMDL) and its implementation plan are also required under the Clean Water Act §303(d). A TMDL is

a numerical calculation of the amount of a pollutant that a water body can assimilate and still meet standards. A TMDL includes one or more numerical targets that represent attainment of the applicable standards in addition to the allocation of the target load among the various sources of the pollutant (dischargers and runoff). Determining the loading capacity of any water body for a given pollutant and assigning responsibility for reducing the load is done using methods based on science and engineering. The scientific basis of a TMDL must undergo external scientific peer review.

Water Quality Standards

Water quality standards (termed "objectives" in California) are established to protect the beneficial uses designated for each water body or segment identified in a basin plan. Twenty-nine beneficial uses have been defined by the State and Regional Water Boards. Protecting each designated beneficial use of water is achieved through a numerical and/or narrative water quality objective. The criteria used to evaluate water quality are established in federal water quality standards and their equivalent state-adopted water quality objectives. U.S. EPA identifies 126 priority toxic pollutants in the California Toxics Rule and provides numerical criteria for 108 of these. (A toxic pollutant can have one or more water quality objectives depending on the number of beneficial uses to be protected, e.g., there can be one for consumption (drinking), body contact (swimming), and one for aquatic organisms.) Additional pollutants and water quality objectives are contained in the California Ocean Plan and the water quality control plans adopted by the State Water Board and Regional Water Boards in their regional Basin Plans. Narrative water quality objectives are used for those waste constituents without numeric criterion. An example of a narrative objective would be 'no toxic substances in toxic amounts shall be permitted.' Toxicity can be measured using bioassays. Toxicity bioassays have the advantage of directly assessing the biological effects of all effluent constituents, including the interactive effects of multiple chemicals. Under this example of a narrative toxicity objective, the water boards essentially regulate almost every substance discharged to waters of the state whether or not its chemical structure or identity is known.

Assessing Water Quality

Adequate and accurate monitoring and assessment are the cornerstones to preserving, enhancing and restoring water quality. The information gathered from monitoring activities is critical to protect the beneficial uses of water, to develop water quality standards, conduct federal Clean Water Act assessments and to determine the effects of pollution and pollution prevention programs. Surface water monitoring and assessment activities are conducted as part of the Surface Water Ambient Monitoring

Program (SWAMP). "Ambient monitoring" collects information about the status of the physical, chemical, and biological characteristics of water quality that can be used to measure overall quality of water resources, temporal trends (degradation or improvement), and overall effectiveness of prevention, regulatory, and remedial actions. SWAMP integrates the existing water quality monitoring of the SWRCB and the RWQCBs and coordinates with monitoring programs of other agencies, dischargers, and citizen groups. The data collected includes: chemical pollutants; toxicity; bacterial indicators; contaminants in fish/shellfish tissue; biological assessment (living organisms); habitat (ecological) assessment; and other field data. The program evaluates, processes, formats, and assures the quality of these data for input into a database that can be integrated into statewide database. Science plays a major role in all of these activities.

The Groundwater Ambient Monitoring and Assessment (GAMA) Program is a comprehensive assessment of statewide groundwater quality. The program is designed to help better understand and identify risks to groundwater resources. Identifying these risks is important because the amount of water stored in California's aquifers is far greater than that stored in the state's surface water reservoirs. To the extent groundwater basins become unusable due to impacts to water quality, additional pressure is placed on limited surface water supplies. When groundwater supplies become contaminated, it takes longer, is more difficult and can be more costly to cleanup than surface water supplies. The GAMA Program has two components: one for public and one for private drinking water wells. GAMA is unique because the water quality data collected include analyses at very low levels for more than 250 chemical pollutants that are not normally monitored by the Department of Health Services. Analyses of these data provide an early indication of potential water quality problems and can also be used to identify the natural and human factors affecting groundwater quality. From the age-dating of groundwater to the detection and identification of endocrine-disrupting contaminants, science, engineering and research are at the heart of GAMA programs. This program permits a better understanding of the susceptibility of groundwater to contamination and allows for long-term management and protection of California's groundwater resources based on sound science.

Water Rights

Competing interests for available water resources in California led to a system for establishing water rights dating back to 1872. Today, the State Water Resources

Control Board is the state agency with the primary responsibility to administer water rights. The California Legislature put both water quality and water rights under the State Water Board in recognition of the inseparable nature of quality and quantity. Water rights are granted in the form of permits and licenses for specific volumes (flows), locations, times, and uses. The State Board is required to maximize the beneficial uses of the state's water resources and at the same time protect their public trust uses (e.g., commerce, navigation and fisheries), the environment, and the public interest. The state retains authority over all waters of the state and regulates their use.

This report includes three examples of where and how science is used in water rights decisions. The first is a discussion of water rights considerations when diverting water from the Russian River stream system and the factors that affect its salmonid fishery. The second is a discussion of water rights issues in the licensing decisions by the Federal Energy Regulatory Commission for three types of hydropower projects. The last is a discussion of water rights under the Bay–Delta Water Quality Control Plan, particularly with respect to flow-dependent objectives to protect the beneficial uses of the Delta and the Suisun Marsh from salinity. Understanding the competing needs of the environment, fisheries, farming, and society are critical to making decisions on diverting water for their uses. These must be based on sound science and engineering practices.

Implementation

The implementation of federal and state water quality laws, water quality plans, and policies is, for the most part, carried out by the Regional Water Quality Control Boards. The nine Regional Boards contributed 27 examples of where, what, and how science and engineering were used in their decision-making activities. These activities include permitting, enforcement, basin planning, developing Total Maximum Daily Loads (TMDLs) and water quality objectives (WQOs), remediation and other projects. They highlight the scientific disciplines and types of engineering used and whether these informed or determined or the decision. The reader is encouraged to see Appendix A for the examples. Spreadsheet formats are included for quick review.

Recommendations

Each of the Regional Boards, Division of Water Rights, Surface Water Ambient Monitoring Program (SWAMP) and the Groundwater Ambient Monitoring and Assessment (GAMA) Program submitted general and specific suggestions and

recommendations on how to improve the science and engineering used by the water boards in decision-making. These are presented in Section IV of this report.

In general, the Regional Boards acknowledge their limitations in scientific expertise and make four proposals to address this issue. The first would have the state set up "blue ribbon" science panels that would provide advice and guidance on complex scientific issues. The second would create a science advisory panel that would provide technical review, comment, and suggestions on Regional Board field studies and interpretation of data (*note: this is not intended as a substitute for formal peer review of the scientific basis of a rule or regulation*). The third would create a pool of in-house experts that would be available to any of the Regional Boards on an as-needed basis (i.e., for expertise not currently available, e.g., economic analysis, risk assessment). The fourth would set up an expeditious mechanism for consulting or contracting with experts in other state, federal, or local agencies on highly technical issues or projects. The commonality of these recommendations is creating a means or mechanism that will enable the Regional Boards to obtain scientific advice and recommendations from technical experts not readily accessible today. It is recommended that the water boards evaluate the feasibility and cost-effectiveness of hiring versus contracting for scientific expertise and advice under one or more of these four proposals. It is recognized that the issues confronting the water boards change over time. Therefore, an analysis of current needs versus long-term needs will be necessary to make decisions regarding potential long-term investments in technical expertise and infrastructure.

In general, the Regional Boards, Division of Water Rights, SWAMP, and GAMA acknowledge the need for more scientific data and information to better inform and support their decisions. The data needs relate to water quality and quantity from a spatial and temporal perspective that can be addressed through directed surface and groundwater monitoring on a seasonal basis. The informational needs relate to better understanding the complex interrelationships between water and California's ecosystems and fisheries, especially anadromous species. There is also a need to prioritize water quality problems for the effective allocation of resources in finding solutions and implementing changes. These needs might be met through a research and monitoring program that collects, analyzes, and interprets water quality and quantity data from an ecological perspective and also meets the informational needs of State and Regional Water Board programs.

A specific recommendation with board-wide application would help address a need for determining water quality objectives and effluent limitations. The sciences of toxicology and risk assessment are used to derive acceptable levels of pollutants in

the water column and sediments to protect biota, ecosystems, and people. Because there is a very limited number of numerical water quality objectives compared to the number and types of pollutants that can affect multiple beneficial uses, it might be both useful and cost-effective to have expertise on staff to help develop these numbers. These scientists could be part of the pool of scientists available to each of the Regional Boards. They would serve to develop water quality criteria and objectives.

A specific recommendation with broad application relates to continuing education and professional self-improvement. Greater access to professional society journals (the "literature"), either through libraries or the Internet, was viewed as helping scientists and engineers to stay current in their areas of specialization. A subscription to *Ingenta*, an on-line service providing access to 4,500 journals and abstracts from 20,000 journals, was recommended. Photocopies of journal articles could be procured through a general service contract with the University of California system. This would complement the "classroom" activities of the Water Board Training Academy by allowing individuals to read technical articles when they have time available at their workplace.

Role of Science and Engineering in Decision-Making Within the State and Regional Water Boards

I. BACKGROUND

The impetus for this report originates in a letter from the Secretary of Cal/EPA to the Legislature indicating his intent to "institute an evaluation process using the University of California to understand the current role that science plays in the decisions reached within the boards, departments and offices at Cal/EPA." In a March 23, 2005 memorandum to the Chairman of the State Water Resources Control Board, the Secretary asked that the Board work with Agency to address a number of technical and policy issues. The first of these is to "assure the appropriate integration of science in decision making, including policies, regulations, basin plans, and permits." It is the purpose of this report to show examples of where, what, and how science is used not only in decision-making, but also in implementing policies and regulations, preparation of basin plans, and writing permit conditions.

Science and Engineering

This report considers science and engineering as equally important in decision-making. Science includes, but is not limited to technical disciplines such as chemistry (organic, inorganic, physical), biochemistry, biology, bacteriology, microbiology, toxicology, analytical chemistry, geochemistry, geology, hydrology, meteorology, oceanography, limnology, agricultural engineering, physics, ecology, mathematics, and statistics. Engineering includes, but is not limited to specialties such as chemical, civil, environmental, fluid dynamics, mechanical and structural engineering, all of which rely on mathematics, statistics, and computer modeling. The importance of engineering is made clear in the State Board's policy for implementing the California Toxics Rule with regard to permit limitations, "regardless of which method is used for deriving water quality-based effluent limitations, the calculated water quality-based effluent limitations shall be compared to the technology-based effluent limitations for the pollutant, and the most protective of the two types of limitations shall be included in the permit" (cf. p. 11). Technology results from sound engineering.

Decision Making

A wide array of decisions is made by State and Regional Water Board members, executive officers, and professional staff. Decisions that most impact the regulated

community and public are permit decisions and water rights decisions. Decisions that affect water board staff and the regulated community can be found in laws, regulations, water quality control plans, and board policies - many of which provide guidance for implementing federal and state programs. The drafting of these documents relied on technical input from scientists and engineers, but final versions were responsive to the comments and concerns of the public, interest groups, politicians, and stakeholders. In many cases, these documents direct or guide the decisions and actions of the water boards. How science and engineering affect decision-making is briefly discussed below.

Science and engineering can affect decisions in essentially two ways. They can either inform or determine a decision. By "informing" a decision, it is meant that science and engineering are considered along with economics, societal needs (e.g., water for new housing developments), environmental laws (e.g., Endangered Species Act), implementability (e.g., feasibility, time, and resources needed), and water rights. Considerations other than science and engineering are not unique to water board decisions. For example, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, or "Superfund" Law) specifically requires U.S. EPA and delegated states (e.g., California) to consider nine criteria when selecting a remedy, only two of which are human health ("overall protection of human health and the environment") and engineering ("reduction of toxicity, mobility, or volume through treatment" [technologies]). In passing laws, both Congress and the Legislature develop language that is often a compromise of competing interests. A decision that does not entirely rely on scientific recommendations and/or engineered technological solutions does not mean that the science and engineering was unsound, but rather that other considerations, individually or collectively took precedence. An informed decision is also one in which science and engineering provide a framework or boundaries that exclude options that either won't work, are not cost effective, or take too long to implement. These considerations are of no less importance than the ones that determined the decision.

Science that "determines" a decision is often imbedded in health criteria (human and ecological) and physical (e.g., temperature and pH) or biological (e.g., availability of oxygen) characteristics of water. Even these have an element of judgment used in their determination. For example, observations and experimentation that determine the concentrations of pollutants that adversely affect aquatic organisms or the human health of those consuming or coming into contact with water have uncertainty. The uncertainty arises in the measurements and the natural variation that occurs in populations. These are often accounted for by including a margin of safety (sometimes referred to as safety factors or uncertainty factors) when deriving

a single value that best represents the experimental data and/or population. Judgment enters into the equation in determining the margin of safety. The margin of safety may be established in law, implementing regulations, policies, or board decisions. But, the end result, the numerical standard, determines a decision when no other considerations modify the value. Where, when, and how standards are applied can be discretionary, but the health standards themselves remain primarily science-based. However, when establishing or changing a water quality objective, the State's Porter-Cologne Act requires that economics also be "considered." How economic considerations affect a water quality objective are subject to public review and comment and independent external scientific peer review.

Defensible Science

Regulatory decisions must be defensible, i.e., they must be able to withstand legal challenge. Accordingly, the science and engineering upon which regulatory decision-making is based must also be defensible. Science and engineering are evolving. Our knowledge is rapidly expanding in almost every area of science due to advances in technology and the financial and human resources invested in research. Still, decision-makers often want and need more complete information to make better decisions. So, how do the water boards decide when they have enough information to make a decision? The courts and the Legislature have indicated that certainty is not required to make a decision with regard to protecting human health and the environment. The standard of review in support of administrative regulations, whether they involve science or not, generally requires a court to uphold such regulations unless they are not supported by substantial evidence. "Substantial evidence" may be less than clear and convincing evidence and is defined as enough relevant information and reasonable inferences to support a conclusion, even if other conclusions might also be reached. Nevertheless, water board staff strive to provide decision-makers with clear and convincing scientific evidence and conclusions along with the best engineering practices and designs.

The quality of science and engineering used by the water boards is critical to good decision-making. To ensure quality, water board staff evaluate the rigor of the science (data quality and reliability), how it was developed, and other information supporting any scientific interpretation or conclusion drawn from the data. To ensure that the science is sound, the water boards make extensive use of external scientific review and formal scientific peer review. Many of the water boards utilize science review panels and science or technical advisory committees whenever broad decisions are made involving scientific or engineering expertise. The public and other interested parties are also invited to comment. External scientific peer review

is addressed in Health and Safety Code (HSC) §57004. Under this statute, the water boards are required to "submit the scientific portions[1] of a proposed rule[2], along with a statement of the scientific findings, conclusions, and assumptions on which the scientific portions of the proposed rule are based and the supporting scientific data, studies, and other appropriate materials, to the external scientific peer review entity for its evaluation." This applies to many aspects of Basin Plans (see p. 9 this report) and Total Maximum Daily Loads (TMDLs, see p. 15 this report). In conducting this formal peer review, the water boards utilize Cal/EPA's contract with the Office of the President of the University of California to identify qualified peer reviewers. This peer review process helps to ensure that the scientific findings relied upon by the water boards will represent the prevailing view of the scientific community at the time a decision is made or a rule is promulgated.

Scope

This report attempts to demonstrate the extensive use of science and engineering in the decision-making processes of the State and Regional Boards. To provide context, the first part of the report briefly describes the roles of the State and Regional Boards in protecting water quality, the laws, plans, and policies that mandate or guide their decisions and actions, and the water quality standards they must enforce. The second part of the report provides examples of where, what, and how science has been used in decision-making by the nine Regional Water Quality Control Boards and the water rights and water quality programs. The last part of the report summarizes the recommendations from the regional boards for improving the science and engineering they rely upon to make decisions. A desired outcome of this report is that it provide impetus for: enhancing research and monitoring programs; further improving staff capabilities; and, finding ways to expand and share the technical expertise available within the water boards.

[1] "those foundations of a rule that are premised upon, or derived from, empirical data or other scientific findings, conclusions, or assumptions establishing a regulatory level, standard, or other requirement for the protection of public health or the environment."

[2] "a regulation" or "a policy adopted by the State Water Board pursuant to Porter-Cologne Water Quality Control Act ... that has the effect of a regulation and that is adopted in order to implement or make effective a statute."

II. INTRODUCTION

The primary purpose of the water boards is to preserve and protect the beneficial uses of all the waters of the State, including surface and ground waters, enclosed bays and estuaries, and the ocean. The State Board has the added responsibility to ensure the equitable distribution of water to meet the historical, present, and future needs of the people and environment of California. No other natural resource is as critical to human health and welfare, preserving habitat and ecological diversity, and ensuring viable populations of wildlife and aquatic life as is water. Without water, there would only be desert.

The State and regional water boards receive their authority and mandates to preserve and protect the beneficial uses of water through federal (Clean Water Act) and State law (Porter-Cologne Water Quality Act). The State and regional water boards are required by Porter-Cologne to develop plans for water quality control. The State Board is required by Porter-Cologne to develop policy for water quality control. Table 1 (see p. 35) lists the laws, plans, and policies that govern and direct the responsibilities and activities of the State and regional water boards. These provide the major framework for decision-making.

A. LAWS

1. Federal Clean Water Act

There are two laws that particularly affect the water boards. The oldest is the federal Water Pollution Control Act of 1948, which after extensive amendment in 1972, became the federal Clean Water Act (CWA). The amendments established two goals: zero discharge of pollutants by 1985; and, water quality that is both "fishable" and "swimmable" by mid-1983. To achieve its objectives, the CWA embodies the concept that all pollutant discharges into the nation's waters are unlawful, unless specifically authorized by a permit. The CWA uses both water quality-based standards and technology-based numerical effluent limitations in permits for specific pollutants from certain sources to protect water quality. The CWA requires each state to establish water quality standards for all surface water bodies in the state. [FR1]These standards backup federally established technology-based requirements.

The CWA established the National Pollutant Discharge Elimination System (NPDES) for industrial and municipal dischargers. Permits are the CWA's principal regulatory tool. Violators are subject to civil suit by US EPA in U.S. District courts,

administrative civil penalties, and criminal penalties for "knowing endangerment." Third party lawsuits are also allowed. Permits specify the control technology applicable to each pollutant (e.g., best available technology (BAT) for heavy metals, pesticides, and other organic chemicals), effluent limitations (mass and/or concentration), and a deadline for compliance. Dischargers are required to maintain records and conduct effluent monitoring. NPDES permits must be renewed every five years, a feature which allows updates based on better science and technology and/or new water quality standards.

Sec. 303(d) of the federal CWA and Title 40, CFR Sec. 130.7 require the states to identify waters within their borders that are not attaining water quality standards. Impaired water bodies must be restored by limiting the aggregate discharges of individual pollutants such that the assimilative capacity (the "total maximum daily load [TMDL]") of the water body for each pollutant is not exceeded. Pollutant loadings from point source discharges are controlled primarily through permit limitations while pollutant loadings from nonpoint sources are controlled primarily by management measures.

2. "Porter-Cologne Water Quality Control Act" (1969, with amendments through January 1, 2005)

In 1969, the California Legislature passed and the Governor signed into law the Porter-Cologne Water Quality Control Act. Porter-Cologne is the principal law governing water quality in California. The Legislature found that "activities and factors which may affect the quality of the waters of the State shall be regulated to attain the *highest water quality reasonable*, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible (§13000)." The Legislature declared "that the State must be prepared to exercise its full power and jurisdiction to protect the quality of waters in the State from *degradation* originating inside or outside the boundaries of the State (§13000)." The Act establishes a comprehensive program to protect water quality and the *beneficial uses* of water. Unlike the Clean Water Act, Porter-Cologne applies to both surface water and ground water. Porter-Cologne designated the State Water Resources Control Board (State Water Board)[3] as the statewide water quality planning agency, and also gave planning and permitting authority to the nine semi-autonomous Regional Water Quality Control Boards (Regional Water Boards)[4]. Porter-Cologne was amended (§§ 13370-13389) to

[3] The State Water Board was established in 1967 by legislation combining the State Water Quality Control Board and the State Water Rights Board.
[4] The Regional Water Boards were established in 1949 by the Dickey Water Pollution Act.

authorize the State to implement the provisions of the federal CWA, including the provisions establishing the National Pollution Discharge Elimination System.

The State Water Board is responsible for developing State *policy* for water quality control (e.g., the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California) and *statewide water quality control plans* (e.g., the Ocean Plan), while the Regional Water Boards are required to develop, adopt, and implement *regional water quality control plans* (basin plans) which address all areas in a region and conform to State water quality policy. These *plans*, both statewide and basin, include (1) designation or establishment of *beneficial uses*[5] of the water body to be protected, (2) establishment of *water quality objectives*[6], and (3) implementation plans that control non-point and point sources of pollution in order to achieve the water quality objectives protecting each designated beneficial use. Regional Boards have the primary responsibility for implementing the provisions of both statewide and basin plans.

Porter-Cologne (§13260) requires any person discharging waste, or proposing to discharge waste, within any region that could affect the quality of waters of the state, to file a *report of waste discharge* with the applicable Regional Water Board. No discharge may take place until the Regional Water Board issues waste discharge requirements (WDRs), or a waiver of the WDRs. Waste discharges to land include municipal waste water and landfill disposal. The issuance of WDRs and waivers to WDRs is a major statewide permitting activity of the RWQCBs, along with federal NPDES permitting.

3. Other laws that affect the water boards include a California law that address underground storage tank leak prevention standards and the federal Resource Conservation and Recovery Act (RCRA), which addresses hazardous waste cleanups.

[5] "beneficial uses" include, but are not limited to: domestic, municipal, agricultural and industrial supply; power generation; recreation: aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. Such uses may be past, present and probable future beneficial uses of water. A water body may have one or more designated beneficial uses.

[6] "water quality objectives" (WQO) are the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specified area. WQOs have three parts: (a) a criteria or standard to be met (typically from the California Toxics Rule or Ocean Plan); (b) beneficial use (what use the WQO is intended to protect); and (c) meets the State's anti-degradation policy.

B. WATER QUALITY CONTROL PLANS

As stated above, Porter-Cologne designated the State Water Board as the statewide water quality planning agency, and also gave planning and permitting authority to the nine Regional Water Boards. There are 14 water quality control plans, four are statewide plans that include the Ocean Plan, the Thermal Plan, the Bay-Delta Plan and the Nonpoint Source Pollution Control Plan. The remaining 10 water quality control plans are Basin Plans developed by each of the Regional Water Boards (the Central Valley RWQCB has two Basin Plans because of its geographic size and major watersheds). Each plan relies heavily on science and engineering in its development and each undergoes extensive public review and input as well as external scientific peer review. The brief summaries of the Ocean Plan and the requirements for basin planning provided below demonstrate the role of science in water quality control plans.

1. Ocean Plan

The first Ocean Plan was adopted in 1972 and has been amended six times (most recent is 2005). The first Ocean Plan predates the federal requirements for ocean planning and protection of ocean waters. The heart of the plan consists of water quality objectives (WQOs). Currently, there are 21 numerical WQOs for protection of marine aquatic life, 20 numerical noncarcinogen WQOs and 42 numerical carcinogen WQOs for protection of human health. There are bacterial "objectives" (for total coliforms and fecal coliforms) that address "water-contact" (e.g., swimming) and shellfish harvesting. There are physical "objectives" (narrative objectives) for floating materials (particulates, grease, and oil), discoloration, attenuation of light transmission, and deposition of solids that would degrade benthic communities. There are chemical "objectives" that include dissolved oxygen, pH, sulfides, organic materials, nutrients, and the 83 numerical WQOs referenced above. There are biological "objectives" for non-degradation of marine communities (vertebrate, invertebrate, and plants); for non-degradation of marine sources of food for humans affecting taste, color and odor; and prohibition of bioaccumulation of organic materials in marine sources of food for human consumption (fish, shellfish). There is a prohibition of discharge of radioactive waste that would degrade marine life. There are specific effluent limitations for grease and oil, suspended solids, settleable solids, turbidity, and pH. There is also a prohibition on the discharge of any waste into 34 Areas of Special Biological Significance.

The RWQCBs implement the Ocean Plan to meet WQOs by issuing National Pollutant Discharge Elimination System (NPDES) permits (these permits also serve

as Waste Discharge Requirements in fulfillment of the State Water Code). The permits specify limits on the amount (concentration and total mass) of effluents that can be discharged. The Plan is prescriptive in how limits are established and how to quantitatively account for dilution credits and mixing zones. The Plan specifies when to conduct acute and chronic toxicity testing and what species or organisms to use to measure toxicity.

To determine compliance with discharge limits, the Plan specifies how monitoring is to be conducted and how often. This includes specifying the analytical methods that can be used, calibration of analytical instruments, and reporting of analytes above and below the method detection limit. Methodolgy for meeting toxicity criteria objectives of Table B in the Plan are also speicified. All the foregoing are based on science (organic, inorganic, physical and analytical chemistry; toxicology; statistics, and engineering) in addition, state-certified analytical laboratories must be used. Where analytical monitoring may not be adequately measuring effluents (evidence for being above the limit, but not quantitatively measured), there are provisions for a Pollutant Minimization Plan or Toxicity Reduction Requirements.

An April 2005 amendment to the Ocean Plan removed the option for permit holders to self-certify that they are not discharging pollutants other than those in their permits. Dischargers must now do an analysis of all listed pollutants (Ocean Plan Table B) to determine which ones might reasonably be expected to appear in the waste stream and thus require monitoring. This "reasonable potential analysis" uses a "scientifically defensible statistical method that accounts for the averaging period (daily, weekly, monthly, etc.) of the WQO, accounts for and captures the long-term variability of the pollutant in the effluent, accounts for limitations associated with sparse data sets, uncertainty associated with censored data sets and assumes a lognormal distribution of facility-specific effluent data." This amendment to the Ocean Plan improves the scientific basis for determining which effluents need permit limitations and therefore require monitoring.

2. Basin Planning

The Porter-Cologne Water Quality Control Act requires the Regional Boards to develop and adopt Basin Plans that conform to State water quality policies and address all areas (water bodies [streams, rivers, lakes, reservoirs], watersheds, and groundwater) in their region. Porter-Cologne requires several key elements in all Basin Plans. First, Basin Plans must designate existing and potential (beneficial) uses of surface and groundwaters of the State. Porter-Cologne identifies a dozen beneficial uses (see footnote 5 on p. 7) while the federal CWA identifies six,

including the "fishable/swimmable" goals for protection and propagation of fish, shellfish, wildlife, and recreation in and on the water. Second, Basin Plans must establish water quality objectives for pollutants or characteristics that are protective of the designated beneficial uses. In establishing water quality objectives, the water boards must comply with antidegradation provisions of federal and state law (see p. 13). Third, Basin Plans must contain implementation programs to achieve the water quality objectives including a description of the actions necessary to achieve the objectives, a time schedule for the actions to be taken, and monitoring activities to determine compliance with the objectives.

The first Basin Plans were developed in the early 1970's. Scientific surveys collected information on fisheries, land use, geography, precipitation, and wildlife for the larger surface water bodies in each region. These surveys also collected technical information on groundwater resources, including hydrology and water quality. Because of the large number of water bodies, not all waters were surveyed initially and beneficial uses were not systematically designated for these. However, to fulfill the federal CWA requirement that the State designate uses for all waters of the United States, the first basin plans relied on a "tributary rule" that allows waters (e.g., streams) flowing into water bodies that have a designated beneficial use(s) to have the same beneficial use(s) as the receiving waters. Subsequent to the development of the first basin plans, the State and Regional Boards have approved standard definitions for 29 beneficial uses (see Table 2, p. 37). Most water bodies now have their individual existing or potential beneficial uses identified and adopted into basin plans. It is important to appreciate that a designated "beneficial use" plays a critical role in determining which standards are applied to a water body and are included in the permit conditions (WDRs and NPDES) to protect that beneficial use.

The second key element of Basin Plans is that they must include water quality objectives (WQO) that establish limits or levels for pollutants or characteristics that are protective of the beneficial uses and comply with antidegradation statutes and policy. By law, objectives to protect beneficial uses must be based on sound and peer-reviewed scientific rationale. U.S. EPA provides technical guidance for developing water quality criteria (objectives). Numerical values are available for 105 of U.S. EPA's 126 priority pollutants published in the California Toxics Rule (40 CFR Part 131 [2000]). The water boards have adopted numerical water quality standards for three pesticides (diazinon, chlorpyrophos, and tributyltin), ammonia, bacteria, nutrients, salt, dissolved oxygen, sediment and others not included on U.S. EPA's list. The California Ocean Plan identifies 30 pollutants with objectives not included in U.S. EPA's list. Water quality objectives must also meet the State's anti-degradation

policy (see p. 13 for discussion of this policy). These water quality objectives undergo thorough peer review (as prescribed in California Health and Safety Code §57004), CEQA review, stakeholder review and comment via workshops and hearings, Water Board adoption, approval by the Office of Administrative Law, and finally U.S. EPA approval. This extensive review of the science supporting the water quality objectives is necessary because they are used to protect beneficial uses that include human consumption of the water itself and the fish and shellfish harvested from fresh and marine waters. WQOs also protect aquatic life and their ecosystems.

The third key element of Basin Plans is that they must contain implementation plans or programs to achieve the water quality objectives. Implementation includes: (a) a description of the actions necessary to achieve the objectives; (b) a time schedule for the actions to be taken; and (c) monitoring activities to determine compliance with the objectives. Water quality objectives can be achieved through issuance of discharge permits that specify waste discharge requirements (WDR permits). For example, such permits include those for point sources discharging to navigable waters (NPDES permits), discharges to groundwater, discharges for irrigated agricultural return flows, or by prohibitions of discharge. Board adoption of total maximum daily loads (TMDLs) and their implementation plans would also achieve WQOs. The time required to achieve WQOs can be dependent upon the concentration or amount of pollutant to be removed and the technologies used. To measure progress towards achieving an objective or effluent limit, permits typically include compliance monitoring as a condition of permitting the discharge. Developing a compliance monitoring plan requires knowledge of the principles of analytical chemistry, toxicology (bioassays), statistics, and a myriad of laboratory methods, including quality assurance and quality control.

Given the technical complexity and importance of the basin plans, it is important to note that prior to approval by the State Board they must go through a public review and comment process and the scientific portions must undergo external scientific peer review (in accordance with HSC §57004). Basin Plans must also be periodically reviewed. This is typically accomplished during the Triennial Review of the state's water quality standards required by the federal CWA. These reviews help to ensure the quality and currency of the science and engineering used.

Extensive Administrative Records are compiled for all Basin Plan amendments to support approval of their regulatory provisions by the Office of Administrative Law

and U.S. EPA. A careful review of these records demonstrates the use of sound science and engineering in development and amendment of Basin Plans.

C. WATER QUALITY CONTROL POLICIES

Section 13140 of the Porter-Cologne Water Quality Control Act states that "the state board shall formulate and adopt state policy for water quality control." To date, the State Board has formally adopted 18 policies related to water quality control (see Table 1, p. 35). Most of these policies incorporate science and engineering. As examples of the use of science and engineering in policy decision documents, four of the 18 are discussed below.

1. State Implementation Policy: "*Policy for Implementation of the Toxic Standards for Inland Surface Waters, Enclosed Bays and Estuaries in California*" (April 2000)

The water quality standards that the State Board and Regional Boards must meet are contained in the National Toxics Rule and the federal California Toxics Rule (both found in the Code of Federal Regulations). The Regional Boards may also adopt numerical and/or narrative water quality objectives to maintain the beneficial uses of water bodies. The State's implementation policy (SIP) for these rules and basin plan objectives is contained in the "*Policy for Implementation of the Toxic Standards for Inland Surface Waters, Enclosed Bays and Estuaries in California*." A brief summary of the SIP and the role of science is provided below.

The federal CWA requires that states adopt numeric criteria for pollutants for which it (the federal CWA) has issued criteria guidance, as part of the states' own water quality standards. Because of lawsuits, the US EPA promulgated a list of criteria pollutants in 2000 known as the California Toxics Rule (CTR). The federal toxics criteria for 126 priority pollutants apply to California's inland surface waters, enclosed bays and estuaries for all purposes and programs under the CWA. These are the minimum water quality standards that must met by dischargers and permittees.

The state regulates discharges of toxic pollutants to inland surface waters, enclosed bays, and estuaries under the authority of California's Porter-Cologne Water Quality Control Act and the federal CWA. Regulation is by issuance of NPDES permits. Permits specify effluent limitations in order to meet water quality criteria/objectives in the CTR (California) and National Toxic Rule (applicable to all states). The procedures, algorithms, and statistics for determining effluent limits (maximum observable effluent concentrations, or MECs) are prescribed in the SIP. The

procedures are based on sound science and engineering practices. Please see Appendix C – 2 on p. 58 for a summary of the science and engineering used in the SIP guidelines for determining effluent limits in discharges and determining compliance with effluent limits in permits.

Adoption and amendment of statewide plans and policies are documented in extensive Administrative Records that cover the full public participation process and science, engineering, and economic considerations. The extent of documentation is exemplified by the 20 file boxes of documents supporting adoption of the State Implementation Policy that are available for public review.

2. Anti-degradation: *"Policy with Respect to Maintaining High Quality of Waters in California" (State Board Policy 68-16)*

Both State policy and federal law address the issue of anti-degradation of water quality (see also Appendix C - 4). State policy adopted in 1968 states that existing high water quality will be maintained until it can be demonstrated that any change: (1) will be consistent with the maximum benefits to the people of the state; (2) will not unreasonably affect present and anticipated beneficial use of such water; and (3) will not result in water quality lower than prescribed in existing policies and water quality control plans. The State's anti-degradation policy applies to both surface and ground waters and to both existing and potential beneficial uses. The intent of the policy is to preserve the existing high quality of water where it is better than a water quality objective or standard. It is not routinely allowed to discharge pollutants up to the limits of a water quality objective or standard. The water may not be degraded unless there is a greater benefit to society in exchange for a small amount of degradation that does not adversely affect its beneficial use(s).

Federal anti-degradation rules apply to surface water quality existing as of November 1, 1975 (California's benchmark date is 1968 and also applies to groundwater). Federal rules restrict some categories (tiers) of water from any degradation whatsoever. These tiers include protection of water quality supporting existing uses and water quality that is necessary to maintain "outstanding national resource waters," such as those in National Parks or wildlife refuges. The federal government has designated Lake Tahoe and Mono Lake as outstanding national resource waters. It is only other waters that are better than necessary to maintain fish and allow water contact by people that may be degraded and only to the extent to allow important social or economic development.

The significance of the State and federal antidegradation policy and rules is that any change to a water quality objective or standard must undergo an antidegradation analysis. Such analysis would include scientific determinations of the potential degradation that could occur, an engineering analysis to determine what technologies could be used to minimize any dedgradation, and the social and economic analyses of any benefits that would accrue to the people of the State.

3. Impaired Waters: *"Water Quality Control Policy for Developing California's Clean Water Act §303(d) List"* (September 2004)

Sec. 303(d) of the federal CWA and Title 40, CFR Sec. 130.7 require the states to identify waters within their borders that are *not* attaining water quality standards. Water bodies are listed due to deleterious impacts from a pollutant or pollutants and *de*listed when evidence reveals that such impacts have ceased or never existed. Placing a water segment on the list of impaired water bodies (the 303(d) list) follows a formal process outlined in *"Water Control Policy for Developing California's Clean Water Act §303(d) List."* This policy document provides detailed guidance on the review and assessment of supporting data and information used to decide which candidate water bodies are placed on or removed from the CWA §303(d) list.

Determining whether a water body or a river/stream segment meets the criteria for listing relies heavily on science. It requires collection of field data on the pollutants of concern or characteristics that are believed to be impaired. Complete background information (metadata) for field data (i.e., when, where measurements were taken, number of samples, detection limits, etc.) and detailed quality assurance and quality control information about sampling and analysis of all numeric data are needed to demonstrate current water quality. Data collection, sampling and analysis rely on chemistry, analytical chemistry, and statistical analyses of the quantitative, spatial, and temporal data. The results of the analyses of the field data are then compared to the water quality standards (WQOs) established to protect the beneficial uses of the water segment or body. The WQOs include the numeric values for aquatic and human health protection listed in the California Toxics Rule, State-adopted WQOs for bacteria (where recreational uses apply), and WQOs adopted in Basin Plans.

Seven other criteria exist for listing, a few are briefly described here. Listing can occur if there are health advisories (e.g., fish consumption advisories issued by OEHHA or DHS) or shellfish harvesting ban (issued by DHS). Health advisories and harvesting bans are based on health risk assessments of the toxicity of the pollutants of concern, the bioconcentration of the pollutant in fish and shellfish, and studies of fish consumption by recreational fishermen – all are science-based. Listing can

occur for water or sediment toxicity alone where the toxicity testing (i.e., bioassays) can be performed with fish, shellfish, or other biota follows specified technical guidelines and statistical analyses. Under the antidegradation principle, if at least a three-year trend of quantitative data shows degradation of water quality, but not yet exceeding a WQO, the water body still may be listed. Listing can occur for "nuisance", i.e., odor, taste, excessive algae growth, foam, turbidity, oil, trash, and color using quantitative data that meets specified requirements. Adverse biological responses in fish or birds, such as fish kills or bird die-offs, reduction in growth, reduction in reproductive capacity, abnormal development, or histophathological abnormalities observed by specialists such as wildlife biologists, ecologists, and toxicologists are a basis for listing. All of the foregoing causes for listing have technical and/or scientific criteria that must be met before the water segment can be a candidate for listing. Because most of this policy document is based on science, it was subjected to formal external scientific peer review in accordance with §57004 of the H&SC prior to adoption and approval by the State Board.

4. Total Maximum Daily Load *"Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options"* (June 16, 2005)

The significance of a water body, stream, or river segment being placed on the CWA §303(d) list of impaired water bodies is that a total maximum daily load (TMDL) and its implementation plan are also required to be established by Clean Water Act. This is a major technical, administrative, and stakeholder participation program implemented by the regional water quality control boards (please also see Regional Board write-ups in Appendix A - 6 through A - 10 of this report). To be enforceable, a TMDL must be adopted into a Regional Basin Plan, after which it becomes, in effect, a water quality standard. The science and engineering considerations made in development of a TMDL are briefly described below.

A TMDL is a numerical calculation of the amount of a pollutant that a water body can assimilate and still meet standards. A TMDL includes one or more numerical targets that represent attainment of the applicable standards, considering seasonal variations and a margin of safety, in addition to the allocation of the target load among the various sources of the pollutant. In practice, a RWQCB must first determine the loading capacity of the water body, e.g. the amount (mass or concentration) of mercury that can enter a river segment (including the water column and sediments) *before* fish would become unsafe to consume (i.e., a fish consumption health advisory would be issued). Determination of loading capacity requires data on hydrology, flow rates and volumes, solubility of mercury, conversion

of mercury to methyl-mercury (chemistry and biochemistry), and bioconcentration rates (biochemistry) in fish (species dependent) in order to address loading capacity (LC). Once the LC is calculated, it is necessary to identify (through sampling and analysis or engineering calculations) all the point ("end-of the-pipe") and nonpoint source (e.g., surface runoff, soil erosion) contributions of mercury to the water segment. Each source is then assigned a load allocation (nonpoint sources) or *waste* load allocation (point sources) and an implementation plan is developed to meet the water quality objective. To achieve TMDLs and individual load and waste load allocations, the water boards use regulatory tools such as waste discharge requirements (WDRs, including compliance monitoring), waivers of waste discharge requirements, enforcement actions, and interagency agreements. (For more discussion of the science involved in developing a TMDL for mercury, please see Appendix item A – 9 "Mercury in Cache Creek and Bear Creeks.")

Basin plans amendments, including TMDLs, must undergo a thorough public hearing process and must be approved by a RWQCB, the SWRCB, Office of Administrative Law, and U.S. EPA Region 9. The scientific basis of a TMDL is peer reviewed in accordance with HSC §57004. An excellent summary of the development of a TMDL for sedimentation/siltation of the Alamo River and the role of science can be found in appendix item A - 7. The nine major tasks in developing a TMDL are clearly described. The Administrative Record for each TMDL is available for public review.

D. WATER QUALITY STANDARDS (OBJECTIVES)

The State's water quality objectives (WQOs) are equivalent to the criteria established for federal water quality standards. Criteria are typically numeric ambient water concentrations needed to protect a designated use and the "use", i.e., they go together. State water quality objectives are established to protect the *beneficial* uses designated by a Regional Board for each water body or segment identified in their Basin Plan. Twenty-nine beneficial uses have been defined by the State and Regional Water Boards (see Table 2, p. 37). Water quality objectives are established through a public participation and scientific process. The water quality objectives are then codified in State regulations and are subject to U.S. EPA approval. Protecting the beneficial uses of water and preventing nuisance (e.g., foul odors) are achieved through *numerical* and/or *narrative* objectives/criteria. U.S. EPA identifies 126 priority toxic pollutants that threaten water quality in the California Toxics Rule. Additional water quality objectives are contained in the California Ocean Plan (see p. 8) and other water quality control plans adopted by the State Water Board and the nine Regional Water Boards in their regional Basin Plans.

Narrative water quality objectives are used for waste constituents without numeric criterion. An example of a California narrative toxicity objective is "all waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life." The equivalent narrative in the federal CWA reads: "it is the national policy that discharge of toxic pollutants in toxic amounts be prohibited (§101(a)(3))." Two approaches to determining compliance with this narrative objective can be taken. First, try to identify numerical limits (published concentrations in water that are associated with toxic effects) for identifiable waste constituents, or use bioassays to determine toxicity levels. To help identify numerical limits, the Central Valley Regional Water Quality Control Board (Region 5) has developed an on-line searchable database containing over 820 chemical constituents and water quality parameters to be used in applying *narrative* water quality objectives. Where numerical effluent limits cannot be identified, toxicity can often be assessed using bioassays. For example, assessment of toxicity to aquatic life can be done using bioassays with indicator species that include vertebrates (e.g., fathead minnow), invertebrates (e.g., water flea), and/or aquatic plants (e.g., alga). Toxicity bioassays have the advantage of directly assessing the biological effects of all effluent constituents, including the interactive effects of multiple chemicals.

Toxicity assessments are required in permits for all discharges that will cause, have reasonable potential to cause, or contribute to chronic (long-term) toxicity. When a discharge is found to cause or contribute to chronic toxicity in the receiving water body, a toxicity reduction evaluation (TRE) is required. If the toxic component is known, then the TRE can be initiated immediately. If the toxicity component is unknown, a Toxicity Identification Evaluation (TIE) may be needed. Once the source of toxicity is identified, the discharger is required to take all reasonable steps necessary to eliminate toxicity. Toxicity testing helps to control chemicals that are not on the priority pollutant lists and consequently *greatly increases* the number of chemicals and substances the Regional Boards must regulate. Including toxicity effluent limits and requiring toxicity monitoring (bioassays) as permit conditions requires an understanding of biology, chemistry, toxicology, sampling and analysis, and interpretation of test results. This can be considerably more complex than pollutant-specific monitoring.

D. MEASURING WATER QUALITY

Assessing water quality relies on water sampling and analysis and the data these produce. Two relatively new state programs, the Surface Water Ambient Monitoring

Program and the Groundwater Ambient Monitoring and Analysis Program, are at the center of providing data on ambient water quality. They can tell us the status of water quality, whether we are making progress in achieving water quality objectives, and where research is needed to address emerging issues. State fiscal constraints have limited the amount of data that has been collected to a fraction of what is needed, including the staff expertise needed to analyze the data. With adequate funding, these two programs would provide the core of a statewide water quality assessment program that is critical to protecting the state's water resources.

1. Surface Water Ambient Monitoring Program

The Surface Water Ambient Monitoring Program (SWAMP) was established under Water Code §13192 (AB 982) as a statewide effort administered by the SWRCB to assess the conditions of surface waters throughout the state. "Ambient monitoring" collects information about the status of the physical, chemical, and biological characteristics of water quality that can be used to measure overall quality of water resources, temporal trends (degradation or improvement), and overall effectiveness of prevention, regulatory, and remedial actions. Responsibility for implementation of monitoring activities resides with the nine Regional Boards. Monitoring conducted by SWAMP is done through contracts with the California Department of Fish and Game, the U.S. Geological Survey, and other entities.

SWAMP integrates the existing water quality monitoring of the SWRCB and the RWQCBs and coordinates with monitoring programs of other agencies, dischargers, and citizen groups. SWAMP creates an ambient monitoring program that addresses all 190 hydrologic units of the State using consistent and objective monitoring, sampling and analytical methods; consistent data quality assurance protocols; and centralized and integrated data management. Monitoring "waters of the state" includes 11,000 miles of rivers and streams, over 10,000 lakes, over 1,300,000 acres of bays and estuaries, and 1,609 miles of coastline. The data collected includes: chemical pollutants; toxicity; bacterial indicators; contaminants in fish/shellfish tissue; biological assessment (living organisms); habitat (ecological) assessment; and other field data. Evaluating, processing, formatting, and assuring the quality of these data for input into a database that can be integrated into statewide database (California Environmental Data Exchange Network [CEDEN]) has been a major effort of SWAMP in the absence of a fully funded water quality monitoring program. A sub-set of the regional monitoring data is incorporated into the Environmental Protection Indicators for California (EPIC) report on the status of the environment. Regional monitoring data also helps to assess program performance and support federal CWA § 305(b) reporting requirements on the area

or percentages of the State's surface waters that fully or partially support their beneficial uses (e.g., that they are safe to swim, drink, and consume the fish).

Please see Appendix D-1 on page 64 for further discussion of where, what and how science and engineering are used in the SWAMP program.

2. Groundwater Ambient Monitoring and Assessment

The Groundwater Ambient Monitoring and Assessment (GAMA) Program is a comprehensive assessment of statewide groundwater quality. The program was developed in response to the Groundwater Quality Monitoring Act of 2001 (AB 599, codified in CWC Sec. 10780-10782.3) which mandates monitoring and assessment of the quality of groundwater used as a public water supply. The program is designed to help better understand and identify risks to groundwater resources. The importance of groundwater is that it supplies about 30 percent (about 16 million acre-feet) of the water for urban and agricultural use in average rainfall years, but can increase to 40 percent when surface supplies are reduced during drought years. The amount of water stored in California's aquifers is far greater than that stored in the state's surface water reservoirs, although only a portion of groundwater can be extracted economically and practically. To the extent groundwater basins become unuseable due to impacts to water quality, additional pressure is placed on limited surface water supplies. When groundwater supplies become contaminated, it takes longer, is more difficult, and can be more costly to cleanup than surface water supplies. It can take decades for the water cycle to displace contaminated groundwater with clean water and only a few years for surface water.

The GAMA Program has two components: the California Aquifer Susceptibility (CAS) Assessment which addresses public supply drinking water wells and the Voluntary Domestic Well Assessment Project which addresses private drinking water wells. A key aspect of the GAMA Program is interagency (SWRCB/RWQCB, USGS, DWR, DHS, LLNL) collaboration and cooperation with local water agencies and well owners. The GAMA Program is important because the data collected during the studies include analyses for chemical constituents and pollutants not normally monitored. These data are especially useful for providing an early indication of potential water quality problems and can also be used to identify the natural and human factors affecting groundwater quality. An understanding of these factors is important for the long-term management and protection of California's groundwater resources.

GAMA Program components rely heavily on science, from initial study design, sampling and analyses, and data interpretation, to final publication and posting of results to an on-line database (GeoTracker). Of the 476 groundwater basins and sub-basins in California, 116 have been identified as priority basins. Collectively, these include more than 75% of public water supply wells. While the California Department of Health Services requires monitoring of public water supply wells for 101 Title 22 constituents, GAMA, in conjunction with USGS, monitor for a much broader suite of 334 constituents (e.g., nutrients, trace elements, pesticides and pharmaceuticals ["emerging contaminants" acting as endocrine disrupters]) with many at much lower detection limits. Endocrine disrupting compounds (EDCs) are being detected with an EDC microarray gene chip (a collaborative effort with UC Davis and Lawrence Livermore National Laboratory). To determine the susceptibility of aquifers to contamination, the GAMA Program is age-dating water by measuring naturally occurring isotopes (e.g., tritium/helium-3). The age of groundwater is the time since the water was recharged and isolated from the atmosphere. Groundwater that has been recharged in the last 50 years is considered more susceptible to contamination from various land-use activities and would be a priority for pollution prevention or abatement activities.

For more information on the GAMA Program, please see Appendix D-2 on page 68.

E. WATER RIGHTS

Competing interests for available water resources in California led to a system for establishing water rights dating back to 1872. Since that time, the water rights program has existed under a variety of administrative programs including the Office of the State Engineer, Department of Water Resources, and the State Water Rights Board. Today, the State Water Resources Control Board is the state agency with the primary responsibility to administer water rights. The California Legislature put both water quality and water rights under the State Board in recognition of the inseparable nature of quality and quantity. In its simplest terms, a water right is the right to divert water from its natural location or course for a specific beneficial use, such as agriculture or power generation. Water rights are granted in the form of permits and licenses for specific volumes (flows), locations, times, and uses. The State Board is required to maximize the beneficial uses of the state's water resources and at the same time protect their public trust uses (e.g., commerce, navigation and fisheries), the environment, and the public interest. Thus, the state retains authority over all waters of the state and regulates their use. Water is a shared resource, with large numbers of users entitled to some share of the common

pool. While water rights are property rights, the "property" is the right to use, not ownership of the water itself. If the water is not used, or is wasted, the right to use can be lost. This prevents those with senior rights from depriving those with junior rights to water that would otherwise go unused or wasted.

The relationship between water quantity and water quality can be critical to fisheries, ecosystems, and habitats. For example, water quantity determines the depths of rivers and streams. Water depth and temperature are critical to fish migration and availability of shallow gravel spawning beds. Lakes with drastically altered shorelines from water diversion (e.g., Mono Lake) do not provide adequate feeding and nesting habitats for migratory birds. Issuing water rights permits that include diversion limits and flow objectives requires an understanding the complex relationships between water and the environment. The studies of these relationships are based on science.

1. Water rights permitting activities

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 coursing through known and definite channels in the State of California must acquire a water right permit.

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.

In the process of making required findings under the Water Code and under the California Environmental Quality Act (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 sufficient information available. If not, the State Water Board may require that scientific studies be conducted in order to be able to make the required findings. In most cases, science informs the State Water Board's water right actions and, conversely, the State Water Board's actions often drive the collection and production of scientific information.

Examples of some of the considerations that need to be made in water rights decisions can be found in the 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, gravel beds, 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 (freshwater-ocean-freshwater life cycle) in the Russian River and the other coastal streams. Because the proposed policy document is based on science, it will be peer reviewed in accordance with HSC § 57004.

For further discussion of the role of science in water right decision-making, please see Appendix item A – 28.

2. Water Quality Certifications for Hydropower Projects

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's Division of Water Rights is responsible for issuing the required water quality certification primarily because in-stream beneficial uses require the maintenance of adequate stream flows as well as limitations on the discharge of waste.

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 are 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 on many factors, such as the location of the dam, the design of the facility, and steps taken to modify the operation of the facility. Modifying the operation of a hydropower facility can significantly 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 streamflow volumes 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, 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 measures to improve trout habitat.

- Improvements to 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 process to secure improvements if necessary.

For further discussion of the role of science in water rights decision-making, please see Appendix A – 29.

3. Water rights under the Bay-Delta Plan

The Bay-Delta Plan is a formal water quality control plan adopted by the State Board. 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. The plan contains flow and flow-dependent objectives to protect the beneficial uses of the Delta and the Suisun Marsh from salinity (from saltwater intrusions and agricultural drainage) and operational objectives to protect the beneficial uses from adverse impacts of operating the California Department of Water Resources' State Water Project and the U.S. Bureau of Reclamation's Central Valley Project (water projects). The plan also contains a dissolved oxygen objective to protect fish, primarily salmonids, from impediments to migration that result from low oxygen levels in the lower San Joaquin River.

Because the flow objectives can only be met through the control of water diversions, the plan is implemented through flow conditions applied to water right permits, including those held by the Department of Water Resources (DWR), U.S. Bureau of Reclamation (USBR), and others. The State Water Board's Division of Water Rights

administers these water rights permits. The permitted flow conditions affect operations of the State's Oroville Reservoir and the federal government's Shasta, Folsom, New Melones, and Friant Reservoirs. They also affect operations of the State's Harvey O.Banks Pumping Plant and the federal government's Tracy pumping plant. The export pumps are also subject to operational objectives that, for instance, control 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. Other operational objectives specify how much water may be diverted at the pumps as a percentage of river flows. These objectives protect both salmonids and Delta smelt, which are protected under the Endangered Species Act.

Flow objectives in the plan are intended to provide adequate water levels in the Delta, to ensure that appropriate low-salinity habitat is provided for fish and wildlife and that water levels are adequate for Delta agriculture, and also to ensure that adequate fresh water is provided to repel salinity from San Francisco Bay. The flows necessary 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 ecological studies to assess factors that affect protected 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 (in the pumps) on population numbers, salmonid migration, and numerous other topics have informed the State Water Board in its activities and decisions in establishing appropriate flow objectives.

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 (i.e., altering flows). 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.

For additional discussion of water rights decisions in the Bay Delta Plan, please see Appendix A – 30.

III. IMPLEMENTATION (Regional Board Examples)

The implementation of federal and state water quality laws, water quality plans, and policies is, for the most part, carried out by the regional water quality control boards. Each of the nine regional boards contributed examples of where, what, and how science and engineering were used in their decision-making activities. These activities include permitting, enforcement, basin planning, developing TMDLs and WQOs, remediation and other projects. They highlight the scientific disciplines and types of engineering used and whether these determined or informed the decision.

The regional board examples are presented in two formats. Most use a narrative description while others use a table with key headings of where, what, and how science and engineering are used and recommendations for improving the science. The write-ups include comments on where the regional boards acquire scientific data and external technical expertise. This is often through contracts and consultation with research organizations such as the Southern California Coastal Water Research Project, San Francisco Estuary Institute, Moss Landing Marine Laboratory, Granite Canyon Laboratory, Scripps Institute of Oceanography, and Lawrence Livermore National Laboratories. The regional boards also establish technical advisory committees, technical review panels, independent scientific review panels, technical workgroups and steering committees to provide input into and review of the science and engineering used by regional board staff.

The following discussions or the role of science and engineering in decision-making at the water boards are available in Appendix A:

A. Permitting
    1. NPDES
        a. City of San Diego's Point Loma Treatment Plant (A – 1)
        b. Ventura Water Reclamation Facility (A – 2)
        c. Power Plants in Coastal Waters (A - 3)
    2. Waste Discharge Requirements
        a. Watershed-wide WDRs for Timber Harvests (A - 4)
    3. Waivers to WDRs
        a. Irrigated Lands Conditional Waivers (A – 5) 53
B. TMDLs
    1. Pathogens in the New River (A - 6)
    2. Silt in the Alamo River (A - 7)
    3. Nutrients in the Indian Creek Reservoir (A - 8)
    4. Mercury in Cache and Bear Creeks (A - 9)
    5. Update of Bacteria Objectives for Santa Monica Bay (A - 10)

C. Enforcement Actions
    1. ACL -- Construction stormwater permit violations (A - 11)
    2. CDO – Sewage Discharges at Eagle Lakes (A - 12)
    3. CAO – Cleanup of marine sediments San Diego Bay (A - 13)
    4. CAO -- Cleanup of perchlorate in groundwater (A - 14)
    5. CAO -- Cleanup of copper and zinc, Peyton Slough (A - 15)

D. Basin Planning
    1. Establishing Beneficial Uses for Wetlands (A - 16)
    2. De-designating MUN use for saline waters (A - 17)
    3. Total Dissolved Solids & Nitrogen Management (A – 18)

E. Water quality objectives
    1. Water quality objectives for diazinon (A- 19)
    2. Site specific objectives for copper & nickel (A - 20)
    3. Identifying numerical water quality *limits* (A - 21)

F. Remediation Projects
    1. *In-situ* groundwater remediation for Cr(6+), Hinkley (A - 22)

G. Projects (other)
    1. Modeling MTBE at LUFT sites (A - 23)
    2. Regional Monitoring Program (A - 24)
    3. Environmentally safe discharge of brine (A - 25)
    4. Preventing vapor intrusions at cleanup sites (A - 26)
    5. Huntington Beach Bacterial Pollution (A – 27)

IV. RECOMMENDATIONS

1. The state should foster, promote, fund and streamline a process to set up blue ribbon science panels that would provide advice and guidance to the Regional Boards on complex scientific issues. One suggestion is to set up a special contract and fund for science review panels *(a separate and distinct activity from that of external scientific peer review under HSC 57004).* (Region 1)

2. Recommend that a pool of in-house experts be made available for use by any of the regional boards. For example, experts in economic analyses (impacts of permit conditions and monitoring requirements), risk assessment, and GIS mapping. *(Could be patterned after how legal counsel is provided to the Regional Boards. Science experts could be housed in a research division.)* (R- 9)

3. Develop a comprehensive soil guidance document to aid staff in making decisions regarding sediment/soil cleanup levels that are protective to groundwater and surface water. *(This would be for the mutual benefit of all the Regional Boards, possibly developed by in-house specialists (research division?) or under contract to outside scientists.)* (R-2)

4. In the absence State and regional board expertise, it would be very helpful to have formal policy that would authorize the Boards to require dischargers to fund escrow accounts to contract with independent scientists. This would allow the Boards to get critical scientific information needed for decision-making (e.g., design and interpretation of field studies, engineering tests and analyses). *This was meant for highly specialized areas of science and engineering that would not otherwise be cost-effective to have on staff.* (R-3)

5. Regional boards do not have specialists in risk assessment or toxicology. It would be useful to establish a mechanism (e.g., memorandum of agreement, interagency agreement, contract resources) to allow regional boards to consult or contract with experts in other state, federal or local agencies. *This recommendation was made in the context of establishing site-specific objectives that are less stringent than federal or state objectives but would not produce sediment or water column toxicity within the receiving waters (e.g., an estuary).* (R-4)

6. The regional boards do not have the resources to allow for peer-review of the technical merit of proposed scientific studies, or for the evaluation of the data or conclusions from such studies. It would be helpful to create an advisory panel for this purpose. *The "peer review" referenced here is not the University of California peer review under HSC 57004. The water boards are looking for technical review, comment, and suggestions on their field studies and the interpretation of their data. This is similar to recommendation #1.* (R-4)

7. The Enclosed Bays and Estuaries Policy (SIP) does not describe a precise method by which enhancement of an estuary should be demonstrated. It is recommended that a method be established to ensure consistency among boards. (R-4)

8. Best management practices (BMPs) and treatment measures designed to address unreasonable or unlikely storm events are not cost-effective. More monitoring and modeling work is needed to optimize "design" storms used in developing best management practices (BMPs) and other treatment measures used in TMDL implementation plans. *This recommendation was made in the context of updating bacteria objectives to protect the "recreational water contact" beneficial use.* (R-4)

9. A five-year cycle of review and update of permits and waste discharge requirements based on current water quality limits would help improve protection of water quality. (R-5)

10. U.S. EPA methodology for deriving toxicity water quality criteria requires data from eight identified families of aquatic organisms. Without data from even one these families, the methodology cannot be applied and criteria cannot be derived. (R-5) *Alternative testing protocols should be developed, or review and approval of available data and its interpretation by a panel of expert scientists should be allowed.*

11. Methodologies are available for deriving criteria for water column toxicity (e.g., from diazinon), but are not readily available for deriving criteria for sediment toxicity. Sediments accumulate less soluble pollutants, typically organics (e.g., pyrethroids). Methodologies for deriving sediment criteria are needed. (R-5)

12. We need a better understanding of how to most effectively reduce the methylmercury levels in water. Whether it is by controlling inorganic mercury, interrupting mercury-to-methylmercury transformation, or increasing the rate of methymercury degradation. Further research is critical to protecting wetland restoration projects and reducing mercury levels in fish. (R-5)

    We also need a better understanding of how to interpret the levels of total (mass) and dissolved (concentrations) mercury found in waste discharges (e.g., from aggregate mining operations) to land to determine their potential for long-term impacts on water quality. (R-5)

13. Review of annual monitoring reports from both coalition and individual discharges is required under the irrigated lands conditional waiver program ("Ag Waivers") to determine whether water quality objectives are being exceeded. While annual monitoring reports are providing much needed baseline data, if information from other agencies and programs were accessible in a one-source database, the reviews would be much improved and could recommend better management and implementation plans. (R-5) *This recommendation supports the need to enhance the Surface Water Monitoring and Assessment Program (SWAMP).*

14. Review of scientific and technical information contained in coalition, water district, and individual watershed evaluation reports (WERs, submitted under the Ag Waiver program) is used to develop and evaluate the most appropriate monitoring and reporting program plans (MRPPs) to be submitted by the discharger. Adequate geographical information system (GIS) services are needed to verify information in the WERs. (R-5)

15. State-of-the-art science continues to demonstrate the importance of wetlands in removing pollutants from stormwater and protecting downstream water quality and beneficial uses. More research and monitoring are needed to develop numerical chemical and biological water quality standards for these waters. While the SWAMP has developed a strategy for the needed monitoring, it is under-funded. (R-6)

16. There is an ongoing need for training to ensure that regional board staff activities regarding wetlands are based on the best available science. (R-6)

17. Ground water investigations should incorporate monitoring wells designed and located for the purpose of delineating and quantifying ground water

pollution. Using domestic wells is unreliable because they often lack sanitary seals and no screening at discrete ground water depths. Better funding is needed for the Groundwater Ambient Monitoring and Assessment Program and SWAMP so as to provide more reliable scientific data. (R-6)

18. Professional scientists and engineers practice "continuing education" (similar to that required of physicians to maintain certification), by attending workshops, conferences, professional society meetings, and training classes. There are also technical publications that serve the professional scientist and engineering communities. Resources (time and money) should be made available to water board scientists and engineers for continuing education (e.g., subscriptions to professional journals, technical books, library cards, and Internet access to journal article services [e.g., Ingenta]). (R-6)

19. The State Water Board's Sources of Drinking Water Policy should be revised to: (a) provide more specific science-based direction regarding the suitability of geothermal and inland saline water bodies for municipal drinking water use; and (b) provide an opportunity for the Regional Boards to take categorical actions to de-designate waters currently designated for MUN (municipal and domestic supply) beneficial uses in accordance with the revised policy without having to undertake multiple Use Attainability Analyses (UAAs). (R-6) *The primary benefit of revising the Sources of Drinking Water Policy to provide more specific science-based guidance would be that the RWQCBs would not have to repeat the UAA analysis required by U.S. EPA for every water body that would be appropriately de-designated.*

20. The State Board's *Water Control Policy for Developing California's Clean Water Act Section 303(d) List* (Sep 2004) ("Listing-Delisting Policy") should be revised to acknowledge that waters designated for MUN (or other) beneficial uses that are subject to natural contamination shall not be listed as impaired when a scientific weight-of-evidence approach indicates that the exceedance of relevant criteria is due to natural causes. (R-6)

21. Facilitate accessing scientific literature, libraries, etc. Recommend reimbursement for copying technical articles and library use. (R-7)

22. More resources for water quality sampling and analysis, SWAMP, and TMDL contracts. Streamline the state contracting process. (R-7)

23. 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. The Regional Board needs access to these computer tools including appropriate software programs and high power computers to run complex computer programs. (R-8)

24. We would benefit from a better understanding of the effects of flow diversions and dam construction on geomorphology, and the interactions of flow rate, water temperature, pollutants, food web, and introduced species on the beneficial uses of water. (WR)

25. We would benefit from more information on how water supply and quality affect crop production, industrial processes, and other uses of water, including drinking. (WR)

26. Aquatic habitat, riparian zones, and stream flows vary seasonally. Our water rights decisions could be improved if we better understood the many interrelated factors that affect the environment individually and in combination. More environmental data that could be integrated into a seasonal model would be helpful. (WR)

27. Understanding the life stages of fish dependent of water flows is essential to understanding where, when, and how much water (and its quality, e.g., temperature) is needed. Our water rights decisions could be improved if we better understood the life stages of the species that utilize the rivers under study (WR)

28. Increase the resources allocated to monitoring and assessment. When the SWAMP program was originally designed it was envisioned to provide information for all the Water Boards' decision-making needs. In a report to the Legislature, it was estimated that the program would cost between $59 and $115 million per year and include 87 to 132 staff positions. The current program is funded at $3.4 million and 17 staff positions or approximately 7 percent of what is needed. (SWAMP)

29. Promote the coordination of monitoring activities and comparability of data among other agencies and monitoring entities. Hundreds of agencies and entities collect water quality information, but differences in design, analysis,

quality assurance and data management make it difficult to use data collected by different groups. At the staff level, many agencies are beginning to work toward data comparability and data integration through the California Environmental Data Exchange Network hosted by the Department of Water Resources. This type of collaboration is supported at the Water Boards, but needs to be supported by other agencies interested in water quality. (SWAMP)

30. Sources for continued funding of the GAMA Program need to be identified. (GAMA)

Table 1

Laws, Plans, and Policies Governing the Activities of the Water Boards

Laws (4)

- Federal Clean Water Act
  - Implementing regulations
    - Adopt water quality standards for surface waters
      - Designates beneficial uses
      - Requires numeric or narrative criteria to protect
      - Antidegradation [40 CFR 131.12]
    - California Toxics Rule
    - Impaired water bodies (Sec. 303(d)) and TMDLs
- California Porter-Cologne Water Quality Control Act *(Calif. Water Code, Div. 7, Water Quality, contained in 24 chapters, last revised January 1, 2005)*
  - Implementing regulations
  - Authorizes State Board to adopt state water quality control plans
  - Requires State Board to adopt water quality control policies
  - Requires Regional Boards to adopt basin plans
- Chapter 6.7 Health & Safety Code (and Implementing Regulations at Title 23, California Code of Regulations, Chapter 16)
  - Underground Storage Tank Leak Prevention Standards
- Resource Conservation and Recovery Act (RCRA) Cleanups

Water Quality Control Plans (14)

- Regional Water Quality Control (Basin) Plans (10)
  - Designate beneficial uses to be protected
  - Establish water quality objectives (WQOs)
  - Implementation program to achieve WQOs
- Water Quality Control Plan for Ocean Waters of California, *aka* the "Ocean Plan"
- Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California, *aka* the "Thermal Plan"
- Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, *aka* the "Bay-Delta Plan"
- Plan for California's Nonpoint Source Pollution Control Program

Policies (17)

- State Policy for Water Quality Control
- Water Quality Control Policy for Developing California's Clean Water Act Sec. 303(d) List of impaired water bodies
- Policy for implementation of the Toxic Standards for Inland Surface Waters, Enclosed Bays and Estuaries in California *(aka State Implementation Policy or SIP)*
- Water Quality Control Policy for Guidance on Development of Regional Toxic Hot Spot Cleanup Plans *(aka Consolidated Toxic Hot Spots Cleanup Plan)*
- Statement of Policy with Respect to Maintaining High Quality of Waters in California *(aka Antidegradation Policy)*
- Water Quality Control Policy for the Enclosed Bays and Estuaries of California
- Water Quality Control Policy for the Use and Disposal of Inland Waters Used for Power Plan Cooling
- Policy with Respect to Water Reclamation in California
- Policy on Disposal of Shredder Waste
- Policy Regarding the Underground Storage Tank Pilot Program
- Sources of Drinking Water Policy
- Pollutant Policy Document for the San Francisco Bay/San Joaquin Delta Estuary
- Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Sec. 13304 *(aka Containment Zone Policy)*
- Policy for Regulation of Discharges of Municipal Solid Waste
- Water Quality Enforcement Policy
- Brownfields Policy
- Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, May 2004. Groundwater Cleanup and Containment Zone Policy, Resolution 92-49.
- Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options. June 16, 2005

TABLE 2

STANDARD BENEFICIAL USE DEFINITIONS

The following are the beneficial uses (BU) for surface and groundwaters that have been adopted by the regional boards in basin plans and have been approved by the State Board. Not all of the beneficial use definitions listed below are appropriate for each basin. The uses and their definitions and abbreviations are to remain standard for all basins.

Municipal and Domestic Supply (MUN) - Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water.

Agricultural Supply (AGR) - Uses of water for farming, horticulture or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Industrial Process Supply (PRO) - Uses of water for industrial activities that depend primarily on water quality.

Industrial Service Supply (IND) - Uses of water for industrial activities that do not depend primarily on water quality, including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Ground Water Recharge (GWR) - Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting saltwater intrusion into freshwater aquifers.

Freshwater Replenishment (FRSH) - Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity).

Navigation (NAV) - Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Hydropower Generation (POW) - Uses of water for hydropower generation.

Water Contact Recreation (REC-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, or use of natural hot springs.

Non-Contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but not normally involving body 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.

Commercial and Sport Fishing (COMM) - Uses of water for commercial or recreational collection of fish and shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Aquaculture (AQUA) - Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

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.

Cold Freshwater Habitat (COLD) - Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Inland Saline Water Habitat (SAL) - Uses of water that support inland saline water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.

Estuarine Habitat (EST) - Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Marine Habitat (MAR) - Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Wildlife Habitat (WILD) - Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Preservation of Biological Habitats of Special Significance (BIOL) - Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection.

Rare, Threatened, or 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.

Migration of Aquatic Organisms (MIGR) - Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

Spawning, Reproduction, an/or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters and mussels) for human consumption, commercial or sport purposes.

Additional Beneficial Use Definitions Adopted By Individual Regional Boards and Approved By The State Board

North Coast Regional Board (Region 1):
Native American Culture (CUL) – Uses of water that support the cultural and/or traditional rights of indigenous people such as subsistence fishing, basket weaving and jewelry material collection, navigation to traditional ceremonial locations, and ceremonial uses.

Subsistence Fishing (Fish) – Uses of water that support subsistence fishing. *Note: no waters have been designated as such to date (Aug 2005).*

Los Angeles Regional Board (Region 4):
Wetland Habitat (WET) - Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

Lahontan Regional Board (Region 6):
Flood Peak Attenuation/Flood Water Storage (FLD) - Beneficial uses of riparian wetlands in flood plain areas and other wetlands that receive natural surface drainage and buffer its passage to receiving waters.

Water Quality Enhancement (WQE) - Beneficial uses of waters that support natural enhancement or improvement of water quality in or downstream of a water body including, but not limited to, erosion control, filtration and purification of naturally occurring water pollutants, streambank stabilization, maintenance of channel integrity, and siltation control.

Santa Ana Regional Board (Region 8):
Limited Warm Freshwater Habitat (LWRM) - Waters support warm water ecosystems which are severely limited in diversity and abundance as the result of concrete-lined watercourses and low, shallow dry weather flows which result in extreme temperature, pH, and/or dissolved oxygen conditions. Naturally reproducing finfish populations are not expected to occur in LWRM waters.

VI. Acknowledgements

This report relied on contributions from State and Regional Water Board staff and program managers who have intimate knowledge of where, what, and how science and engineering are used in their daily work and decision-making. Their individual and collective efforts must comply with the many laws, plans and policies that govern the water boards. Their expertise, creativity, and adaptability allow them to respond to emerging issues that require new science and engineering to address. Their abilities are reflected in the quality of work presented to their respective boards, the policies and resolutions adopted by their boards, and the comments received from external scientific peer reviewers. Their abilities are also reflected in the complex permit conditions and monitoring requirements that are approved by their boards and Executive Officers. The use of sound scientific principles and practices is prevalent among water board staff. Science and engineering are the foundation of their mission to protect the current and future beneficial uses of California's surface and ground waters.

In the preparation of this report, no one in Cal/EPA or any of its boards, departments or offices asked or directed that any topic be included, excluded, or revised. The organization, drafting, and preparation of the report were done by the consultant and reflect his interpretation and understanding of water board programs and activities. Protecting the beneficial uses of California waters is an extremely complex task and not every subject or issue was included in this report, to do otherwise would take several years and require much more text to complete. Consequently, the report provides a general overview with a few specific examples of the role of science and engineering in decision-making. The report provides enough information to demonstrate the wide use of science and engineering among the water boards and would be a place to start if a more in-depth review is required.

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