# Pollution Prevention and Reduction

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|---|---|---|
| | **Goals** | New 2007 |
| | **Problem Statement** | New 2007 |
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| | **Achievements** | |
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| **Objective PO-1** | **Reduce pollutants by establishing a Pollution Prevention Program** | 1993 CCMP |
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| Action PO-1.3 | Develop environmental audit procedures for toxic substances | 1993 CCMP |
| Action PO-1.4.1 | Improve agricultural practices to reduce pollutants | 1993 CCMP |
| Action PO-1.4.2 | Implement control measures to reduce ag pollution | New 2007 |
| Action PO-1.5 | Develop incentives to reduce selenium in ag drainage | 1993 CCMP |
| Action PO-1.6 | Update pesticide strategy | Revised 2007 |
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| Action PO-1.7.2 | Reformulate/replace products that are pollution sources | New 2007 |
| Action PO-1.8 | Pollution prevention to trash, bacteria, sediment & nutrients | New 2007 |
| **Objective PO-2** | **Improve regulatory systems for point & nonpoint source control** | 1993 CCMP |
| Action PO-2.1 | Incentives for mass emission strategy | Revised 2007 |
| Action PO-2.2 | Adopt objectives to protect estuarine species and human health | 1993 CCMP |
| Action PO-2.3 | Control selenium and mercury in the Estuary | 1993 CCMP |
| Action PO-2.4 | Urban runoff management update | Revised 2007 |
| Action PO-2.5 | Control measures for energy & transportation systems | Revised 2007 |
| Action PO-2.6 | Control agricultural sources of toxic substances | 1993 CCMP |
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| Action PO-2.8 | Establish a model compliance program at federal facilities | 1993 CCMP |
| **Objective PO-3** | **Remediate pollution threats to public health and wildlife** | 1993 CCMP |
| Action PO-3.1 | Cleanup of contaminated sites—new priorities | Revised 2007 |
| Action PO-3.2 | Expedite cleanup of contaminated sites—improve processes | Revised 2007 |
| Action PO-3.3 | Funding of large-scale infrastructure improvements | New 2007 |
| **Objective PO-4** | **Improve water quality by restoration of tidal wetlands, riparian & floodplains** | New 2007 |
| Action PO-4.1 | Incentives to restore stream and wetland functions | New 2007 |
| Action PO-4.2 | Appropriate regulatory oversight and collaboration | New 2007 |
| Action PO-4.3 | Encourage opportunistic stream/wetland restoration | New 2007 |

**Pollution Prevention and Reduction Goals:**
The four goals identified in the CCMP adopted in 1993 remain applicable and important. A fifth goal has been added, which is explained briefly below.

- Promote mechanisms to prevent pollution at its source.
- Where pollution prevention is not possible, control and reduce pollutants entering the Estuary.
- Clean up toxic pollution throughout the Estuary.
- Protect against toxic effects, including bioaccumulation and toxic sediment accumulation.
- Promote restoration and enhancement of stream and wetland functions to enhance resiliency and reduce pollution in the Estuary and its watersheds.

Resource managers have come to appreciate that healthy streams and wetlands perform functions related to pollutant removal. This is not to suggest that natural systems should be viewed exclusively or even primarily as waste treatment systems. Rather, they can perform this function as part of their very existence. Therefore, restoration of stream and wetland functions can serve not only to enhance the beauty of the natural landscape and provide valuable habitat, but can also help cleanse estuarine waters and prevent pollution while protecting the beneficial uses of streams and wetlands. For example, long, straight, open channels often exhibit nuisance algae growth that pollutes the water. By restoring hydrologic and riparian functions to such areas, we not only reduce the pollution itself, but also increase the resiliency of the system's ability to reduce the adverse effects on biota and aesthetics.

**Problem Statement**
The discussion of pollutant sources in the 1993 CCMP is still largely applicable in 2007. The list of pollutants is relatively complete. Mercury has continued to be a focus of effort and attention, and there is evidence that it impairs the reproductive success of various species of birds and other wildlife that consume fish from the Estuary. Planned and much-needed, large-scale restoration of wetlands raises the concern that these restored wetlands may promote mercury methylation and subsequent incorporation into Estuary food webs. This is also an issue in riparian wetland restorations in some regions. Both mercury and polychlorinated biphenyls (PCBs) continue to be measured in high enough concentrations to limit consumption of fish by humans. Trash is gaining attention as a continuing problem both as an aesthetic nuisance and as a serious threat to aquatic life in tributaries and marine life in estuaries and oceans. For example, plastic from trash persists for hundreds of years or longer in the environment; is a threat to wildlife through ingestion, entrapment, and entanglement; and can leach potentially harmful constituents, such as phthalates, bisphenol A, styrene, vinyl chloride, and flame retardants, to the environment. Pesticides continue to be measured at concentrations high enough to impair beneficial uses in the Estuary. One recent success, the phase-out of diazinon for urban

uses, has led to the increased use of replacement pesticides, which can also threaten aquatic life.

Adding to the list of pollutants are the so-called “emerging pollutants.” These are pollutants of concern about which we do not have enough historical monitoring information to assess trends and which are not captured within existing water quality regulatory frameworks, but that are found at relatively high concentrations in sediment and biota. Emerging pollutants include polybrominated diphenyl ethers (PBDEs) used as flame retardants in many consumer products and perfluorinated chemicals used as nonstick or stain-resistant coatings (trade names like Teflon, Scotchgard, Zonyl, etc.). The broad class of pollutants known as endocrine disrupting compounds is included as an emerging pollutant and will be a focus of concern in the coming decade. An additional regulatory challenge associated with these emerging pollutants is that, as of 2007, there are almost no water quality criteria to assess impairment. One exception to this is the case of nonylphenol, for which the U.S. Environmental Protection Agency has developed an aquatic life criterion.

The discussion of trends in the 1993 CCMP remains relevant. Since 1982, there has been a continuing decline in Bay bivalve PCB concentrations, but there are no recent declines in PCB concentrations in sportfish. Regional Monitoring Program for Water Quality data show an apparent decrease in total mercury concentrations in sediment, but there have not been measurable declines in mercury concentrations in birds or sportfish since the Regional Monitoring Program started measuring these concentrations.

**Existing Management Structure**

The description of the existing management structure in the 1993 edition of the CCMP remains valid and is relatively complete. The California Department of Pesticide Regulation has been partnering with the State Water Resources Control Board and the Regional Water Quality Control Boards to address water quality concerns associated with a wide variety of pesticides—especially through the registration and re-evaluation processes. The California Air Resources Board and local air quality management districts have a future role to play as the connections between atmospheric deposition and water quality impairments are further demonstrated.

**Recommended Approach**

In 1993, the recommended approach was a three-tiered action program for addressing pollution that emphasized pollution prevention, control of pollutants that could not be avoided, and recommended remediation of existing pollution. To this program we add a fourth tier of actions to support the objective of improving water quality through restoration and enhancement of tidal and floodplain wetland functions.

More attention needs to be paid to consumer products as a water quality threat. There are some potentially harmful new pollutants whose presence in consumer products is so ubiquitous that their control by traditional pollution prevention efforts is problematic. Furthermore, once these pollutants enter the environment, it is extremely difficult, if not impossible, to remove them through conventional treatment, so they may remain in

reclaimed water. Even if treatment is successful and the pollutants are removed from wastewater and transferred to biosolids, the pollutants can be reintroduced into the environment if these biosolids are not properly managed. Therefore, emphasis needs to be placed on developing new ways to control these pollutants.

Tables 1–3 on the following pages summarize the current state of knowledge about sources and control strategies for most pollutants of concern in the Estuary. These tables present, by pollutant, the issue of concern, characteristics relevant to treatment or transport to the Estuary, and the control strategies appropriate for the pollutant. The pollutants shown in Table 1 are well-characterized in terms of sources, and there are effective control strategies available that are often already in place. The pollutants in Table 2 are those for which sources are known, but for which effective control strategies are not yet available due to insufficient information on how best to accomplish the desired results. Note that some pollutants (e.g., FOG, or fats, oils, and grease) appear in both Table 1 and Table 2 if there is a different degree of certainty regarding control strategies for different pollutant sources. Finally, Table 3 contains pollutants for which there is a lack of both sufficient information on sources and effective control strategies. As a measure of progress over the next decade, many or most of the pollutants in Table 2 should be moved into Table 1, and those in Table 3 should be moved to Table 2 or Table 1.

## Pollutant of Concern Categorization Tables—State of Knowledge on Sources, Fate, and Control Strategies

**Table 1: Pollutants for which effective controls are available**

| Pollutant | Issue of Concern/Impact | Origin/Sources | Fate | Control Strategies |
|---|---|---|---|---|
| **Copper** | Aquatic toxicity | -Brake pads<br>-Pesticides<br>• Copper sulfate root control, banned in Bay Area<br>• Pool, spa, or fountain discharges<br>-Industrial/commercial<br>• Numerous industrial uses: electroplating, printing, various chemical solutions<br>-Architectural materials<br>-Residential (pesticides)<br>-Water supply/piping<br>-Marine antifouling paints | Adsorbs to solids but substantial fraction remains dissolved in water | -Product substitutions (brake pad materials; copper sulfate root control; less toxic pesticides)<br>-BMPs for installation and maintenance of architectural copper<br>-Effective pretreatment for industrial uses<br>-BMPs for commercial uses (e.g., vehicle service, printers)<br>-Product bans (copper sulfate root control)<br>-BMPs for plumbers<br>-Alternative hull coatings<br>-Marina/boatyard BMPs |
| **FOG (Fats, Oils, and Grease)** | Raw sewage overflows to streets, creeks, and the Estuary, as well as direct stormwater discharge to the Estuary | -Commercial: food service establishments<br>-Automobiles via streets and parking facilities | Collection system blockages | -Grease interceptors<br>-Public outreach<br>-Take-back programs<br>-Structural controls |
| **Mercury** | Methylation, persistent bioaccumulative toxin | -Industrial/commercial<br>• Dental amalgam<br>• Laboratories: thermometers, liquid Hg, chemical solutions<br>• Hospitals<br>-Residential<br>• Thermometers<br>• Fluorescent bulbs<br>• Novelty items (now banned)<br>• Thermostats and switches (in buildings and vehicles) | -Adsorption to biosolids, small amount of pass-through to receiving waters<br>-Mercury not passing through treatment plant usually binds to solids and is transported with sediment | -Discharge permits<br>-Dental amalgam separators<br>-Detention and disposal of high-mercury sediments<br>-Waste fluorescent bulb management<br>-BMPs<br>-Product substitution<br>-Product bans (novelty items) |

**Table 1: Pollutants for which effective controls are available**

| Pollutant | Issue of Concern/Impact | Origin/Sources | Fate | Control Strategies |
|---|---|---|---|---|
| **Cyanide** | Aquatic toxicity | Industrial—metal finishing, pharmaceutical manufacturing | Can be produced in a wastewater plant. Degrades rapidly in receiving water. | Effective pretreatment for industrial uses |
| **Selenium** | Bioaccumulative toxin | Sedimentary deposits in Central Valley. Can be present in crude oil taken from high-selenium deposits and possibly refined products that are combusted. | Complex fate depending on redox form. Substantial fraction remains dissolved. | Reduce agricultural drainage from source areas in Central Valley |
| **Trash** | Trash is a public nuisance pollutant because it impacts habitat, is ingested by fish and birds, and conveys pollutants adsorbed to trash that can pose a threat to fish, birds, and wildlife in creeks, wetlands, and the Estuary; and is a contaminant because of the presence of hazardous materials, including broken glass, hypodermic needles, diapers, etc. | -Urban runoff and illegal dumping<br>-Direct deposition to shoreline and piers<br>-Boats/ships | Depending on the physical and chemical nature of the item, the trash may become lodged in vegetation, settle into sediments, or be deposited on banks. However, long-term fate is transport downstream and reduction in size, but threats to wildlife may increase as this occurs (ingestion by fish, birds, and wildlife). | -Public education<br>-Product substitution<br>-Street sweeping<br>-End-of-pipe full capture devices<br>-Physical removal from creeks, wetlands, and the Estuary |

**Table 2: Pollutants for which sources are identified, but not sufficient information to do effective pollution prevention**

| Pollutant | Issue of Concern/Impact | Origin/Sources | Fate | Control Strategies |
|---|---|---|---|---|
| **Pesticides (Current) (e.g., pyrethroids, organophosphate pesticides, agricultural use of diazinon, and chlorpyrifos)** | Aquatic toxicity | -Commercial: pest control operators<br>-Residential: garden/landscape use<br>-Agricultural uses | Urban creeks, the Estuary, biosolids, aerial drift, and subsequent runoff into surface waters | -Product substitutions<br>-Outreach for proper use/disposal<br>-Implement least-toxic pest control methods and use Integrated Pest Management<br>-Change use directions to minimize amount reaching surface waters |
| **PCBs (Polychlorinated Biphenyls)** | Dioxin-like toxicity, bioaccumulation | Legacy: industrial | Resistant to degradation; adsorbs to organic solids | Contaminated site cleanup |
| **Mercury** | Methylation, persistent bioaccumulative toxin | -Air (combustion)<br>-Mining legacy in watersheds and receiving waters | Adsorption to biosolids; small amount of pass-through to receiving waters | -Fireplace ordinances<br>-Mine cleanup<br>-Permit requirements at refineries |
| **FOG (Fats, Oils, and Grease)** | Raw sewage overflows to streets, creeks, and the Estuary, as well as direct stormwater discharge to Estuary | -Residential: domestic grease use/discharge<br>-Automobiles via streets and parking facilities | Collection system blockages | -Residential outreach<br>-Public outreach<br>-Take-back programs<br>-Structural controls |
| **Pesticides (Legacy) (organochlorine [e.g., DDT] and organophosphate [e.g., diazinon])** | Aquatic toxicity | Legacy: agricultural and urban | Surface waters; possible groundwater contamination from landfill leaching | |

**Table 2: Pollutants for which sources are identified, but not sufficient information to do effective pollution prevention**

| Pollutant | Issue of Concern/Impact | Origin/Sources | Fate | Control Strategies |
|---|---|---|---|---|
| **Phthalates** | Possibly damaging to liver, lungs, kidneys, and reproductive systems from large doses; endocrine disruption | Soft flexible plastics, nail polish, solvents, perfumes, adhesives, caulks, pigments | Generally non-persistent to moderately persistent in the environment. Will generally adsorb to soil and sediments and should not leach appreciably to groundwater. Will undergo biodegradation, but not evaporation. | -Product substitutions |
| **Alkylphenol Ethoxylates (APEs) and Nonylphenol Ethoxylates (NPEs)** | Endocrine disruption, estrogenic | Residential and commercial detergents, plastics, paints, textiles, paper and pulp manufacturing, all-purpose cleaners, floor care products, sanitizers, contraceptives, hair products, and degreasers | Pass-through to receiving waters; adsorption to biosolids | -Reformulations<br>-Product substitution |
| **Antimicrobial Products/Triclosan** | Materials not primarily broken down in treatment processes, endocrine disruption, bioaccumulation | Commercial and residential cleaning products, soaps, toothpaste, cutting boards, pesticides, plastics, and hair products | Most antimicrobials go into biosolids. Some pass-through into receiving waters. Methyl triclosan may be produced in the treatment process and is known to be extremely persistent. | -Consumer education<br>-Substitutions for entire group of products<br>-Statewide interagency collaboration |

**Table 3: Pollutants for which insufficient information exists regarding sources (most are emerging pollutants)**

| Pollutant | Issue of Concern/Impact | Origin/Sources | Fate | Control Strategies |
|---|---|---|---|---|
| **Perfluorinated Compounds (PFAs, PFOs)** | Toxicity and developmental impacts | -Residential (Teflon)<br>-Fabric protector (Scotchgard) | Extremely resistant to degradation | -Product ban/reformulation |
| **Pharmaceuticals and Personal Care Products (PPCPs)** | Endocrine disruption, antibiotic resistance, toxicity, etc. | -Hospitals and other medical facilities: sewer disposal and excretion<br>-Residential: sewer disposal and excretion | Pass through into receiving waters; adsorption to biosolids | -BMPs and permit requirements for hospitals and medical facilities<br>-Medicine collection events for residents<br>-Outreach and disposal alternatives |
| **PBDEs (Polybrominated Diphenyl Ethers)** | Persistent bioaccumulative toxins | Commercial and/or residential carpets, cushions, carpeting, bedding | | -Product bans/reformulation |
| **PAHs (Polyaromatic Hydrocarbons)** | Cancer, and damage to eyes, kidneys, liver | Combustion byproduct, paving sealants, fuel spills, boat motors, creosote pilings | Low molecular weight PAHs degrade, high weight buildup in sediments | -Support BCDC restriction on creosote pilings in Estuary<br>-Reduce use of high-PAH paving sealants |
| **Dioxin/ Dibenzofurans** | Persistent bioaccumulative toxins | | | |

**Achievements, 1993–2007**

One of the ongoing achievements from the past decade has been the maturation and growth of the Regional Monitoring Program for Water Quality (RMP). It has evolved from a program to track status and trends of pollutants in the Estuary to one that is increasing scientific understanding of the Estuary and its watershed to aid decision-makers in resource management.

Another achievement is that the RMP and the State Mussel Watch have demonstrated that concentrations of PCBs in bivalves have been declining since 1982. There is a shorter period of record of PCBs in fish tissue concentrations, so trends there are not yet apparent.

Since 1993, the total maximum daily load (TMDL) program has begun. The phase-out of most urban uses of diazinon can be partly attributed to the attention this pesticide received as a source of water quality impairment and TMDL development. TMDLs have also been adopted for salt, selenium, pesticides, oxygen, and mercury.

Other notable regulatory achievements for the Estuary include the development of the Long Term Management Strategy (LTMS) that should result in less dredged material (and associated pollutants) disposed in the Estuary. The development and implementation of the Phase I and Phase II stormwater permits and management programs is another significant achievement. While formidable challenges remain in terms of proper stormwater management, every city, town, and county in the Bay Area has a stormwater quality management program, and thousands of businesses and construction sites have permits that require proper management of stormwater runoff.

Another development that will affect all of California is the Universal Hazardous Waste Rule that is now part of the California Code of Regulations. This rule prohibits common hazardous materials like batteries, fluorescent tubes, thermostats, mercury thermometers, rubber flooring, cathode ray tubes, and similar products from being discarded in the trash.

In the Central Valley, there has been progress in the area of regulation of agricultural sources of pollution. Discharges from agricultural lands include irrigation return flow, flows from tile drains, and stormwater runoff. These discharges can affect water quality by transporting pollutants, including pesticides, sediment, nutrients, salts (including selenium and boron), pathogens, and heavy metals, from cultivated fields into surface waters. Many surface water and groundwater bodies are impaired because of pollutants from agricultural sources.

Success has also come from individual strategic projects that targeted specific sources of certain pollutants. The Brake Pad Partnership is a joint effort of regulators, urban runoff management agencies, environmental groups, and brake pad manufacturers funded through Proposition 13 to develop scientific information assessing the role of brake pads as a source of copper to the Bay.

Local municipal wastewater treatment plants have encouraged dental offices to install amalgam separators to control the chief source of mercury in wastewater. One local environmental organization and a local utility district formed an effective partnership to work together on a take-back program for mercury-containing thermometers to replace them with ones that do not contain mercury. Another success is the Our Water, Our World program—a

partnership between local water quality agencies (wastewater and stormwater) and local hardware and nursery stores to educate consumers about pesticides and water quality and promote less toxic pest prevention. The program has grown from a pilot in a few stores to hundreds of stores across the state, garnered numerous awards, changed pesticide purchasing behaviors, and reduced the potential for water pollution. This is a model that can and should be extended to the entire watershed of the Estuary.

**Challenges, 2007–2017**

Many of our most difficult water quality problems in the Estuary come from the impacts of legacy pollutant sources (like mercury and PCBs). There are large amounts of these legacy pollutants already in the Bay with relatively small ongoing loads entering the Bay every year. However, because it is not practical to remove large quantities of sediment from the Bay and the processes for burial or export of those pollutants from the Bay are slow, the impacts of these legacy pollutants are going to be with us for decades.

Another challenge for the future will come from emerging pollutants. These are compounds like perfluorinated compounds (used in stain-resistant and nonstick coatings), PBDEs (flame retardants in consumer products), phthalates (used as plasticizers), triclosan (in antibacterial soaps), and a variety of other endocrine disrupting compounds, along with pharmaceuticals and personal care products. Many of these emerging pollutants are associated with common consumer products that are not viewed as toxic and are often associated with the convenience of modern life. However, these pollutants are becoming known for their ubiquity and resistance to degradation while tending to bioaccumulate. One possible strategy is to encourage manufacturers to take greater responsibility for assessing the total environmental fate and effects of all products and packaging they produce and take responsibility for the fate and effects throughout the life cycle of the product and packaging. In fact, there is movement in this direction in some European countries.

The current process in place for identifying and conducting cleanups of contaminated sites both in the Estuary and on surrounding lands is incomplete, insufficiently funded, and beset with difficulties, including the way in which the public participates in the process. There are many sites that have been identified as needing remediation, but agency resources to begin oversight of cleanup are lacking. There are likewise insufficient resources to do an exhaustive accounting of other sites on land or in the Estuary that may be contaminated but that have not been discovered. Disputes over jurisdiction and authority have made cleanup efforts for current or former military facilities unnecessarily slow and difficult.

A growing body of information suggests that a primary conveyance of pollution to the Estuary is urban runoff. Part of this pollution appears to be coming from atmospheric deposition, so it will be necessary to integrate the work of air and water regulatory agencies to address this component. However, there are other contributions to urban runoff that can be effectively addressed by urban runoff management agencies.

Currently, the financial resources available for effective urban runoff are inadequate. To make more comprehensive progress in addressing all pollutants for which urban runoff is a major conveyance, it will be necessary to increase the financial resources devoted to urban runoff management. To increase financial resources, the appropriate agencies should consider mandating responsible reduction and prevention requirements, and the public should

be convinced of the benefits and cost-effectiveness of the proposed investment. Achieving this support will involve clear communication of the problems, the legal and regulatory requirements for improvement, the possible solutions, the costs, what the benefits will be, and the cost for not solving the problem. A potential model exists in Southern California, where public acceptance of bond funding to improve infrastructure was obtained by educating the public about beach closures and their impact on the local economy and the general quality of life for residents.

The Delta and upstream areas are experiencing many of the same challenges as the Bay, along with some unique challenges. For example, controlling agricultural discharges is a major challenge in the Delta and upstream areas.

Looking to the future, decision-makers must adaptively manage solutions to water quality problems in the Estuary. All strategies to address water quality problems have uncertainties in terms of technical approach, effectiveness, cost, and practicability that must be resolved.

As scientists and managers continue to learn more about the Estuary and develop more sophisticated tools to model and understand how the various parts of the system work, it is crucial that this enhanced understanding be integrated into decision-making. This is a formidable challenge because of the rapid pace of scientific discovery compared with the relatively slower pace and complicated process of policy-making or regulatory action. There has been greater cooperation and communication between scientists and policy-makers during the past decade.

Finally, global climate change may present profound challenges that are difficult to predict. Global climate change may impact strategies to control pollutants to the Estuary, and it could have a dramatic impact on local and statewide rainfall patterns and the timing and magnitude of water delivery to the system. These factors, in turn, need to be taken into account in the design of treatment systems, the management of stormwater runoff, and other measures to control pollution.

## Pollution Prevention and Reduction Actions

### A. Pollution Prevention

**Objective PO-1**

*Reduce pollutants entering into the Estuary by establishing a pollution prevention program.*

**ACTION PO-1.1 (1993 CCMP)**

***Establish specific goals for reducing the discharge of toxic pollution over time and discourage reliance on toxic materials. All dischargers should implement measures to reduce pollutants at their source.***

***Who:*** California Legislature, U.S. Congress, California Environmental Protection Agency, California Department of Food and Agriculture, California Department of Fish and Game, State Water Resources Control Board, San Francisco Bay Regional Water Quality Control Board, Central Valley Regional Water Quality Control Board, California Department of Pesticide Regulation, Natural Resources Conservation Service, and the private sector

***What:*** Building upon the pollution prevention audits required under the 1991 Senate Bill 14, which focuses on hazardous waste and right-to-know reports, pollution prevention should be a primary element in all watershed management plans and regulatory actions. All dischargers should participate in a pollution prevention program, and publicly owned treatment works should require industrial, commercial, and residential sources connected to their systems to implement pollution prevention measures. Pollution prevention measures should be incorporated into all levels of government planning and enforcement programs. An active public outreach program is also fundamental to a successful pollution prevention program.

A comprehensive pollution prevention program should include the following strategies, where practicable:

1) Redesign or reformulation of products;

2) Substitution of raw materials or alternative chemicals that introduce smaller quantities of hazardous substances into agricultural and industrial production processes;

3) Improved process technology and equipment to alter the primary source of waste generation;

4) Improved plant operations (housekeeping); and

5) Recycling of polluted substances at the site of their generation (closed-loop recycling).

Pollution prevention programs should include a comprehensive toxic reduction program, with defined goals for reducing the loading of toxic pollutants over time, identification of areas where pollution prevention techniques should be implemented, and monitoring and reporting of success in meeting these goals.

***When:*** Ongoing

***Cost:*** $2,700,000 estimated total ($300,000 federal and $2.4 million state)

**ACTION PO-1.2 (Revised 2007)**
***Recommend institutional and financial changes needed to place more focus on pollution prevention.***

***Who:*** California Legislature, regulatory agencies, and local agencies

***What:*** Economic incentives should be created to discourage reliance on toxic materials and reduce the discharge of toxic pollutants over time. Resources are needed to fund urban runoff control, pretreatment, and waste minimization programs that are currently being started by federal regulations, state requirements, and local government initiatives. Revenue enhancement measures, in the form of additional fees and direct cost measures, could provide local agencies with needed resources to adequately implement these programs.

Economic measures for agricultural discharges should incorporate incentives in water pricing to reduce sediment loading and improve water quality. Provisions of the Food Security Act

and the Agricultural Credit Act should be used more aggressively to conserve soils on erosion-prone lands. Voluntary retirement of marginal agricultural lands that currently yield a high discharge of toxic elements, such as selenium, should be encouraged through public/private joint ventures.

The following economic incentives to encourage pollution prevention should be evaluated:

1) Deposit/rebate systems (to encourage recycling of hazardous consumer products that might otherwise be released to the environment);

2) Effluent taxes based on mass loading to stimulate waste minimization by dischargers; and

3) Effluent credits based on mass loading to encourage municipal wastewater treatment plants to accept strategically routed urban runoff into the sanitary sewer to enable net reduction in pollutants to the Estuary.

***When:*** Immediately

***Cost:*** $$$ (Policy action, program development and implementation, staff)

***Uncertainty:*** Difficulty of developing policy/programs

**ACTION PO-1.3 (1993 CCMP)**
***Develop environmental audit procedures for all significant users and/or producers of toxic substances.***

***Who:*** California Environmental Protection Agency, State Water Resources Control Board, San Francisco Bay Regional Water Quality Control Board, and Central Valley Regional Water Quality Control Board

***What:*** The California Environmental Protection Agency should develop uniform requirements for environmental audits for industrial use of toxics and discharge. The need for legislation to legally mandate pollution prevention audits should be evaluated. Audits could be conducted by the user or discharger. Information collected under this program should be used to encourage corporate management accountability, as well as to provide regulatory agencies with data needed to conduct mass balance analyses of toxics use and wasteload allocations within the Estuary. The program should include a mandatory annual reporting of pollution prevention activities.

The Central Valley and San Francisco Bay Regional Water Quality Control Boards should make pollution prevention audits mandatory for all industrial facilities that discharge significant toxic pollutants into the Estuary. The audits should be mandated in National Pollutant Discharge Elimination System (NPDES) permits and publicly owned treatment works pretreatment programs.

***When:*** 1993

***Cost:*** $4 million estimated total ($4 million state)

**ACTION PO-1.4.1 (1993 CCMP):** ***Improve agricultural practices that reduce introduction of pollutants into the Estuary.***

***Who:*** California Department of Water Resources and water districts, landowners, Natural Resources Conservation Service, and the State Legislature as needed

***What:*** The California Department of Water Resources and the water districts should coordinate efforts to improve agricultural practices that contribute to the introduction of pollutants into the Estuary. Using best available information, best management practices (BMPs) and water management plans should be developed and implemented.

Agricultural practices should be developed and implemented to encourage efficient water use to reduce pollutants entering the estuarine system.

***When:*** As soon as possible

***Cost:*** $19,060,000 estimated total ($9,060,000 federal and $10 million state)

**ACTION PO-1.4.2 (New 2007):** ***Implement control measures to reduce pollutant loadings from certain agricultural practices.***

***Who:*** San Francisco Bay and Central Valley Regional Water Quality Control Boards, Central Valley Coalition Groups, individual agricultural operations, Resource Conservation Districts, California Department of Health Services, Natural Resources Conservation Service

***What:*** Confined animal feeding operations, irrigated agriculture, and open pasture livestock grazing have the potential to discharge pollutants to water courses tributary to the Bay-Delta system and are subject to regulation under the federal National Pollutant Discharge Elimination System (NPDES) permit program and/or the California Water Code.

1) Discharges from confined animal feeding operations are subject to NPDES permits issued and administered by the Regional Water Quality Control Boards that have four main sets of requirements: effluent limitations, special conditions, standard conditions, and monitoring and recordkeeping requirements.

2) The Central Valley Regional Water Quality Control Board established a program to regulate discharges from irrigated lands that relied on Coalition Groups and individual dischargers to conduct monitoring programs to determine the water quality impacts of discharges from agricultural drains and irrigation runoff, determine compliance with water quality standards, assess the effectiveness of best management practices, and identify the need for additional control measures.

3) While water quality impacts associated with open pasture grazing have not been subject to regulation under federal and state water quality programs, guidance for those types of operations has been issued by the U.S. Environmental Protection Agency under the Coastal Zone Act Reauthorization Amendments to Section 6217. Total maximum daily load (TMDL)

programs are also starting to address common impacts of increased sediment loadings and temperature impacts due to riparian area alterations from grazing.

The Regional Water Quality Control Boards should continue the implementation of the existing programs to minimize the water quality impacts from agricultural practices. The recent nationwide public health concern from contamination of produce grown in California provides an even greater incentive for the agriculture community to control pollutants in the state's waterways.

***When:*** As soon as possible

***Cost:*** $$$ (Program development and implementation, monitoring, and staff costs)

***Uncertainty:*** Intensity and duration of program and ongoing staff costs

***Performance Measures:***
1) Achieve water quality standards in affected receiving waters.

2) Percentage of dischargers that have properly filed complete waste discharge requirement applications or request for waivers

3) Number of best management practices implemented by landowners or revisions to regulatory process to better protect source waters

4) Percentage compliance with permit requirements determined by facility inspection

**ACTION PO-1.5 (1993 CCMP)**
***Reinforce existing programs and develop new incentives where necessary to reduce selenium levels in agricultural drainage.***

***Who:*** California Department of Water Resources, water districts, U.S. Bureau of Reclamation (210 Authority), Natural Resources Conservation Service, U.S. Environmental Protection Agency (319 program), and the Regional Water Quality Control Boards

***What:*** A strategy based upon existing programs and new incentives should be implemented to reduce selenium levels in agricultural drainage. Components include evaluation of attainment of selenium standards through non-structural methods and on-farm practices before use of drain extensions, use of waste discharge permits by the Regional Water Quality Control Boards where cooperative methods are ineffective, and low-cost loans. The San Joaquin Valley Drainage program should be implemented and supported. Use of incentive programs should include awards, developing model programs, educational tools, such as the Agricultural Water Program developed by California Polytechnic University, and recognizing innovative water district programs.

***When:*** As soon as possible

***Cost:*** $10,560,000 estimated total ($6,060,000 federal and $4.5 million state)

**ACTION PO-1.6 (Revised 2007)**
***Implement a comprehensive strategy to reduce pesticides coming into the Estuary.***

***Who:*** State Water Resources Control Board, Regional Water Quality Control Boards, California Environmental Protection Agency, California Department of Pesticide Regulation, California Department of Fish and Game, U.S. Environmental Protection Agency, county commissioners, county agricultural commissioners, California Department of Consumer Affairs, University of California Statewide Integrated Pest Management Program, pesticide manufacturers, formulators, distributors, retailers and users, urban runoff/management agencies, and the State Legislature

***What:*** The pesticide-related total maximum daily load (TMDL) developed by the San Francisco Bay Regional Water Quality Board proposed a comprehensive strategy that can serve as a blueprint for preventing impairments due to pesticides in the future. The strategy includes:

1) Proactive regulation to prevent pollution using existing regulatory tools;

2) Education and outreach to decrease demand for pesticides that threaten water quality and increase awareness of less toxic alternatives; and

3) Fill data gaps and measure progress and success through research and monitoring.

The Central Valley Regional Water Quality Control Board has adopted total maximum daily loads (TMDLs) to regulate agricultural and urban discharges of diazinon and chlorpyrifos and replacement products. These TMDLs should be fully implemented. In addition, the Central Valley Regional Water Quality Control Board is implementing a control program for discharges from irrigated lands that includes pesticides.

Ideally, Water Quality Control Plans should contain numerical objectives for all pesticides detected in the Estuary. However, with more than 900 pesticide active ingredients registered for use in California, this is probably already impractical. Recent regulatory efforts have focused on pesticide-related toxicity as the preferred success metric rather than environmental concentrations of individual pesticides. Therefore, it is essential that biotoxicity monitoring continue to be used or supervised by the Regional Water Quality Control Boards, the California Department of Pesticide Regulation, or other state agencies to ensure the data are reliable.

Biotoxicity monitoring should continue to be used to identify waters where pesticides and other toxic materials are impacting aquatic life. Toxicity identification evaluations can then be used to find the chemicals that are causing adverse impacts, and control strategies should be developed to address those impacts. However, a lesson that emerged recently is that it is vitally important, when developing control strategies, not simply to eliminate the use of one compound such that another can take its place and cause problems. Strategies targeting pesticides should always take a comprehensive view to ensure that implementing the solution reduces overall environmental risk.

The U.S. Environmental Protection Agency should ensure that there is an approved laboratory analysis method for every pesticide and significant breakdown products. The detection level should be below concentrations that may impact beneficial uses.

When a pesticide is detected in waters of the Estuary, the California Department of Pesticide Regulation should work with the Regional Water Quality Control Boards and other appropriate parties to determine whether water quality objectives are violated and to develop control measures, if necessary, that will result in compliance with these objectives.

The U.S. Environmental Protection Agency should be notified of detection of pesticides in waters of the San Francisco Estuary. The U.S. Environmental Protection Agency should then provide technical and monetary support for the development of any necessary control measures and determine whether the local problem should result in a change in pesticide regulation and label directions. Contamination of surface water as a result of drift from aerial applications should be quantified. Drift in aerial applications that results in violations of water quality standards should be mitigated.

Pesticide users should work with the county agricultural commissioners to keep informed of new control measures, including measures to protect endangered species, which are disseminated primarily through "county bulletins." Agricultural extension and other education and outreach programs can be used to show pesticide users best application methods. The California Department of Pesticide Regulation and county agricultural commissioners should take strong enforcement action against pesticide users who do not comply with label instructions and other use restrictions.

Where control effort is based on voluntary use of specified management practices versus mandatory restrictions, goals and a timetable must be set to gauge progress toward compliance. Failure to make meaningful progress in a reasonable timeframe should result in a regulatory-based program that mandates such progress.

***When:*** As soon as possible

***Cost:*** $$$ (Water Boards' costs for implementation, and for agricultural pest management in the Bay and Delta)

***Uncertainty:*** Number of staff, amount of outreach material, and cost for studies to fill data gaps

***Performance Measure:***
Percentage decrease in monitoring sites exhibiting toxicity due to pesticides

**ACTION PO-1.7.1 (New 2007):** ***Develop product stewardship program for new commercial products to minimize future pollutant releases.***

***Who:*** Local governments, non-governmental agencies, agencies of the California Environmental Protection Agency and the California Resources Agency

***What:*** Develop a new program to ensure that a pollutant release minimization strategy (strategy) is developed along with each new commercial product. These strategies should consider the complete product life cycle. They would be required before a new consumer product designed to be used in a manner that could release environmentally relevant quantities of potentially harmful pollutants to the Estuary or its watershed is brought to market. The strategy, which should be the responsibility of the product manufacturer, should ensure that the product's use will not result in discharges to surface waters that result in violation of water quality standards in place to protect beneficial uses in the Estuary. Because there are not numeric water quality objectives for most emerging contaminants, when strategies are developed for new chemicals or new uses of existing chemicals, they will generally look to narrative water quality standards, such as those that speak to the idea of preventing toxic substances from being present in receiving waters in toxic amounts.

The new program should be developed incrementally by building consensus among environmental non-governmental organizations, government, manufacturers, and retailers. The San Francisco Estuary Project Implementation Committee would provide input to the national Product Stewardship Institute, the California Product Stewardship Council, the San Francisco Bay Area Pollution Prevention Group, and others working on program development.

The key concept is that manufacturers would either design products to minimize release, or provide for "take-back" at the end of the product life, or a combination of the two. Legislation will be required to implement the program, so the next step would be to build consensus in the Legislature. It will also be necessary to conduct public education and outreach to make the program effective.

***When:*** As soon as possible

***Cost:*** $$$ (Program development and implementation, and staff costs)

***Uncertainty:*** Level of effort, staff costs, and types of analysis needed as part of program development

***Performance Measure:***
Development of a workable program with legislative support

**ACTION PO-1.7.2 (New 2007): *Seek redesign, reformulation, or replacement of existing commercial products that are sources of pollution to the Estuary.***

***Who:*** U.S. Congress, U.S. Environmental Protection Agency, California Legislature, California Environmental Protection Agency, State Water Resources Control Board, Regional Water Quality Control Boards, and the private sector

***What:*** Commercial products have been associated with numerous water pollution problems. For example, past use of PCBs in electrical products (from which releases are inevitable) and in uncontained applications like sealants and coatings continues to impair Estuary water quality today. Other consumer products that have been linked to pollution of the Estuary include copper-based root control products, tributyltin-containing cooling water additives,

and copper-containing vehicle brake pads. Many emerging pollutant concerns are also linked to consumer products:

- Polybrominated diphenyl ethers (PBDEs) are used as flame retardants in a wide range of products like computers, couches, carpets, and mattresses.

- Perfluorinated chemicals like perfluorooctane sulfonate (PFOS) and perflurorooctanoic acid (PFOA) are components of waterproof and nonstick coatings used in products like cookware, coats, microwave popcorn bags, and stain-resistant fabric treatments.

- Pharmaceuticals are used to improve human health.

- Phthalates are added to polymers to make flexible plastics like shower curtains, flexible tubing, and intravenous (IV) bags.

- Triclosan is an antimicrobial that is added to soaps, such as dish and clothing detergents, to kill bacteria.

- Tiny particles (nanometers in diameter)—much smaller than particles normally occurring in the environment—that are being developed through nanotechnology are bringing new properties to a vast array of consumer products like sunscreen, paint, and fabrics.

While understanding fate and transport is important and can improve the design of control strategies, it should not become a barrier to the implementation of control strategies. Components of consumer products can degrade into other chemicals that may also be environmentally significant. For example, degradation breakdown products of certain pharmaceuticals have been linked to endocrine disruption in aquatic life and amphibians.

The U.S. Environmental Protection Agency should ensure that there is an approved laboratory analysis method for every potentially harmful chemical that is used in a manner that could release meaningful quantities to the Estuary or its watershed (methods for significant breakdown products should also be required). The detection level should be below concentrations that may impact beneficial uses.

When a potentially harmful chemical associated with consumer products is detected in the Estuary, the California Environmental Protection Agency should work with the Regional Water Quality Control Boards, product manufacturers, product users, and other appropriate parties to determine whether water quality standards are violated and, if necessary, to develop control strategies, including possible phase-out, that will result in compliance with these standards.

When control programs are required to prevent consumer product-related discharges from exceeding water quality standards, the costs for the development of the control program and the monitoring needed to verify that the control program is effective should generally be borne directly or indirectly by the users and manufacturer of the product. Costs of water quality monitoring should be borne by product manufacturers and users. If necessary, legislation should be enacted to provide adequate funds to address consumer product-related water pollution, especially in the case of bioaccumulative pollutants.

Where control effort is based on voluntary use of specified management practices versus mandatory restrictions, goals and a timetable must be set to gauge progress toward compliance with water quality standards. Failure to make meaningful progress in a reasonable time frame should result in a regulatory-based program that mandates such progress.

***When:*** As soon as possible

***Cost:*** $$$ (Program development and implementation, and agency staff costs)

***Uncertainty:*** Level of effort, cooperation by manufacturers, staff costs, and types of analysis needed as part of program development

***Performance Measures****:*
1) Percentage of manufacturers participating in expired product take-back programs

2) Percentage (or quantity) of expired product or packaging taken back

3) Percentage of products reformulated

4) Percentage of manufacturers implementing procedures to assess and prevent environmental risks from products

5) Percentage of pollutants of concern for which appropriate laboratory testing methods are available

**ACTION PO-1.8 (New 2007)**
***Develop and implement programs to prevent pollution of the Estuary by other harmful pollutants like trash, bacteria, sediments, and nutrients.***

***Who:*** California Legislature, California Environmental Protection Agency, State Water Resources Control Board, San Francisco Bay Regional Water Quality Control Board, Central Valley Regional Water Quality Control Board, Natural Resources Conservation Service, local agencies, California Department of Health Services, local health departments, U.S. Army Corps of Engineers, local water districts, local flood control districts, California Ocean Protection Council, California Resources Agency, and the private sector

***What:*** In many shoreline areas, full use of the Estuary is being impeded by the presence of pollutants like trash, bacteria, excess sediments, and excess nutrients (pollutants other than metals and synthetic organic chemicals). Sediment and natural nutrients can be either beneficial or damaging, depending on the amounts and circumstances. They only become pollutants when they occur in quantities out of balance with other beneficial uses or needs of the receiving water. Trash from watersheds also contributes to the problem of marine debris (See Aquatic Resources Actions AR-9.1 and AR-9.2). The presence of fats, oils, and grease contributes to sewer line blockages and overflows that can release untreated wastewater to the Estuary. Region-specific pollution prevention strategies based upon existing programs,

watershed-specific voluntary and regulatory programs, and new incentives should be implemented to correct these problems.

Region-specific evaluations of the sources of the pollution are appropriate to form the basis for developing the region-specific strategies. Examples of practical strategies include: restrictions on use of plastic retail bags and cups; modifications of contracts with refreshment vendors to eliminate trash sources, particularly plastics; beach smoking bans; increased availability of well-maintained trash receptacles, recycling containers, and ashtrays; increased public education and enforcement of littering laws; installation of treatment control facilities; diversion of dry weather flows to sanitary sewer systems; ordinances that require sewer lateral or septic system testing and repair upon property transfer; programs and ordinances for fats, oil, and grease control; erosion control projects for unpaved roads; providing pet waste pickup bags at parks and beaches; and modification of fertilizer application and leaf litter collection practices to reduce nutrient flow to slough and shoreline areas experiencing nuisance algae problems.

***When:*** As soon as possible

***Cost:*** $$$ (Program development and implementation, assessment/evaluation of the problems, and staff costs for ongoing implementation)

***Uncertainty:*** Level of effort, staff costs, and types of assessments needed as part of program development

***Performance Measures:***
1) Publish report that examines case studies of past and ongoing efforts that are successful.

2) Percentage reduction in trash and other pollutants of concern

3) Percentage reduction in incidents of algae fouling in areas experiencing nuisance algae

4) Percentage of municipalities with sewer lateral ordinances (via survey)

**B. Pollution Control and Reduction**

**Objective PO-2**

*Improve regulatory systems for point and nonpoint source pollution control.*

**ACTION PO-2.1 (Revised 2007)**

***Pursue a mass emissions strategy to reduce pollutant discharges into the Estuary from point and nonpoint sources and to address the accumulation of pollutants in estuarine organisms and sediments.***

***Who:*** San Francisco Bay Regional Water Quality Control Board and Central Valley Regional Water Quality Control Board, U.S. Environmental Protection Agency, State Water Resources Control Board, and local pollution control authorities

***What:*** A mass emissions strategy should be developed that includes the following elements, where appropriate:

1) The Regional Water Quality Control Boards should implement waste load allocation projects for all water bodies in the Estuary that do not meet water quality standards for pollutants.

2) Pretreatment programs should be expanded to control persistent, accumulative pollutants and to include mass limits.

3) The Regional Water Quality Control Boards should impose numerical effluent limitations, toxicity control requirements for point sources, best management practices for nonpoint sources, and other regulatory and enforcement mechanisms to assure compliance with adopted standards.

4) Evaluate marketable discharge permits to ensure that the capacity of the ecosystem to accept pollutants is not exceeded.

5) Provide incentives for collaboration between municipal wastewater treatment plants and urban runoff management agencies to promote the strategic routing of runoff into the sanitary sewer to enable net reduction in pollutant loading to the Estuary.

***When:*** As soon as possible

***Cost:*** $8,260,000 estimated total ($60,000 federal and $8.2 million state)

**ACTION PO-2.2 (1993 CCMP)**
***Adopt water quality objectives that effectively protect estuarine species and human health.***

***Who:*** State Water Resources Control Board, San Francisco Bay and Central Valley Regional Water Quality Control Boards, California Department of Health Services, and California Environmental Protection Agency

***What:*** The State Board and the Regional Water Quality Control Boards should, to the extent provided by law, revise their Water Quality Control Plans so that water quality objectives protect the most sensitive species in the Estuary. Objectives should be developed for all pollutants of concern that are discharged into the Estuary, taking into account data regarding species sensitivity and, where this sensitivity is unknown, use an appropriate safety factor in the standards to account for this uncertainty. In the long-term, toxicity test information and additional research should be performed in order to determine overall species sensitivity.

The Regional Water Quality Control Boards should take into account the proportion of receiving water species and conditions that have been tested, known or suspected interactions between pollutants, other sources of stress to receiving water populations, natural variability, and other relevant factors. The Regional Water Quality Control Boards should also perform a hazard assessment of affected receiving waters and species.

Water quality objectives for appropriate water body segments for copper, selenium, mercury, and others should be developed and adopted to address bioaccumulation effects and protect aquatic life. Objectives should be developed to protect against potential adverse effects due to accumulation through the food chain.

Chemical-specific or toxicity-based sediment quality objectives that are protective of aquatic life for the Bay and Delta should be developed and adopted. Tissue levels that protect human health and predator species against adverse effects from contaminated fish or shellfish should be adopted.

***When:*** Immediately through 1994

***Cost:*** $2,412,000 estimated total ($2,412,000 state)

**ACTION PO-2.3 (1993 CCMP)**
***Identify and control sources and sinks of selenium and mercury where they are accumulating in aquatic populations in the Estuary.***

***Who:*** State Water Resources Control Board, San Francisco Bay Regional Water Quality Control Board, Central Valley Regional Water Quality Control Board, and the Natural Resources Conservation Service (with assistance from California Department of Fish and Game)

***What:*** Sources of mercury into the Estuary need to be identified and controlled. Loading of selenium from petroleum refineries, agriculture, sewage treatment, and other identified sources discharging to the Estuary must also be reduced. The State Water Resources Control Board and/or the Regional Water Quality Control Boards should fund and/or carry out necessary investigations to identify the source(s) of selenium (e.g., oil refineries, agricultural return flows, etc.) and implement necessary regulations to control its discharge. Source loads and areas of accumulation should also be identified.

Based upon results obtained in monitoring bioaccumulation of selenium, discharge permits for petroleum refineries and other significant dischargers need to include mass emission limitations for selenium. The control strategy should include management practices and waste discharge requirements as necessary to limit selenium in agricultural subsurface drainage to reduce selenium loadings to the Delta and attain water quality objectives for selenium in the San Joaquin River.

***When:*** 1992–1997; control measures: 1997–2002

***Cost:*** $21,400,000 estimated total ($8.4 million federal and $13 million state)

**ACTION PO-2.4 (Revised 2007)**
***Improve the management and control of urban runoff from public and private sources.***

***Who:*** San Francisco Bay Regional Water Quality Control Board, Central Valley Regional Water Quality Control Board, and local agencies

***What:*** Continue to implement comprehensive urban runoff management programs having the following elements:

1) Baseline control programs with a focus on prevention in all watersheds;

2) Comprehensive control programs with a focus on prevention and remediation in urban watersheds;

3) Industrial activity control programs;

4) Construction and post-construction (new and redevelopment) control programs;

5) Education and outreach; and

6) Forum to address barriers.

**Baseline Control Programs**
These programs should continue to implement:

1) Operation and maintenance of new and existing public and private storm drain systems;

2) Ordinance and general procedures updated as needed to require the control of runoff from new and existing development and significant redevelopment both during and after construction; and

3) Measures toward educating the public.

The Regional Water Quality Control Boards require municipalities to submit annual reports documenting program activities. The municipal programs should continue to be integrated into the implementation of watershed management plans, and the Regional Boards should consider issuing waste discharge requirements to municipalities that do not demonstrate adequate progress or fail to participate in watershed management. The Regional Boards should consider enforcement actions.

**Comprehensive Control Programs**
In addition to baseline control program elements, comprehensive control programs include:

1) Measures to reduce pollutants in runoff to the maximum extent practicable (MEP) from commercial, residential, and industrial areas;

2) Measures to eliminate illicit connections and illegal dumping into storm drain systems;

3) Measures for operating and maintaining public highways to reduce pollutants in runoff;

4) Measures to reduce pollutants in discharges associated with the application of pesticides, herbicides, and fertilizer; and

5) Compliance monitoring.

The requirements of the comprehensive control program are intended to be consistent with National Pollutant Discharge Elimination System (NPDES) regulations for municipal stormwater discharges. Discharges from storm sewer systems that cause or contribute to violations of water quality standards are prohibited. Therefore, urban runoff management agencies will implement measures that not only reduce pollutants in runoff to the maximum extent practicable, but the State Water Resources Control Board and the Regional Water Quality Control Boards may require implementation of additional measures to ensure achievement of water quality standards. The State and Regional Water Boards recommend an iterative approach to achieving compliance with water quality standards. The Regional Water Quality Control Boards issue NPDES permits to municipalities in urban watersheds for the implementation of comprehensive control programs and include transportation entities as responsible parties.

**Industrial Activity Control Programs**
The State and Regional Water Boards have issued general or individual NPDES permits for stormwater discharges from categories of industry or individual facilities that pose a significant threat to water quality. The Regional Water Quality Control Boards also issue NPDES permits for stormwater discharges from facilities that were not originally required in the federal regulations to obtain permits (such as automotive operations), but pose a significant threat to water quality. These permits should include specific requirements beyond those in the existing industrial stormwater general permits as necessary to meet water quality objectives. Regional Water Quality Control Boards' actions should be coordinated with municipalities required to implement comprehensive control programs.

**Construction Control Programs**
Construction is regulated by the State Water Resources Control Board's general permit to address the discharge of construction waste material and pollutants during construction. Storm Water Pollution Prevention Plans (SWPPPs) include specific measures for erosion and sediment control, post-construction stormwater management, waste management and disposal, and ongoing maintenance and inspection of pollutant control measures.

Municipalities should continue to include pollution measures in their plan development and approval process to assure implementation of the Storm Water Pollution Prevention Plan.

**Education and Outreach**
The Regional Water Quality Control Boards and local agencies should develop collaborative programs to inform the public, commercial entities, and industries about the proper use and disposal of materials and waste, and correct practices of urban runoff control.

**Forum to Address Barriers**
Establish a forum to address and remedy, where appropriate, administrative and regulatory barriers that inhibit implementation of urban runoff control measures, including construction, operation, and maintenance of detention/retention devices, wetlands, and paved surfaces.

***When:*** As soon as possible

***Cost:*** $$$$

**ACTION PO-2.5 (Revised 2007)**
***Develop and implement control measures to reduce pollutant loadings from energy and transportation systems.***

***Who:*** California Air Resources Board, Metropolitan Transportation Commission, Bay Area Air Quality Management District, Association of Bay Area Governments, California Department of Transportation, local congestion management agencies, and existing hazardous waste control agencies

***What:*** The Clean Air Plan and regional and local transportation plans should include measures to control and/or prevent the impact of atmospheric deposition and runoff from paved surfaces. Potential contributions to water pollution need to be considered in the development of air pollution standards, such as those involving automotive emissions. Regional programs need to be created to ensure proper recycling of waste oil (e.g., a deposit system for motor oil). Mass transportation systems need to be supported to reduce personal automobile use. Control measures for transportation facilities should be implemented. In the near-term, these measures should focus on trash from roadways, as well as a host of automobile-associated pollutants like metals and polycyclic aromatic hydrocarbons (PAHs) that are often associated with fine particulate matter. Much information has been gained through studies to characterize pollutants in runoff, and some of this knowledge has already been put into practice to design effective pollution prevention and treatment strategies. More can and should be done to extend these strategies to optimize transportation facilities for pollutant removal, especially as new facilities are built.

Transportation and energy system changes in response to current and future state and federal regulations and programs addressing global climate change are expected to have the additional benefit of reducing pollutants released into the air. Control measures for fine particulate matter are being put in place, and these measures will reduce transportation-related pollutant loads in urban runoff.

***When:*** Immediately

***Cost:*** $$$$$

**ACTION PO-2.6 (1993 CCMP)**
***Improve the management and control of agricultural sources of toxic substances.***

***Who:*** California Environmental Protection Agency, California Department of Food and Agriculture, California Department of Fish and Game, State Water Resources Control Board, Central Valley Regional Water Quality Control Board, Natural Resources Conservation Service, and California Department of Pesticide Regulation

***What:*** The State Water Resources Control Board and the Regional Water Quality Control Boards should utilize existing nonpoint programs in developing and implementing best management practices (BMPs). Specifically, better management of agricultural uses of pesticides (herbicides, fungicides, etc.) is needed to reduce concentrations of these pollutants to below toxic levels in receiving waters. Periodic reviews for the effectiveness of this

program should be conducted. Where water quality objectives are not met through best management practices, the Regional Water Quality Control Board should consider waste discharge requirements when there is evidence that agricultural drainage is limiting the defined beneficial uses of any body of water.

The California Inland Surface Water Plan and other appropriate policies and laws should be implemented and strengthened where needed to reduce pesticides in the environment.

The Regional Water Quality Control Board and water districts should encourage the establishment of legally responsible drainage entities. Farmers could be organized into groups to facilitate water quality monitoring and develop best management practices plans to be submitted to the Regional Board for review and approval. These plans could be used to prioritize efforts based upon known or suspected water quality problems and their solutions.

The State Water Resources Control Board and the Regional Water Quality Control Boards should develop an enforceable instream toxicity program. Elements of this program would include:

1) Continued and expanded ambient biotoxicity monitoring efforts;

2) Relating biotoxicity monitoring to biomonitoring and chemical data; and

3) Development of compliance points for measuring chronic toxicity.

***When:*** Immediately

***Cost:*** $44,120,000 estimated total ($28,120,000 federal and $16 million state)

**ACTION PO-2.7 (1993 CCMP)**
***Reduce toxic loadings from mines.***

***Who:*** U.S. Environmental Protection Agency, California Environmental Protection Agency, California Department of Health Services, State Water Resources Control Board, San Francisco Bay Regional Water Quality Control Board, Central Valley Regional Water Quality Control Board, and California Legislature

***What:*** Require the development and implementation of control measures to reduce the discharge of metals associated with sediments, acid mine drainage, or process wastes and require effective closure of inactive mines. The implementation of a program should include measures prioritized by loadings to particular watersheds. Responsible parties and potential sources of funding should be identified. State and federal Superfund programs should give high priorities to these remediation projects to rapidly correct water quality problems as well as human health problems from abandoned mines.

Regional Water Quality Control Boards should use state Clean-Up and Abatement Act funds to correct abandoned mine pollutant discharge. Legislation is needed to limit or exempt the Regional Boards and their members from liability for mine cleanup efforts, including implementation through the NPDES stormwater permits.

***When:*** 1994

***Cost:*** $8,600,000 estimated total ($2.6 million federal and $6 million state)

**ACTION PO-2.8 (1993 CCMP)**
***Establish a model environmental compliance program at federal facilities within the jurisdiction of the Estuary Project.***

***Who:*** U.S. Department of Defense, U.S. Department of Energy, U.S. Environmental Protection Agency, State of California, U.S. Department of the Interior, U.S. Department of Agriculture, and other active facilities

***What:*** The U.S. Department of Defense, the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Estuary Project should establish a memorandum of understanding (MOU) to create a model federal facilities program within the boundaries of the Estuary Project. The MOU would comprehensively address issues affecting environmental quality of the Bay-Delta. Elements to be included in the MOU are:

1) Pollution prevention, including review and revision of contract specifications to allow use of nontoxic or less toxic substitutes by contractors;

2) Improved compliance with environmental regulations;

3) Stormwater and collection systems;

4) Expedited remediation of sites affecting the Bay-Delta; and

5) Restoration/creation of wildlife habitat on unoccupied federal land and adequate funds to implement action.

***When:*** As soon as possible

***Cost:*** $13,440,000 estimated total ($13,440,000 federal)

**Objective PO-3**
*Remediate pollution threats to public health and wildlife in the Estuary.*

**ACTION PO-3.1 (Revised 2007)**
***Clean up contaminants currently affecting fish, wildlife, their habitats, and food supplies in the Bay and Delta.***

***Who:*** U.S. Environmental Protection Agency, State Water Resources Control Board, San Francisco Bay Regional Water Quality Control Board, Central Valley Regional Water Quality Control Board, California Department of Fish and Game, and U.S. Fish and Wildlife Service

***What:*** A comprehensive watershed analysis should be undertaken to evaluate, identify, and reduce toxicity in problem areas. Where toxic agents and sources are known, the resources agencies should immediately seek damages to effect the cleanup or remediation of contaminants affecting public trust resources. Special attention should be placed on implementing cleanup of upland and Bay-Delta margin sites contaminated with mercury and polychlorinated biphenyls (PCBs). In addition, efforts should be undertaken to determine if there are sites contaminated with emerging contaminants where cleanup (e.g., cap in place, removal, pump and treat, etc.) can substantially reduce risk to humans and wildlife. The priority list of emerging contaminants currently includes polybrominated diphenyl ethers, perfluorinated chemicals, and pharmaceuticals and personal care products. However, other compounds may be identified and should be included in cleanup decisions as appropriate.

***When:*** Immediately

***Cost:*** $$$

**ACTION PO-3.2 (Revised 2007)**
***Expedite the cleanup of toxic hot spots in estuarine sediments.***

***Who:*** State Water Resources Control Board, Regional Water Quality Control Boards, California Department of Toxic Substances Control, and California Legislature

***What:*** Pursuant to the Bay Protection and Toxic Cleanup Program established by the California Legislature, the State Water Resources Control Board has adopted a workplan to identify and develop cleanup plans for toxic hot spots in bays and estuaries. This cleanup or remediation will reduce the potential exposure of aquatic organisms and humans to contaminated sediments. Completion of this work should be a high priority for the Regional Water Quality Control Boards. Particular attention should be given to those contaminated areas where the Estuary receives runoff from industrial areas. In such cases, the ongoing cause of the contamination should be addressed at the same time as cleanup efforts. Legislation is needed to require the implementation of the cleanup plans and to identify a funding mechanism. Where responsible parties are known, the resource agencies should seek damages.

In cases where expedited cleanup is needed, the state should establish a funding mechanism or specific contracting authority to allow cleanups to proceed under the direction of the State Water Resources Control Board or the Department of Toxic Substances Control. Cost recovery to reimburse the state can then be accomplished as cleanup proceeds.

Additionally, the state should seek legal authority to compel cleanup at sites with no readily identifiable responsible party and also seek enhanced authority in those cases when dealing with recalcitrant responsible parties. As part of the cleanup efforts, state agencies should emphasize outreach efforts to inform local citizens of the technical issues involved.

***When:*** Ongoing

***Cost:*** $$$

**ACTION PO-3.3 (New 2007)**
***Accomplish large-scale improvements to Bay-Delta area infrastructure and implement pollution prevention strategies to prevent pollution threats to public health and wildlife.***

***Who:*** Regional Water Quality Control Boards, local governments, State Legislature, San Francisco Estuary Project

***What:*** Large-scale improvements in infrastructure (flood control, stormwater conveyance systems, wastewater treatment and conveyance, etc.) and pollution prevention efforts are needed, particularly for addressing the impacts of urban runoff to the Estuary. Jurisdictions have ongoing needs to upgrade and maintain sanitary sewer collection and treatment systems. The resources needed for such improvements will require the approval of Bay-Delta area residents and decision-makers. To achieve this consent, the public must be engaged through effective communication regarding the types of pollutant-related threats to the Estuary. The case must also be made that the solutions to these problems will require significant public expenditures, possibly hundreds of millions of dollars. A successful example of such a strategy can be found in the way Southern California addressed chronic beach closures. The problem was communicated to the public and galvanized public support for a $500 million bond measure to be spent on public infrastructure improvements to remedy the causes of the beach closures. Similar measures may be necessary to address emerging pollutants and controlling pollution to the Estuary. The following are the first steps toward accomplishing this action in the Bay-Delta Area:

1) Clearly communicate to the public and decision-makers the nature of the problem to be addressed, its causes, and that clear legal mandates and regulatory requirements already exist and must be implemented.

2) Clearly communicate the possible solutions to address these sources of pollutants and the cost of such solutions.

3) Assess the public's willingness to pay for such solutions.

4) Propose funding mechanisms to decision-makers and the public (e.g., bond measures, property tax assessments, rate increases, etc.).

5) With funding secured, initiate infrastructure improvements and pollution prevention strategies to address the most urgent needs as identified by the public, local experts, the State and Regional Water Boards, and municipalities.

***When:*** Immediately

***Cost:*** $$$$$ (Program development and implementation, outreach to public, effort to secure funding, assessment/evaluation of the problems, and staff costs for ongoing implementation)

***Uncertainty:*** Level of effort, especially in securing funding, staff costs, and types of assessments needed as part of program development

***Performance Measures:***
1) Develop opinion surveys to assess whether infrastructure needs and financing are supported by the public and decision-makers.

2) Percentage increase in spending on infrastructure improvements directly related to reducing pollutants entering the Estuary

**Objective PO-4**

*Improve water quality through restoration and enhancement of tidal wetland functions in the Estuary and riparian and floodplain wetland functions in the watersheds.*

**ACTION PO-4.1 (New 2007)**
***Increase regulatory incentives for municipalities, through urban runoff and other programs, to invest in projects that restore or enhance stream and wetland functions.***

***Who:*** State Water Resources Control Board, Regional Water Quality Control Boards, California Department of Fish and Game, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, National Marine Fisheries Service, local agencies, and the environmental community

***What:*** Stream and wetland functions to be restored or enhanced can be divided into hydrologic functions, biogeochemical functions, and habitat functions. All of these processes in watersheds and the Estuary contribute to improved water quality and support beneficial uses. Restoration of stream and wetland functions is not a formally recognized element of urban runoff pollution prevention programs. These programs have always struggled to have enough funding for the minimum control programs, so the pollution reduction benefits of urban stream and wetland restoration have not been pursued or realized by municipalities, with few exceptions.

Through traditional urban development, the functions of streams and wetlands have been lost, reducing the capacity of natural systems to maintain water quality and habitat. Channelization of urban streams and diking and filling of tidal wetlands have made it more difficult to meet water quality standards for dissolved oxygen, temperature, sediment and other parameters. While urban stormwater pollutants certainly play a role in depleting water quality, the removal of native vegetation and meanders from the streams and wetlands, most often as part of flood control projects, has also negatively affected water quality. Additionally, the design of stormwater drainage in watersheds, to rapidly move stormwater to streams and the Estuary, has caused destruction of habitat and property near creeks, transported pollutants such as trash and contaminated sediments to wetlands, and not provided enough travel time for pollutants to be naturally reduced prior to entering aquatic habitat.

As land is developed or redeveloped, opportunities arise to restore or enhance stream and wetland functions. For example, projects that reduce direct connections of impervious surfaces to streams and tidal wetlands should be encouraged because they can improve functions of stream systems by reducing the rapid and destructive peak flows of the urban runoff. Additionally, projects to use existing public rights-of-way near streams for re-establishing riparian corridors and floodplains should be encouraged because they improve

biogeochemical and habitat functions that reduce urban runoff pollution and improve dissolved oxygen, temperature, and sediment levels for aquatic life.

Incentives should be offered by the regulatory agencies through stream and wetlands system protection policies (see Land Use and Watershed Management Action LU-2.7), total maximum daily loads (TMDLs), National Pollutant Discharge Elimination System (NPDES) permits, Section 404/401 Wetland Permits, California Department of Fish and Game Streambed Alteration Agreements (SAA), and other programs that recognize and reinforce the importance of restoring and enhancing natural functions to attain water quality standards, improve aquatic habitat, and provide greater recreational opportunities for local citizens.

One example of an incentive could be pollutant mass reduction credits to be applied to total maximum daily load (TMDL) requirements for urban runoff. This would require some technical development of a defensible credit system for different types of function-enhancement projects. For instance, mass reduction credits for TMDL pollutants should be based on recent local research conducted on various pollutant reductions associated with urban runoff best management practices.

To create more incentives for function enhancement, other regulatory programs, such as the Section 404/401 Wetland Permit and Streambed Alteration Agreement programs, could emphasize that certain function enhancements, such as disconnecting impervious surface runoff from streams or restoring a stable active stream channel, make projects "self-mitigating," reducing the regulatory burden of restoration projects that have short-term impacts during and after construction.

The urban runoff programs of the San Francisco Bay-Delta region should consider the voluntary implementation of an additional control measure: "Restoration and enhancement of stream and wetland functions." For this measure to be successful, the Regional Water Quality Control Boards, the State Water Resources Control Board, and the U.S. Environmental Protection Agency would need to recognize that the control measure goes beyond the six minimum control measures the regulatory program requires, and consider the granting of regulatory tradeoffs or credits, with input from local agencies and the environmental community.

Flood control districts are part of urban runoff programs. The above voluntary control measure could be met through preparation of flood control watershed plans that integrate restoration and enhancement activities coordinated with municipalities as part of a watershed-wide project description. The authorization of such watershed plans by regulatory agencies through a public process would authorize all flood control, restoration, and enhancement projects within a watershed. Such wide-scale approaches are likely to be more effective in recovering stream and wetland functions in urbanized areas.

***When:*** 2007

***Cost:*** $$$ (Program development and implementation, and staff costs for ongoing implementation)

***Performance Measures:***
1) Number of total maximum daily load (TMDL)-related mass reduction credits issued for stream and function enhancement

2) Percentage of jurisdictions with authorized flood control watershed plans or other programs/policies that restore stream and wetland function (via survey)

**ACTION PO-4.2 (New 2007)**
***Apply reasonable regulatory requirements and improve collaboration to facilitate tidal and riparian restoration projects and pollution reduction projects, emphasizing fish and wildlife habitat improvement, human community benefits, and pollution reduction benefits of restoring stream and wetland functions (see also Land Use and Watershed Management Action LU-1.2).***

***Who:*** U.S. Fish and Wildlife Service, National Marine Fisheries Service, California Department of Fish and Game, State Water Resources Control Board and Regional Water Quality Control Boards, U.S. Environmental Protection Agency, San Francisco Bay Conservation and Development Commission, local agencies, U.S. Army Corps of Engineers, and the environmental community

***What:*** Municipalities should invest in projects that benefit the Estuary and its watersheds by enhancing stream and wetland functions that reduce pollution. They are reluctant to propose work in aquatic habitats because these habitats support sensitive species and trigger complex and sometimes lengthy regulatory and environmental review processes that undermine momentum in achieving improvements in stream and wetland functions. This can be minimized to a certain extent by involving the appropriate agencies earlier in the planning process than is customary.

The Endangered Species Act consultation requirements and other permitting programs in state waters have undoubtedly assisted in preserving wetland functions through habitat protection. Sometimes these requirements can have unintended consequences of slowing down or even discouraging needed restoration and enhancement of stream and wetland functions. Understaffed agencies justifiably target staff resources to regulation of projects that can harm endangered species or water quality, and are consequently unable to prioritize projects with potential transient or relatively minor impacts on sensitive species during the restoration process.

The permitting process is sometimes complex and challenging for tidal and riparian wetland restoration because these areas are adjacent to critical remnant habitats that support the last of sensitive species of concern. To achieve Objective PO-4 on the large scale needed, the process needs to be streamlined for local agencies and private concerns that are restoring functions near sensitive areas, recognizing that their projects will likely expand and strengthen the remnant habitats that the consultation process aims to protect, and ultimately may contribute to removal of species from threatened or endangered species lists.

In some cases, the environmental review process under the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) can slow down or discourage restoration efforts and add unnecessary costs. While potential adverse

environmental side effects must be contemplated in any restoration effort, a full environmental impact report or statement, or even an environmental assessment or negative declaration entail public processes that are sometimes unnecessarily lengthy and costly for environmentally beneficial projects that have limited funding.

For projects that have been determined not to have a significant effect on the environment, CEQA includes categorical and statutory exemptions, and NEPA has categorical exclusions for environmental impact reports/statements and other documents. These exemptions and exclusions do not remove the opportunity for the public to comment, in case some extraordinary circumstances exist that warrant more analysis of potential impact and mitigation. The categorical exemptions and exclusions save time and money by reducing the public review period and the paperwork requirements of environmental assessments and reports.

Over the past decade, regulatory agencies of the San Francisco Bay-Delta region have been successful in partnering to make the permitting and environmental review processes more efficient for state and federal restoration projects. These partnerships can be built upon to create streamlined permitting and environmental review processes for beneficial restoration and infrastructure projects conducted by local agencies.

A workgroup of the regulatory agencies should be formed to agree upon a Joint Aquatic Resources Permit Application (JARPA) process for infrastructure improvements related to: 1) stream and wetland restoration projects, 2) drainage improvements that enhance functions, and 3) sanitary sewer infrastructure projects, that would recognize the benefits to water quality and habitat functions and speed up the recovery of these vital elements in the Estuary and its watersheds. Such a streamlined process would encourage municipalities, special districts, and other entities to take more risk in investing in these projects in and near aquatic habitats, which have the additional incentives of local community benefits, improving the local quality of life, and increasing property values.

CEQA and NEPA already contain categorical and statutory exemptions/exclusions, some pertaining to maintenance of aquatic and riparian habitat, and these should be used by the workgroup of regulatory agencies to clarify what kinds of the three types of projects above are categorically exempted under CEQA and categorically excluded under NEPA. The workgroup could consider certain thresholds in applying categorical exemptions/exclusions in the San Francisco Estuary watershed, such as lengths of stream enhanced or acreages of wetlands restored.

***When:*** 2008

***Cost:*** $$ (Program development and implementation, and staff costs for ongoing implementation)

***Performance Measures:***
1) Develop a coordinated permitting process for water quality-related infrastructure improvements.

2) Number of aquatic habitat restoration projects

**ACTION PO-4.3 (New 2007)**
***Encourage opportunistic and cost-effective stream and wetland function restoration and enhancement in existing drainage infrastructure of urban areas around the Estuary.***

***Who:*** State Water Resources Control Board, Regional Water Quality Control Boards, California Department of Fish and Game, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Army Corps of Engineers, local agencies, and the environmental community

***What:*** The drainage infrastructure of the urban areas of the San Francisco Estuary is an amalgamation of gutters, pipes, ditches, impervious areas (roofs, roads, and parking lots), permeable areas, detention basins, pump stations, water supply reservoirs, streams, and tidal sloughs. As this infrastructure is replaced or upgraded, there are cost-effective opportunities for adding enhancements that would provide numerous water quality and restoration benefits. This complex infrastructure conveys stormwater runoff, as well as dry weather urban runoff, to the aquatic ecosystem. In most cases, the design of this infrastructure is solely based on reducing the risk of flooding, minimizing the retention time, and maximizing peak flows. This design results in lower travel time and less reduction of pollutants prior to discharge to aquatic habitats. It also results in destructive peak flows that increase erosion and siltation and can damage property near stream and wetland systems.

Some parts of the urban drainage system, particularly reservoirs and detention basins, are conversely designed to retain water for various purposes, but sometimes this water can stagnate and cause increased water temperatures, reduced oxygen, and perhaps mercury methylation problems in the downstream aquatic habitats. Often the stagnation is a byproduct of lack of attention, infrastructure maintenance, monitoring, and simple management.

As infrastructure, the drainage system in urban areas tributary to the San Francisco Estuary requires maintenance and periodic capital improvements. While the upper reaches of the infrastructure are on private property and more difficult to control, a substantial portion of it is within the jurisdiction and ownership of public agencies that spend millions of dollars annually to maintain and upgrade it. Pipes, gutters, and roadside ditches need periodic repair and/or replacement. Detention basin capacities need to be maintained. Pump stations need to be maintained and periodically upgraded or replaced. These are all controllable water quality factors that are on various schedules to be upgraded or replaced. Some private developments and redevelopments do lend themselves to better design for hydrologic functions, for instance through the existing urban runoff programs' new and redevelopment post-construction stormwater treatment requirements.

As municipalities and special districts implement capital improvement plans to improve elements of the public drainage system, they should be encouraged to enhance stream and wetland functions as part of the capital expenditures. Projects should be reviewed by local agencies from a hydrologic standpoint to take advantage of opportunities to reduce stagnant waters that deplete oxygen, methylate mercury, and create mosquito problems. Detention basins and reservoirs should be designed and operated to minimize these adverse effects by installing aeration devices or better managing the flow rates and patterns for water quality.

For this effort, the local agencies should be afforded regulatory credit for the proposed voluntary urban runoff control measure described in Action PO-4.1, above.

There is an opportunity to improve stream and wetland functions as public drainage projects are implemented, which are usually built to reduce local flooding. These projects should have measures incorporated to slow the storm flows that incise stream channels and destroy habitat, and to enhance natural functions in the open channel portions of the drainage system, creating enough capacity for both natural functions and peak flows. Underground pipes should be replaced with open channels with natural functions wherever feasible. Pump stations should be designed and operated to mimic natural flow regimes and not as episodic washout events of waters containing low levels of dissolved oxygen. Pollutant removal systems should be considered in every pump station upgrade in order to enhance the water quality of the urban runoff pump station discharges.

***When:*** Ongoing

***Cost:*** $$$$ (A three percent to five percent add-on to existing capital improvement budgets to enhance pollutant removal functions)

***Performance Measures:***
1) Develop a set of affordable, easily maintainable best management practices for urban runoff pump stations and detention basins.

2) Percentage of municipalities with best management practices installed that improve drainage and increase infiltration and other natural hydrologic functions (via survey)