Pollution Prevention

Photo caption. City drain with medallion warning that the drain flows into the local creek or river.

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Chapter 17. Pollution Prevention

Pollution prevention can improve water quality for all beneficial uses by protecting water at its source and therefore reducing the need and cost for other water management and treatment options. An important pollution prevention strategy is implementation of proper land use management practices to prevent sediment and pollutants from entering the source water. By preventing pollution throughout a watershed, water supplies can be used, and reused, for a broader number and types of downstream water uses. Improving water quality by protecting source water is consistent with a watershed management approach to water resources problems. In addition, the legal doctrine of "public trust" demands that the State protect certain natural resources for the benefit of the public, including uses such as fishing, protection of fish and wildlife, and commerce, all of which are affected by pollution.

Status of Pollution Prevention in California

In the past, our main water pollution concern was from point source discharges. Pollution can enter a water body from point sources like wastewater treatment facilities, industrial, construction, or municipal discharges from storm water runoff. In recent years, as point sources have been regulated and controlled, so-called "non-point sources" (NPS) of pollution have become our main concern. These pollutants are generated from land use activities associated with agricultural development, forestry (silviculture) practices, animal grazing, uncontrolled urban runoff from development activities, and discharges from marinas and recreational boating activities. There are many tools—regulatory, self-determined, or incentive-based—available for preventing water pollution, particularly point source pollution. Understanding, documenting, managing, and controlling NPS pollution through better land use management is a relatively new challenge and tools for this are still under development.

The US Environmental Protection Agency (USEPA), State Water Resources Control Board (State Water Board), California Coastal Commission (CCC), and Regional Water Quality Control Boards (Regional Water Boards) coordinate closely on NPS pollution issues. These agencies implement permitting, enforcement, remediation, monitoring, and watershed-based programs to prevent pollution. In addition, as part of the State of California's NPS Program Fifteen-Year Strategy (NPS Program Strategy), begun in 1998, the State Water Board established an Interagency Coordinating Committee (IACC) to assist more than 20 other State agencies with NPS regulatory authorities and/or land use responsibilities to familiarize themselves with each others' NPS activities, and to better leverage their resources.

The State Water Board funds many water quality projects in the state through bond funds and federal Clean Water Act (CWA) section 319 (CWA 319) implementation grants. Unless additional water bond funds are proposed in the coming years, these funds

Box 17-1 Acronyms and Abbreviations

AFO	animal feeding operation
AB	California State Assembly bill
Basin Plans	Regional Water Boards' Water Quality Control Plans
CA WALUP	California Water and Land Use Partnership
CAFs	confined animal facilities"
CAFOs	concentrated animal feeding operations
CBI	Clean Beaches Initiative
CCAMP	Central Coast Ambient Monitoring Program
CCC	California Coastal Commission
CCRWQCB	Central Coast Regional Water Quality Control Board
CDPH	California Department of Public Health
Center	Center for Water and Land Use, University of California, Davis
CMAP	California Monitoring and Assessment Program
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	federal Clean Water Act
CWQMC	California Water Quality Monitoring Council
DDT	dichloro-diphenyl-trichloroethane
EMAP	Environmental Monitoring and Assessment Program
USEPA	The US Environmental Protection Agency
IACC	Interagency Coordinating Committee
LARWQCB	Los Angeles Regional Water Quality Control Board
LID	Low Impact Development
MMs	management measures
MPs	management practices
MS4	Municipal Separate Storm Sewer Systems
NEMO	Nonpoint Education for Municipal Officials
NPDES	National Pollutant Discharge Elimination System
NPS	non-point sources
NPS Program Strategy	NPS Program Fifteen-Year Strategy
OEHHA	Office of Environmental Health Hazard Assessment
OWTS	Onsite Wastewater Treatment Systems
PCB	polychlorinated biphenyls
Prop.	Ballot proposition
Regional Water Boards	Regional Water Quality Control Boards
SB	California State Senate bill
State Water Board	State Water Resources Control Board
SWAMP	Surface Water Ambient Monitoring Program
The Center	UC Davis Center for Water and Land Use
TMDL	Total Maximum Daily Loads
US EPA	The US Environmental Protection Agency
WDR	waste discharge requirements

will eventually be depleted with only the CWA 319 implementation grants continuing through the State Water Board.

Antidegradation Policy

The CWA requires each state to adopt a statewide antidegradation policy and establish procedures for its implementation. The State and federal antidegradation policies require, in part, that where surface waters are of higher quality than necessary to protect beneficial uses (e.g., designated uses of the water which can 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), the high quality of those waters must be maintained unless otherwise provided by the policies. The federal antidegradation policy prohibits any activity or discharge that would lower the quality of surface water that does not have assimilative capacity, with limited exceptions. The State's Antidegradation Policy was adopted by the State Water Board in 1968 as State Water Board Resolution No. 68-16 which establishes the requirement that state water discharges be regulated to achieve the "highest water quality consistent with maximum benefit to the people of the state." The State's Antidegradation Policy applies more comprehensively to water quality changes than the federal policy because it also applies to groundwater, not just surface water.

The Antidegradation Policy has been incorporated into all Regional Water Boards' Water Quality Control Plans (Basin Plans). A Basin Plan establishes a comprehensive program of actions designed to preserve, enhance, and restore water quality in all water bodies within the State of California. The Basin Plan is each Regional Water Board's master water quality control planning document. It designates beneficial uses of surface water and groundwater and water quality objectives that protect those uses. Title 40, Part 131 of the Code of Federal Regulations requires each state to adopt water quality standards by designating beneficial uses to be protected and promulgating water quality criteria that protect the designated uses. In California, the beneficial uses and water quality objectives are the State's water quality standards.

The State Water Board uses the precautionary principle approach in many of its ongoing programs, particularly those that involve environmental justice issues. According to this approach, when an activity raises threats to the environment or human health, precautionary measures are taken even if some cause and effect relationships are not fully established. Key elements of the principle include exercising precaution in the face of scientific uncertainty; exploring alternatives to possibly harmful actions; placing the burden of proof on proponents of an activity rather than on victims or potential victims of the activity; and using democratic processes to carry out and enforce the principle – including the public right to informed consent.

Total Maximum Daily Loads (TMDLs)

The CWA Section 305(b) requires each state to report biennially on the quality and condition of its waters. The State Water Board and Regional Water Boards conduct physical, chemical, and biological monitoring of the waters of the state and prepare an assessment report for USEPA (SWRCB, 2009a). The reports submitted by states serve as the basis for EPA's National Water Quality Inventory Report to Congress. California's CWA Section 303(d) (CWA 303d) Listing Policy sets the rules to identify which waters do not meet water quality standards, even after point source dischargers have installed the required levels of pollution control technology (SWRCB, 2009b). The law requires that these jurisdictions establish priority rankings for water on the CWA Section 303(d) list and develop action plans, called Total Maximum Daily Loads (TMDLs) for specific pollutants to improve water quality. TMDLs are typically adopted through the Basin Planning process. The Regional Water Boards conduct triennial reviews of the basin plans to solicit input from interested parties and assist staff in prioritizing Basin Plan amendment projects.

Water bodies are most often listed as impaired for sediment, pathogens, nutrients, pesticides, metals, and organic chemicals. The resulting TMDLs are then implemented through the point source and NPS regulatory programs, such as the National Pollutant Discharge Elimination System (NPDES) permits for point sources (e.g., wastewater treatment facilities, storm water runoff); State waste discharge requirements (WDRs) for both point and NPS discharges not subject to the NPDES permit program; and NPS agricultural waivers of WDRs. Additionally, the USEPA and the California Department of Public Health (CDPH) have sanitary survey and source water assessment programs specifically for drinking water sources. Beyond these State and federal efforts, many local agencies, businesses, farmers, non-governmental organizations, and watershed-based groups have implemented pollution prevention programs directly on their own, or through partnerships. A more detailed discussion of the legal and regulatory framework for protecting ambient water quality is presented in chapter 3 of volume 1 of the Water Plan Update 2009.

Surface Water Quality

Water quality impairments threaten beneficial uses of surface waters such as domestic, riparian, and aquatic habitats in many parts of the state. In some instances these are major impediments to ecosystem restoration. Urban, military, industrial, hydropower, mining, logging, agriculture, grazing, and recreational activities can potentially degrade water quality. Depleted freshwater flows as a result of upstream dams, diversions, interbasin transfers, and increased urbanization also affect the quality of water downstream, and have public trust doctrine implications. Other water management actions and projects, such as conjunctive use, conveyance, transfers, and conservation, can also affect water quality, both positively and negatively. Many significant pollution problems today are the result of persistent "legacy" pollutants, such as mercury, extracted from the Coastal Range and used to process gold in the Sierra Nevada mines in the 19th century; industrial chemicals such as polychlorinated biphenyls (PCBs),

used in electrical transformers; and pesticides such as dichloro-diphenyl-trichloroethane (DDT). These pollutants also contaminate sediments, making ecosystem restoration efforts more difficult. Hydraulic mining during the 1900s still has an adverse impact on numerous Central Valley rivers as well as the San Francisco Bay. Some environmental contaminants of concern, such as mercury and selenium, are persistent and/or bioaccumulative. Their concentration and toxicity magnify in the food chain and could be toxic to key food chain links, such as aquatic invertebrates, and negatively impact communities and Native American Tribes dependent upon subsistence fisheries.

Assessments based on USEPA's Environmental Monitoring and Assessment Program (EMAP) for Coastal Waters, and data collected in California from 1999 through 2000 suggest that most of the state's coastal waters appear to be in "fair" to "good" condition. EMAP and the California Monitoring and Assessment Program (CMAP) data collected in California from 2000 through 2005 suggest that approximately 57 percent of wadeable perennial streams statewide are in "good" condition based on two benthic macroinvertebrate indicators. The 2006 California CWA 303(d) List of Water Quality Limited Segments includes 691 water bodies that exceeded established water quality objectives (SWRCB, 2009c). In some cases, a water body is listed for more than one pollutant; and in total, there are 1,780 pollutant-water body listings. The listings are primarily driven by the lack of attainment or maintenance of water quality to support aquatic organisms. The listing not only assures protection of public water supplies, but also assures the protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife and allows for recreational activities such as swimming, wading, and fishing (40 C.F.R. 125.62). The criteria set to protect aquatic plants and animals are more stringent in most cases than the criteria set to protect human health via drinking water. Exceptions include pollutants which are potential human carcinogens, teratogens, and reproductive toxicants.

About 12 percent of the total miles of California's rivers and streams, and about 30 percent of its lake acreage are now listed as impaired under the 2006 California CWA 303(d) List. As of 2008, advisories warning against fish consumption, an indirect indicator of surface water quality, were posted for 20 percent of California's lakes, while less than 0.5 percent of the state's rivers were similarly posted (OEHHA, 2009; Klasing and Brodberg, 2008).

Groundwater Quality

Human activities increase the discharge of salt and other pollutants to land. Such activities include the application of fertilizers (even at accepted optimal agronomic rates), application of imported water for irrigation containing dissolved salts, and industrial, municipal, and domestic wastewater discharges.

Salts are leached to underlying groundwater by rainfall or irrigation practices. Additionally, salts in native soils can be dissolved by irrigation water and leach to groundwater. For additional discussion see chapter 18 on Salt and Salinity Management.

Use of nitrogen fertilizers and discharges from onsite wastewater treatment systems (septic tank) systems often results in nitrate concentrations in groundwater that exceed drinking water standards. Nitrate in groundwater has resulted in the closure of more public water wells statewide than any other contaminant. Nitrate from agricultural fertilizer is the largest threat to groundwater quality in California, particularly in the Central Valley growing areas. Wellhead treatment programs and blending with higher quality water both are effective at protecting public supply well water quality. However, both can be costly particularly for lower income communities. Domestic wells are also often at risk from nitrate contamination. Testing is not required of domestic wells, unlike public supply wells. So domestic well owners are typically not aware of the quality of the water they consume. For additional discussion, see chapter 15 on Groundwater and Aquifer Remediation.

Recharge areas are those areas that provide the primary means of replenishing groundwater. Good natural recharge areas are those where good quality surface water is able to percolate unimpeded to groundwater. If recharge areas cease functioning properly, there may not be sufficient groundwater for storage or use. Protection of recharge areas requires a number of actions based on two primary goals. These goals are (1) ensuring that areas suitable for recharge continue to be capable of adequate recharge rather than covered by urban infrastructure, such as buildings and roads; and, (2) preventing pollutants from entering groundwater in order to avoid expensive treatment that may be needed prior to potable, agricultural, or industrial beneficial uses.

Protection of recharge areas is necessary if the quantity and quality of groundwater in the aquifer are to be maintained. However, protecting recharge areas by itself does not provide a supply of water. Recharge areas only function when aquifer storage capacity is available, and when regional and local governments and agencies work together to secure an adequate supply of good quality water to recharge the aquifer. Protecting existing and potential recharge areas allows them to serve as valuable components of a conjunctive management and groundwater storage strategy.

Zoning can play a major role in recharge areas' protection by amending land-use practices so that existing recharge sites are retained as recharge areas. Some areas that would provide good rates of recharge have been paved over or built upon and are no longer available to recharge the aquifer. Local governments often lack a clear understanding of recharge areas and the need to protect those areas from development or contamination. Land use zoning staff does not always recognize the need for recharge area protection for water quantity and water quality.

For further discussion, see chapter 25, Recharge Areas Protection.

Land Use Categories and Pollution Prevention

The State NPS Program addresses NPS pollution by promoting management measures (MMs) and management practices (MPs) for each of the six separate land use categories: agriculture, urban, forestry (silviculture), marinas and recreational boating, hydromodification, and wetlands. Management measures serve as general goals for the control and prevention of polluted runoff. Site-specific MPs are then used to achieve the goals of each management measure. Management practices refer to specific technologies, processes, siting criteria, operating methods or other alternatives to control NPS pollution.

State Water Board and Regional Water Boards and CCC have developed and adopted successive, five-year plans (NPS Implementation Plans) to implement the NPS Program Strategy. The NPS Implementation Plan (1998-2013) focuses on the progress made in the NPS Program thus far, describes the additional regulatory, educational, and financial tools made available to the Regional Water Boards, and identifies the need for prioritizing resources and efforts. The goals of the current NPS Implementation Plan are similar to those of the past five-year plans, with a closer focus on the following activities:

- Implementing the *Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program* (NPS Implementation and Enforcement Policy) by the Regional Water Boards, particularly through the Regional Water Boards' irrigated lands regulatory programs;
- Concentrating NPS cleanup resources on TMDL implementation priorities;
- Focusing overall efforts and resources on high priority watersheds and problems, as defined by priority TMDLs and other region-specific problems; and
- Acknowledging the balancing act required by State Water Board programs to both clean up waters polluted by nonpoint sources and preserve clean waters.

In the next five years the State Water Board expects to have a fully integrated database of existing and tested management measures and management practices, many success stories based on proper implementation and maintenance of these measures and practices, well-established cleanup programs based on actions taken pursuant to the NPS Implementation and Enforcement Policy, and an accurate assessment of the remaining NPS pollution problems in the state. At that time, the State Water Board will be well-positioned to take another long-term look at the future of NPS pollution cleanup priorities.

The State Water Board has developed the NPS Encyclopedia to help practitioners choose management practices for implementation. It is a free online reference guide designed to facilitate a basic understanding of NPS pollution control and to provide quick access to essential information from a variety of sources. This is done through hyperlinks to other resources available on the worldwide web. The purpose of the NPS Encyclopedia is to support the implementation and development of the NPS aspects of TMDLs and

watershed action plans with a goal of protecting high quality waters and restoring impaired waters. The companion tool, the NPS MP Miner, allows users to cull data from studies of management practices, peer reviewed and otherwise, by filtering studies using relevant site-specific variables, such as land use category, pollutant of concern, and removal efficiency required. Both tools are available at the State Water Board Web site (SWRCB, 2009d).

Agriculture

According to the USEPA, agricultural NPS pollution is the leading source of water quality impacts on surveyed rivers and lakes, the second largest source of impairments to wetlands, and a major contributor to contamination of surveyed estuaries and groundwater. (USEPA, 2005) Agriculture is a source of organic carbon, particularly in the Delta. Agricultural activities that cause NPS pollution include poorly located or managed animal feeding operations; overgrazing; plowing too often or at the wrong time; and improper, excessive, or poorly timed application of pesticides, irrigation water, and fertilizer. Farm and ranching pollutants include sediment, nutrients, pathogens, pesticides, metals and salts. To control NPS pollutants generated from this land use category, agricultural MMs address: (1) erosion; (2) facility wastewater and runoff from confined animal facilities; (3) nutrient management; (4) pesticide application; (5) grazing practices; and (6) irrigation practices.

Urban

With approximately 80 percent of the nation's population living in coastal areas, controlling polluted runoff in urban areas is a challenge. Negative impacts of urbanization on coastal and estuarine waters are well documented in a number of publications, including California's CWA Section 305(b) and Section 303(d) reports and the Nationwide Urban Runoff Program. Major pollutants found in runoff from urban areas include sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons, pesticides, pathogenic bacteria, and viruses. In addition to organic carbon and pathogens such as *Giardia* and *Cyptosporidium,* suspended sediments constitute the largest mass of pollutant loadings from urban areas into receiving waters. Construction is a major source of sediment erosion. Petroleum hydrocarbons result mostly from automobile sources. Nutrient and bacterial sources include garden fertilizers, leaves, grass clippings, pet wastes, and faulty septic tanks. As population densities increase, a corresponding increase occurs in pollutant loadings generated from human activities. Many of these pollutants enter surface waters via runoff without undergoing treatment. To control NPS pollutants generated from this land use category, urban MMs address: (1) runoff from developing areas; (2) runoff from construction sites; (3) runoff from existing development; (4) septic tank systems; and (5) transportation development (roads, highways, and bridges).

Forestry (Silviculture)

Silviculture contributes pollution to 17 percent of the polluted rivers and 21 percent of the polluted lakes in California (as of 1996). Without adequate controls, forestry operations may degrade the characteristics of waters that receive drainage from forest lands. Sediment concentrations can increase due to accelerated erosion, water temperatures can increase due to removal of over-story riparian shade, dissolved oxygen can be depleted due to the accumulation of slash and other organic debris, and concentrations of organic and inorganic chemicals can increase due to harvesting, fertilizers, and pesticides. To control NPS pollutants generated from this land use category, forestry MMs address: (1) preharvest planning; (2) streamside management areas; (3) road construction/reconstruction; (4) road management; (5) timber harvesting; (6) site preparation/forest regeneration; (7) fire management; (8) revegetation of disturbed areas; (9) forest chemical applications; (10) wetland forest management; and (11) postharvest evaluation.

Marinas and Recreational Boating

Recreational boating and marinas are increasingly popular uses of coastal areas and inland surface water bodies (e.g., lakes and San Francisco Bay-Delta), and an important means of public access to navigable waterways. Therefore, California must balance the need for protecting the environment and the need to provide adequate public access. Because marinas and boats are located at the water's edge, pollutants generated from these sources are less likely to be buffered or filtered by natural processes. When boating and adjunct activities (e.g., those that take place at marinas and boat maintenance areas) are poorly planned or managed, they may pose a threat to water quality and the health of aquatic systems.

Water quality issues associated with marinas and recreational boating include:

- Poorly flushed waterways
- Pollutants discharged from the normal operation of boats (recreational boats, commercial boats, and "live-aboards")
- Pollutants carried in storm water runoff from marinas, ramps, and related facilities
- Physical alteration of wetlands and of shellfish/other benthic communities during construction of marinas, ramps, and related facilities
- Pollutants generated from boat maintenance activities on land and in the water.
- Dredging in marinas and boat maintenance areas.

Common pollutants generated from marinas and recreational boating activities include: copper, bacteria and pathogens, nutrients, aquatic and invasive species such as quagga mussels and *Caulerpa taxifolia*, and oil and grease. To control NPS pollutants generated from this land use category, marina and recreational boating MMs include: (1) marina facility assessment, siting, and design – water quality assessment, marina flushing, habitat assessment, shoreline stabilization, storm water runoff, fueling station design, sewage facilities, and waste management facilities and (2) operation and maintenance –

solid waste control, fish waste control, liquid material control, petroleum control, boat cleaning and maintenance, sewage facility maintenance, and boat operations.

Hydromodification

Hydromodifications that can impair water quality include: channel modification (channelization), flow alterations, levees, and dams. Channel modification activities are undertaken in rivers or streams to straighten, enlarge, deepen, or relocate the channel. These activities can affect water temperature, change the natural supply of fresh water to a water body, and alter rates and paths of sediment erosion, transport, and deposition. Hardening the banks of waterways with shoreline protection or armor also accelerates the movement of surface water and pollutants from the upper reaches of watersheds into coastal waters. Channelization can also reduce the suitability of instream and streamside habitat for fish and wildlife by depriving wetlands and estuarine shorelines of enriching sediments, affecting the ability of natural systems to filter pollutants, and interrupting the life stages of aquatic organisms. Dams can adversely impact hydrology and the quality of surface waters and riparian habitat in the waterways where the dams are located. A variety of impacts can result from the siting, construction, and operation of these facilities. For example, improper siting of dams can inundate both upstream and downstream areas of a waterway. Dams reduce downstream flows, thus depriving wetlands and riparian areas of water. During dam construction or dredging, removal of vegetation and disturbance of underlying sediments can increase turbidity and cause excessive sedimentation in the waterway.

The erosion of shorelines and streambanks is a natural process that can have either beneficial or adverse impacts on riparian habitat. Excessively high sediment loads resulting from erosion can smother submerged aquatic vegetation, cover shellfish beds and tidal flats, fill in riffle pools, and contribute to increased levels of turbidity and nutrients (USEPA, 2009a). To control NPS pollutants generated from this land use category, hydromodification MMs address: (1) channelization-channel modification; (2) dam construction and operation – erosion and sediment control and chemical pollutant control issues, and the downstream impact of reservoir releases on riparian habitat; and (3) streambank and shoreline erosion control.

Wetlands

Wetlands and riparian areas reduce polluted runoff and enhance water quality by filtering out runoff-related contaminants, such as fine-grained sediment, nutrients (nitrogen and phosphorus), and some metals. Functional wetlands and riparian systems provide other services such as surface and groundwater storage; flood control (with adequate set-backs) and storm surge attenuation. They also support valuable wildlife and aquatic habitats. Highly modified wetlands and riparian systems are typically managed for a few beneficial uses or services, are costly to maintain, and have questionable long-term sustainability. Natural wetlands are self-sustaining when not adversely impacted by pollution.

Changes in hydrology, soil texture, water quantity, and/or species composition can impair the ability of wetland or riparian areas to filter out excess sediment and nutrients and therefore can result in deteriorated water quality. Wetlands and riparian areas may be impacted or destroyed by construction, filling, or other alterations. Historically, significant losses of wetlands have been caused by draining wetland soils for conversion to croplands, or dredging wetland soils for waterway navigation. Spongy wetland soils are compacted by over-grazing and grading. Loss of wetland acreage increases polluted runoff, leading to degradation of surface water quality.

The MMs for wetlands promote protecting and restoring wetlands and riparian areas and using vegetated treatment systems to control NPS pollution from upland activities prior to discharging into existing wetlands, riparian areas, and/or adjacent water bodies.

Major Issues facing Pollution Prevention

Irrigated Agriculture

Agricultural discharges including irrigation return flow, flows from tile drains, and storm water runoff affect water quality by transporting pollutants such as pesticides, sediments, nutrients, salts (including selenium and boron), pathogens, and heavy metals from cultivated fields into surface waters. Many surface water bodies are impaired because of pollutants from agricultural sources. Groundwater bodies have also suffered pesticide, nitrate, and salt contamination. Statewide, approximately 9,493 miles of rivers/streams and some 513,130 acres of lakes/reservoirs are listed on the CWA 303(d) list as being impaired by irrigated agriculture. Of these, approximately 2,800 miles, or approximately 28 percent, have been identified as impaired by pesticides.

To control and assess the effects of discharges from irrigated agricultural lands, the Central Coast, Central Valley, Los Angeles, and San Diego Regional Water Boards have adopted comprehensive conditional waivers of waste discharge requirements (WDRs). Growers must comply with the conditions of the waiver in order to avoid direct regulation through issuance of individual WDRs. The Colorado River Basin Regional Water Board has adopted a Conditional Prohibition as a TMDL implementation plan incorporated into their Basin Plan. An estimated 80,000 growers, who cultivate over 9 million acres, are subject to Regional Water Board irrigated agriculture regulatory programs in these regions. These Regional Water Boards have made significant strides to implement their irrigated agriculture regulatory programs and are committed to continue their efforts to work with the agricultural community to protect and improve water quality. Other Regional Water Boards have no immediate plans to adopt waivers for agricultural discharges, but may do so eventually to implement TMDLs.

Confined Animal Facilities

California has approximately 2,200 dairies with an average size of about 700 milk cows. There are also several hundred feedlots, poultry operations, and other animal feeding

operations (AFOs) in the state. California regulations refer to these operations, including concentrated animal feeding operations (CAFOs), as "confined animal facilities" (CAFs). The exact number of facilities that are CAFs based on animal populations is unknown, but is estimated at between 1,000 and 1,200. Most of the commercial CAFs are within the jurisdiction of the Central Valley Regional Water Board, including over 80 percent of the dairies. There are also about 150 dairies and feedlots in the Santa Ana Region, and about 200 dairies (mostly smaller facilities with less than 300 milk cows) in the North Coast and San Francisco Bay Regions.

Each Regional Water Board develops its own regulatory program for CAFs. Dairies and feedlots in the Santa Ana Region operate under a General NPDES permit that requires preparation of an engineered waste management plan. The Central Valley Regional Water Board was developing a general NPDES permit for dairies, but stopped when the Second Circuit Court of Appeals ruled that only facilities discharging to a water body of the United States require a permit. Subsequently, the Central Valley Regional Water Board adopted Order No. R5-2007-0035: Waste Discharge Requirements General Order for Existing Milk Cow Dairies on May 3, 2007 (CVRWQCB, 2007). This Order requires the dairies to develop and implement nutrient management plans and to submit annual reports. The permitted facilities pay an annual fee that is based on animal population and ranges from $200 to $4,000 plus a surcharge to support the State Water Board's Surface Water Ambient Monitoring Program (SWAMP). Since impact to groundwater is the major concern at these CAFs, the Order requires groundwater monitoring in some instances.

Urban Impacts

Urban storm water runoff washes pollutants such as nutrients (lawn fertilizers and pet wastes), pesticides, oil and grease, metals, organic chemicals, human pathogens, and debris from city streets and other hard surfaces into surface waters (including beaches), and negatively impacts existing and future groundwater replenishment projects that use storm water for recharge (see Urban Runoff Management, and Recharge Area Protection strategies). Runoff from municipalities has been regulated by the NPDES Municipal Separate Storm Sewer Systems (MS4s) permit since 1992. The MS4 permit requires the discharger to develop and implement a Storm Water Management Plan/Program with the goal of reducing the discharge of pollutants to the maximum extent practicable. The management program specifies what best management practices will be used to address certain program areas. The program areas include public education and outreach, illicit discharge detection and elimination, construction and post-construction, and good housekeeping for municipal operations. Medium and large municipalities are required to conduct chemical monitoring, though small municipalities are not.

The State Water Board and other federal, State, and local agencies have been actively involved in a statewide organization called the California Water and Land Use Partnership (CA WALUP). This is a local affiliate of the National NPS Education for Municipal Officials (NEMO) Network, which is dedicated to protecting natural

resources through better land use and land use planning. CA WALUP has participated in education and outreach, Low Impact Development (LID) training workshops, and collaborated on the development of an impervious surface analysis tool for California (OEHHA, 2007). The State Water Board has also funded the Center for Water and Land Use (Center), an affiliate of UC Davis Cooperative Extension. The Center's mission is to increase awareness and understanding of the relationships between water resources and land use policies and practices through education, training, applied research, collaboration, and dissemination of information.

Natural Impacts and Legacy Pollutants

Arsenic, asbestos, radon, minerals, and sometimes microbes and sediment are examples of naturally occurring contaminants for which a pollution prevention approach is obviously infeasible. Furthermore, some contaminants that are of concern specifically for drinking water, such as organic carbon from watershed runoff, and bromide—a component of ocean salinity, are a result of natural processes for which a pollution prevention approach is not possible. While there are natural sources of organic carbon, agriculture drainage, urban runoff, and wastewater discharges typically contain higher concentrations than natural runoff.

Abandoned mines and former industrial and commercial sites, such as gas stations and dry cleaner operations, often leave behind contamination problems without a clear link to any legally responsible or financially viable party or entity to pay for cleanup. The State and federal governments and potentially responsible parties often wind up in extensive regulatory and legal proceedings determining legal and financial responsibility while the contaminants remain.

Emerging Issues

Traditionally, water agencies focus on pathogens (disease-causing microorganisms), chemicals, and disinfectant byproducts (potential cancer-causing contaminants), that are regulated or will be regulated in the near future. Recently, though, other unregulated chemicals and pollutants are being discovered to have unexpected health and environmental effects. Chemicals found in pharmaceuticals and personal care products, byproducts of fires and fire suppression, and discarded elements of nanotechnology are emerging as actual or potential water contaminants. Air deposition of a whole host of pollutants is now seen as a significant contributor to water pollution. Most of these emerging pollutants have not yet been subject to rigorous assessment or regulatory action.

Institutional barriers continue to contribute to the difficulty of addressing pollution from uncontrolled runoff, especially as the State moves towards a broader watershed approach to pollution prevention and regulatory action. Various State, local and federal agencies have divided jurisdiction over groundwater versus surface waters, polluted runoff versus point source discharges, water quantity versus water quality issues, and even over

monitoring and assessing pollutants. These various "stovepipes" of regulatory authority hamper the more holistic watershed approach to water quality management, and will need to be addressed in the coming years. Management and regulation of water quality in California is fragmented among at least eight State and federal agencies, with no one agency looking after water quality from source to tap. For example, the State Water Board and Regional Water Boards regulate ambient water quality, while the California Department of Public Health (CDPH) primarily regulates treatment and distribution of potable water. Further, surface water storage and conveyance in California is mostly managed by the Department of Water Resources and the US Bureau of Reclamation, while groundwater is usually not managed at all. Moreover, serving drinking water to Californians is an obligation of cities, water districts, and private water companies that were generally not formed in any comprehensive pattern.

Finally, the diffuse nature of NPS pollution and the need to control sources on private and public land adds to the difficulties of instituting pollution prevention measures.

Climate Change

It is widely recognized that changes in temperature and precipitation patterns will impact water availability and quality. Higher air temperatures lead to increases in water demand and changes in hydrologic conditions, resulting in drought and greater threats of wildfires, and reduced snowpack, earlier snowmelt, and a rise in sea level that may cause more seawater intrusion. Also, higher water temperatures reduce dissolved oxygen levels, which can have an adverse effect on aquatic life. Where river and lake levels fall, there will be less dilution of pollutants; however, increased frequency and intensity of rainfall will produce more pollution and sedimentation due to runoff. In addition, more frequent and intense rainfall may overwhelm pollution control facilities that have been designed to handle sewage and storm water runoff under assumptions anchored in historical rainfall patterns.

Water quality impairments are especially critical as droughts and expected increases in the impacts of climate change further limit water supplies. Changes in hydrology, such as reduced snow pack and earlier snowmelt, result in less natural water storage and more difficulties managing reservoirs and reservoir releases to maintain river temperatures that are cool enough for anadromous fish. Moreover, lower groundwater tables resulting from less recharge and/or more extractions can reduce or eliminate base flow in creeks, severely affecting aquatic habitat. The condition of California's fish populations reveals the need for action. Currently, 34 fish species are listed as threatened or endangered in California, including coastal and Central Valley runs of steelhead, spring-run and winter-run Central Valley Chinook salmon, a central coast population of Coho salmon, Delta smelt, three species from the Colorado River, and several species from the Klamath Basin and southern deserts. Consequently, to ensure a reliable water supply and adequate aquatic habitat, California must manage water in ways that protect water supply and protect and restore the environment.

Monitoring and Assessment

California Senate Bill 1070was enacted to better orchestrate the many water quality monitoring efforts already in progress within the state, and to make that process more visible to the user population and to the entities committed to the protection, monitoring and supply of water to all its users. It provides for the creation of a structure to allow the public to access any available water quality data, current methods and research, as well as current regulations and enforcement actions. The bill also creates a California Water Quality Monitoring Council (CWQMC) to connect the myriad activities throughout the state in a more cohesive and sensible manner, with the ability to provide direction to reduce redundancies, prioritize actions and recommend funding necessary to give the critical information necessary to protect California's water. This bill specifically addresses Recommendation 3 of the California Water Plan Update of 2005.

The Surface Water Ambient Monitoring Program (SWAMP) is a statewide monitoring effort that provides the scientifically sound data we need to effectively manage California's water resources. "Ambient" monitoring refers to the collection of information about the status of the physical, chemical and biological characteristics of the environment. The State Water Board and the Regional Water Boards introduced SWAMP in 2001. The program's purpose is to monitor and assess water quality to determine whether we are meeting water quality standards and protecting beneficial uses. Data from SWAMP are used to improve the state's water quality assessment and impaired water bodies list, required under CWA Sections 303(d) and 305(b).

The Central Coast Ambient Monitoring Program (CCAMP) is the Central Coast's regional component of SWAMP. CCAMP plays a key role in assessing Central Coast regional goals and has a number of program objectives: (1) assess watershed condition on a five-year rotational basis, using multiple indicators of health; (2) assess long-term water quality trends at the lower ends of coastal creeks; (3) conduct periodic assessments of harbors, estuaries, lakes, and near-shore waters using multiple indicators of health; and (4) support investigations of other water quality problems, including emerging contaminants, sea otter health, pathogenic disease, toxic algal blooms and others.

In 2004, California Monitoring and Assessment Program (CMAP) for wadeable perennial streams was initiated. This program builds on USEPA's Environmental Monitoring and Assessment Program and uses a probabilistic monitoring design incorporating land use classes to allow for assessments of status and trends in aquatic life beneficial use protection in streams. Historic EMAP data were analyzed to produce assessments of the condition of streams statewide and in special study areas in northern and southern coastal California. Several assessments will also be completed focusing on providing water quality information statewide, and for the broad land use categories such as urban, agriculture, and forested areas. These efforts directly relate to recommendation 3 of this strategy in the 2005 California Water Plan and can be seen as some success in responding to this recommendation.

The last sampling effort was in 2007. The Perennial Streams Survey will be initiated in 2008. This effort, and expansion of CMAP, is aimed at developing a coordinated and

comprehensive statewide monitoring design that would integrate bioassessment efforts currently funded through the State's SWAMP and the NPS Programs with existing local and regional bioassessment efforts. A key feature of the design would be to identify relationships between land-use stressors and response.

Wastewater Infrastructure Needs

While great strides have been made in providing treatment of wastewater before being discharged to surface waters, much of the wastewater treatment infrastructure has exceeded its useful life expectancy. Without continued upgrade and replacement, the failure rates of wastewater treatment facilities could increase, thereby degrading the surface waters that receive the effluent from these facilities.

With changes in streamflow patterns predicted with climate change, the historic assimilative capacity of streams with respect to wastewater discharges would need to be re-evaluated. Treatment processes may need to be upgraded to more advanced levels. In addition, advances in our knowledge of the impacts of emerging contaminates may necessitate more implementation of more advanced treatment processes.

Onsite Wastewater Treatment Systems (OWTS)

The use of septic systems can be an effective means of treating and disposing of wastewater; however, improper siting of septic systems and other factors can lead to public health and environmental issues, including direct human exposure to effluent and degradation of groundwater and surface water quality. To address these issues, Assembly Bill (AB) 885 was approved by the California State Legislature and signed into law in September 2000. Under AB 885, the State Water Board is required to draft and implement statewide OWTS regulations for the siting, installation, operation, and maintenance of OWTS. It is expected that the work done to comply with this mandate should correct pollution problems in some surface waters and prevent some further groundwater degradation in the future.

A 2003 study jointly prepared by the California Wastewater Training and Research Center at California State University, Chico and the USEPA estimated that about 1,202,300 housing units were using septic systems in 1999. A Census-based projection estimates that there will be approximately 1,438,000 housing units using OWTS in the year 2013. As such, any activity that requires maintenance, monitoring, or sampling on such a large number of systems will have serious cost implications.

Costs Associated with Pollution Prevention

According to the 2008 USEPA Clean Water Needs Survey, California has more than $21 billion of needs to prevent both point source and NPS pollution.(USEPA, 2009b) This survey, though, emphasized point source discharges, which represented more than $20 billion of the needs, and likely underestimated the cost of measures to adequately

prevent NPS pollution. An assessment of water quality conditions in California shows that NPS pollution has the greatest effect on water quality. It affects some of the largest economic segments of the state's economy, from agricultural development to the tourist industry. As previously discussed, nonpoint sources are not readily controlled by conventional means. Instead, they are controlled with preventive plans and practices used by those directly involved in those activities and by those overseeing such activities. The following examples provide some insight into the complexity and costs associated with NPS pollution prevention in California.

Clean Beaches

Runoff from urban areas can contain heavy metals, pesticides, petroleum hydrocarbons, trash, and animal and human waste.(Heal the Bay, 2009) This urban runoff can have a detrimental impact on one of California's greatest natural and economic resources, its world-renowned beaches. This natural resource attracts millions of tourists and locals alike each year. The direct revenues generated by the California beach economy amounted to nearly $12 billion in 2004. (NOEP, 2009) Unfortunately, runoff from creeks, rivers, and storm drains creates the largest source of water pollution for the beaches. Often the currents in the bays, around offshore islands, and along sections of the coast can exacerbate pollution by trapping or directing pollutant to a particular area along the coast. Some stretches of beaches in Southern California are permanently posted by local health departments as unsafe for swimming and surfing, or periodically posted after storm events. It is recommended that no one swim in the ocean during and for at least three days after a significant rain event because of contaminated urban storm water runoff draining directly into the ocean. During dry weather, California beaches experience much better water quality, although sewer spills that result in beach closures and other sources of pollution exist year-round.

In response to protecting the state's beach resources, the governor identified $32.3 million of grant funding in the 2001 state budget to help fund the Clean Beaches Initiative (CBI). The water quality goal of the CBI is to make beaches safe for recreational ocean water contact. The projects being funded through the CBI include storm water diversions to wastewater treatment plants, storm water treatment systems, the implementation of best management practices that reduce the amount of urban runoff reaching the beaches, and source identification studies to identify potential projects. Since 2001, the CBI program has funded approximately 97 projects totaling about $92 million. In addition, $37 million of Prop. 84 funds has been allocated to the CBI program and will be available for projects through 2013. The beaches are located from the Monterey Bay (Pacific Grove) to just north of the US-Mexico border (Imperial Beach).

Diverting storm water away from Southern California beaches has historically cost approximately $500,000 to more than $1 million per project. However, such diversions are extremely effective in reducing bacterial levels in the water, as well as other pollutants associated with urban runoff. A success story is the Santa Monica Bay beaches in Los Angeles County. Some beaches on the bay were either permanently

posted or regularly posted until many of the storm water drains were diverted to a nearby wastewater treatment facility. After the diversions, beaches near the Santa Monica Pier are now off the permanently posted list and are only rarely posted. The beaches on the bay can get well over a million visitors over the course of a summer weekend. This level of visitation implies a high level of direct and indirect economic benefits gained by the beach community and high indirect economic benefits experienced by surrounding areas.

California beaches are an important environmental and economic resource for the state and the Nation. Efforts such as the CBI to fund storm water diversions and other water quality improvement projects are creating benefits that are likely to far outweigh their costs.

Irrigated Agriculture

Staff of the Los Angeles Regional Water Board estimated the costs associated with grower implementation of their irrigated lands agricultural waiver for the five years the waiver would be in effect (LARWQCB, 2005) For the estimated 4,000 growers with 263,000 acres under production, these estimated costs included the development and implementation of a monitoring and reporting program, a quality assurance program plan, annual monitoring report, and a water quality management plan. In addition, for growers with water quality violations, they estimated the costs of implementing additional MPs for sediment control, fertilizer control, and pesticide/irrigation management. The average annual cost for all growers subject to the waiver to implement the program varied from $697,000 to $1,633,000, which includes the cost of additional MP implementation, or approximately $170 to $408 per grower per year.

Benefits Associated with Pollution Prevention

For the vast majority of contaminants, it is generally accepted that a pollution prevention approach to water quality is more cost-effective than end-of-the-pipe treatment of wastes, or advanced domestic water treatment for drinking water. Pollution prevention measures are usually more cost-effective because they have lower initial capital costs, as well as less ongoing operations and maintenance costs including lower energy needs to clean up polluted water, than traditional engineered treatment systems. By preventing further degradation of water through pollution prevention we see overall improvement of water quality over time in both surface and groundwater.

Pollution prevention activities such as stormwater runoff and low impact development (see the Urban Runoff Management resource management strategy) can reduce or maintain the peak runoff from urbanized areas such that they can meet the channel capacity of the natural system without the need for new manmade protection structures.

Small rural water systems, which generally lack technical and financial capacities, may be more reliant upon pollution prevention measures than other options available to larger systems, such as advanced treatment. When surface water is polluted the only

other available source is groundwater. Therefore, preventing pollution of surface water keeps options for water supply open which is especially important in areas where the groundwater resources may already be in overdraft.

By protecting the quality of surface water and near-shore coastal waters this management strategy provides multiple benefits or uses by providing opportunities for water contact recreation, as well as serving as a water source for desalination plants, and maintaining suitable habitat for wildlife.

Recommendations for Pollution Prevention

1. Pollution prevention and management of water quality impairments should be based on a watershed approach. A watershed-based approach adds value, reduces cost, promotes cross-media, and integrates programmatic and regional strategies.

2. The Department of Water Resources should collaborate with the State Water Board to integrate the Basin Plans and other statewide water quality control plans and policies into a comprehensive Water Quality Element of the Water Plan.

3. The CWQMC should include a focus on emerging, unregulated contaminants in order to provide an early warning system of future water quality problems, as well as identify trends in water quality using multiple indicators of health. Drinking water supplies should have outcome-based monitoring, such as bio-monitoring and waterborne disease outbreak surveillance. The proposed Interagency Water Quality Program would be modeled after the existing Interagency Ecological Program. The groundwater portion of this effort should be consistent with the recommendations of the Groundwater Quality Monitoring Act of 2001 and DWR's Bulletin 118, while the surface water aspects should be coordinated with the State Water Board's Surface Water Ambient Monitoring Program.

4. Regional, Tribal, and local governments and agencies should establish drinking water source and wellhead protection programs to shield drinking water sources and groundwater recharge areas from contamination. These source protection programs should then be incorporated into local land use plans and policies.

5. Identify communities that rely on groundwater contaminated by anthropogenic sources as their drinking water source, and take appropriate regulatory or enforcement action against the responsible party. Address improperly destroyed, abandoned, or sealed wells in these communities that may serve as potential pathways for contaminants to reach groundwater.

6. The State should prioritize grant funding for source water protection activities, including building institutional capacity for watershed planning and wastewater treatment facilities.

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