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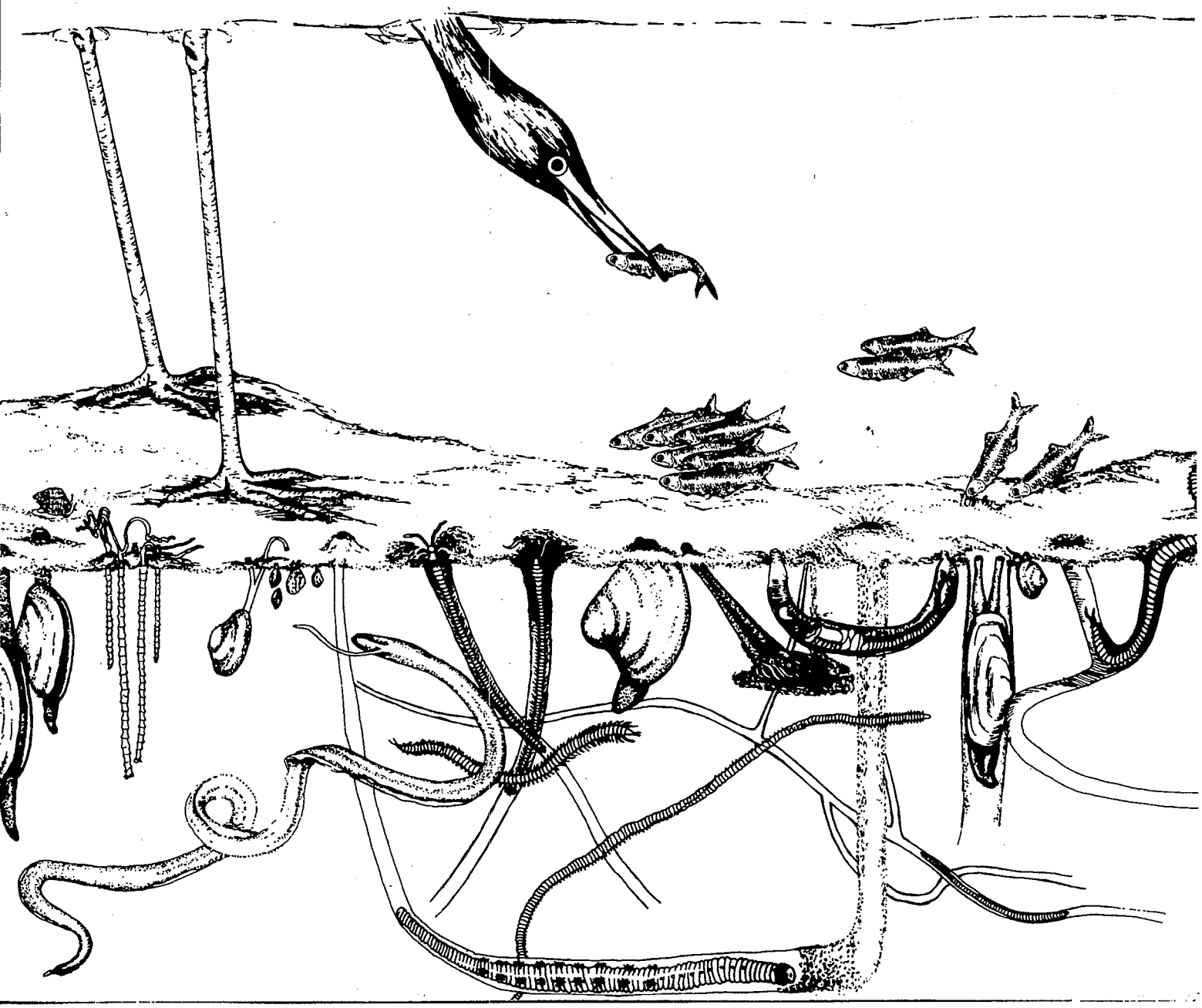
EPA's Contaminated Sediment Management Strategy



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 30 1998

THE ADMINISTRATOR

Dear Reader,

I am pleased to provide the Environmental Protection Agency's (EPA) *Contaminated Sediment Management Strategy*. The Strategy will help coordinate EPA's activities to minimize the risks to human health and aquatic life posed by contaminated sediment.

Many pollutants released into our air, land, and water can settle and accumulate in the silt and mud (sediment) that lines our rivers, lakes, harbors, estuaries, and oceans and can persist in the environment for many years. Contaminated sediments are a significant source of fish contamination, causing a human health risk, particularly to children and the recreational and subsistence fishers that consume fish. The contaminated sediment may also adversely effect aquatic life living in and around the sediment.

The Strategy establishes four main goals to address the problem of contaminated sediment, and describes actions EPA will take, under existing authorities, to accomplish them. The goals are: 1) prevent the volume of contaminated sediment from increasing; 2) reduce the volume of existing contaminated sediment; 3) ensure that sediment dredging and dredged material disposal are managed in an environmentally sound manner; and 4) develop scientifically sound sediment management tools for use in pollution prevention, source control, remediation, and dredged material management.

In cooperation with our stakeholders, we will identify impaired waterbodies and watersheds at risk from sediment contamination, take appropriate actions to accomplish the goals described above, and monitor their effectiveness to ensure greater protection of public health and provide for healthier watersheds where we live.

Sincerely,

Carol M. Browner

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ACKNOWLEDGMENTS

This document was prepared by the U.S. Environmental Protection Agency (EPA) Sediment Steering Committee and its staff workgroups. The workgroups were composed of representatives from EPA Regional and Headquarters program offices, and were chaired by Jane Marshall Farris of EPA's Office of Science and Technology. Beverly Baker of EPA coordinated development of the proposed Contaminated Sediment Management Strategy, released for public comment in August 1994. Technical support for production of the final Contaminated Sediment Management Strategy document was provided by Shari Ring of the Cadmus Group, Inc. under EPA Contract Number 68-C4-0051.

EPA sincerely appreciates all comments received from various stakeholders who responded to the Federal Register notice of availability of the proposed Strategy on August 30, 1994. Our thanks are extended to all federal, regional, state and tribal government officials, trade association representatives, environmental advocacy professionals, members of the scientific and technical community, and others who provided valuable comments and suggestions for improving the document. The Comment and Response Document is now available for review in the Water Docket, mail code 4101, Environmental Protection Agency, 401 M Street, SW, Washington, D.C. 20460. Technical support for compilation of the public comments and responses was provided by Eastern Research Group, Inc. and the Cadmus Group, Inc. under EPA Contract Number 68-C4-0051. To arrange for an appointment to review the Comment and Response Document, contact the Water Docket at 202-260-3027.

The cover art is an adaptation of an illustration from Life in the Chesapeake Bay, by Alice Jane and Robert Lippson, published by Johns Hopkins University Press, 701 West 40th Street, Baltimore, MD 21211.

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FOREWORD

Managing Contaminated Sediment in the United States

Issue Background

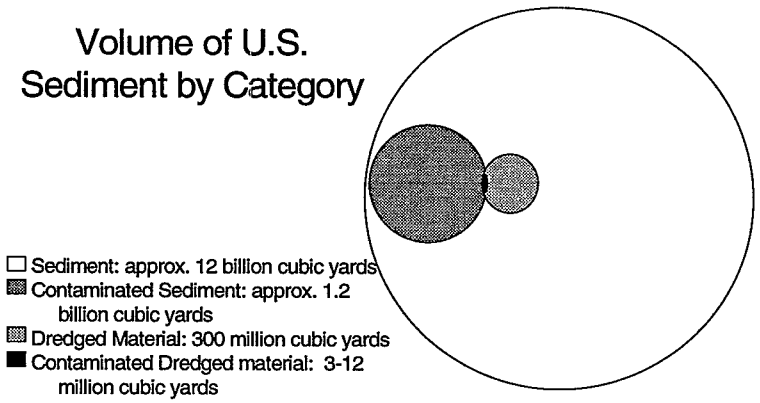
Many pollutants released to the environment settle and accumulate in the silt and mud called sediment on the bottoms of rivers, lakes, estuaries, and oceans. Much of the contaminated sediment in the U.S. was polluted years ago by such chemicals as DDT, PCBs, and mercury, which have since been banned or restricted. These contaminants are now found less frequently in overlying surface water than in the past. However, they can persist for many years in the sediment, where they can cause adverse effects to aquatic organisms and to human health. Some other chemicals released to surface waters from industrial and municipal discharges, and polluted runoff from urban and agricultural areas, continue to accumulate to environmentally harmful levels in sediment.

Costs of Sediment Contamination

Ecological and human health impairment due to contaminated sediment imposes costs on society. Fish diseases causing tumors and fin rot and loss of species and communities that cannot tolerate sediment contamination can severely damage aquatic ecosystems. Contaminants in sediment can also poison the food chain. Fish and shellfish can become unsafe for human or wildlife consumption. Potential costs to society include lost recreational enjoyment and revenues or, worse, possible long-term adverse health effects such as cancer or children's neurological and IQ impairment if fish consumption warnings are not issued and heeded. The health and ecological risks posed by contaminated sediment dredged from harbors can lead to increased cost of disposal and lost opportunities for beneficial uses, such as habitat restoration.

Volume of Contaminated Sediments

The U.S. Environmental Protection Agency estimates that approximately 10 percent of the sediment underlying our nation's surface water is sufficiently contaminated with toxic pollutants to pose potential risks to fish and to humans and wildlife who eat fish. This represents about 1.2 billion cubic yards of contaminated sediment out of the approximately 12 billion cubic yards of total surface sediments (upper five centimeters) where many bottom dwelling organisms live, and where the primary exchange processes between the sediment and overlying surface water occur. Approximately 300 million cubic yards of sediments are dredged from harbors and shipping channels annually to maintain commerce, and about 3-12 million cubic yards of those are sufficiently contaminated to require special handling and disposal. These amounts are graphically illustrated in the diagram below.



Where is contaminated sediment a potential concern?

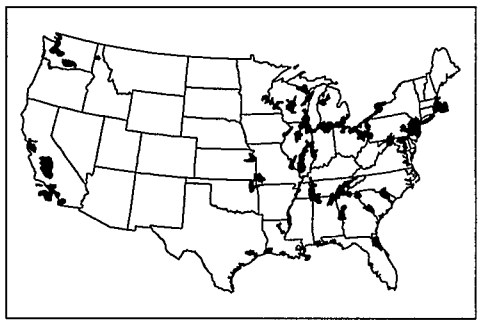
EPA has studied data from 1,372 of the 2,111 watersheds in the continental U.S. Of these, EPA has identified 96 watersheds that contain "areas of probable concern" where potential adverse effects of sediment contamination are more likely to be found. These areas, identified in the figure below, are on the Atlantic, Gulf, Great Lakes, and Pacific coasts, as well as in inland waterways, in regions affected by urban and agricultural runoff, municipal and industrial waste discharges, and other pollution sources. Some of these areas have been studied extensively, and now have appropriate management actions in place. However, others may require further evaluation to confirm that environmental effects are occurring.

EPA's Contaminated Sediment Goals

EPA's Contaminated Sediment Management Strategy establishes four goals to manage the problem of contaminated sediment, and describes actions the Agency intends to take to accomplish those goals. The four goals are:

1. **Prevent the volume of contaminated sediment from increasing.** To accomplish this, EPA will employ its pollution prevention and source control programs. Both the pesticides and toxic substances programs will use new and existing chemical registration programs to reduce the potential for release of sediment contaminants to surface waters. The water program will work with States and Tribes to identify waterbodies with contaminated sediment as impaired and target them for Total Maximum Daily Load evaluations. EPA will also work with the States and Tribes to enhance the implementation of point and nonpoint source controls in these watersheds.

2. **Reduce the volume of existing contaminated sediment.** EPA will consider a range of risk management alternatives to reduce the volume and effects of existing contaminated sediment, including in-situ containment and contaminated sediment removal. In some cases, risk managers may select a combination of practicable alternatives as the remedy. Where natural attenuation is part of the selected alternative, EPA will accelerate pollution prevention and source control efforts, where appropriate, to ensure that clean sediments will bury contaminated ones within an acceptable recovery period. During the recovery period, EPA will work with the States to improve human health protection by establishing and maintaining appropriate fish consumption advisories. In all cases, environmental monitoring will be conducted to ensure that risk management goals are achieved.



3. **Ensure that sediment dredging and dredged material disposal are managed in an environmentally sound manner.** EPA carefully evaluates the potential environmental effects of proposed dredged material disposal. In addition, EPA is initiating a national stakeholder review process to help the Agency review the ocean disposal testing requirements and ensure that any future revisions reflect both sound policy and sound science. EPA and the Army Corps of Engineers also will provide appropriate guidance to further encourage and promote beneficial uses of dredged material.

4. **Develop scientifically sound sediment management tools for use in pollution prevention, source control, remediation, and dredged material management.** Such tools include national inventories of sediment quality and environmental releases of contaminants, numerical assessment guidelines to evaluate contaminant concentrations, and standardized bioassay tests to evaluate the bioaccumulation and toxicity potential of specific sediment samples.

Working with States and Tribes through existing statutory authorities, EPA can identify impaired waterbodies and watersheds at risk from contaminated sediment, implement appropriate actions to accomplish the goals described above, and monitor the effectiveness of actions taken to accomplish the Agency's goals.

EXECUTIVE SUMMARY

EPA's Contaminated Sediment Management Strategy - Reinventing Government to Streamline Decision-Making

Contaminated sediment poses ecological and human health risks in many watersheds throughout the United States. In these watersheds, sediment serves as a contaminant reservoir from which fish and bottom-dwelling organisms can accumulate toxic compounds and pass them up the food chain. Sediment contaminants can be passed to fish, birds, and mammals until they accumulate to levels that may be toxic. Such toxic effects may include neurological, developmental, and reproductive impacts. Toxic chemicals come from discharges from industrial waste and sewage; storm water runoff from waste dumps, city streets, and farms; air pollutants contained in rainwater; contaminants in ground water; discharges to surface water; and from natural sources. The magnitude of the sediment contamination problem in the United States is evidenced in more than 2,100 State advisories that have been issued against consuming fish. Sediments were identified as a potential source of contamination at many of the sites where consumption of fish may pose health risks. EPA has studied sediment quality data from 1,372 of the 2,111 watersheds in the continental United States. Of these, EPA has identified 96 watersheds that contain "areas of probable concern" where potential adverse effects of sediment contamination are more likely to be found.

More than ten Federal statutes provide authority to many EPA program offices to address the problem of contaminated sediment. This has resulted in fragmented, and in some cases

duplicative, efforts to complete the necessary research, technology development, and pollution control activities required to effectively manage contaminated sediment. Often it has been difficult for EPA programs to agree even upon the fundamental question of whether sediment at a particular site poses ecological or human health risks. EPA's Contaminated Sediment Management Strategy was developed to streamline decision-making within and among the Agency's program offices by promoting and ensuring the use of consistent sediment assessment practices, consistent consideration of risks posed by contaminated sediment, the use of consistent approaches to management of contaminated sediment risks, and the wise use of scarce resources for research and technology development.

Goals of the Contaminated Sediment Management Strategy

EPA's Contaminated Sediment Management Strategy describes actions that the Agency intends to take to accomplish the following four strategic goals: 1) prevent the volume of contaminated sediment from increasing; 2) reduce the volume of existing contaminated sediment; 3) ensure that sediment dredging and dredged material disposal are managed in an environmentally sound manner; and 4) develop scientifically sound sediment management tools for use in pollution prevention, source control, remediation, and dredged material management.

What the Strategy Does

The Contaminated Sediment Management Strategy is comprised of six component sections: assessment, prevention, remediation, dredged material management, research, and outreach. In each section, EPA describes actions that the Agency intends to take to accomplish the four broad strategic goals.

In the assessment section of the Strategy, EPA proposes that Agency program offices use standard sediment toxicity test methods and chemical-specific sediment quality criteria to determine whether sediments are contaminated. Actions that EPA has taken to develop a biennial

national inventory of sites and sources of sediment contamination (the National Sediment Quality Survey and National Sediment Inventory Database) are described in the assessment section of the Strategy. EPA plans to use the National Sediment Inventory Database (NSI) to identify sites that may be associated with adverse effects to human health and the environment. These assessment actions should enable EPA to focus on cleaning up the most contaminated waterbodies and ensuring that further sediment contamination is prevented. The National Sediment Quality Survey is a screening-level assessment of sediment quality data and sources of pollution that will be used by various EPA programs.

EPA's plan to stop sediment contaminants from reaching the environment is described in the prevention section of the Strategy. In order to regulate the use of pesticides and toxic substances that accumulate in sediment, EPA proposes the use of acute sediment toxicity tests to support registration of chemicals under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the evaluation of chemicals under the Toxic Substances Control Act (TSCA). In the prevention section of the Strategy, EPA also proposes considering sediment contamination as a factor in determining which industries should be subject to new and revised effluent guidelines, using pollution prevention policies to reduce or eliminate sediment contamination resulting from noncompliance with permits, developing guidelines for design of new chemicals to reduce bioavailability and partitioning of toxic chemicals to sediment, and implementing point and nonpoint source controls to protect sediment quality. EPA's prevention actions would minimize further contamination of sediment and reduce ecological and human health risks.

In the remediation section of the Strategy, EPA proposes using multiple statutes to require contaminated sediment remediation by parties responsible for pollution. These statutes include the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), the Clean Water Act (CWA), TSCA, the Rivers and Harbors Act, and the Oil Pollution Act. The Agency will consider whether a combination of pollution prevention and source controls will allow contaminated sediments to recover naturally without unacceptable impacts to human health and the environment. On a site-specific basis, cleanup programs intend to consider natural attenuation as a remedy. EPA's remediation actions would clean up existing sediment contamination that adversely affects the Nation's waterbodies.

In the dredged material management section, EPA describes its commitment to continue to work with the United States Army Corps of Engineers (COE) to ensure that dredged materials are managed in an environmentally sound manner. Physical, chemical, and biological test methods will continue to be used to guide disposal and management decisions.

In the research section of the Strategy, EPA proposes a program of investigative research that is needed to develop and validate chemical-specific sediment criteria and other sediment assessment methods, improve EPA's understanding of the transfer of sediment contaminants through the food chain, and develop and evaluate a range of technologies for remediating contaminated sediments. EPA's proposed research program would support improved assessment, prevention, and remediation of contaminated sediment.

The outreach section of the Strategy describes actions that EPA intends to take to demonstrate, through public involvement, the Agency's commitment to, and accountability for, sediment management efforts. EPA plans to produce, and make available to the public, status reports on sediment management activities as part of the biennial updates of the National Sediment Quality Survey Reports.

Next Steps Toward Implementation of EPA's Contaminated Sediment Management Strategy

EPA intends to begin tracking activities of the Agency's program offices as they implement the Contaminated Sediment Management Strategy. Future updates of Agency-wide contaminated sediment activities will be included in the biennial National Sediment Quality Survey Report to Congress.

EPA's NSI is a screening-level assessment of sediment quality and sources of pollution that can be used in various programs. This database can be used by Federal, State, and local agencies to target their pollution prevention and remediation efforts on the sites where sediment may be contaminated.

EPA's Contaminated Sediment Management Strategy will promote EPA and COE research to develop technologies for remediation of contaminated sediment under authority of the CWA, CERCLA, RCRA, TSCA, the Rivers and Harbors Act, the Oil Pollution Act, and the Water Resources Development Act (WRDA).

Guidance provided in future updates of the Strategy will facilitate the coordination of dredged material management activities among Federal agencies and nongovernmental organizations. Coordination of dredged material management activities has been called for in the December 1994 action plan, "The Dredging Process in the United States: An Action Plan for Improvement," developed by the Federal Interagency Working Group on the Dredging Process (U.S. DOT, 1994). The working group was convened by the Secretary of Transportation in the fall of 1993. The group has held a series of outreach sessions throughout the country to solicit ideas on improving the dredging process. The working group identified important activities needed to improve the dredging process. These activities include enhanced research and monitoring to improve dredged material disposal decision-making, identification of opportunities to control sources of sediment contaminants, and effective education and communication with the public on

the risks and impacts associated with dredged material disposal. Future updates of the Contaminated Sediment Management Strategy will address these issues.

Listing of Actions Identified in EPA's Contaminated Sediment Management Strategy

EPA's Contaminated Sediment Management Strategy proposes that Agency program offices take the following actions.

Assessment

All EPA program offices intend to use standard sediment testing methods to determine whether sediments are contaminated. The Office of Water (OW) intends to use standard sediment toxicity and bioaccumulation test methods for monitoring, interpretation of narrative water quality standards, and dredged material disposal testing. The Office of Pesticide Programs (OPP) and the Office of Pollution Prevention and Toxics (OPPT) intend to use standard sediment toxicity tests to assess the toxicity of pesticides and chemicals when registering or re-registering these chemicals for use and for evaluating new and existing chemicals under TSCA. The Office of Emergency and Remedial Response (OERR) intends to use standard sediment toxicity and bioaccumulation test methods for Superfund Remedial Investigation/Feasibility Studies. The Office of Solid Waste (OSW) intends to use biological sediment toxicity test methods for site-specific risk assessments and monitoring at hazardous waste facilities.

Where appropriate, EPA program offices intend to use sediment quality criteria, when they are published, to assess contaminated sediment sites. All EPA programs conducting sediment monitoring intend to use the criteria to interpret sediment chemistry data. Upon publication, the criteria may be used along with appropriate test endpoints from chronic sediment bioassays to interpret the narrative State water quality standard of "no toxics in toxic amounts." National Pollutant Discharge Elimination System (NPDES) permit limits would be based on applicable water quality standards, which may include the State's narrative standard. EPA intends to use

sediment criteria (as appropriate) with other information to make site-specific decisions concerning corrective action at hazardous waste facilities and to assess Superfund sites. The Agency has begun to develop a more detailed *User's Guide for Multi-Program Implementation of Sediment Quality Criteria in Aquatic Ecosystems,* describing how the Agency's programs intend to use these criteria. This document will be submitted for public review after it is drafted.

EPA program offices intend to use the NSI as a screening-level assessment tool of sediment quality and sources of pollution. The NSI can be used by the various EPA program offices to identify sites for further assessment. The inventory can be used to identify potentially contaminated sediment sites for consideration for remedial action, identify for further assessment sites that may be candidates for injunctive relief or supplemental enforcement projects, identify problem pesticides and toxic substances that may require further regulation or be evaluated for possible enforcement action, identify impaired waters for National Water Quality Inventory reports or possible development of Total Maximum Daily Loads (TMDLs), target watersheds for nonpoint source best management practices, and help select industries for effluent guidelines development.

Prevention

In order to regulate the use of pesticides that may accumulate to toxic levels in sediment, EPA intends to propose that acute sediment toxicity tests be included in procedures required to support registration, re-registration, and special review of pesticides likely to sorb to sediment. In fiscal year 1996, EPA proposed incorporating acute toxicity bioassays and spiking protocols into the Agency's pesticide assessment guidelines (40 Code of Federal Regulations [CFR] Part 158). To prevent other toxic substances from accumulating in sediment, EPA intends to propose incorporating acute sediment toxicity tests and sediment bioaccumulation tests into routine chemical review processes required under TSCA. In addition, EPA intends to develop guidelines for design of new chemicals to reduce bioavailability and partitioning of toxic chemicals to sediment.

EPA's Office of Enforcement and Compliance Assurance (OECA) plans to take action to prevent sediment contamination by negotiating, in appropriate cases of noncompliance with permits, enforceable settlement agreements to require source recycling and source reduction activities. The Office of Regulatory Enforcement within OECA also intends to monitor the progress of Federal facilities toward the goal of halving toxic emissions by the year 1999 and plans to monitor the reporting of toxic releases to the public.

OW and other EPA program offices intend to work with nongovernmental organizations and the States to prevent point and nonpoint source contaminants from accumulating in sediments. EPA intends to: 1) promulgate new and revised technology-based effluent guidelines for industries that discharge sediment contaminants; 2) encourage the States to use biological sediment test methods and sediment quality criteria to interpret the narrative standard of "no toxics in toxic amounts;" 3) encourage the States to develop TMDLs for impaired watersheds specifying point and nonpoint source load reductions necessary to protect sediment quality; 4) use the NSI to identify point sources of sediment contaminants for potential permit compliance tracking after further evaluation using program-specific criteria to confirm sediment quality problems; 5) ensure that discharges from CERCLA sites and RCRA facilities subject to NPDES permits comply with future NPDES permit requirements to protect sediment quality; and 6) use the NSI to identify watersheds where technical assistance and grants could effectively be used to reduce nonpoint source loads of sediment contaminants.

Remediation and Enforcement

OW, OERR, and OECA intend to use the NSI to help target sites for further study which may lead to enforcement action requiring contaminated sediment remediation. EPA plans to use standard sediment toxicity, bioaccumulation tests, and site-specific field-based methods to identify potential sites for remediation, to assist in determining clean-up goals for contaminated sites, and to monitor the effectiveness of remedial actions. RCRA Corrective Action sites are generally

determined by facilities seeking a RCRA permit, not by the program identifying contaminated areas, except in enforcement under 7003 orders.

Research

EPA's Office of Research and Development (ORD), through its Environmental Monitoring and Assessment Program (EMAP), will provide information on methods to gather chemical and biological data on sediment quality on a regional scale, and will continue to assist with data evaluation for the National Sediment Quality Survey. ORD also has a contaminated sediments research program that includes the development of new biological methods to assess the ecological effects of sediment contaminants, data and methods to support the development of chemical-specific sediment quality criteria, methods to conduct sediment toxicity identification evaluations, and methods to identify bioaccumulative chemicals in sediment. ORD intends to develop dredged material disposal fate and transport models, sediment wasteload allocation models, and technologies for remediation of contaminated sediment.

Outreach

EPA plans to undertake a program of outreach and technology transfer to educate target audiences about contaminated sediment risk management. Target audiences would include: other Federal agencies, State and local agencies, the regulated community, the scientific community, environmental advocacy groups, the news media, and the general public. EPA plans to provide technical and nontechnical information to these audiences by developing a range of outreach products. Future updates to the Strategy will be reported in biennial updates of the National Sediment Quality Survey Report to Congress.

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AEDG ..... Aquatic Effects Dialogue Group

ARCS ..... Assessment and Remediation of Contaminated Sediments

AVS ..... Acid Volatile Sulfides

AWPD ..... Assessment and Watershed Protection Division

BAT ..... Best Available Technology

BCT ..... Best Conventional Technology

BIOS ..... Bio-STORET; the portion of STORET containing biological data

BLM ..... United States Bureau of Land Management

BMP ..... Best Management Practice

CAA ..... Clean Air Act (1970)[1]

CCMP ..... Comprehensive Conservation and Management Plan

CDF ..... Confined Disposal Facility

CERCLA ..... Comprehensive Environmental Response, Compensation, and Liability Act (1980)[1]

CFR ..... Code of Federal Regulations

COE ..... United States Army Corps of Engineers

CWA ..... Clean Water Act (1977)[1]

CZARA ..... Coastal Zone Act Reauthorization Amendments of 1990

CZMA ..... Coastal Zone Management Act (1972)[1]

DAIS ..... Dredged Analysis Information System

[1]Date of original enactment

DMATS ..... Dredged Material Tracking System

DOD ..... United States Department of Defense

DOE ..... United States Department of Energy

DOI ..... United States Department of the Interior

DOJ ..... United States Department of Justice

DOT ..... United States Department of Transportation

DWE ..... Division of Water Enforcement

EAB ..... Exposure Assessment Branch

EBR ..... Exposure Based Review

EMAP ..... Environmental Monitoring and Assessment Program

EPA ..... United States Environmental Protection Agency

EqP ..... Equilibrium Partitioning

ERL ..... Effects Range-Low Value

FIFRA ..... Federal Insecticide, Fungicide, and Rodenticide Act (1972)[1]

GLCPA ..... Great Lakes Critical Programs Act

GLNPO ..... Great Lakes National Program Office

GLWQA ..... Great Lakes Water Quality Agreement

HRS ..... Hazard Ranking System

HWIR ..... Hazardous Waste Identification Rule

IRIS ..... Integrated Risk Information System

ITFM ..... Intergovernmental Task Force on Monitoring Water Quality

IWI ..... Index of Watershed Indicators

[1]Date of original enactment

LA ..... Load Allocation of the TMDL

LD_{50} ..... Concentration of contaminant (lethal dose) which will result in mortality of 50 percent of exposed organisms

MMS ..... United States Minerals Management Service

MOU ..... Memorandum of Understanding

MPRSA ..... Marine Protection, Research, and Sanctuaries Act (1972)[1]

NAWQA ..... National Water Quality Assessment

NCAPS ..... National Corrective Action Prioritization System

NEP ..... National Estuary Program

NEPA ..... National Environmental Policy Act (1969)[1]

NOAA ..... National Oceanic and Atmospheric Administration

NPDES ..... National Pollutant Discharge Elimination System

NPL ..... National Priorities List

NRC ..... National Research Council

NRCS ..... Natural Resource Conservation Service

NS&T ..... National Status and Trends

NSQS ..... National Sediment Quality Survey

OCPD ..... Oceans and Coastal Protection Division

ODES ..... Ocean Data Evaluation System

OECA ..... Office of Enforcement and Compliance Assurance

OERR ..... Office of Emergency and Remedial Response

OFA ..... Office of Federal Activities

[1]Date of original enactment

OPP ..... Office of Pesticide Programs

OPPE ..... Office of Policy, Planning and Evaluation

OPPT ..... Office of Pollution Prevention and Toxics

OPPTS ..... Office of Prevention, Pesticides, and Toxic Substances

ORD ..... Office of Research and Development

OSRE ..... Office of Site Remediation Enforcement

OST ..... Office of Science and Technology

OSW ..... Office of Solid Waste

OW ..... Office of Water

OWM ..... Office of Wastewater Management

OWOW ..... Office of Wetlands, Oceans, and Watersheds

PAHs ..... Polycyclic Aromatic Hydrocarbons

PCBs ..... Polychlorinated Biphenyls

ppm ..... parts per million

POTW ..... Publicly Owned Treatment Works

PRP ..... Potentially Responsible Party

QA/QC ..... Quality Assurance/Quality Control

RAGS ..... Risk Assessment Guidance for Superfund

RCRA ..... Resource Conservation and Recovery Act (1976)[1]

REMAP ..... Regional Environmental Monitoring and Assessment Program

RFA ..... RCRA Facility Assessment

RFI ..... RCRA Facility Investigation

[1]Date of original enactment

ROD ..... Record of Decision

SAB ..... Science Advisory Board

SARA ..... Superfund Amendments and Reauthorization Act of 1986

SITE ..... Superfund Innovative Technology Evaluation

STORET ..... EPA Office of Water's Storage and Retrieval System

TCLP ..... Toxicity Characteristic Leaching Procedure

TIE ..... Toxicity Identification Evaluation

TMDL ..... Total Maximum Daily Load

TOC ..... Total Organic Carbon

TSCA ..... Toxic Substances Control Act (1976)[1]

TVA ..... Tennessee Valley Authority

USCG ..... United States Coast Guard

USDA ..... United States Department of Agriculture

USFDA ..... United States Food and Drug Administration

USFS ..... United States Forest Service

USFWS ..... United States Fish and Wildlife Service

USGS ..... United States Geological Survey

WLA ..... Wasteload Allocation of the TMDL

WRDA ..... Water Resources Development Act of 1992

[1]Date of original enactment

1. INTRODUCTION

1.1 PURPOSE OF THE STRATEGY

The purpose of the Environmental Protection Agency's (EPA's) Contaminated Sediment Management Strategy is to summarize EPA's understanding of the extent and severity of sediment contamination, including uncertainties about the dimension of the problem; to describe the cross-program policy framework in which EPA intends to promote consideration and reduction of ecological and human health risks posed by sediment contamination; and to describe actions EPA believes are needed to bring about consideration and reduction of risks posed by contaminated sediments.

Chapter Highlights

- Strategy Purpose
- Contaminated Sediments Defined
- The Problem of Contaminated Sediments
- Strategy Goals and Principles

This Strategy is an Agency workplan which is being issued in support of EPA's regulatory and policy initiatives, and is Agency guidance only. This document does not establish or affect legal rights or obligations. It does not establish any binding norms and is not finally determinative of the issues addressed. Instead, it describes how the Agency intends to exercise its discretion under various statutory authorities in the future. Agency decisions in any particular case would be made by applying the law and regulations on the basis of the specific facts.

1.2 DEFINITION OF CONTAMINATED SEDIMENTS

Contaminated sediments are soils, sand, organic matter, or minerals that accumulate on the bottom of a water body and contain toxic or hazardous materials that may adversely affect human health or the environment. They may wash from land, be deposited from the air, erode from aquatic banks or beds, or form from underwater breakdown or buildup of minerals (U.S. EPA, 1993a). Consistent with WRDA, EPA defines contaminated sediments as aquatic sediments that contain chemical substances in excess of appropriate geochemical, toxicological, or sediment quality criteria or measures, or are otherwise considered to pose a threat to human health or the environment.

1.3 BACKGROUND

1.3.1 Statement of the Problem

The contamination of sediments in waterbodies of the United States has emerged in recent years as an ecological and human health issue of concern. EPA and others estimate that approximately 10 percent of the sediment underlying our nation's surface water is sufficiently

contaminated with toxic pollutants to pose potential risks to fish and to humans and wildlife who eat fish. This represents about 1.2 billion cubic yards of contaminated sediment out of the approximately 12 billion cubic yards of total surface sediments (upper five centimeters) where many bottom-dwelling organisms live, and where exchange processes between the sediment and overlying surface water occur.

Approximately 10 percent of the sediment underlying the nation's surface water is sufficiently contaminated to pose potential risks to fish and to humans and wildlife who eat fish.

Contaminated sediments can have an impact on aquatic life by making areas uninhabitable for benthic organisms, and they can affect fish and wildlife by contributing to the bioaccumulation and biomagnification of contaminants in the food chain (Pfitezenmeyer, 1975; Reinharz, 1981). Documented adverse ecological effects from contaminated sediments include fin rot, increased tumor frequency, and reproductive toxicity in fish as well as decreased biodiversity in aquatic ecosystems. Contaminated sediments can also pose a threat to human health when pollutants in sediments bioaccumulate in edible aquatic organisms (Puget Sound Estuary Program, 1988; Baumann, 1987). There are numerous examples of cases where fish consumption advisories or bans have been issued for pollutants such as polychlorinated biphenyls (PCBs), mercury, dioxins, and kepone because of the transfer of the pollutants into the food chain (U.S. EPA, 1997e).

While sediment contamination has been recognized as a serious problem for some time, limited success has been demonstrated in managing the problem. One reason is the general lack of national guidelines for determining what levels of various pollutants in sediments cause adverse ecological and human health effects. To date, problems have been defined primarily on the basis of observed effects on aquatic life in the field, such as the presence of pollution-tolerant species or diseased fish or the absence of certain benthic organisms. In some instances EPA Regional or State guidelines, including sediment standards and regionally appropriate bioassays, have also been used effectively for problem definition. To date, nine States have developed sediment quality guidelines which are used to identify the extent and severity of contamination (Washington, Florida, California, New York, New Jersey, South Carolina, Texas, Massachusetts, and Wisconsin).

The expense associated with the remediation of contaminated sediments also contributes to the extent of the problem. Not only are specialized dredging techniques and disposal sites sometimes needed, but the sediments often must be dewatered or otherwise treated before disposal can occur. Other complicating factors are the high concentrations of contaminants that sometimes underlie surface sediments, and the difficulty in identifying a responsible party to pay for the clean-up, particularly when old sediments or multiple sources are involved. Frequently, sediment contamination is the result of historical discharges of pollutants before the NPDES regulatory program was established.

1.3.2 Extent and Severity of the Problem

In surveys conducted in 1985 and 1987 (U.S. EPA, 1985 and 1988a), OW first began to document the extent and severity of sediment contamination. The surveys found that heavy metals and metalloids (e.g., arsenic), PCBs, pesticides, and polycyclic aromatic hydrocarbons are the most frequently reported contaminants in sediments. There may be great variability in the types and levels of contaminants in sediments from region to region or harbor to harbor; this variability poses unique risks and management challenges.

More recently, in Section 503 of WRDA, Congress requested that EPA, in consultation with the National Oceanic and Atmospheric Administration (NOAA) and the Secretary of the Army, conduct a comprehensive national survey of data regarding sediment quality in the United States and report the information to Congress. To further define the extent of contamination, EPA, under the authority of Section 503 of WRDA, developed the first biennial national inventory of contaminated sediment sites for submission to Congress in 1997. To comply with the WRDA mandate, EPA's Office of Science and Technology (OST) initiated the biennial National Sediment Quality Survey Report to Congress, a compilation of existing sediment quality data (the NSI),

protocols used to evaluate the data, and various reports and analyses produced to present the findings, conclusions, and recommendations for action.

In 1997, EPA completed the Report to Congress, *The Incidence and Severity of Sediment Contamination in Surface Waters of the United States* in four volumes. This is the first EPA analysis of sediment chemistry and related biological data to determine the national incidence and severity of sediment contamination. *Volume 1: National Sediment Quality Survey* is a screening analysis which estimates the probability of associated adverse human or ecological effects based on a weight-of-evidence evaluation. *Volume 2: Data Summary for Areas of Probable Concern (APCs)* provides sampling station location maps and chemical and biological summary data for APC watersheds. *Volume 3: Sediment Contaminant Point Source Inventory* is a screening analysis which identifies probable point source contributors of sediment pollutants. *Volume 4: Sediment Contaminant Nonpoint Source Inventory* (in preparation for subsequent biennial reports to Congress) will be a screening analysis to identify probable nonpoint source contributors of sediment pollutants.

The analysis of the NSI data indicates that potential sediment contamination exists in all regions and States of the country. The waterbodies affected include streams, lakes, harbors, near shore areas, and oceans. A number of specific areas in the United States had large numbers of sampling stations associated with a higher probability of adverse effects. Puget Sound, Boston Harbor, the Detroit River, San Diego Bay, and portions of the Tennessee River were among those locations. Several United States harbors (e.g., Boston Harbor, Puget Sound, Los Angeles, Chicago, and Detroit) appear to have some of the most severely contaminated sediments in the country. These harbors have been affected throughout the years by large volumes of boat traffic, contaminant loadings from upstream sources, and many local point and nonpoint sources.

The results of the NSI are consistent with the findings of the other national assessments of sediment contamination. For example, in EPA's 1992 *National Water Quality Inventory Report,* 27 States identified 770 known contaminated sediment sites (U.S. EPA, 1994e). The NSI evaluation identified approximately 2,400 river reaches in 50 States where adverse effects from sediment contamination are probable.

In 1994, NOAA released its *Inventory of Chemical Concentrations in Coastal and Estuarine Sediments* (NOAA, 1994). This study characterized 2,800 coastal sites as either "high" or "hot," based on the contaminant concentrations found at the sampling locations. NOAA did not use risk-based screening values for its analysis. Using the National Status and Trends Mussel

Watch data set, "high" values were defined as the mean concentration for a specific chemical plus one standard deviation.

NOAA's "high" values corresponded to about the 85th percentile of contaminant concentration. "Hot" concentrations were defined as those exceeding five times the "high" values. Most of the "hot" sites were in locations with high ship traffic, industrial activity, and relatively poor flushing such as harbors, canals, and intracoastal waterways (NOAA, 1994). Mercury and cadmium exceeded the NOAA "hot" thresholds at a greater percentage of sites where they were measured (about 7 percent each) than other sediment contaminants.

In many studies, ecological impacts were often reported at contaminated sediment sites, including impairment of reproductive capacity and impacts to the structure and health of benthic and other aquatic communities (VanVeld et al., 1990; U.S. EPA, 1993c; Kubiak et al., 1989). Potential human health impacts were noted at a number of sites where fish consumption advisories or bans were issued (U.S. EPA, 1996). In 1989, a study by the National Academy of Sciences, entitled *Contaminated Marine Sediments - Assessment and Remediation* (National Academy of Sciences, 1989), also identified the potential for far-reaching health and ecological effects from contaminated sediments.

Many potential sources of contaminants to sediments are identified in the reports cited above. These sources include municipal sewage treatment plants, combined sewer overflows (CSOs), storm water discharges from municipal and industrial facilities, direct industrial discharges of process waste, runoff and leachate from hazardous and solid waste sites, agricultural runoff, runoff from mining operations, runoff from industrial manufacturing and storage sites, atmospheric deposition of contaminants, and contaminated groundwater discharges to surface water.

Much of the sediment data used in the EPA studies were collected prior to regular analysis for such parameters as grain size, total organic carbon, or acid volatile sulfides. Such data are needed to determine bioavailability of sediment contaminants. Rarely is such information available for historical sediment data. EPA believes that better data on sediment quality, as well as direct measurements of chemical concentrations in edible fish tissue, are needed. Large quantities of both published and unpublished data on sediment quality have not been placed in accessible or usable form, and many locations in the country have not been adequately sampled. Several recent national and regional sediment monitoring programs, including EMAP and NOAA's National Status and Trends (NS&T) Program, are currently collecting data on physical and chemical

characteristics of sediments, parameters describing bioavailability of contaminants, contaminant residues in aquatic organism tissues, and biological community structures.

It is evident from the best data currently available that sediments in many waterbodies across the country are contaminated to levels that harm benthic and aquatic communities and that may contribute to increased cancer and noncancer diseases for consumers of contaminated fish and shellfish. EPA and others estimate that approximately 10 percent of the sediment underlying our nation's surface water is sufficiently contaminated with toxic pollutants to pose potential risks to fish and to humans and wildlife who eat fish.

1.4 GOALS AND PRINCIPLES OF THE STRATEGY

The goals of EPA's Contaminated Sediment Management Strategy are: 1) to prevent further contamination of sediments that may cause unacceptable ecological or human health risks; 2) when practical, to clean up existing sediment contamination that adversely affects the Nation's waterbodies or their uses, or that causes other significant effects on human health or the environment; 3) to ensure that sediment dredging and the disposal of dredged material continue to be managed in an environmentally sound manner; and 4) to develop and consistently apply methodologies for analyzing contaminated sediments.

The Strategy is designed around the following principles:

1. EPA programs with authority to address sediment contamination operate under the mandate of many statutory provisions. Therefore, regulatory decisions must be based on requirements that are not always consistent among EPA programs. EPA programs should respond to the risks of sediment contamination as consistently as possible, taking into account statutory requirements and the need for national or regional programs to address other problems that pose similar or higher risks. EPA continuously stresses its long-term commitment to pollution prevention and improving the environment.

2. In assessing and managing contaminated sediments, EPA intends to continue to improve coordination of research and regulatory activities among other Federal agencies, State agencies, international organizations, and private parties.

3. EPA intends to continue to develop and improve methods for identifying contaminated sediments. These methods include numerical sediment quality criteria and improved biological testing methods. EPA intends to recommend that the States use these numerical chemical criteria, which are guidance, along with appropriate test endpoints for chronic sediment bioassays (toxicity and bioaccumulation tests) in interpreting their narrative criteria, e.g., of "no toxics in toxic amounts," in the event a State adopts sediment quality criteria as part of its water quality standards program.

4. Assessment of sediment contamination and any subsequent steps taken by the Agency to reduce risks should be based on sound science and, when available, site-specific information. Where scientific information is unavailable, the Agency will utilize conservative scientific assumptions.

5. To better assess the extent and severity of sediment contamination, the Agency plans to continue to conduct a national inventory of sediment quality and improve its monitoring of sediment contamination. The Agency plans to identify a list of chemicals of concern based on their toxicity, persistence, and propensity to bind to sediment particles, and identify sources of these chemicals.

6. To ensure that data gathered by EPA programs are comparable, EPA intends to develop standard sampling, analytical, and statistical methods, including the application of numerical sediment quality criteria, to assess sediment contamination and its effects.

7. Where sediment quality is sufficient to support, or could support, the full designated uses of a waterbody, the Agency intends to use appropriate means to ensure that existing pollution prevention measures and source controls would maintain, or achieve, the appropriate level of sediment quality.

8. Where sediments are contaminated, the Agency intends to implement pollution prevention measures and source controls to limit/control further contamination.

9. Subject to any limitations in the authorizing statute or regulations, EPA intends to undertake remediation of contaminated sediment sites first to limit serious risks to human health and the environment, and then to restore sites to a degree sufficient to

support existing and designated uses of the waterbody, including potential or designated uses of the sediment whenever such restorations are practicable, attainable, and/or cost effective. Potential uses of the sediment are a subset of the designated uses of the waterbody determined by each State and discussed in EPA's water quality standards program guidance. Designated uses are those uses specified in a State's Water Quality Standards program for each waterbody or segment of waterbody. Other potential uses may include beneficial uses such as beach nourishment.

10. Before implementing a clean-up of a contaminated sediment site, EPA will carefully evaluate the short-term and long-term impacts of such a clean-up in relation to the reduction of risks to human health and the environment and other benefits. If impacts of the remedial alternative are determined to cause more environmental harm than leaving the contaminants in place, EPA may not proceed with a cleanup at that time. EPA will evaluate a "no action" decision as new information or technologies become available.

11. Selection of the appropriate remedial option at a contaminated sediment site will be undertaken on a case-by-case basis after careful consideration of the risks posed by the contaminants to human health and the environment, the benefits of remediation, the short-and long-term effects of implementing the remedial option, the implementability of the remedial option, and the costs of remediation. Where short-term and long-term risks and effects are determined to be acceptable, and where statutes or international agreements do not require remediation or establish other preferences (e.g., preference for treatment under the Superfund Amendments and Reauthorization Act of 1986 [SARA]), the appropriate treatment of a contaminated sediment site may be to implement pollution prevention measures and source controls and to allow natural processes such as biodegradation, chemical degradation, and the deposition of clean sediments to diminish risks associated with the site to within acceptable levels. In cases where natural resources have not been restored through other actions, natural resource trustee agencies may still seek claims for damages to natural resources.

12. At sites where pollution prevention, source control, and natural processes will not reduce risks and adverse effects in an acceptable time frame, EPA intends to assign highest priority to remediating contaminated sediment: 1) that is contributing to the

most severe effects and substantial risks to aquatic life, wildlife, and human health; 2) where continued delay would result in the spread of contaminants into other areas that were previously unaffected; and/or 3) where remediation is cost effective.

13. The cost of sediment remediation cannot be borne solely or substantially by Federal, State, and local governments. Appropriate statutory authority will be used to encourage voluntary clean-ups or to compel responsible parties to clean up sediments contaminated by their activities and/or to seek restitution for damages of natural resources.

14. EPA will continue to work with the COE to ensure that dredged materials are managed in an environmentally sound manner. Physical, chemical, and biological test methods will continue to be used to guide disposal and management decisions. After final sediment quality criteria have been published by EPA, and the Agency has issued guidance describing how criteria values and uncertainties would be interpreted, EPA intends to use the criteria, along with biological test methods, to guide disposal and management decisions. Interpretation of results to meet program-specific goals will be maintained, and management alternatives will remain consistent with the requirements of the applicable statutes.

2. WHY EPA NEEDS AN AGENCY-WIDE STRATEGY FOR MANAGING CONTAMINATED SEDIMENTS

EPA needs an Agency-wide strategy for managing contaminated sediments in order to promote and ensure consistent consideration of risks posed by contaminated sediments.

2.1 CROSS-PROGRAM COORDINATION

EPA has the authority under numerous statutes to address contaminated sediments. These statutes include the National Environmental Policy Act; the Clean Air Act; the Coastal Zone Management Act (CZMA); FIFRA; the Marine Protection, Research, and Sanctuaries Act (MPRSA); RCRA; TSCA; CWA; CERCLA; and the Great Lakes Critical Programs Act of 1990. A complete summary of EPA authorities for addressing sediment contamination is provided in *Contaminated Sediments - Relevant Statutes and EPA Program Activities* (U.S. EPA, 1990a).

Chapter Highlights

- Coordination of Agency Programs
- Congressional Interest in Contaminated Sediments

Many EPA offices implement these statutory authorities or coordinate implementation in specific geographic areas, such as through the Chesapeake Bay Program, the Great Lakes National Program, the Gulf of Mexico Program, the Washington State Sediment Management Standards Program, and the States of Washington, Florida, California, New York, New Jersey, South Carolina, Texas, Massachusetts, and Wisconsin. Depending on statute and program structure, EPA's Regional offices and the States may also exercise wide latitude in their determination of sediment quality and impacts.

EPA has the authority under numerous statutes to address contaminated sediments.

Implementation of these programs by different EPA program offices under a wide range of statutory authorities has created inconsistencies in procedures for assessing the relative risks posed by contaminated sediments and has increased the potential for duplication in the areas of research, technology development, and field activities. EPA must strive to coordinate activities among the Agency's program offices to promote and ensure consistent sediment assessment practices, consistent consideration of risks

posed by contaminated sediments, consistent decision-making in managing these risks, and wise use of scarce resources for research, technology development, and field activities.

2.2 CLIENT DEMAND

In March 1990, a formal request, in the form of proposed legislation, was made to EPA Administrator William Reilly to create a national program to address contaminated sediments. The request was made by the National Contaminated Sediments Working Group, a coalition of 13 environmental advocacy groups, and was endorsed by 235 Federal, State, and local public interest groups, including labor unions, health organizations, and fishing, sporting, citizen, and environmental groups. Several EPA Regional offices and States have also identified as a high priority the need for technical guidance on assessing sediment quality.

2.3 CONGRESSIONAL INTEREST

Congressional interest in issues related to contaminated sediments has been expressed repeatedly over the past 5 to 10 years. In Section 118(c)(3) of the 1987 CWA amendments, EPA's Great Lakes National Program Office (GLNPO) was authorized to coordinate and conduct a 5-year study and demonstration project relating to the control and removal of toxic pollutants in the Great Lakes, with emphasis on the removal of toxic pollutants from bottom sediments. To fulfill the requirements of the Act, GLNPO initiated the Assessment and Remediation of Contaminated Sediments (ARCS) program. The Great Lakes Critical Programs Act (GLCPA) of 1990 extended the ARCS Program by one year and specified completion dates for interim activities.

Since 1990, EPA has presented testimony concerning contaminated sediments at dozens of Congressional hearings before the House Committee on Merchant Marine and Fisheries, the House Committee on Public Works and Transportation, and the Senate Committee on Governmental Affairs. Members of Congress have also expressed interest in addressing sediment contamination in CWA reauthorization.

More recent legislation addressing contaminated sediments is the Water Resources Development Act of 1992. Section 503 of WRDA requires the EPA Administrator, in consultation with the Administrator of NOAA and the Secretary of the Army, to conduct a comprehensive national survey of data regarding sediment quality in the United States. EPA is required to compile all existing information on the quantity, chemical and physical composition, and geographic location of pollutants in sediments, including the probable sources of such pollutants. In 1997,

EPA completed the first Report to Congress (with plans for biennial updates) on the findings of the survey (also mandated under WRDA).

WRDA Section 503 further requires that EPA conduct, in consultation with NOAA and the COE, a comprehensive and continuing program to assess sediment quality which shall at a minimum: 1) identify the location of pollutants in sediments; 2) identify the extent of pollutants in sediments determined to be contaminated; 3) establish methods and protocols for monitoring the effects of contaminated sediments and the pollutants therein; 4) develop a system for the management, storage, and dissemination of data concerning sediment quality; 5) provide an assessment of sediment quality trends over time; 6) identify locations where pollutants in sediments may pose a threat to the quality of drinking water supplies, fisheries resources, and marine habitats; and 7) establish a clearinghouse for information on technology, methods, and practices available for the remediation, decontamination, and control of sediment contamination. The results are to be reported to Congress biennially, starting four years from the date of enactment. WRDA also requires recommendations on actions. Updates on EPA programs' accomplishments in sediment management will be included in updates to the NSI.

Reduction of contaminated sediments is a goal of the Agency; this will be reported on in the process of updating the NSI. Contaminated sediment data will also be included as one of the conditions used to evaluate watershed quality in the Index of Watershed Indicators (IWI). The IWI is the first national effort to organize nationally available aquatic resource information and present it at the watershed level. The Index is built on 15 different water resource indicators using information from a variety of public and private partners. Drawing on these indicators, the Index provides a description of the condition and vulnerability of each of the 2,111 watersheds in the continental United States. EPA will include Alaska and Hawaii later.

3. COORDINATION OF STRATEGY IMPLEMENTATION

3.1 INTERAGENCY COORDINATION

Interagency coordination is paramount to successful implementation of the Contaminated Sediment Management Strategy. There are numerous recent examples of successful coordination among agencies, including: 1) the Intergovernmental Task Force on Monitoring Water Quality which is composed of members from EPA, United States Geological Survey (USGS), eight other Federal agencies, and ten State agencies and whose mission is to more effectively collect and present water quality data by formulating national monitoring protocols, quality assurance/quality control (QA/QC) procedures, and data collection and sharing systems; 2) the Federal Interagency Sedimentation Project, which includes representatives from the USGS, the COE, the United States Bureau of Land Management (BLM), the United States Forest Service (USFS), the Tennessee Valley Authority (TVA), and the United States Department of Agriculture (USDA), and whose mission is to study physical properties of sediments to determine both the degree to which sediments trap contaminants and the time frame for biodegradation, chemical degradation, or burial of contaminants; 3) the National Water Quality Assessment Program formed by members of the USGS, USDA, EPA, and the United States Fish and Wildlife Service (USFWS) to measure baseline conditions at 60 sites nationwide and monitor conditions over time to define trends; and 4) the U.S. Department of Energy (DOE) Environmental Restoration Program, through which DOE has entered into agreements with several States and EPA to coordinate implementation of remedial actions at DOE facilities.

Chapter Highlights

- Coordination of Federal Agencies
- Agency Coordination within EPA
- States' Role in Managing Contaminated Sediments

There are also a number of ongoing staff-level activities which have been successfully coordinated. As an example, the State of Florida and NOAA have collaborated on a survey of sediment and biological conditions along Florida's shoreline at over 700 sites (MacDonald, 1993).

3.2 AGENCY COORDINATION

OST has coordinated development of the Contaminated Sediment Management Strategy

Coordination among EPA program offices and with other agencies is important for successful implementation of the Strategy.

and will continue to coordinate implementation of the Strategy with the relevant program and Regional offices. Oversight for coordination of Strategy implementation will be provided by the Agency-wide Sediment Steering Committee.

3.3 STATES' ROLE

States will play a central role in Strategy implementation. States may, for example, promulgate sediment quality standards that are protective of sediment quality. Insofar as possible, the Strategy will be consistent with Regional and State policies and will not impede State and local management and prevention measures. Strategy implementation will include State training and information dissemination as described in Section 11, Outreach Strategy.

4. POLICY FRAMEWORK FOR THE STRATEGY

4.1 BACKGROUND

In 1989, EPA Administrator Lee Thomas formed an Agency-wide Sediment Steering Committee to address the problem of contaminated sediments on a national scale. The committee, chaired by OW's Deputy Assistant Administrator, was composed of senior managers from all program offices with the authority to address contaminated sediments, and a representative from each of EPA's ten Regional offices. A Sediment Technical Committee composed of staff members from each program and EPA Regional office was also established in 1989. The Sediment Technical Committee provided technical input to the Sediment Steering Committee. The regular meetings of the Sediment Technical Committee provided an EPA forum for exchanging information on research, program, and field activities.

Chapter Highlights

- Strategy Background
- Public Forums and Comments on the Strategy

In January 1990, the Sediment Steering Committee decided to prepare an Agency-wide Contaminated Sediment Management Strategy to coordinate and focus the Agency's resources on contaminated sediment problems. Four workgroups were established to prepare option papers on how to improve the Agency's efforts to assess, prevent, remediate, and manage the disposal of contaminated sediments. The option papers were distributed to other Federal agencies including the COE, USGS, the United States Food and Drug Administration (USFDA), NOAA, the USFWS, U.S. Minerals Management Service (MMS), U.S. Department of Justice, U.S. Coast Guard (USCG), U.S. Navy, U.S. Army, and representatives of 11 State governments with active contaminated sediment management programs. The views of these Federal and State officials were presented to the Sediment Steering Committee in May 1991, when preliminary options were selected to form the basis of a draft Contaminated Sediment Management Strategy.

Four workgroups have worked to develop the Strategy.

In September 1991, EPA's Deputy Administrator, Hank Habicht, was briefed on the options selected for developing the Strategy. He suggested that EPA distribute the document in outline form as a proposal for discussion to solicit public comments. EPA distributed over 2,000 copies of the draft outline to Federal, State, and local environmental and public health agencies; industry and industry coalition groups;

national, State, and local environmental advocacy groups; law firms; consulting firms; academia; and other interested parties. To further the outreach effort, OW's Risk Assessment and Management Branch, at the Deputy Administrator's request, sponsored a series of three public forums to solicit feedback on the draft outline. In August 1994, EPA distributed the proposed Contaminated Sediment Management Strategy for public comment. More than 2,000 copies of the document were distributed, and comments were received from 126 organizations.

4.2 FORUMS

The three public forums were designed to include participants representing all parties responsible for addressing contaminated sediments at the Federal, State, and local levels. The first forum, "The Extent and Severity of Contaminated Sediments," was held April 21 and 22, 1992, in Chicago, IL (U.S. EPA, 1992a). The forum consisted of panel discussions on three topics of concern: 1) the extent of sediment contamination; 2) the severity of contamination with respect to human health effects; and 3) the severity of contamination with respect to ecological effects. Forum participants concluded that contaminated sediments are a national problem, and that both human health effects and ecological effects have been documented at a number of sites.

The second forum, "Building Alliances Among Federal, State, and Local Agencies to Address the National Problem of Contaminated Sediments," was held May 27 and 28, 1992, in Washington, DC (U.S. EPA, 1992a). The forum was conducted in three parts corresponding to the assessment, prevention, and remediation elements of the draft Strategy. Forum participants concluded that: 1) EPA should expedite development and implementation of the Strategy; 2) development of a national inventory of contaminated sediment sites was a high priority; 3) all represented agencies would provide data for the national inventory; 4) more attention should be devoted to nonpoint sources of contaminants in the Strategy; 5) the addition of sediment toxicity and bioaccumulation tests to requirements for chemical registration under FIFRA and TSCA was a high priority to prevent point and nonpoint source contamination of sediments; and 6) consideration should be given to developing an integrated Federal agency strategy for managing contaminated sediments.

The third forum, "Outreach and Public Awareness," was held June 16, 1992, in Washington, DC (U.S. EPA, 1992a). The forum provided recommendations for effective public outreach from four perspectives: 1) State government, 2) the regulated community, 3) environmental advocacy groups, and 4) a public awareness group. Forum participants agreed that EPA should engage in active dialogue with the public and be responsive to public concerns.

The document, *Proceedings of the EPA's Contaminated Sediment Management Strategy Forums* (U.S. EPA, 1992a), published in September 1992, includes summaries of all presentations and discussions held at the three forums as well as appendices containing the draft outline of the Contaminated Sediment Management Strategy; a plan entitled "Proposed Outreach Activities to Support Implementation of EPA's Contaminated Sediment Management Strategy;" agendas from the three forums; and addresses of forum participants and speakers. Over 1,000 copies of the document have been distributed.

4.3 WRITTEN COMMENTS

In the March 1992 transmittal letter releasing the draft Contaminated Sediment Management Strategy outline and announcing the three forums, EPA solicited written comments on the Strategy to be submitted by July 15, 1992. The Agency actually received comments until August 31, 1992. Comments were submitted by 11 Federal agencies, 17 State agencies, 4 municipal agencies, 13 business, trade, and industry organizations, 2 environmental consulting companies, 1 environmental coalition representing 12 organizations, 1 government coalition, and 1 law firm. The areas that received the most comments were implementation of sediment quality criteria, consistent minimum testing, and point versus nonpoint source control.

The proposed Contaminated Sediment Management Strategy was announced for public comment in the August 30, 1994, Federal Register. The comment period was extended from October 31, 1994, to November 30, 1994, as announced in the October 28, 1994 Federal Register.

In all, the Agency received comments from 126 organizations. The commenters included State, municipal, and Federal agencies; industry; environmental groups; public interest groups; and others. A response to public comments document can be obtained for review through EPA's Water Docket (202-260-3027) by requesting Contam Sediment Mgt Str, NOA, I-G 1.

5. STRATEGY FOR ASSESSING SEDIMENT CONTAMINATION

To implement effective pollution abatement and control programs for contaminants that are accumulating in sediments and to take appropriate remedial action at sites with identified sediment contamination, EPA has developed a strategy for assessing the extent and severity of sediment contamination. The assessment strategy outlines actions that EPA intends to take to generate and interpret the environmental data needed to: 1) consistently assess the ecological and human health risks of sediment contaminants and take appropriate regulatory action under the Agency's existing statutory authorities; and 2) identify sites where contaminated sediment remediation is needed, and rank those sites according to the extent and severity of contamination as well as associated ecological and human health risks.

Chapter Highlights

- Consistent Sediment Testing Methods
- Sediment Quality Criteria
- EPA's National Sediment Quality Survey
- EPA's National Sediment Contaminant Point Source Inventory
- Sediment Monitoring and Assessment Programs

5.1 CONSISTENT SEDIMENT TESTING METHODS

5.1.1 Establishment of an Agency-wide Sediment Tiered Testing Committee

EPA established an Agency-wide Sediment Tiered Testing Committee, chaired by OST, to select chemical and biological sediment test methods to be standardized and used by all Agency program offices. These methods will also include guidance on statistical analysis of test results. The Sediment Tiered Testing Committee will also develop a tiered testing framework; this framework will identify within each tier a complete set of tests to determine either that the sediment is not contaminated or that additional tests are necessary to make such a determination. The EPA Science Advisory Board (SAB) will review the tiered testing framework, and test methods will be proposed by the Sediment Tiered Testing Committee to be standardized for Agency-wide use within the testing framework.

EPA intends to continue to develop and improve methods for identifying contaminated sediments.

Tiered testing refers to a structured, hierarchical procedure for determining data needs relative to decision-making that involves a series of tiers, or levels, of investigative intensity. Typically, increasing tiers in a tiered testing framework involve increased information and decreased uncertainty. This approach is intended to ensure the maintenance and protection of environmental quality as well as the optimal use of resources.

Each EPA program office intends to develop guidance for interpreting the tests conducted within the tiered framework. Although the standard sediment test methods are intended for use by all program offices, each office may not always need to perform all of the tests included in a particular tier.

5.1.2 Agency-wide Use of Consistent Test Methods

All EPA program offices have committed to using consistent chemical criteria and biological test methods to determine whether sediments are contaminated. The Agency intends to develop and use standard test methods to provide high-quality data in support of regulatory and enforcement actions for pollution prevention, contaminated sediment remediation, and the management of dredged material disposal. Test methods will be available to address a variety of situations ranging from screening to relatively definitive tests of the effects of contaminated sediments on biological organisms. Test methods will be tiered in order to promote efficient use of resources and screening of sites. OST and the ORD laboratory in Duluth, MN are developing a field manual that will cover sediment sampling, handling, spiking, and manipulation.

5.1.3 Selection of Sediment Toxicity Tests for Agency-wide Use Within the Tiered Testing Framework

Assessment of sediment contamination and any subsequent steps taken by the Agency to reduce risks should be based on sound science and, when available, site-specific information.

The following solid phase acute sediment toxicity tests and bioaccumulation tests have been selected by the Sediment Tiered Testing Committee for Agency-wide use within the tiered testing framework. EPA has published these test methods as standard methods for adoption and use by all Agency program offices in conducting contaminated sediment assessments (U.S. EPA, 1994b; U.S. EPA, 1994c):

1. Ten-day freshwater acute toxicity tests using Hyalella azteca (amphipod or scud) and Chironomus tentans (midge).

2. Twenty-eight day freshwater bioaccumulation tests using Lumbriculus variegatus (freshwater oligochaete worm). (Although some data are available, it would be useful to collect additional data to field validate the bioaccumulation protocol for the marine organisms.)

3. Ten-day marine and estuarine acute toxicity tests using the amphipods Ampelisca abdita, Rhepoxynius abronius, Hyalella azteca, Eohaustorius estuarius, and Leptocheirus plumulosus.

4. Twenty-eight day marine bioaccumulation tests using Macoma nasuta (clam) and Neries spp. (polychaete worm).

These test species and methods were selected for standardization on the basis of consensus reached at an Agency-wide workshop on tiered testing issues for freshwater and marine sediments held September 16 to 18, 1992 (U.S. EPA, 1992b). Test method protocols for Agency-wide use, including QA/QC requirements, were published for these species in fiscal year 1994. EPA has also published *QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations* (U.S. EPA, 1995a). Protocols for sediment spiking, collection, handling, and manipulation are expected to be published in fiscal year 1998. The final protocols will be reviewed by the Agency's Environmental Monitoring Management Council before publication by ORD as EPA manuals. All OW programs intend to use the sediment test protocols immediately. The Office of Prevention, Pesticides, and Toxic Substances (OPPTS) can develop test rules using these methods, and OPP has proposed incorporating these tests into the Agency's test guidelines for pesticide registration and re-registration. OSW intends to distribute these test methods to Regional and State program offices for use in site-specific risk assessments involving contaminated sediments. EPA's Regional laboratories, which perform much of the testing for the Superfund program, already use these methods. As additional test methods are developed, they will be considered by the Tiered Testing Committee for Agency-wide use.

Since 1994, EPA has been developing standard chronic sediment toxicity test protocols and toxicity identification evaluation methods for sediment assessment. Standard methods for two species of freshwater organisms and one marine species will be available by the end of fiscal year 1998.

5.1.4 Supplemental Specific Assessment Methods

In addition to the consistent set of standard sediment assessment methods included in the Tiered Testing Framework, each EPA program office may select and use supplemental program specific assessment methods. Some programs intend to develop their own guidance describing specific regulatory actions to be taken on the basis of results derived from the consistent set of standard tests, and any supplemental methods used in tiered testing. Where culturing and testing methods for indigenous species (other than those recommended for use by EPA) have been developed, data comparing the sensitivity of the substitute species and one or more of the recommended species will be required using sediments or reference toxicants to ensure that the species tested are at least as sensitive and appropriate as the EPA-recommended species.

5.2 SEDIMENT QUALITY CRITERIA

Pursuant to Sections 304(a)(1) and 118(c)(7)(C) of the CWA, EPA is developing sediment quality criteria for the protection of benthic organisms. These criteria are designed to be applied where total organic carbon (TOC) equals or exceeds 0.2 percent of the sediment dry weight, the primary route of exposure is direct contact with the sediment, and the sediments are continually submerged or there is information indicating that equilibrium has been established between water and sediments. Documents presenting proposed criteria for five chemicals have been made available for public review. The documents present proposed sediment quality criteria for the nonionic organic compounds acenaphthene, dieldrin, endrin, fluoranthene, and phenanthrene. EPA will publish the documents for dieldrin and endrin in final form after considering public comments. The proposed criteria for acenaphthene, fluoranthene, and phenanthrene will not go final. Instead, EPA will be proposing a total polycyclic aromatic hydrocarbon (PAH) sediment criterion in the future. EPA intends to develop sediment quality criteria for additional nonionic organic compounds using a methodology called the Equilibrium Partitioning Approach (EqP). EPA selected this method after considering a variety of approaches that could be used to assess sediment contamination. The SAB conducted a technical review of the criteria and supporting science (U.S. EPA, 1992c). In fiscal year 1995, EPA also presented to SAB a methodology for developing

To ensure that data gathered by EPA programs are comparable, EPA intends to develop standard sampling, analytical, and statistical methods, including the application of numerical sediment quality criteria, to assess sediment contamination and its effects.

sediment quality criteria for metals. EPA will prepare sediment quality criteria for metals once the SAB review comments on the methodology have been addressed. EPA intends to periodically review and amend all sediment quality and bioassay criteria to reflect new scientific insights regarding sediment quality and effects.

The SAB has concluded that sediment quality criteria can be used to support regulatory decisions when the uncertainty associated with the EqP methodology is addressed. The SAB subcommittee reviewing the sediment criteria recommended that "these criteria not be used as a stand-alone, pass-fail value for all applications" (U.S. EPA, 1992c). Therefore, the Agency expects that remediation programs will not use the criteria as mandatory clean-up levels, but rather as a means to identify potential contamination problems and to provide focus and continuity to remediation efforts. However, States may adopt the sediment quality criteria as State water quality standards or criteria. In the event this occurs, the Superfund program may be required to use them as cleanup standards in order to comply with the State's applicable or relevant and appropriate requirements (ARARs). EPA does not intend to promulgate national sediment quality criteria as water quality standards in a National Toxics Rule (NTR). Once EPA publishes sediment quality criteria and the accompanying user's guide, EPA intends to recommend that the States use these numerical chemical criteria, which are guidance, along with appropriate test endpoints for chronic sediment bioassays (toxicity and bioaccumulation tests) in interpreting their narrative criteria, e.g., of "no toxics in toxic amounts." Each State will determine how sediment quality criteria should be incorporated into its standards during the triennial water quality standards review process. EPA is also developing a guidance manual on sediment collection methods.

To clarify the role of sediment criteria in a regulatory context, OST and the program offices are developing a user's manual that fully describes how sediment criteria values and uncertainty will be interpreted within the context of each regulatory program. Generally, however, program offices intend to use the criteria as described below. In addition, EPA plans to request public comment on the sediment criteria user's guide and related technical basis document (TBD) as the volumes are completed. The TBD will contain technical information on the scientific basis for the criteria, references to sampling methods, documents, chemistry, limitations, uncertainty, and case studies. The user's guide will describe how sediment quality criteria will be applied within each program, including the Water Quality Standards, NPDES permitting, Superfund site assessment and remediation, RCRA site investigations, and dredge and disposal programs.

Great Lakes Program. The Great Lakes States and EPA Regions intend to use the sediment criteria to assist in the ranking of contaminated sediment sites needing further

assessment, to target hot spots within an area for remediation, and to serve as a partial basis for the development of State sediment quality standards. The Great Lakes program also intends to use the criteria to assist in the selection of methods for contaminated sediment remediation and the determination of whether a contaminated sediment site should be added or removed from its list of designated Areas of Concern.

EPA Monitoring Programs. All EPA programs conducting sediment monitoring activities intend to use sediment quality criteria to evaluate sediment contamination at sites. Acute and chronic toxicity bioassays and bioaccumulation tests will also be used to evaluate ecological and human health risks.

National Pollutant Discharge Elimination System. State and Federal permit writers currently have the authority to establish water quality-based effluent limits in NPDES permits for the protection of aquatic resources. NPDES permit limits are currently derived from State water quality standards, which in turn may be derived from EPA's water quality criteria. Once EPA publishes sediment quality criteria and the accompanying user's guide, EPA intends to recommend that the States use these numerical chemical criteria, which are guidance, along with appropriate test endpoints for chronic sediment bioassays (toxicity and bioaccumulation tests) in interpreting their narrative criteria, e.g., of "no toxics in toxic amounts." NPDES permit limits would continue to be based on applicable water quality standards, which may include the States' narrative criteria. OST, in coordination with the Office of Wastewater Management (OWM), is developing sediment-based modeling tools for use in calculating NPDES permit limits and TMDLs.

RCRA Corrective Action Program. The RCRA Corrective Action Program intends to use the sediment criteria as one of the factors to consider in making site-specific decisions about remediation at hazardous waste facilities. OSW has a proposed Corrective Action regulation which it uses as guidance in operating the program, and which lists action levels of contaminants that may be used to trigger further investigation. Currently, the Agency is considering whether or not to promulgate a final rule, and whether that rule will include action levels. At some facilities, technical feasibility and long- and short-term effectiveness of alternatives could result in clean-up levels that differ from the action levels. If the final corrective action regulations define specific action levels, sediment criteria will be one of the factors used in setting action levels for remediation projects.

Superfund (CERCLA) Program. The Superfund program intends to use sediment quality criteria as one of the factors to assess CERCLA sites that have contaminated sediments if there is

reason to suspect potentially significant contamination of sediments at the Remedial Investigation stage of analysis. The assessment is used to set clean-up targets for remediation pursued under the authority of CERCLA and SARA.

5.3 NATIONAL SEDIMENT QUALITY SURVEY

In accordance with the requirements of Title V of WRDA, OST has developed the first comprehensive national survey of data regarding sediment quality in the United States, hereafter referred to as the National Sediment Quality Survey (NSQS). OST has compiled all available information currently contained in national and regional computer databases on the quantity, chemical and physical composition, and geographic location of pollutants in sediment. This information will be maintained in a national database referred to as the National Sediment Inventory. OST completed the first biennial National Sediment Quality Survey Report to Congress on sediment quality in 1997. The NSI will be maintained and updated on a regular basis by OST so that it can be used to assess trends in both sediment quality and the effectiveness of existing regulatory programs at the Federal, State, and local levels. The design of the NSQS is described in *The Incidence and Severity of Sediment Contamination in Surface Waters of the United States. Volume 1: National Sediment Quality Survey,* (U.S. EPA, 1997b). The NSQS should not be confused with the CERCLA National Priorities List; sites appearing in the NSQS do not constitute regulatory determinations, whereas sites on the National Priorities List (NPL) do.

5.3.1 Purpose of the National Sediment Inventory

To better assess the extent and severity of sediment contamination, the Agency plans to continue to conduct a national inventory of sediment quality and improve its monitoring of sediment contamination.

EPA developed the NSI to: 1) obtain the best possible current assessment of the extent and severity of the problem of contaminated sediments nationwide, 2) distinguish those areas that may be contaminated and need further assessment from those that are not contaminated, and 3) identify areas that may be associated with adverse effects to human health and the environment. Once these areas are identified, Agency program offices plan to evaluate them for appropriate action. The NSI is a screening-level assessment of sediment quality that could be used in various programs with contaminant source information (see Section 5.4).

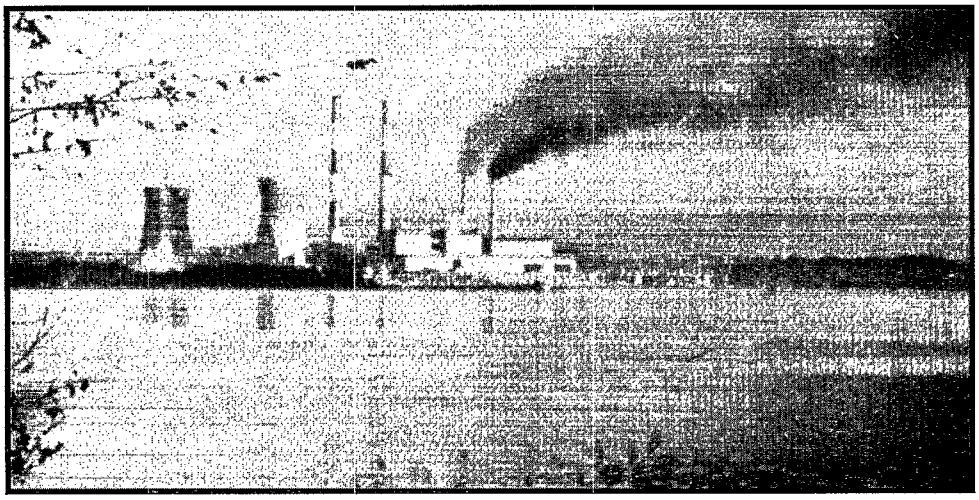
5.3.2 Scope of the National Sediment Inventory

The NSI developed by EPA contains detailed sediment quality, toxicity, and fish tissue data from both freshwater and marine ecosystems nationwide. The NSI was compiled and evaluated in two phases. During the first phase, EPA compiled and evaluated data from existing national and regional computer-readable databases. The inventory includes available data on contaminant concentrations in all types of sediments, including those from rivers, lakes, and estuaries, and from other geographic areas. During the second phase of inventory development, EPA actively solicited, compiled, and evaluated detailed State data describing contaminated sediment sites.

5.3.3 EPA Program Office Uses of the National Sediment Inventory

The following EPA program offices intend to use data contained in the NSI for the assessment, pollution prevention, and remediation activities identified below.

Office of Air and Radiation (OAR). Atmospheric deposition may be an important source of sediment contamination. OAR intends to use the NSI to evaluate the contribution of atmospheric deposition to sediment quality problems. The Clean Air Act (CAA) Amendments of



1990 include specific sections to increase protection of aquatic systems from the impacts of atmospheric deposition. Section 112(c)(6) required EPA to list, by 1995, source categories of seven specific pollutants, ensuring that sources accounting for not less than 90 percent of the aggregate emissions of air pollutants are subject to standards under Section 112(d)(2) or 112(d)(4).

The seven pollutants are alkylated lead compounds, polycyclic organic compounds, hexachlorobenzene, mercury, PCBs, 2,3,7,8-TCDD, and 2,3,7,8-TCDF. Emissions standards are to be promulgated for the listed categories by the year 2000, ensuring regulation of these sources of atmospheric contamination of waterbodies.

Section 112(m) requires EPA, in cooperation with NOAA, to conduct extensive monitoring and research to identify and assess the extent of atmospheric deposition of hazardous air pollutants for the Great Lakes, Chesapeake Bay, Lake Champlain, and coastal waters. A Report to Congress was required by November 1993 and biennially thereafter to include, for those waters, an assessment of the relative atmospheric contribution to total loadings, an assessment of the environmental and human health effects attributable to atmospheric deposition, and a description of any statutory or regulatory revisions necessary to ensure adequate protection. In addition, EPA is required to determine whether the other provisions of Section 112 are adequate to prevent serious adverse public health effects and serious or widespread environmental effects associated with atmospheric deposition of hazardous air pollutants to these waters. Based on this determination and the Report to Congress, EPA was to promulgate any additional regulations under Section 112(m) found to be necessary and appropriate.

In July 1997, EPA issued its second Report to Congress under the Great Waters Program, in which the Agency did not recommend any revisions to statutory or regulatory requirements to protect the environment from atmospheric deposition. In addition, EPA issued a notice containing its draft determinations that other provisions of Section 112 are adequate to prevent the enumerated effects associated with atmospheric deposition of hazardous air pollutants, and that no further emissions standards or control measures, beyond those otherwise authorized or required by Section 112, are necessary and appropriate to prevent such effects. Final determinations are to be issued by March 15, 1998, pursuant to a consent decree entered in the United States District Court for the District of Columbia in Sierra Club v. Browner, CIV No. 96-1680, on May 21, 1997.

Office of Emergency and Remedial Response. OERR intends to identify sites with contaminated sediments so that they can be added to the NSI, and to review high priority contamination sites identified in the inventory. These sites can become candidates for assessment under CERCLA. This assessment may include evaluation with the Hazard Ranking System, which is used to identify sites that may warrant long-term clean-up under the Superfund program.

Office of Enforcement and Compliance Assurance. OECA intends to use the NSI to identify areas and industries that may be evaluated for further inspection, development of

injunctive relief, and supplemental enforcement projects. The NSI can also be used to identify sites where known sources of sediment contamination may be linked with ecological and human health effects. Where appropriate, enforcement actions can be initiated to remediate severely contaminated sites. Available statutory authority for enforcement and remediation of contaminated sediments is described in detail in Section 8.

Office of Federal Activities (OFA). OFA, within OECA, intends to use the NSI, including contaminant source information (discussed in Section 5.4), and other available data on sediment contamination to identify potential issues to be addressed during environmental reviews conducted as part of the National Environmental Policy Act (NEPA) process. OFA intends to use the NSI to evaluate the status of sediment quality and potential environmental issues associated with current Federal projects, and to identify areas requiring programmatic, long-term, and/or multi-agency NEPA analysis.

Office of Pesticide Programs. OPP intends to use the NSI to identify currently registered pesticides that are present in high concentrations at sites nationwide. OPP plans to evaluate whether special review of these pesticides should be undertaken, whether sediment toxicity testing must be required to support registration of additional uses or formulations of these chemicals, and whether special labeling or use restrictions should be required.

Office of Pollution Prevention and Toxics. OPPT intends to use the NSI to identify existing chemicals regulated under TSCA that occur in areas of sediment contamination. OPPT will evaluate these chemicals for further testing. OPPT will also use the NSI to identify possible violations of TSCA regulations. OPPT will investigate the sources of contaminants occurring at inventory sites and determine whether enforcement actions should be initiated.

Office of Science and Technology. OST intends to use the NSI to identify chemicals of concern for sediment criteria development and to evaluate the effectiveness of technology-based effluent guidelines, water quality-based permit limits, and total maximum daily loads.

Office of Site Remediation Enforcement (OSRE). OSRE intends to use the NSI to identify sites where hazardous waste facilities may be contributing contaminants to sediment. The information in the inventory will be used to augment current approaches for identifying sites for investigation and possible remediation.

Office of Wastewater Management. OWM intends to use the NSI to assess the potential incidence and severity of sediment contamination caused by point source discharges and to identify the pollutants causing sediment toxicity. This analysis could contribute to the identification of watersheds where permitting and enforcement efforts to protect sediment quality can be focused. In some cases, site-specific data along with modeling may show that violations of water quality-based permit limits are causing an impact on the sediment or that there is a need to develop additional permit limits specifically for the purpose of protecting sediment quality.

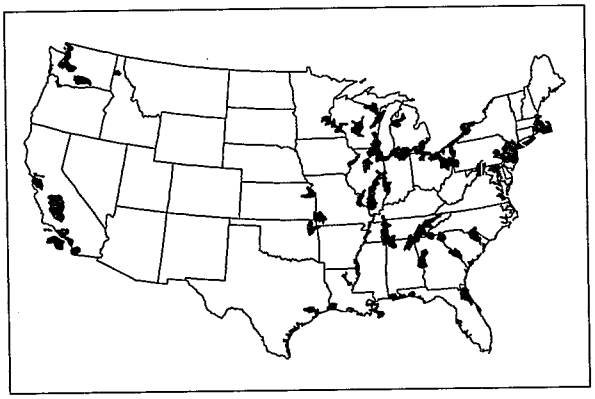
Office of Wetlands, Oceans, and Watersheds (OWOW). OWOW intends to use the NSI data to help support its programs in nonpoint source control and estuarine management. OWOW's Assessment and Watershed Protection Division (AWPD) intends to use the NSI to help identify impaired waters for the National Water Quality Inventory, 305(b) reports, and Index of Watershed Indicators. States may use the NSI to assist in developing a list of sites for development of TMDLs, and for evaluation of TMDL effectiveness. AWPD also intends to use the NSI to assist State nonpoint source control programs in updating their lists of waterbodies in need of nonpoint source (NPS) management practices, including control of sediment contaminants entering surface waters from nonpoint sources.

The Oceans and Coastal Protection Division (OCPD) intends to use the NSI in evaluating the incidence and severity of sediment contamination in the Nation's estuaries. If the NSI includes potentially contaminated sites located in estuaries that are part of the National Estuary Program (NEP), during review of the NEP deliverables, OCPD could recommend that NEP develop Comprehensive Conservation and Management Plans for those estuaries that include action plans for addressing contaminated sediment.

The NSI could be used to generate information on the impact of sediment contamination on wetlands functions as well.

5.3.4 Evaluation of Data Included in the National Sediment Inventory

EPA has developed a "weight-of-evidence" approach based on sediment chemistry and biological effects data for evaluating sites described in the inventory. The weight-of-evidence approach underwent peer review and was received favorably. OST plans to use this approach to identify sites in the inventory where contaminated sediment may be associated with probable adverse effects to human health or aquatic life. Depending on the availability of data for sites, the weight-of-evidence approach employs a combination of the following assessment methods to determine whether identified threshold chemical concentration levels or biological effects levels are exceeded at a site: sediment quality criteria or advisory levels using equilibrium partitioning, apparent effects threshold, effects ranges derived by Long and Morgan (1990), Threshold Effects Level or Probable Effects Level (MacDonald, 1993), whole sediment toxicity test data, fish tissue contaminant data, and a theoretical bioaccumulation potential model of accumulation from sediment. EPA has evaluated data in the NSI and reported the results of this evaluation in the first biennial Report to Congress entitled *The Incidence and Severity of Sediment Contamination in Surface Waters of the United States.*



Watersheds Identified in NSQS Where Potential Adverse Effects of Sediment Contamination are More Likely to be Found

5.4 NATIONAL SEDIMENT CONTAMINANT POINT SOURCE INVENTORY: ANALYSIS OF FACILITY RELEASE DATA

As part of the National Sediment Quality Survey, EPA has developed an inventory of sources of sediment contamination, hereafter referred to as the Source Inventory. The Source Inventory will be useful to: 1) identify sites where additional evaluation is necessary to determine whether sediment contamination may occur at levels adverse to human health and the environment, 2) identify industrial categories potentially contributing sediment contaminants to surface waters, and 3) select industries for the development of effluent guidelines on the basis of quantities of potentially toxic sediment contaminants discharged. The Source Inventory, used in

conjunction with other data used in the NSI and in some cases additional monitoring data, should assist in determining whether some sites are problematic due to past environmental abuses or as the result of ongoing contamination. EPA's National Sediment Quality Report to Congress, completed in 1997, includes information describing point source discharges of potential sediment contaminants (U.S. EPA, 1997d). Subsequent NSQS reports to Congress will also include an assessment of nonpoint sources. OST will update these reports every two years.

5.4.1 Approach to Developing the Source Inventory

EPA has undertaken the following tasks to develop the Source Inventory:

1. Searched databases containing the results of sediment monitoring studies to develop a list of contaminants found in sediment. EPA used the following databases to compile the initial list of sediment contaminants: 1) 1987 EPA Sediment Quality Study (Lyman et al., 1987); 2) EPA Region IV/VI Coastal Contaminated Sediment Site Inventory (U.S. EPA, 1992d; U.S. EPA, 1993b); 3) NOAA NS&T monitoring data; 4) Puget Sound Study data; 5) OW's Storage and Retrieval system (STORET) sediment observations; 6) Ocean Data Evaluation System (ODES) sediment observations; 7) EPA Region IX Dredged Material Tracking System (DMATS); 8) EPA Region X Dredged Analysis Information System (DAIS); and 9) SEDQUAL and FSEDQUAL databases of marine and freshwater chemistry, bioassays, and benthic data.

2. Identified databases containing information on the sources of the contaminants and amounts discharged. EPA used the following databases to compile the initial list of sources of sediment contaminants: 1) EPA Effluent Guidelines Industry Status Sheets database; 2) NPDES Permit Compliance System; and 3) Toxics Release Inventory. Future releases of the Source Inventory will also include an assessment of nonpoint sources of sediment contamination.

3. Identified those contaminants that can be linked to sources and that are likely to be found in sediments.

4. Determined loadings of identified sediment contaminants according to standard industrial classification codes (Office of Management and Budget, 1987).

5. Evaluated potential contaminants of concern using a fate/toxicity index. The index was calculated on the basis of: 1) contaminant propensity to bind to sediment; 2) contaminant persistence in the environment; 3) aquatic life toxicity assessed using published effects ranges, apparent effects thresholds, or aquatic life sediment criteria derived using the equilibrium partitioning method; and 4) human health toxicity (systemic toxicity and carcinogenicity) assessed using current Integrated Risk Information System (IRIS) reference doses and cancer potency slopes. Quantities of contaminants released will be normalized using the fate/toxicity index.

6. Identified point and nonpoint sources of the potential sediment contaminants (where data are available) and evaluated to determine chemicals, geographic areas, and industrial categories of concern based on the discharge of potential sediment contamination. EPA also identified watersheds potentially at risk from sediment contamination by calculating the sum of normalized quantities of contaminants released into each waterbody. (Normalization refers to the process of developing a load score for each contaminant reflecting its relative persistence in the environment and toxicity to aquatic organisms and humans.)

5.4.2 Uses of the Source Inventory

Monitoring. The methodology used to develop the Source Inventory is described in Section 5.4.1. EPA anticipates that the Source Inventory would indicate areas where sediment contamination may exist but where no ambient sediment quality data exist. The Source Inventory can be used to provide information to assist in identifying sites for sediment evaluation and/or monitoring. Knowledge of existing sources of sediment contamination can help distinguish between sites that have been contaminated by historical sources and sites that are currently being contaminated by active sources. This information is useful to States when identifying sources of impairment to rivers, lakes, and estuaries for their CWA Section 305(b) reports. This information can also assist EPA and the States in determining appropriate remediation activities. The presence of contaminated sediments at sites without current or historical sources nearby may indicate potential illegal dumping activities.

Pollution Prevention. OPPT intends to use the Source Inventory to identify potential reductions in sediment contaminant discharge that can be achieved through the voluntary 33/50 Program, which encourages industries to reduce the generation of toxic wastes.

Effluent Guidelines Development. Under Sections 301, 304, 306, and 307 of the CWA, OST promulgates technology-based national effluent limitations guidelines that control the discharge of toxic chemicals and other pollutants by categories of industrial dischargers. OST selects industries for promulgation of new and revised effluent limitations guidelines based on environmental factors and utility to States and publicly owned treatment works (POTWs). OST intends to include the Source Inventory among the environmental data sources it will use in the selection process. Accordingly, degradation of the sediment environment may be considered in the selection of industries for the development of new or revised effluent limitations guidelines. The effluent limitations guidelines process involves developing and evaluating treatment options reflecting the Best Available Technology Economically Achievable (BAT), Best Conventional Technology (BCT), New Source Performance Standards, and Pretreatment Standards for indirect dischargers. The Source Inventory can be used in technology option development and selection by providing information on chemicals causing the greatest risk to aquatic life and human health. In addition, the Source Inventory data can be used in the environmental assessment of regulatory options.

Total Maximum Daily Loads. Under Section 303(d) of the CWA and EPA's implementing regulations at 40 CFR 130.7, TMDLs are a tool to implement water quality standards, typically by allocating the receiving waters' pollutant loading capacity among point and nonpoint sources of the pollutants of concern. State and EPA authorities begin the TMDL process by selecting waterbodies which are water quality limited, targeting high-priority waterbodies for TMDL development, and assessing pollutant sources. The Source Inventory can provide EPA and States with a screening tool to identify contaminant sources and possibly distinguish between point source and nonpoint source loadings. Additionally, when sediment quality-based standards exist in a State's water quality standards program, the Source Inventory, in conjunction with other NSI data, could be used to identify waterbodies which may not attain these standards. State authorities could then select these waterbodies for further assessment and possible TMDL development. Sediment quality criteria and guidance can be used in TMDL studies to derive loading allocations for nonpoint sources that are protective of sediment quality. In some waterbodies, sediment contamination has been caused by contaminated sediment washing into the waterbody. EPA will encourage, but cannot require, States to modify or develop their own erosion and sediment control legislation to include consideration of toxics.

Permitting. Through the NPDES permitting program, administered by OWM, EPA and State regulatory authorities establish water quality-based pollutant concentration limits on the effluent of individual discharge facilities and monitor to ensure compliance with those limits. The

Source Inventory will be used, in conjunction with other NSI data, as a screening tool to identify current point and nonpoint sources of contaminants nearby or upstream from sediment with elevated pollutant levels. Permit-issuing authorities can then select watersheds and specific facilities for further assessment and possibly for development of water quality-based permit limits to protect the sediment. EPA Headquarters may also use the NSI data on sources and sites of potential sediment contaminants to identify facilities where procedures for developing water quality-based permit limits for sediment quality could be demonstrated, to identify pollutants contributing to sediment quality problems nationwide, and to evaluate whether current point source permit limits are sufficiently protective of human health and the environment.

Enforcement. OECA is currently planning a water quality initiative to identify sources contributing pollutants to waterbodies for which a State has issued water quality advisories against fish consumption or swimming because of excess loadings of pollutants. Frequently, the advisories are a result of sediment contamination. The Source Inventory can assist OECA by providing information on nearby or upstream dischargers of potential sediment contaminants. The Source Inventory could be used to develop the initial list of likely pollutant sources for a given watershed. Further, the Source Inventory can provide data on specific chemicals most likely to cause adverse environmental impacts. This could provide OECA with information necessary to identify the discharges or industrial activities that should be examined for their potential to contribute to the water quality advisory. This information in turn could support enforcement actions that would compel a facility to reduce its discharges.

Other Potential Uses. Additional program offices within OW may use the Source Inventory to support their activities. For example, OWOW identifies priority watersheds for nonpoint source control strategies and manages the NEP. OCPD, within OWOW, can target waterbodies where sediment is contaminated for management under its program. Knowledge of current sources of sediment contaminants could help both the States and EPA determine point source and nonpoint source pollutant contributions to waterbodies and to identify potentially significant contaminant sources. The Source Inventory could help OST identify chemicals that are potentially most toxic and are discharged in the greatest amounts, and thus guide the development of sediment quality criteria.

5.5 INCREASE IN SEDIMENT MONITORING IN WATER QUALITY MONITORING PROGRAMS

Section 503 of WRDA requires EPA to establish a comprehensive and continuing program to assess aquatic sediment quality. EPA will comply with this requirement by increasing sediment monitoring in the Agency's water quality monitoring programs. EPA intends to take the following actions to establish the Agency's sediment monitoring program:

1. The Regional Environmental Monitoring and Assessment Program (REMAP) intends to gather chemical and biological data describing sediment quality at EMAP sampling stations. Data collected under REMAP are being entered into the NSI. REMAP sampling is dependent on the availability of ORD resources.

2. OW intends to expand provisions for sediment monitoring in the national monitoring framework developed by the Intergovernmental Task Force on Monitoring Water Quality (ITFM). Through this framework, agreements should be reached with other Federal, State, and local agencies concerning incorporation of sediment monitoring protocols, sediment monitoring QA/QC procedures, and appropriate information system linkages into monitoring programs.

3. OW and the Office of Information Resources Management intend to ensure that the capability to store and use sediment data is enhanced as part of the ongoing modernization of the Agency's water quality data systems (STORET, Bio-STORET, and ODES). OW intends to work with the EPA Regions to ensure that Regional databases developed for the purpose of archiving and analyzing sediment information are compatible with the Agency's national databases.

4. EPA intends to allocate additional resources for the purpose of sediment monitoring if funds are appropriated for monitoring activities authorized under WRDA or CWA.

5. OW is developing an EPA field protocol manual on sampling, spiking, handling, and manipulation of sediment samples.

5.6 ASSESSMENT OF ATMOSPHERIC DEPOSITION OF SEDIMENT CONTAMINANTS

As described above in this Strategy document, under Section 112(m) of the CAA, EPA is undertaking a program to assess the effects of hazardous air pollutants on the Great Lakes, Lake Champlain, the Chesapeake Bay, and near-coastal waters. This program is referred to as the "Great Water Bodies Study." As part of this study, EPA will monitor the air deposition of toxics, monitor tissue levels of airborne toxics in aquatic organisms, and develop models of contaminant transport. An initial Report to Congress on this program was completed in May 1994. The second report, *Deposition of Air Pollutants to the Great Waters, Second Report to Congress* (EPA-453/R-97-011, June 1997), is available from NTIS. The NTIS document request number is PB-97189815. Subsequent reports to Congress on the Great Water Bodies Program are required every two years thereafter. The reports will address contribution of air pollutants to water pollution, sources of pollutants, and whether they contribute to violations of water quality standards. OST will incorporate these results into the Source and Site Inventories.

5.7 COORDINATION OF ASSESSMENT ACTIVITIES WITH OTHER FEDERAL AGENCIES

EPA will coordinate its sediment assessment activities with the USGS and other Federal and State agencies through the ITFM. EPA will also coordinate its sediment assessment activities with the USGS, COE, BLM, USFS, NOAA, TVA, USDA, and other agencies participating in the Federal Interagency Sedimentation Project.

In the future, the ITFM will be succeeded by the National Water Quality Monitoring Council, which will coordinate and provide guidance and technical support for the voluntary implementation of the Nationwide Water-Quality Monitoring Strategy. This Council will be composed of Federal, Regional, State, Tribal, and local agencies, and private volunteer organizations. To the extent possible, the Council will recommend use of comparable field and laboratory methods to obtain data that can be aggregated and synthesized over time and space.

6. STRATEGY FOR PREVENTING SEDIMENT CONTAMINATION

Implementation of an effective program to prevent sediment contamination from occurring is the most environmentally protective and, in most cases, cost-effective way to address the problem. EPA's current statutory and regulatory authority is adequate to prevent many sediment contaminants from being released to the environment. The strategy for preventing sediment contamination describes the actions that EPA program offices intend to take under a number of different statutes, including FIFRA, TSCA, RCRA, CAA, and CWA to prevent sediment contamination. As part of an outreach strategy (Section 11) for prevention, community-based entities will need to promote education about and prevention of contaminated sediment at the citizen level.

Chapter Highlights

- Office of Pesticide Programs Actions
- Office of Pollution Prevention and Toxics Actions
- Office of Enforcement and Compliance Assurance Actions

6.1 OFFICE OF PESTICIDE PROGRAMS ACTIONS

6.1.1 Control of Sediment Contaminants Regulated Under FIFRA

FIFRA gives EPA the authority to ban or restrict the use of pesticides that have the potential to contaminate sediments if the risk to nontarget organisms or the environment is judged to be unreasonable. In making decisions on pesticides, FIFRA requires EPA to consider economic, social, and environmental costs and benefits. Sediment toxicity is not currently addressed in routine test procedures and risk assessments for pesticide registration, re-registration, and special review.

FIFRA gives EPA authority to ban or restrict the use of pesticides that have the potential to contaminate sediments if the risk to nontarget organisms or the environment is judged to be unreasonable.

6.1.2 OPP Use of the National Sediment Quality Survey

OPP intends to use the National Sediment Quality Survey developed by OW to develop a list of pesticides that may pose risks or cause harmful effects on a national scale. OPP intends to evaluate these pesticides to determine whether appropriate regulatory action should be taken.

6.1.3 Memorandum of Agreement with USGS

There is currently a Memorandum of Agreement between OPP and the USGS's National Water Quality Assessment (NAWQA) Program. The NAWQA Program is integrating the results from monitoring most major river basins and aquifer systems with other programs. Information will be provided at the regional and national scales. At the start of this program, data collection is being focused on pesticides and nutrients in sediment. OPP has played an active part in the USGS NAWQA Program Federal Advisory Council, has had technical input, and is currently working on several joint USGS/OPP publications.

6.1.4 Pesticide Incident Reports

In addition to other information sources, OPP uses voluntary pesticide incident reports made by citizens, farmers, and pesticide registrants to obtain information on use, misuse, and problems associated with pesticides. OPP also requires information from registrants on unreasonable adverse effects of pesticides. EPA has recently promulgated a final rule concerning collection of these unreasonable adverse effect data (required under Section 6(a)(2) of FIFRA). OPP has set up a special process for cataloging, sorting, processing, and using both the voluntary reports and the required registrant unreasonable adverse effects reports in the regulatory program. OPP will continue to investigate information concerning sediment contamination in these incident reports on a case-by-case basis. If data or other information on pesticides in sediment and adverse ecological or human health effects warrant, then special review of the chemicals causing possible unreasonable adverse effects, or other appropriate regulatory action, may be undertaken by OPP.

6.1.5 Development of Technical Guidance Documents for Evaluation of Pesticide Risks

OPP intends to continue work to develop technical guidance documents on the evaluation of pesticide risks and evaluation of pesticides to determine their potential to run off into surface waters, leach into surface waters, or accumulate in sediment.

6.1.6 Aquatic Effects Dialogue Group Recommendations

In 1990, the Conservation Foundation's program on Environmental Dispute Resolution made recommendations on aquatic issues for the Agency's consideration. One topic of the discussions of the Aquatic Effects Dialogue Group (AEDG) was the evaluation of sediment toxicity. AEDG recommended that tests of sediment toxicity to aquatic organisms be considered for pesticides that are likely to sorb to sediment. The following scheme, proposed for EPA consideration, integrated sediment testing with FIFRA testing tiers (World Wildlife Fund, 1992):

Tier I:	Equilibrium partitioning calculations to estimate chemical concentrations in porewater and sediment.
Tier II:	Acute porewater and whole sediment toxicity tests with spiked sediment.
Tier III:	Chronic whole sediment toxicity tests with spiked sediment.
Tier IV:	Benthic community structure, colonization rate, laboratory toxicity tests with field collected sediment, and *in situ* sediment toxicity testing within a mesocosm.

Although sediment toxicity testing can be required as a special test, the data routinely required for pesticides do not address potential ecological and human health effects of sediment contamination. OPP therefore intends to develop a strategy to systematically evaluate the risk of sediment contamination posed by the registration and use of pesticides. OPP intends to propose the following actions as part of its strategy for evaluating the potential for pesticide contamination of sediments:

1. OPP intends to revise both the regulatory requirements for registration of pesticides at 40 CFR Part 158 and Subdivision E of the Pesticide Assessment Guidelines to incorporate the EPA standard acute whole sediment bioassay methods and spiking protocols developed by the Agency-wide Sediment Tiered Testing Committee. OPP has proposed revised sediment testing guidelines incorporating whole sediment toxicity tests, which are currently being reviewed by the Science Advisory Panel. OPP intends to develop Standard Evaluation Procedures for the sediment toxicity

tests and submit them for Science Advisory Panel review. OW will provide OPP with supporting information regarding sensitivity of species and appropriateness of life stages used.

2. When chronic sediment toxicity tests are developed by the Agency-wide Sediment Tiered Testing Committee, OPP intends to revise both 40 CFR Part 158 and Subdivision E of the Pesticide Assessment Guidelines to incorporate these methods and protocols. OPP intends to develop Standard Evaluation Procedures for these tests and submit them to the Science Advisory Panel for review.

3. OPP intends to routinely require aquatic fate tests to support many terrestrial uses of pesticides that persist or bioaccumulate.

4. OPP is evaluating the feasibility of integrating into the Pesticide Assessment Guidelines a new test requirement that combines protocols for two existing tests: the water column monitoring test ("Aquatic Field Dissipation Test"), and the aquatic life tissue monitoring study ("Accumulation in Aquatic Non-Target Organisms"). Regulatory requirements for routinely conducting this new test will be proposed.

5. OPP intends to develop better information for distribution to the public on crop management practices and Integrated Pest Management practices that will most effectively reduce the levels of toxic pesticide contaminants in sediment. OPP will work with OW's nonpoint source program to reduce the levels of toxic pesticides in sediment by providing information on best management practices and integrated pest management to farmers.

6. OPP intends to develop criteria for pesticide residues in sediments to be used as one of several screening tools for the determination of "Reduced Risks" (i.e., "Safer") pesticides. This would allow for expedited registration of chemicals that fit into the category and possibly displace use of pesticides that are more harmful to human and ecological health.

7. OPP intends to investigate the feasibility of using the OPPT screening method that uses parameters such as chemical properties, environmental fate, hazard, and exposure for identifying those chemicals that pose a greater risk.

6.2 OFFICE OF POLLUTION PREVENTION AND TOXICS ACTIONS

EPA has authority under TSCA to regulate new and existing chemicals that have the potential to contaminate sediments, if the resulting ecological or human health impacts are judged to pose unreasonable risks. OPPT is committed to a program that will incorporate into routine chemical review processes performed under Sections 4 and 5 of TSCA, assessment of environmental fate, and effects of toxic chemicals that could potentially contribute to sediment contamination. EPA believes that OPPT can contribute most significantly to the management of contaminated sediment through its pollution prevention efforts. OPPT therefore intends to take the following actions to prevent sediment contamination:

1. OPPT intends to incorporate the acute whole sediment toxicity test methods and sediment bioaccumulation test methods developed by the Tiered Testing Committee into the OPPTS test guidelines. When chronic whole sediment test methods are developed by the Tiered Testing Committee, OPPT will incorporate them into the OPPTS test guidelines as well.

2. OPPT intends to use the National Sediment Quality Survey and the Source Inventory to assist in selecting chemicals for review. OPPT intends to develop, and update on a regular basis, a list of sediment contaminants to be evaluated for review. This list will include all chemicals regulated under TSCA that have been identified as exceeding toxic threshold concentration levels at locations included in the National Sediment Quality Survey. As additional sites are included in the inventory, the list of chemicals for review will be updated. OPPT intends to use the Source Inventory database (compilations of the Toxics Release Inventory database, the Office of Water Effluent Guidelines database, and the Office of Water Permit Compliance System database) to evaluate the sources of contaminants on the list of chemicals for review.

3. Through the New Chemicals Program, OPPT can ban or otherwise regulate the production of chemicals that could contribute to sediment contamination and result in unreasonable risk to human health or the environment. OPPT can and has prevented pollution from occurring. OPPT intends to use the New Chemicals Program to engage the chemical industry in dialogues on the redesign of chemicals to reduce both bioavailability and partitioning of toxic chemicals to sediment.

OPPT intends to draft guidelines and implement a policy encouraging the design of new chemicals having the following characteristics: molecular weight greater than 1,000 grams per mole to prevent transport through biological membranes, large cross-sectional diameters to prevent movement through cell membranes, functional groups embedded within the molecule to enhance rapid transformation to low toxicity products, and log K_{ow} (octanol-water partition coefficient) values greater than 8 to prevent effects at saturation or less than 3.5 to avoid partitioning to sediment.

4. OPPT is working on an assessment of a cluster of chemicals that may be persistent bioaccumulators. Chemicals that are persistent bioaccumulators are also likely to accumulate in sediments. To the extent that this cluster, or elements thereof, appears to pose an unreasonable risk to human health or the environment, OPPT intends to engage industry in discussions to first attempt to mitigate this risk through voluntary pollution prevention measures. Should voluntary initiatives fail, OPPT can consider issuance of regulations to address these situations.

5. Under the New Chemicals Program, OPPT has developed an exposure-based review policy. In this program, environmental fate and effects tests (e.g., sediment toxicity tests) may be triggered if certain criteria are met in OPPT's initial review. Data gathered in this way will improve the OPPT risk evaluation and management processes. OPPT intends to revise this policy to include criteria triggering requirements for sediment toxicity testing.

6. Staff in OPPT's Exposure Assessment Branch (EAB) worked with EPA's Region 5 office to develop a testing strategy to assess the environmental risks associated with biocides used to prevent zebra mussels from fouling water pipes. While the final report of this project is not available, it has been determined that some biocides do not degrade well and therefore can persist in sediment. Region 5 plans to severely restrict the use of this group of chemical biocides. Some other chemicals used as surfactants or wetting agents in biocides have been identified as potential risk concerns. Region 5 intends to propose language for paper mill permits limiting the amount of these chemicals used. In addition, permittees may be required to submit plans for the use of different surfactants that will degrade in the environment.

7. OPPT is working with a number of industry trade associations to provide product toxicity testing information and guidance to their member companies. OPPT and other program offices are assisting members of the Ecological and Toxicological Association of the Dyestuffs Manufacturing Industry in developing a pollution prevention program to record pollution prevention achievements, further reduce waste generation, and continue to realize the benefits of pollution prevention in the dye industry. As part of this pollution prevention program, OPPT intends to specifically document the actions that the dye industry can take to reduce the generation of waste products that concentrate in sediment. The Site and Source Inventories may be used to produce an initial list of toxic waste products that may be present in sediment.

8. In evaluating new chemicals, OPPT intends to use the Site and Source Inventories to assist in identifying geographical areas where additional chemical discharges may lead to unacceptable levels of sediment contamination.

6.3 OFFICE OF ENFORCEMENT AND COMPLIANCE ASSURANCE ACTIONS

OECA has issued two policies related to the use of pollution prevention conditions in EPA enforcement settlements. These two policies are: 1) the Policy on the Use of Supplemental Enforcement Projects in EPA Settlements (issued February 12, 1991); and 2) the Policy on the Inclusion of Pollution Prevention Conditions in Enforcement Settlements (issued February 25, 1991). These policies are designed to help reduce or eliminate root causes of noncompliance with permits by commuting penalties through enforceable agreements, if appropriate source recycling and source reduction activities are undertaken. OECA will aggressively apply both of these policies to negotiate settlements that will reduce sediment contamination. Settlements will also emphasize actions which will enhance the prospects for long-term or continuous compliance. OECA intends to take the following actions to implement programs to reduce sources of sediment contamination:

1. OECA intends to continue to implement pollution prevention initiatives with the OPPTS, Office of Air Quality Planning and Standards, NPDES, and RCRA compliance programs.

2. Under these initiatives, OECA intends to provide technical support to EPA negotiation teams to identify and evaluate the feasibility of specific pollution prevention conditions to reduce sediment contamination.

3. OECA also intends to monitor respondent or defendant activities in cases pursued and ensure compliance with all settlement conditions related to prevention of sediment contamination.

4. OECA intends to evaluate and report on the effectiveness of the pollution prevention conditions related to sediment contaminants that are obtained in the settlements.

5. OECA intends to develop technical pollution prevention guidance that can be used to train the EPA Regions in enforcement actions that can be taken to reduce sediment contamination.

6. An executive order signed on August 3, 1993 requires Federal facilities to halve their toxic emissions by 1999 and to begin reporting to the public any release of toxic pollutants. EPA will monitor compliance with the executive order.

7. STRATEGY FOR ABATING AND CONTROLLING SOURCES OF SEDIMENT CONTAMINATION

The goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. NPDES permits are the primary means for preventing the discharge of pollutants into water from point sources. Under Sections 301, 304, 306, and 307 of the CWA, EPA has set minimum, technology-based requirements for municipal dischargers (e.g., primary and secondary treatment standards) and sets similar requirements for industrial dischargers (e.g., best available technology economically achievable and pretreatment standards for existing sources). Under Section 301 of the CWA, NPDES permits must also include additional limits as necessary to achieve applicable water quality standards.

Chapter Highlights

- Technology-Based Controls for Point Sources
- Water Quality-Based Controls for Point Sources
- Controls for Nonpoint Sources
- Coordination with Other Agencies

7.1 TECHNOLOGY-BASED CONTROLS FOR POINT SOURCES

To date, EPA has promulgated BAT effluent guidelines for 40 industrial categories. Over 1 billion pounds of the 126 priority pollutants are removed annually as a result of these requirements. Historically, EPA has not directly considered sediment contamination in developing these guidelines. However, the program has reduced loadings of toxicants to both water and sediment. In addition to developing these nationally applicable effluent limitations, EPA sets technology-based limitations in permits on a site-specific basis using Best Professional Judgment. Effluent guidelines are also the basis for local pretreatment programs, which require toxics controls on industries discharging into municipal sewage treatment plants. In 1986, it was estimated that 37 percent of the toxic industrial compounds that entered surface waters had passed through sewage treatment plants (U.S. EPA, 1986). As a result of this finding, EPA identified the 1,500 municipal sewage treatment plants that handle the majority of industrial wastewater. EPA required these plants to develop and enforce appropriate effluent limits for industries discharging into their system. An estimated

Where sediments are contaminated, EPA intends to implement pollution prevention measures and source controls to limit/control further contamination.

12,000 significant industrial user's in pretreatment cities are required to meet one or more of the effluent guideline categorical standards.

Under Section 304(m) of the CWA, EPA is required to publish a biennial plan that establishes a schedule for the annual review and revision of promulgated effluent guidelines and identifies categories of sources discharging toxic and nonconventional pollutants for which guidelines have not yet been published. Following publication of the first such Effluent Guidelines Plan in 1990, the Natural Resources Defense Council and Public Citizen Inc. filed suit, claiming that the plan did not fulfill the requirements of Section 304(m). In a Consent Decree dated January 31, 1992 (and since revised a number of times), EPA agreed to promulgate 19 new and revised effluent limitations guidelines over an 11-year period. Fifteen of the industrial categories for rulemaking have been selected based on need and potential for risk reduction. The remaining four must be selected in accordance with timelines in the Consent Decree. The Agency agreed to study a number of additional industrial categories in the intervening time and to evaluate the need and risks involved before making the selections.

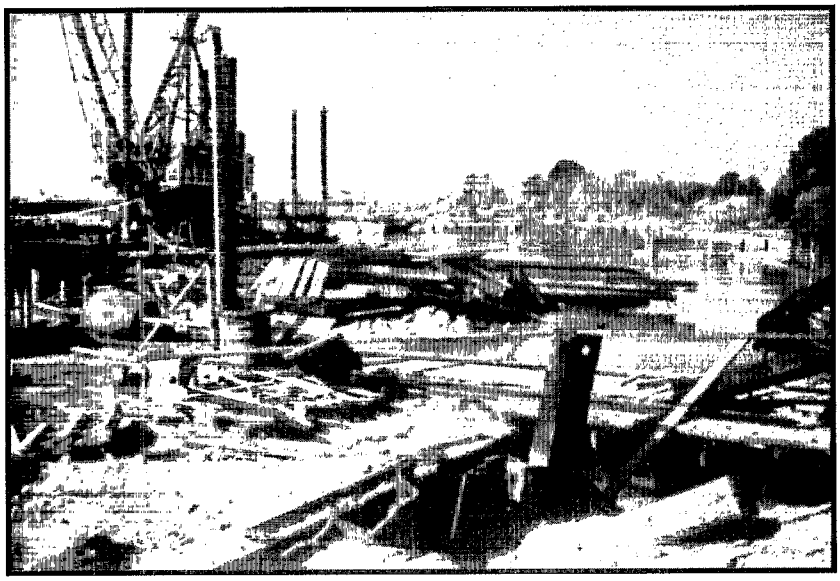
EPA 's effluent guidelines program has evaluated risk as one criterion used to select industrial categories for guidelines development. Since 1994, the Effluent Guidelines Plan has included sediment contamination as a specific factor in the selection of new industrial categories for future effluent guidelines development. The inclusion of sediment contamination as a specific factor could increase the potential for industries discharging sediment contaminants to be the subject of new or revised effluent limitations guidelines. This would ensure that the Agency will consider sediment contaminants in establishing guidelines in the future. Once an industry has been selected for development or revision of guidelines, it has generally taken a minimum of 4 years to promulgate the rule. Guidelines are not self-implementing, but are implemented in permits; therefore, 5 to 10 years is the minimum time period to be expected for implementation of new technology-based NPDES permit limitations.

7.2 WATER QUALITY-BASED CONTROLS FOR POINT SOURCES

Although in many cases past discharges are partly responsible for today's contaminated sediment problem, sediment quality problems are not solely the legacy of past discharges. Monitoring and assessment data compiled by Federal, State, local, and private sources indicate that currently discharging sources do contribute to sediment contamination. On the States' CWA Section 304(l) lists of waterbodies that will not meet water quality standards for toxics because of point source discharges, 11 waterbodies were listed because an active point source was entirely or

substantially contributing to or causing sediment contamination and thus impairing uses of the waters. The point sources of sediment contaminants identified by States under Section 304(l) included POTWs, power plant outfalls, and industrial discharges. EPA studies have documented additional cases of sediment contamination from storm water discharges, CSOs, metal finishing industries, pulp and paper mills, and oil storage terminals. Furthermore, preliminary data from the Source Inventory indicate that active point source discharges are contributing to sediment contamination.

EPA has published water quality criteria identifying the concentrations of specific chemicals in the water column that should not be exceeded in order to protect aquatic life and human health. These criteria are often used by the States as the basis for adoption of legally enforceable water quality standards for waterbodies. Every 3 years, States are required under the CWA to review their water quality standards to determine if they meet the requirements of the Act, and standards are to be revised as necessary. In 1987, Congress amended the CWA to require States to adopt numeric toxics criteria in their water quality standards as necessary to support designated uses. By early 1990, only six States had met this requirement. EPA initiated action to promulgate Federal water quality criteria for toxic pollutants applicable to those States that had failed to comply fully with the Act. On December 22, 1992, EPA promulgated criteria for toxic pollutants for the jurisdictions that had not yet complied with the Act. Numeric water quality criteria for toxics in place in the States and territories will assist in the development of numeric water quality-based NPDES permit effluent limits for toxics. Due to the lack of published chemical-specific sediment quality criteria and the very recent development of sediment bioassay methods, however, most NPDES permits do not contain limits specifically developed to protect sediment quality. The recent development of standard chemical and biological sediment test methods has enabled EPA and the States to use these methods in the



process of developing water quality-based permit limits for targeted discharges as necessary to attain water quality standards to protect sediment quality. Sediment toxicity bioassays may be used to confirm whether point source contamination of sediments causes or contributes to aquatic life toxicity. Sediment toxicity identification evaluations can be performed to identify the chemicals causing the toxicity. For human health and wildlife protection, bioaccumulation bioassays can be used to confirm that the chemicals discharged are bioconcentrating in the food chain.

The CWA also includes requirements in Section 303(d) for development of TMDLs. Under current regulations, every two years States must: 1) identify waters that do not meet water quality standards (including designated uses and criteria) and still require TMDLs, 2) rank the waters in priority order, and 3) develop TMDLs according to the priority ranking. TMDLs specify the particular source reductions necessary to attain and maintain water quality standards. The wasteload allocation (WLA) of the TMDL establishes the source reductions for point sources. The load allocation (LA) establishes the load that may be contributed by nonpoint sources and background concentrations without risk of exceeding a water quality standard. The projected source reductions may be implemented through NPDES permit limits and through State nonpoint source programs. TMDLs are especially valuable when there are multiple sources or when loadings to threatened waters that may not yet exceed water quality criteria need to be allocated to point source discharges. In 1998, one State has sediment quality standards and eight other States have numerical sediment quality "guidelines" that can be used to interpret the narrative of "no toxics in toxic amounts." If chemical-specific sediment quality criteria along with chronic sediment bioassays were available to interpret the narrative standard, modeling could be used to establish WLAs to meet those criteria. If sediment criteria are not available for problem pollutants, a permit writer may still develop pollutant-specific NPDES limits based on a State's narrative standard, in order to protect against sediment toxicity and bioaccumulation.

OST is currently in the process of developing a geographic information system (GIS)-based sediment modeling package that can be used to predict water to sediment concentrations resulting from a point source discharge. The model package is intended for use in calculating WLAs based on sediment quality criteria which will be used to interpret narrative standards. Models within the package may also be used to evaluate the significance of nonpoint source inputs. If the model package is satisfactory, OW intends to prepare a user's manual on how to use the modeling

package to derive wasteload allocations and permit limits to protect sediment quality. The Standards and Applied Science Division (SASD) of OST will evaluate this model package and several other models for their effectiveness in deriving sediment quality-based TMDLs and permit limits. SASD intends to develop the package of sediment quality models and an accompanying user's manual by the year 2000.

ORD is investigating methods to link contaminated sediments to point sources. These methods include toxicity identification evaluations to identify the chemicals causing toxicity; contaminated sediment gradient assessment, in which contaminant concentrations are measured as a function of proximity to a pipe; and fingerprinting, which examines the correlation between the specific chemicals produced by a company and the chemicals found in nearby sediments. These methods may be incorporated into the OW modeling guidance as they become available.

Once EPA publishes sediment quality criteria and the accompanying user's guide, the Agency intends to recommend that the States use these numerical chemical criteria, which are guidance, along with appropriate test endpoints for chronic sediment bioassays (toxicity and bioaccumulation tests) in interpreting their narrative criteria, e.g., of "no toxics in toxic amounts." NPDES permit limits would continue to be based on applicable water quality standards, which may include the States' narrative criteria. Details on how sediment quality criteria will be used in NPDES permitting and other EPA programs will be included in the *User's Guide for Multi-Program Implementation of Sediment Quality Criteria in Aquatic Ecosystems*. NPDES permits generally are written for a 5-year term; thus, as many as 5 to 10 years may pass after EPA issuance of sediment quality criteria guidance before States develop permits with water quality-based limits specifically to protect sediment quality. Additional time may be allowed for compliance with these limits if the inclusion of compliance schedules in permits is explicitly allowed by State water quality standards or implementation regulations and guidance. The *Sediment Quality Criteria User's Guide* will be provided for public review and comment before it is final.

The 1987 amendments to the CWA also require EPA and the States to develop NPDES permits for discharges from municipal separate storm sewer systems that serve populations of more than 100,000, and to issue NPDES permits for storm water discharges associated with industrial activity. Permits for municipal separate storm sewer systems typically include best management practices that should reduce contamination of sediments, as well as sediment discharges themselves, in urban areas. Under the existing NPDES program, there is also some authority to control storm water point source discharges from some silvicultural and mining sources. The final storm water regulations, which were published on November 2, 1990, established permit

application requirements for 11 major industrial categories and certain municipal separate storm sewer systems designed to reduce and/or eliminate the contribution of pollutants, including common sediment contaminants, in surface runoff. Controls required in NPDES permits frequently require the implementation of structural and nonstructural best management practices as pollution prevention measures.

The National Sediment Quality Survey contains the first comprehensive evaluation of ongoing discharges of sediment contaminants from point sources. The Survey data are limited by a lack of site-specific information and therefore may be used for screening purposes only. OW intends to use the data in the NSQS to screen for geographic areas that have the greatest likelihood of experiencing adverse aquatic life and human health risks due to sediment contaminants. In addition, OW intends to use the NSQS, including data on sources of sediment contamination, as part of future assessments to help determine if active point sources are responsible in part for causing such risks. OW also intends to use the NSQS to help identify industrial storm water discharges, discharges from municipal separate storm sewer systems, and CSOs that are known to contribute to contaminated sediment. Under the NPDES storm water program (40 CFR 122.26), over 100,000 industrial activities and nearly 900 municipal entities are already required to seek a NPDES permit for their storm water discharges. In fiscal year 1998, a Phase II storm water rule is being proposed to address the remaining urban storm water systems. The principal mechanism for reducing the contribution of pollutants (including sediment contaminants) in runoff is the implementation of storm water pollution prevention plans (for industrial sources) and storm water management programs (for municipal separate storm sewer systems). Because of the quantity of pollutants found in runoff, permits typically require implementation of source controls, best management practices, and pollution prevention measures. These types of storm water control measures, along with end-of-pipe limitations on process wastewater discharges, are needed in order to achieve the desired level of human health and ecological protection. EPA's 1994 CSO control policy addresses discharges from approximately 950 sewer systems, which contain both sanitary sewage and storm water runoff.

Point source discharges are also addressed through CERCLA and RCRA. Discharges from CERCLA sites and RCRA facilities subject to NPDES permits must comply with requirements in the future NPDES permits that are protective of sediment quality. As with other NPDES permits, these permits generally do not currently contain limitations specifically developed to protect sediment quality. Both on-site and off-site direct discharges from CERCLA sites are required to meet the substantive requirements of NPDES permits. (On-site actions are exempt from actually acquiring the permit, and may in some cases receive a waiver from the substantive NPDES

requirements.) Under RCRA, hazardous waste facilities that have point source discharges are required to obtain a NPDES permit. Run-on and run-off controls are also required at active facilities to control nonpoint source contributions to surface waters (40 CFR §270.14).

7.3 CONTROLS FOR NONPOINT SOURCES

Section 319 of the CWA provides an overall framework for States to prevent and manage all nonpoint sources of water pollution. Under Section 319, States are required to complete a comprehensive assessment of their navigable waters and evaluate the effects of all categories and sources of nonpoint pollutants. Biennial updates of the assessments are now included in the States' CWA Section 305(b) reports to EPA on water quality. In its *Nonpoint Source Guidance* (U.S. EPA, 1987a), EPA encouraged States to provide information regarding those waters not meeting beneficial uses, including those not meeting designated uses due to contaminated sediments. The guidance classified contaminated sediments as a nonpoint source pollution category. EPA's Section 319 grant guidance makes contaminated sediment prevention and, in some limited instances, remediation efforts eligible for funding. Section 319 gives EPA authority to award grant funds to States as an incentive for nonpoint source control, including control of sources of sediment contamination. Section 319 grant funds totaled $80 million in fiscal year 1994, $100 million in fiscal year 1995, $100 million in fiscal year 1996, $100 million in fiscal year 1997, and $105 million for fiscal year 1998. Section 319 does not provide any Federal authority to regulate nonpoint sources, however. State nonpoint source management programs are to include plans for preventing and managing nonpoint sources of pollution by encouraging, assisting, or requiring the implementation of best management practices (BMPs). At their own discretion, States can enact legislation or regulations for control of nonpoint sources. The development of TMDLs under Section 303 of the CWA is a regulatory tool for addressing nonpoint sources as well as point sources; States are increasingly including nonpoint sources in their TMDLs.

In 1992, EPA set aside $800,000 to fund demonstration of urban and agricultural BMPs specifically designed to remove sediment contaminants in storm water runoff. EPA will publicize the effectiveness of these demonstration projects. States can use the NSQS to prioritize sites for grants and technical assistance to prevent further sediment contamination. EPA expects States to incorporate findings into the updates of NPS assessments carried out as part of the CWA Section 305(b) process.

Other EPA programs contribute significantly to the control of nonpoint sources. Under Section 314 of the CWA, the Clean Lakes Program provides grants to States for the classification,

assessment, study, and restoration of lakes. EPA has entered into over 400 Clean Lakes Cooperative Agreements with participating States. Many of these agreements have funded nonpoint source controls to prevent pollutants originating in the watershed from entering lakes. Several projects have used storm water retrofitting to control urban runoff, and others have used wetlands to buffer and filter pollutants from agricultural and silvicultural areas. Beginning in 1990, the Implementation Memorandum for the Clean Lakes Program encourages States to integrate their Clean Lakes projects with Section 319 nonpoint source programs for targeted watershed demonstration projects. This guidance memorandum also mentions that USDA PL 83-566 projects may offer assistance in watersheds significantly affected by agricultural nonpoint source pollution. As in the case of the Section 319 program, EPA's National Sediment Quality Survey will be used to help target watersheds for Clean Lakes grants to prevent further sediment contamination. Funding for BMPs effective in removing sediment contaminants can be provided to these Clean Lakes sites.

EPA's NEP, authorized under CWA Section 320, is a program that uses a comprehensive watershed management approach to address water quality and habitat problems in designated estuaries on the Atlantic, Gulf, and Pacific coasts and in the Caribbean. Under the Act, management conferences, consisting of Federal, State, and local agencies, scientists, citizens, industry, and environmental groups, develop Comprehensive Conservation and Management Plans within five years of NEP designation. These plans address toxic and pathogen contamination, nutrient overenrichment, habitat loss or alteration, impacts to living resources, and other problems from point and nonpoint source pollution and physical alterations (e.g., dredging and construction). A number of the NEP watersheds have identified contaminated sediments as a problem and are developing action plans to reduce or eliminate the problem through point and nonpoint source controls.

EPA expects States to use the National Sediment Quality Survey to assist in identifying both estuaries that should be nominated for NEP designation and controls for nonpoint sources of contamination to sediments. The inventory may also provide information to determine whether already designated estuaries should have more attention focused on nonpoint or point source controls for contaminated sediments. If EPA determines that additional NEP management conferences are to be convened, OW's OCPD intends to advise States that nomination packages for new programs should include identification of sites that are included in the National Sediment Quality Survey. EPA will also advise States that the Agency intends to use this information in evaluating the nominations.

Another important nonpoint source control program is the coastal nonpoint source control program established by the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA). Under CZARA, States have developed and are beginning to implement coastal NPS programs in accordance with joint NOAA/EPA guidance. EPA has developed guidance specifying management measures for nonpoint source categories located within the coastal area. These management measures are considered best available technology for agricultural, silvicultural, urban, hydromodification, and marina nonpoint sources. In addition, CZARA requires States to adopt State-enforceable policies and mechanisms to ensure implementation of the management measures for coastal watersheds. Failure by the States to adopt approvable programs can result in reductions in CZMA and CWA grants to such States. EPA and NOAA will work with States to ensure that the measures that are found to be most effective for controlling sediment contaminants are incorporated into States' coastal nonpoint source programs when State programs receive final approval. Roughly one-half of the coastal States have received conditional approval of their programs; the remainder are expected to receive conditional approval within the next year.

7.4 COORDINATION WITH OTHER AGENCIES

States play a key role in controlling point and nonpoint source pollution. In order for controls to be focused on sediment quality, the States can, as necessary, use sediment quality criteria or EPA's sediment bioassays to interpret their narrative standards in their water quality standards program. EPA intends to recommend that the States use these numerical chemical criteria, which are guidance, along with appropriate test endpoints for chronic sediment bioassays (toxicity and bioaccumulation tests) in interpreting their narrative criteria, e.g., of "no toxics in toxic amounts." Most States are authorized to issue NPDES permits to control point sources, so EPA will work closely with the States to ensure implementation of water quality-based limits to protect sediment quality. Guidance will be developed and workshops will be held to train States regarding using EPA-consistent sediment testing methods, developing permit limits to protect sediment quality, and monitoring for compliance with these limits.

In the nonpoint source area, EPA will encourage the States to modify the Model State Act for erosion and sediment control to include consideration of toxics. This Act, developed for the Council of State Governments, is currently directed only at "clean sediment" problems. EPA will also encourage the States to develop their own legislation, based on the Model State Act, for preventing sediment contamination. EPA's nonpoint source program will continue to coordinate with USDA, USFS, and the Bureau of Reclamation as in the past, and will include consideration of contaminated sediment as well as clean sediment issues. EPA will also seek to ensure that

coordination with Mexico and Canada to control point and nonpoint sources of pollution will address prevention of contaminated sediment. An important means of coordinating with Canada will be through revising the Great Lakes Water Quality Agreement (GLWQA).

8. REMEDIATION AND ENFORCEMENT STRATEGY

EPA may take actions directed at remediation of contaminated sediments under CERCLA, RCRA, CWA, the Rivers and Harbors Act, TSCA, and the Oil Pollution Act of 1990. Where sediments are contaminated to levels that cause ecological harm or pose a risk to human health, EPA will strive to implement whatever remediation strategy will most effectively reduce the risk. In certain circumstances, the best strategy may be to implement pollution prevention measures as well as point and nonpoint source controls to allow natural attenuation. Natural attenuation may include natural processes that can reduce or degrade the concentration of contaminants in the environment including biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biologic stabilization, transformation or destruction of contaminants, and the deposition of clean sediments to diminish risks associated with the site. In other cases, active remediation may be necessary. Before implementing a clean-up of a contaminated sediment site, EPA will carefully evaluate the short-term and long-term impacts of such a clean-up in relation to the reduction of risks to human health and the environment and other benefits. If impacts of the remedial alternative are determined to cause more environmental harm than leaving the contaminants in place, EPA may not proceed with a cleanup at that time. EPA will evaluate a "no action" decision as new information or technologies become available.

Chapter Highlights

- Remediation and Enforcement under EPA Legislation
- Coordination with Other Agencies on Remediation and Enforcement

EPA intends to develop a criteria selection document with guidelines for deciding whether natural attenuation is the appropriate remedial alternative on a site-specific basis, using such factors as: the specific contaminants present and their associated risks; the designated uses impaired during recovery; the size of the affected area; the feasibility and cost of remediation; site hydrodynamics, including the extent of downstream transport; the time required for natural attenuation; and, as discussed below, the liability associated with active remediation. The specific contaminants present in sediment affect the type (ecological versus human health) and severity (acute versus chronic toxicity) of the impact. Natural attenuation is normally not acceptable where contamination poses severe and substantial risks to aquatic life, wildlife, and human health. In addition, natural attenuation may not be the method of choice for contaminants that biodegrade or transform into more persistent, toxic compounds. Guidelines should be included in the criteria selection document on use of natural attenuation. Where cleanup is being conducted under a program that has its own regulatory criteria for designing remediation, those criteria would govern.

However, the factors discussed in this section would generally be evaluated in applying those criteria.

Identification of the designated uses impaired by sediment contamination will allow the risk manager to evaluate the tradeoffs over both the short- and long-term involved with active remediation compared to natural attenuation. The size of the contaminated area is a key parameter to be considered. Widespread, low levels of contaminants may favor natural attenuation, while geographically limited areas containing high levels of contaminants favor active remediation. Technology also plays a part in the use of natural attenuation. Natural attenuation is an option, and State or local institutional controls may assist the natural attenuation process. Site hydrodynamics affect the decision because sediments must be stable for clean sediment burial to be effective. If contaminated sediments are being transported, or have the potential to be transported, into more critical habitats or are being spread over a wider area where remediation is less technically or economically feasible, active remediation should be performed. Also, for natural attenuation to be effective, groundwater discharges to streams, particularly at low-flow periods, must be carefully evaluated to ensure that ground water is not a significant contaminant transport mechanism. In some situations, combinations of active remediation and natural attenuation may be the best option. For example, if fairly discrete areas of contamination are removed, the rest of a site may be left alone for natural attenuation. Alternatively, limited capping of contaminated sediment with clean material may be done in anticipation of further natural deposition of clean sediment. Before initiating any remediation, active or natural, it is important that point and nonpoint sources of contamination be identified and controlled.

Selection of the appropriate remedial option at a contaminated sediment site will be undertaken on a case-by-case basis after careful consideration of the risks posed by the contaminants to human health and the environment, the benefits of remediation, the short-and long-term effects of implementing the remedial option, the implementability of the remedial option, and the costs of remediation.

A decision to allow natural attenuation should be site-specific and take into account the amount of time needed as compared to the risks and other adverse effects posed by the contaminants to human health and the environment during this period. The amount of time needed and considered acceptable will vary from site to site. Natural attenuation times will obviously be shortened if the area of contamination is small in size, sediment burial rates are high, the

bioavailability of the contaminant is low or limited, and the sources of contamination are controlled.

The goal of all active remediation and natural attenuation projects is to achieve sediments that pose no acute or chronic toxicity to aquatic life and wildlife, and no significant risk to human health and the environment. It should be noted, however, that the Strategy does not mandate specific clean-up standards for contaminated sediment sites. The decision on an appropriate clean-up level for a site is based on reduction of risk and other adverse effects to human health and the environment and should incorporate a number of site-specific factors. These include the level of restoration of impacted beneficial uses of the waterbody, contaminant characteristics (e.g., bioaccumulation potential), the public's concerns and interests, and consideration of sensitive communities. In addition, the decision on a clean-up level should take into consideration clean-up criteria developed and published in the scientific literature or developed by State or other government agencies. The statutes and regulations governing the program conducting the clean-up will affect the decision on clean-up levels. For Great Lakes contaminated sediment sites, additional factors generally to be considered include reduction in loadings to the lake or atmosphere, the mass of contaminant to be removed, goals of the pertinent Lakewide Management Plan and Remedial Action Plan, and resulting reduction in fish body burdens of the contaminant.

The weight-of-evidence approach, developed for the National Sediment Quality Survey, will play a significant role in targeting sites for assessment and possible source controls to protect sediment quality. Each remediation program will then set its own priorities for the sites in the National Sediment Quality Survey based on applicable statutory and regulatory authority. A program decision to select active remediation or natural attenuation for any site will require the detailed data gathered during a remedial investigation/feasibility study of the environmental and human health impacts and risks posed by the contamination, and cost-effectiveness and technical achievability of remedial alternatives.

Subject to any limitations in the authorizing statute or regulations, EPA intends to undertake remediation of contaminated sediment sites first to limit serious risks to human health and the environment, and then to restore sites to a degree sufficient to support existing and designated uses of the waterbody, including potential or designated uses of the sediment whenever such restorations are practicable, attainable, and/or cost effective.

EPA is committed to using all potential enforcement authorities to seek to obtain sediment remediation. CERCLA, RCRA, CWA, the Rivers and Harbors Act of 1899, TSCA, and the Oil Pollution Act of 1990 contain provisions that, under the appropriate circumstances, can compel responsible parties to contribute to the

clean-up of contaminated sediments. Depending on the particular statute, EPA can use these authorities to: 1) compel parties to clean up the sites they have contaminated, 2) recover costs from responsible parties for EPA-performed clean-ups, and/or 3) coordinate with natural resource trustees to seek restitution from responsible parties for natural resource damages. The Agency's ability to obtain sediment remediation within a reasonable time frame may be enhanced through the coordinated use of contractor listing (40 CFR Part 15), debarment and suspension (40 CFR Part 32), State or local laws and regulations, and the Agency's criminal enforcement authority.

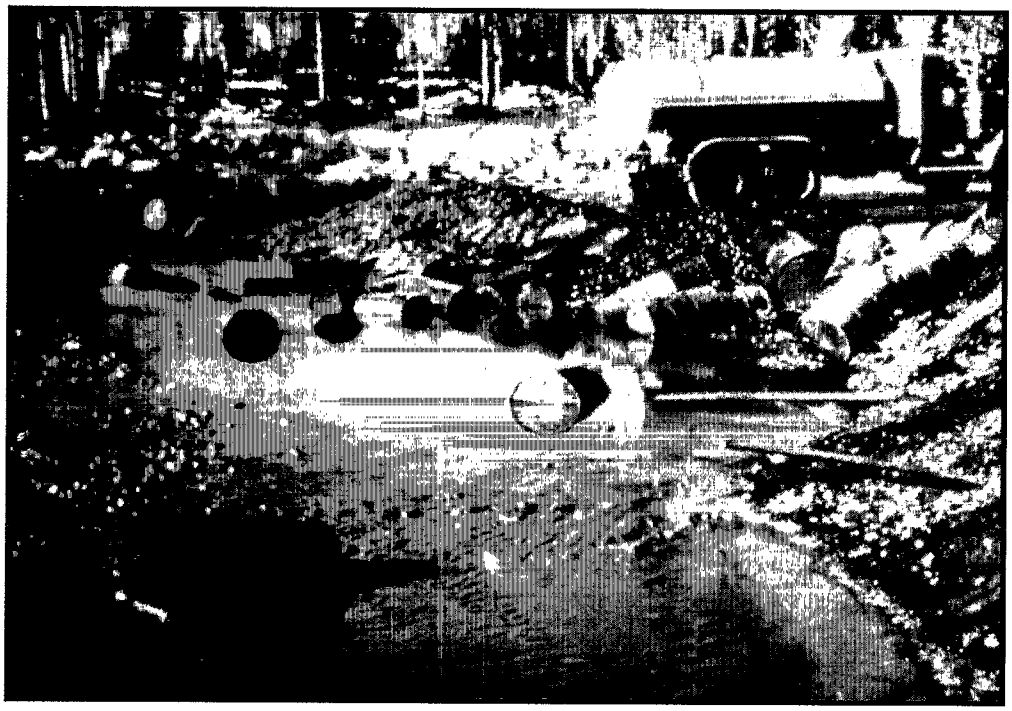
To date EPA has successfully used Section 309(b) of the CWA, Section 3008(h) of RCRA, and Section 106 of CERCLA in conjunction with its violating facility listing authority to require clean-ups at contaminated sediment sites. In addition, settlements of CWA unauthorized discharge enforcement cases have incorporated sediment clean-up as part of the injunctive relief. Under this Contaminated Sediment Management Strategy, EPA intends to use these statutes and the other authorities described in this section to require sediment remediation by responsible parties. Now that EPA has developed the National Sediment Quality Survey and the Source Inventory, this information will assist the development of enforcement actions for sediment remediation. The Agency intends to use consistent test methods indicative of sediment toxicity to identify areas needing remediation and to help provide clean-up goals for enforcement-based remediation. The following sections describe the EPA remedial and enforcement programs that can be used for contaminated sediment clean-up.

8.1 CERCLA REMEDIATION AND ENFORCEMENT

Under CERCLA, EPA has established a comprehensive program for identifying, investigating, and remediating sites contaminated with hazardous substances. Clean-up activities may take place under CERCLA's removal program. Sites must be placed on the NPL to be eligible for remedial funding. The CERCLA process for assessing sites involves a tiered system for evaluation that is used to screen out sites that do not warrant placement on the NPL. Before a site is added to the NPL, it is evaluated using the Hazard Ranking System (HRS); a resultant score of at least 28.5 is needed to support listing. (HRS scores range between 0 and 100.)

Local governments, States, and EPA Regional offices typically identify sites that should be evaluated for threats to public health and the environment. Sediment assessment data collected as part of the Superfund program will be added to the National Sediment Quality Survey. Sites that are already identified in the National Sediment Quality Survey and that are not currently under the jurisdiction of another program (e.g., RCRA) may be appropriate for evaluation under CERCLA.

However, the decision on whether to evaluate a site for NPL listing will be made separately by the Superfund program.



Under CERCLA, EPA carries out a detailed analysis of risks posed by contaminants at the site to human health and the environment, and the feasibility of various response action alternatives to reduce risk. The *Risk Assessment Guidance for Superfund* (RAGS), (U.S. EPA, 1989a; U.S. EPA, 1989b; U.S. EPA 1997f) provides a framework for the assessment of human health and environmental impacts. Various EPA publications, including guidance in RAGS, Ecological Updates, and fact sheets, are used to develop assessments that are presented as a part of the Remedial Investigation/Feasibility Study (RI/FS) of a CERCLA site. The process is not designed specifically for sediments, but rather for the purpose of assessing all exposure routes from contamination at CERCLA sites. There are nine criteria used in the FS to evaluate options for remedial actions at CERCLA sites. These criteria are: 1) overall protectiveness of human health and the environment; 2) compliance with ARARs, i.e., national and State standards and criteria; 3) long-term effectiveness and permanence; 4) reduction of toxicity, mobility, or volume through treatment; 5) short-term effectiveness; 6) implementability; 7) cost; 8) State acceptance; and 9) community acceptance.

The CERCLA Program intends to use the EPA-wide sediment testing methods of the Tiered Testing Framework in the Remedial Investigation/Feasibility Study stage of analysis. OERR intends to provide guidance on the use of the testing methods to promote consistency of these methods within the CERCLA process. EPA standard protocols for acute sediment toxicity testing have been completed. After the EPA standard protocols for chronic sediment toxicity testing are completed, the Superfund Program will develop guidance describing the use of the EPA testing methods. CERCLA program guidance on the use of sediment quality criteria will be issued following public review and comment on the *User's Guide for Multi-Program Implementation of Sediment Quality Criteria in Aquatic Ecosystems.*

CERCLA provides one of the most comprehensive authorities available to EPA to obtain sediment clean-up, reimbursement of EPA clean-up costs, and compensation to natural resource trustees for damages to natural resources affected by contaminated sediments. Once EPA determines that there is a release, or substantial threat of a release, of hazardous substances to the environment, it may undertake response action necessary to protect public health and the environment and, if there may be imminent and substantial endangerment to public health or welfare or the environment, compel the potentially responsible parties (PRPs) to undertake the clean-up. Liability under CERCLA is "strict," meaning the responsible parties are liable without fault, often "joint and several," meaning that they are responsible both collectively and individually for the entire cost of the clean-up, and "retroactive," meaning that liability exists for disposal that occurred prior to CERCLA's enactment. If the contamination resulted from a Federally permitted release, cost recovery is not available. CERCLA defines "hazardous substances" and lists those substances covered by the statute. Removal actions and enforcement actions can be brought at both NPL and non-NPL sites.

Section 106 of CERCLA authorizes the U.S. Attorney General to secure such relief as is necessary to abate an imminent and substantial threat to the public health or welfare, or the environment, because of an actual or threatened release of a hazardous substance. A judicial action or issuance of an order under Section 106 to compel responsible parties to perform clean-ups may be appropriate. Failure or refusal to comply with the Section 106 order, without sufficient cause, subjects responsible parties to treble damages and penalties up to $25,000 a day.

Section 107 of CERCLA provides that the United States may recover all costs of CERCLA response actions, when not inconsistent with the National Contingency Plan, as well as damages for injury to natural resources and costs of health assessments. Liable parties are certain persons who owned or operated facilities from which there is a release or threatened release, or who were

involved with disposal, treatment, or transport of hazardous substances. Section 107(j) provides that EPA cannot recover response costs or damages resulting from a Federally permitted release under Section 107. CERCLA Federally permitted releases include three types of releases from point sources with NPDES permits, as set out in Section 101(10)(A)-(C). Natural resource damages resulting from sediment contamination may be recovered only by the United States, State, and foreign governments, and Indian Tribes and their members, as provided in CERCLA Section 101(16). Natural resource trustees are routinely notified of any CERCLA clean-up activity, pursuant to Section 122(j) of CERCLA, and are encouraged to participate in negotiations where natural resources under their trust may be affected. The natural resources trustees' participation in settlement negotiations is important to PRPs seeking release from liability. The natural resource trustees can grant a "covenant not to sue" if the PRP agrees to undertake appropriate actions to protect and restore the damaged natural resources.

Section 122 of CERCLA authorizes EPA to enter into settlements with responsible parties to perform response actions. Settlements negotiated under this authority generally will reflect the strength of evidence of liability, the strength of responsible party defenses, and public interest considerations. Settlements may include compensation for, or remediation of, natural resources damages if the Department of the Interior (DOI), the State, or another designated natural resources trustee is a party to the settlement.

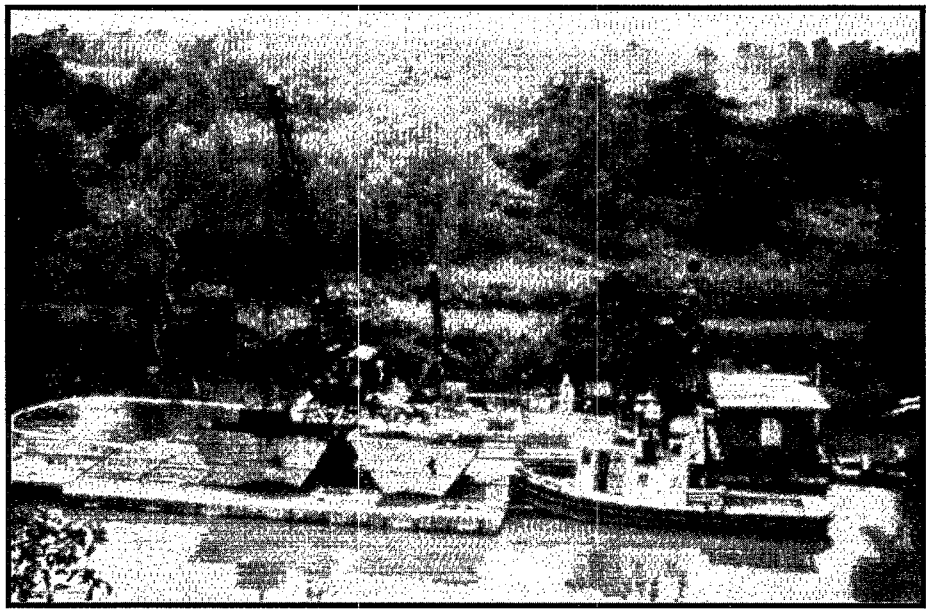
8.2 RCRA REMEDIATION AND ENFORCEMENT

Subtitle C of RCRA provides EPA with the authority to assess whether releases from a hazardous waste treatment, storage, or disposal facility have contaminated sediments and to require corrective action, including possible remediation, if contamination is discovered. RCRA corrective action authorities apply to, among other things, all releases of hazardous waste or constituents from any solid waste management unit at a treatment, storage, and disposal facility seeking a RCRA permit, regardless of when the waste was placed in the unit (Section 3004(u)). EPA assesses hazardous waste facilities that have RCRA permits. These assessments are called "RCRA facility assessments" (RFAs). If an RFA suggests that a release has occurred, hazardous waste permit writers can require facility operators or owners to conduct extensive RCRA facility investigations (RFIs) to determine the extent of any contamination. If the RFI indicates that solid waste management units at the facility caused contamination, the permit can be modified to require sediment remediation. EPA also has enforcement authority to order owners and operators of "interim status" facilities (including facilities that once had or should have had interim status) to conduct corrective action, or other such response measures that are necessary to protect human

health or the environment from a release of hazardous waste including sediment remediation. "Interim status" facilities are those that qualified to handle hazardous waste prior to the issuance of a final permit.

Section 3004(v) of RCRA authorizes EPA to establish standards requiring corrective action for releases from a facility that have migrated beyond the boundaries of a facility (e.g., off-site sediments), where necessary to protect human health or the environment unless, despite best efforts, the facility's owner or operator demonstrates that he was unable to obtain access to the contaminated areas.

To date several facilities have been required to investigate contaminated sediments, pursuant to consent orders entered into under Section 3008(h) and permit conditions issued under Section 3004(u) and Section 3004(v).



Remedial Operation

Section 7003 of RCRA authorizes EPA to bring suit against persons who contributed to past or present handling, storage, treatment, transportation, or disposal of any solid or hazardous waste that may present an imminent and substantial threat to human health or the environment. EPA may further order such persons to take other actions as may be necessary to protect public

health and the environment. This authority has already been used to enter into consent orders whereby the facility has agreed to investigate contaminated sediments.

OSW and OECA currently use the RCRA National Corrective Action Prioritization System (NCAPS) to prioritize facilities for corrective action. They will use the information in the National Sediment Quality Survey to supplement the information used for prioritization. For facilities which have not yet been ranked with NCAPS, and where it is clear that releases from a RCRA facility have caused the sediment contamination identified in the National Sediment Quality Survey, EPA intends to score such contamination as an "observed release" for the surface water route under the NCAPS. An observed release score will often lead to the classification of a facility as high priority for corrective action. For facilities that have already received an NCAPS score, the information from the National Sediment Quality Survey can be used to elevate their overall priority.

EPA has agreed to include sediment bioassays and chemical criteria for Agency-wide use when they become available, and OSW has also agreed to distribute these test methods to Regional and State program offices for use in site-specific risk assessments involving contaminated sediments.

As a benchmark for the scope and magnitude of the above-described action items, RCRA remediation applies to several thousand sites across the country.

8.3 CWA REMEDIATION AND ENFORCEMENT

Section 115 of the CWA directs EPA to identify the location of in-place pollutants with an emphasis on toxic pollutants in harbors and navigable waterways. EPA is authorized, acting through the COE, to make arrangements for the removal and disposal of such materials from critical port and harbor areas. The $15 million authorized by this Section has only been appropriated once, and all the funds were spent in the 1970s.

If new appropriations are made for Section 115, EPA will use the National Sediment Quality Survey and the Source Inventory for initial selection for possible remediation. The Survey and Inventory reports identify sites where sediment contamination may potentially affect human health or the environment. EPA intends to use the Agency-wide consistent sediment tests to select clean-up goals and monitor the effectiveness of remedial actions. Section 115 funds would be effectively used by "piggybacking" the remediation project onto the COE's navigation

maintenance projects. "Piggybacking" projects could save the costs associated with dredge mobilization and demobilization and possibly with some sediment testing. A formalized system of coordination between EPA and the COE would be required to facilitate Section 115 and "piggybacking" projects.

Section 309 of the CWA authorizes EPA to commence civil action for appropriate relief, including permanent or temporary injunction, for enumerated violations, including any discharges in violation of permit limits. Given establishment of a link between the unlawful discharge and the contaminated sediment, both administrative orders and judicial orders in civil suits can require remediation in the form of the removal of illegally discharged pollutants. Where this link is not well established, enforcement actions can also encourage polluters to undertake sediment pollution removal as an environmentally beneficial expenditure in lieu of a civil penalty. Environmentally beneficial expenditures may be used in conjunction with, but not in lieu of, civil penalties that recover a violator's unlawful economic benefit. Even if the sediment contamination is the result of permitted discharges, the facility may be willing to clean up in mitigation of a portion of the civil penalties or to limit possible liability under any other applicable statute.

Wastewater discharges are typically regulated by Section 402 of the CWA. Pollutants found in wastewater discharges and nonpoint source runoff that have been designated as hazardous substances, however, are regulated under Section 311, except for Federally permitted discharges. Section 311 of the CWA authorizes the President to act to remove, or arrange for the removal of, an actual or threatened discharge of oil or hazardous substances into navigable waters, adjoining shorelines or waters of the contiguous zone, or that may affect natural resources of the United States. Section 311 can be utilized to address oil or CWA hazardous substances which have accumulated in sediments.

Section 504 provides a possibility for injunctive relief if it can be shown that polluted sediments present an imminent and substantial endangerment to the health of persons, or the livelihoods of persons whose employment might be affected by contaminated sediments. Enforcement actions under Section 504 can compel responsible parties to clean up contaminated sediment whether or not the contamination resulted from a discharge not in compliance with permit limits.

OW has developed guidance on how to use CWA enforcement authorities to obtain sediment remediation. Training workshops are also being held in the Regional EPA offices to teach enforcement staffs how to pursue cases of their own.

8.4 TSCA ENFORCEMENT

Unlike CERCLA and RCRA, which require clean-up of hazardous releases no matter when they occurred, TSCA does not explicitly require clean-up of regulated substances other than PCBs if they were discharged before the effective date of the TSCA regulations requiring such clean-up. Regardless of the date of contamination, any party that removes or handles sediments containing TSCA-regulated substances must follow the regulations promulgated under TSCA for the handling of these substances.

PCB spills that occurred before the effective date of TSCA are subject to regulation under TSCA. The Agency has proposed a rule that would allow EPA Regional Administrators discretion on a case-by-case basis and within certain limits to define how the cleanups would be conducted at such sites. EPA Regional Administrators would be able to approve alternatives to incineration or disposal in TSCA-approved facilities for sediments contaminated with PCBs if the disposal is adequately protective of human health and the environment. EPA anticipates issuing the final rule in 1998.

8.5 RIVERS AND HARBORS ACT ENFORCEMENT

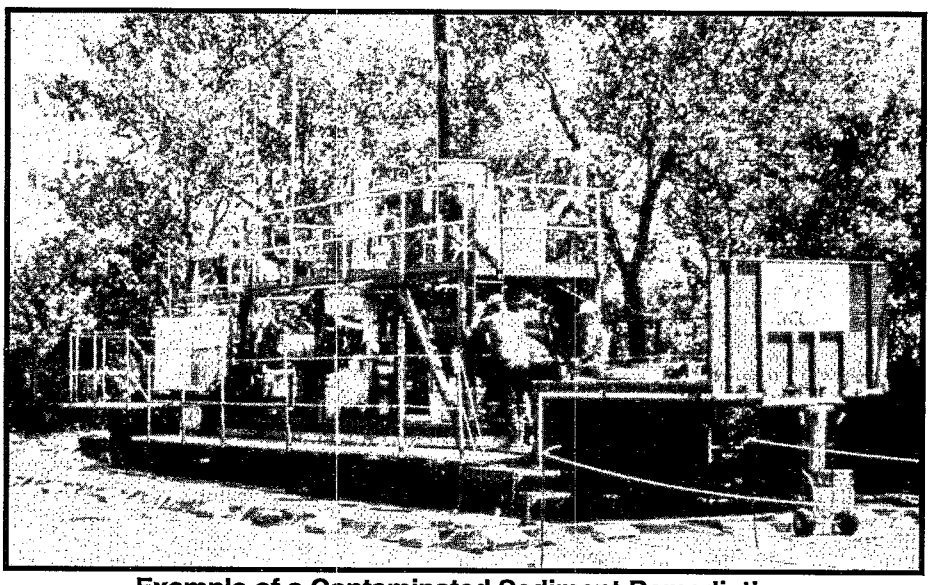
The Rivers and Harbors Act of 1899 includes two provisions which the United States, through the Department of Justice (DOJ), may use to bring enforcement actions to address sediment contamination. First, the Act provides for criminal and injunctive relief against anyone who is responsible for obstructing the navigable capacity of any water of the United States and for altering the condition of the channel of such waterway. Second, the Act provides for criminal and injunctive relief in response to discharges of "refuse matter" into any navigable water or tributary of a navigable water. Courts have broadly interpreted this Act to prohibit discharges other than those in compliance with a permit under the CWA. The injunctive relief available under the Act includes the ability to order the removal of the obstruction or the refuse.

8.6 ENFORCEMENT UNDER CWA SECTION 311

Under CWA Section 311, as amended by the Oil Pollution Act of 1990, EPA may require responsible parties to clean up contaminated sediments resulting from oil spills and discharges. EPA may use this authority to obtain sediment remediation whenever appropriate circumstances exist.

8.7 RELATED LEGISLATION

As part of the 1987 amendments to the CWA, Section 118(c) established the Assessment and Remediation of Contaminated Sediments (ARCS) Program to assess the extent of sediment contamination in the Great Lakes and to demonstrate bench- and pilot-scale treatment technologies for contaminated sediment. The Great Lakes Critical Programs Act of 1990 extended the ARCS



Example of a Contaminated Sediment Remediation Project Using BEST Equipment

Program from 5 to 6 years, requiring a Report to Congress in December 1993 (U.S. EPA, 1994e). The ARCS Program is the only EPA effort specifically directed at developing innovative treatment technologies for contaminated sediment. The Superfund Innovative Technology Evaluation (SITE) program does some investigations into sediment remedial techniques, but its resources must be used to evaluate clean-up techniques for all contaminated media.

8.8 COORDINATION WITH OTHER AGENCIES

Facilities of the Department of Defense (DOD) and DOE have on-site sediments contaminated with radionuclides, PCBs, metals, and other toxics. As part of this Strategy, EPA will work with these agencies on assessing their sediment quality problems and remediating the sites to appropriate clean-up levels. DOE has already entered into "Federal facility agreements" with several States and EPA to coordinate implementation of remedial actions at their facilities.

OECA will work closely with States and other Federal agencies to monitor implementation of the Federal Facilities Compliance Act.

EPA will also coordinate with the Federal Interagency Sedimentation Project. Under this project, USGS, the COE, BLM, USFS, TVA, and USDA have initiated a joint effort to investigate the physical properties of sediments. These agencies are conducting research to determine the degree to which sediments trap contaminants and the time frame for natural attenuation.

9. STRATEGY FOR DREDGED MATERIAL MANAGEMENT

Approximately 300 million cubic yards of sediment are dredged from the nation's harbors and waterways each year. Of this amount, some 60 million cubic yards of dredged material is disposed in the ocean at sites regulated under MPRSA (Lee, 1992). The remaining dredged material is discharged in open water sites, at confined disposal facilities, and for beneficial uses regulated under CWA, as well as on uplands (Lee, 1992).

The COE, as the Federal agency designated to maintain navigable waters, conducts a majority of this dredging and disposal under its Congressionally authorized civil works program (Moore and Wilson, 1992). The balance of the dredging and disposal is conducted by a number of local public and private entities. In either case, the disposal is subject to a regulatory program administered by the COE and EPA under the above statutes. EPA shares the responsibility of managing dredged material, principally in the development of the environmental criteria by which proposed discharges are evaluated and disposal sites are selected, and in the exercise of its environmental oversight authority. Dredged material management activities are generally subject to NEPA, as well as a number of other laws, executive orders, and State and local regulations.

Chapter Highlights

- Coordination with Other Agencies and States
- Framework for Dredged Material Management
- Dredged Material Assessment

Estimates by the COE indicate that a small percentage of the total annual volume of dredged material disposed, approximately 3 million to 12 million cubic yards, is contaminated such that special handling and/or treatment is required (Lee, 1992). A number of ongoing and recently completed EPA and COE efforts affect the assessment and management of dredged material, contaminated and otherwise. EPA and the COE intend to continue to further consistent implementation of the various statutes and regulations governing dredged material management in an environmentally sound manner.

9.1 COORDINATION WITH OTHER AGENCIES AND STATES

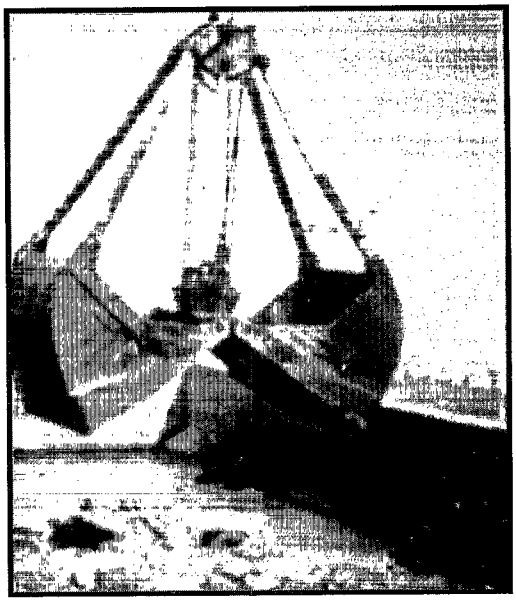
EPA will continue to work with the COE to ensure that dredged materials are managed in an environmentally sound manner.

EPA and the COE have jointly administered the dredged material disposal provisions of CWA and MPRSA for over 20 years. EPA is committed to maintaining strong coordination with the COE on issues such as dredged material testing and assessment, evaluation of sediment management alternatives, monitoring of disposal sites, training of field staff, and research and development activities in order to continue to ensure that dredged material is managed in an environmentally sound manner.

Likewise, EPA is committed to a dredged material management process, through established mechanisms, that coordinates effectively with other Federal agencies, including USFWS, National Marine Fisheries Service, and NOAA, as well as States and other stakeholders. The National Dredging Team (NDT), co-chaired by EPA and the COE, as well as the Regional Dredging Teams and Local Planning Groups formed under the auspices of the NDT, are designed to further this coordination.

9.2 DREDGED MATERIAL MANAGEMENT FRAMEWORK DOCUMENT

In 1992, EPA and the COE published a guidance document entitled *Evaluating Environmental Effects of Dredged Material Management Alternatives - A Technical Framework* (U.S. EPA and the COE, 1992). The document is a framework for evaluating the potential environmental effects of proposed discharges of dredged material in open water and in confined disposal sites, as well as the possibility of using dredged material for beneficial purposes, such as beach enrichment. The document discusses the regulatory requirements of applicable statutes, the equipment and techniques employed in dredging and disposal, the general framework in which alternatives are evaluated, and the more detailed assessments for evaluating open water and confined disposal options and beneficial use alternatives. The analysis of each of these major



Clamshell Dredge

alternatives includes a discussion of site characteristics, physical effects or suitability of dredged material, site capacity, contaminant pathways of concern or site suitability, and management actions and contaminant control measures.

EPA and the COE are now in the final review process of a follow-up guidance document to help promote beneficial use of dredged material which will discuss approaches for comparing economic and environmental cost and benefits among environmentally acceptable alternatives, and will present a number of authorities that could be used to fund more costly, environmentally preferable alternatives. Publication of the document is expected in early 1998.

9.3 DREDGED MATERIAL ASSESSMENT

On July 24, 1996, the Administration issued its plan to address dredging issues, in particular with respect to New York/New Jersey Harbor. As part of this plan, EPA has initiated a process with all interested stakeholders— environmental, industry, and labor— to ensure that any further revisions to ocean disposal testing requirements are based on sound science and policy. Because this process is underway, it would be premature to identify or predict any particular outcome. The Agency is committed to pursuing this inclusive stakeholder process and will determine what, if any, appropriate measures should be taken subsequent to its completion. For information on dredged material management or regarding this process, contact the Oceans and Coastal Protection Division at 202-260-1952.

10. RESEARCH STRATEGY

ORD is committed to a comprehensive, coordinated program of research that will identify relationships between sediment contaminants and the viability and sustainability of benthic ecosystems, and ultimately will clarify how such information can be used to direct source control and pollution prevention strategies. The contaminated sediment research strategy describes how ORD intends to support the EPA program offices, other Federal agencies, States and Tribes, and local governments by undertaking research to: 1) evaluate the extent of sediment contamination; 2) develop approaches and data methods to assess ecological exposure and effects of sediment contaminants; 3) develop sediment quality criteria and validate supporting science; and 4) develop and evaluate contaminated sediment risk management approaches. To complete this research, ORD intends to conduct the projects discussed below as part of sediment quality research initiatives in the budgets for fiscal years 1998 and beyond.

Chapter Highlights

- Evaluation of the Nature and Extent of Sediment Contamination
- Assessment of Ecological Exposure and Effects of Sediment Contaminants
- Development of Sediment Quality Criteria for Marine and Freshwater Systems
- Development of Contaminated Sediment Risk Management Strategies
- Completion of Research and Technology Transfer

10.1 EVALUATE THE NATURE AND EXTENT OF SEDIMENT CONTAMINATION

In the past, chemical and physical data on sediment quality based on a regional scale were collected as part of EPA's EMAP. The focus of EMAP has shifted since the draft Contaminated Sediment Management Strategy was published, but the program will provide information on methods to gather chemical and biological data on sediment quality on a regional scale using a randomized sampling grid. Inclusive of the

Scientists Examining a Sediment Core

EMAP data previously collected, ORD will also continue to assist with data evaluation for the National Sediment Quality Survey.

10.2 METHODS AND DATA TO ASSESS ECOLOGICAL EXPOSURE AND EFFECTS OF SEDIMENT CONTAMINANTS

10.2.1 Sediment Toxicity Test Assessment Methods to Evaluate Impacts on Individual Test Species and Populations of Benthic Organisms

In consultation with EPA's Tiered Testing Committee, ORD is developing state-of-the-science standardized protocols for assessing potential impacts of contaminated sediments on aquatic ecosystems. The development of these tests is essential to the success of the tiered testing approach adopted by EPA as part of this Strategy. ORD is continuing to work with the EPA program offices to develop standard test protocols which can be used in a hierarchical tiered testing approach that proceeds from simple acute toxicity assessments to chronic and sublethal test endpoints. Standard culture, acute toxicity, and chronic toxicity protocols will be developed and validated for a variety of appropriately sensitive freshwater and marine benthic species.

In consultation with EPA's Tiered Testing Committee, ORD is developing state-of-the-science standardized protocols for assessing potential impacts of contaminated sediments on aquatic ecosystems.

Section 5 lists two method protocols for acute sediment toxicity tests for freshwater and marine and estuarine waters which were published in fiscal year 1994. ORD is developing additional laboratory toxicity tests to assess the short-term effects (circa 10 days) of contaminated sediments on survival and sublethal endpoints for freshwater and marine benthic organisms. Chronic test methods are also being developed for a subset of these tests species, and inter-laboratory and lab-to-field comparisons using these techniques began in 1996. ORD's research in this area includes development of test methods for Gulf Coast organisms (which are not as advanced as those for species from the East and West Coasts), certain classes of organisms such as aquatic macrophytes, and assays with population endpoints which are not well represented in the battery of tests currently available.

Work is also being done to evaluate the effects of sediment contaminants on native populations at chemical concentrations below those that show measurable effects in standard, short-term, single-species, sediment toxicity tests in the laboratory. These effects may occur

because the test organisms used have lower sensitivity to certain sediment contaminants relative to native assemblages, or because the endpoints measured (or exposure periods) in the existing tests do not capture important mechanisms of toxicity that affect populations in the field. ORD is attempting to address these shortcomings by modifying or expanding procedures for existing test organisms, developing tests for additional, more sensitive organisms, and developing new test procedures that better reflect the mechanisms and biological interactions that occur in natural systems. In any case, there is a need to ensure that the evaluation techniques used to detect sediment toxicity are predictive of effects on natural populations. This includes demonstrating correlation between responses in toxicity tests and *in situ* responses of the benthic community.

10.2.2 Chemical Analytical Methods Development

ORD intends to develop sensitive, low-cost, analytical methods to detect sediment contaminants at concentrations compatible with Federal and State water quality criteria. ORD intends to develop methods for measurement of sediment characteristics that control biological availability of chemicals in sediments. Methods would also be developed to minimize or eliminate the use of hazardous solvents and reagents, thereby both reducing the exposure of laboratory workers to these chemicals and minimizing waste which must be disposed of in accordance with RCRA regulations. Research will also be completed to develop sensitive chemical methods for analyzing metals and organics in suspended sediments. Such research may be of particular use in the NPDES permitting program.

One approach to detect sediment contaminants which ORD has begun to apply is the use of the microplate-based enzyme-linked immunosorbent assay (ELISA) to evaluate its potential for providing rapid, low-cost field methods for determining the presence of PCBs, PAHs, and some pesticides in sediments.

10.2.3 Field-Based Methods to Assess Biological Effects of Contaminated Sediments

In addition to toxicity tests, ORD is also developing field-based methods to assess biological effects of contaminated sediments.

Beyond toxicity tests, ORD is also developing field-based methods to assess biological effects of contaminated sediments. Field-based methods have the advantages of including natural exposure scenarios and the natural assemblage of exposed organisms, and they tend to measure endpoints which are more easily related to the maintenance of natural and diverse benthic populations. Thus far, many field-based

procedures have been hampered by difficulties in reliably detecting changes in benthic communities and/or reliably distinguishing the biological effects of chemical contaminants from habitat differences or other types of stressors (e.g., organic enrichment). Toward this end, ORD is evaluating other biological indices which will be sensitive to the qualitative and quantitative changes in benthic communities that result from chemical exposure, and evaluating better designs for sampling and analyses to detect these changes. In addition to enhancing initial assessment of areas with potentially contaminated sediments, improvements in field-based measurements will likely assist in diagnosing causes of sediment toxicity and improving the link between exposure and observed effects within a risk assessment.

10.2.4 Development and Field Validation of Bioaccumulation Test Methods

Demersal (bottom-dwelling) fishes and some benthic taxa, typically molluscs and polychaetes, have a relatively high tolerance to sediment contaminants and are able to survive in very polluted habitats. Unfortunately, such species often accumulate a high body burden of various toxic chemicals in their tissues. As with acute sediment toxicity testing discussed in Section 10.2.1, in consultation with the Sediment Tiered Testing Committee, ORD published standardized test methods for bioaccumulation tests for freshwater and marine and estuarine waters in fiscal year 1994. EPA plans to develop and validate bioaccumulation test methods for additional species which are more representative of local species at risk. Additional test protocols will be field validated by comparing tissue residues measured in organisms collected from selected sites with residue concentrations measured in transplanted organisms as well as in organisms exposed to the same sediments in controlled laboratory exposures. To evaluate precision, results from a variety of analytical laboratories will be compared.

10.2.5 Bioavailability and Trophic Transfer of Sediment-Associated Contaminants

In addition to effects on benthic organisms, some sediment-associated contaminants may pose a direct risk to wildlife and human health through direct consumption of contaminated benthic organisms such as clams and lobsters, or an indirect risk through the trophic transfer of contaminants up the food chain into edible fish. These effects are not well addressed by currently used toxicological and bioaccumulation evaluations. ORD intends to conduct research on the bioavailability and trophic transfer of contaminants in sediments with special emphasis on residue levels in shellfish and higher trophic level aquatic species. Information on relationships between contaminant concentrations in sediments and higher trophic level and commercially important aquatic species will be developed. This work is being done to develop food chain models to

predict the exposure of higher trophic organisms, including humans, to contaminants associated with sediments. This information will help determine the classes of compounds and the conditions which warrant the generation of sediment criteria protective of human health.

10.2.6 Development of Tissue Residue Thresholds

One of the major uncertainties in assessing the effects of sediment-associated contaminants is the ecological significance of bioaccumulated compounds. ORD intends to undertake research to determine the tissue residue levels of contaminants in fish and invertebrates which result in both death and sublethal effects such as reproductive impairment. Because they rely on internal doses rather than external pollutant concentrations, tissue residue thresholds avoid the errors inherent in predicting the bioavailable fractions of sediment contaminants. Tissue residue threshold levels would be used to identify the toxic agents in sediments with multiple contaminants, derive wasteload allocations based on existing tissue residues, and generate insight into pollutant interactions.

10.2.7 Evaluation of the Effects of Multiple Sediment Contaminants

To allow prospective risk assessments, one must be able to project biological effects based on exposure information in the form of measured concentrations of individual substances or mixtures of contaminants in sediments or interstitial water. The equilibrium partitioning-based sediment quality criterion for metals discussed above is an example. Knowledge of the sediment phases that control biological availability of sediment contaminants is a prerequisite for predictive approaches that are intended to apply across sediments. ORD is conducting biological testing necessary to confirm that the fundamental chemical theories which identify chemical phases of concern are correct.

ORD is developing Toxicity Identification Evaluation (TIE) procedures for sediment contaminants which rely on the integration of chemical manipulations and toxicity testing of samples in the laboratory. Chemical manipulations are designed to selectively remove, or render non toxic, specific classes of compounds in samples. Samples are tested before and after every manipulation to determine changes in toxicity. Through these procedures, interstitial water can be used as a test fraction for direct identification of chemicals responsible for acute toxicity to aquatic organisms. TIEs have proved to be effective in effluents and porewaters to determine cause and effect toxicity relationships. They have successfully characterized toxicant classes and in some cases identified specific chemicals. Currently, ORD's research effort for TIEs is focused on

developing whole sediment methods. These methods will be more reliable than porewater methods to ascertain the bioavailable portion of toxicity. In some cases, porewater exposures appear to overestimate the toxicity of highly water-soluble compounds and underestimate the toxicity of highly lipophilic compounds. Challenges in developing whole sediment methods include removal, or rendering non toxic, highly lipophilic compounds or metals that are slow-desorbing or tightly bound to sediments. Research still needs to be done in TIE method development for selective removal of metals, nonionic organic compounds, and ammonia; identification of ionic organic compounds; and field validation of methods linking laboratory observations with field effects. In addition, TIEs are only as effective as the endpoint tested. Further research into sensitive, chronic endpoints as well as population/community endpoints compatible with TIEs is needed. Once available, TIEs can help guide the selection of appropriate contaminated sediment remediation strategies, augment post-remediation monitoring, and be used for determining appropriate factors for ecological risk assessment.

10.2.8 Transport and Transformation of Contaminants in Sediments

Many environmentally important contaminants are low-solubility, neutral organic compounds that are highly sorbed on the organic matter associated with sediments. While good predictive tools exist for estimating the magnitude of sorption of contaminants on sediments, comparable tools for estimating the kinetics of the sorption and desorption processes are lacking. The importance of characterizing the sorption/desorption kinetics of contaminants on sediments is highlighted by experimental observations that contaminants take much longer to desorb and enter the aqueous phase than would be predicted based on equilibrium partitioning. For many contaminants, the kinetics of release from sediments will determine the magnitude and duration of sediment biota exposure, thus constituting an important exposure link to the food web.

The nature of the effect of sorption on the transformation of organic compounds in soils and sediments has been an enduring problem in environmental science. A number of studies have indicated that sorption decreases organic compound availability for microbial reductive transformations. Although the effect of sorption on abiotic reductive transformations has not been as thoroughly investigated, the limited data set suggests that abiotic reductions are also inhibited by sorption. ORD is conducting research that will include experimental and modeling work to improve the understanding of the sorption/desorption kinetics of contaminants on sediments. The ultimate goal of this work is to develop *a priori* techniques for estimating the sorption/desorption kinetic constants for contaminants on sediments.

Research is also being conducted to elucidate the factors that control the kinetics of reduction in sediments. Such studies will provide the mechanistic foundation for the development of sound quantitative structure-activity relationships (QSARs) for predicting reduction rates for contaminants in anoxic environments. Eventually, experimental techniques for evaluating the effect of sorption on the reaction kinetics of contaminants in sediments will be developed and also sorption and transformation models will be developed and evaluated for their utility in describing field and laboratory data.

10.2.9 Routes of Biological Exposure

All methods of generating sediment quality criteria require assumptions about the routes of biological exposure and their relative importance in relation to equilibrium conditions. ORD intends to undertake research to evaluate the importance of different routes of exposure in relation to biological variables such as feeding and burrowing behavior of organisms, chemical partitioning behavior, and sediment characteristics. It is expected that this research will produce techniques for incorporating various routes of sediment contaminant uptake by benthic organisms into the derivation of sediment quality criteria.

10.2.10 Indicators of Individual and Population Exposures

As part of estimating and projecting risks to valued ecological resources in streams, harbors, wetlands, and estuaries, the risks posed by contaminated sediments relative to the risks sediments pose through habitat modification and nutrient enrichment need to be characterized. Indicator methods to measure environmental exposures are being developed for aquatic, sediment, and terrestrial systems. Research is based on scientific advances at all levels of biological organization (molecular, cellular, organismal, population, and community ecosystem) and links of biological responses to known chemical, physical, and/or biological stressors will be elucidated where possible. Indicator methods development addresses characterization of the sources of relevant stressors and, ultimately, prediction of total exposures to both aquatic and terrestrial ecological systems. This research will provide scientific evaluations of the critical exposures to valued ecological resources for management by all levels of government.

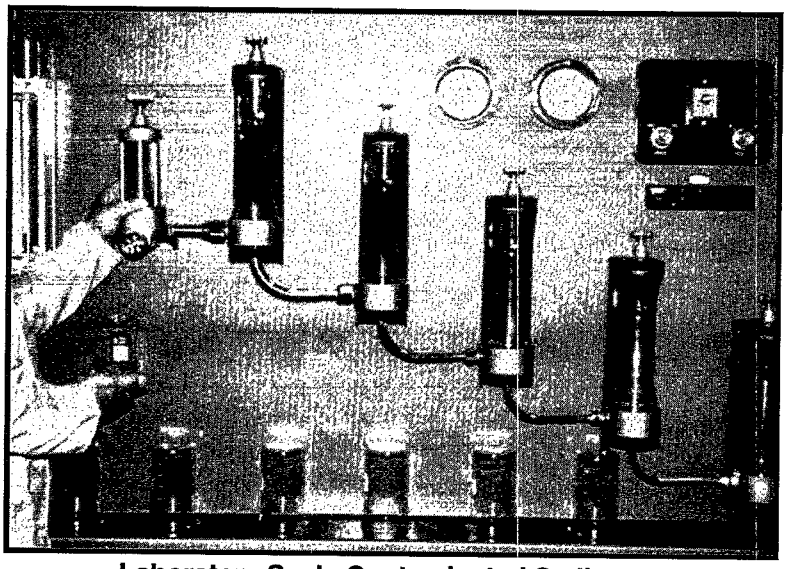
New methods are being developed to measure specific chemical exposures for use in both short-term, site-specific studies and regional, multiple-scale assessments. Cellular and biochemical measurements are used to show that xenobiotics are bioavailable to ecosystem residents and in most cases can be used to establish levels of exposure, thereby facilitating fate and transport

modeling of chemical species between sediment and surface waters. Statistical analyses will be performed to link habitat and toxic stressors with metrics collected for benthic invertebrate, fish, periphyton, and mussel assemblages. Conceptual models will then be created to show how numerous varying measurements can demonstrate exposures.

10.3 DEVELOPMENT AND VALIDATION OF SEDIMENT QUALITY CRITERIA FOR MARINE AND FRESHWATER SYSTEMS

10.3.1 Development of Sediment Quality Criteria for Nonionic Organic Chemicals

In 1994, EPA noticed the publication of draft Sediment Quality Criteria for the Protection of Benthic Organisms for five non ionic organic contaminants: Dieldrin, Endrin, Acenaphthene, Fluoranthene and Phenanthrene in the Federal Register. EPA is currently finalizing the Dieldrin and Endrin documents. In response to public comment and additional research conducted over the past two years, EPA will withdraw the three PAH documents. Over the next year the Agency will be preparing, for peer review and public comment, a document that addresses mixtures of PAHs. In addition, EPA plans to publish a Response to Public Comments Document and a Technical Support Basis Document which provides the technical basis for deriving sediment quality criteria for nonionic organics for both freshwater and marine sediments using the equilibrium partitioning approach.



Laboratory Scale Contaminated Sediment Remediation Project

Also under development is a *User's Guide for Multi-Program Implementation of Sediment Quality Criteria in Aquatic Ecosystems,* which is intended to provide useful information to users of sediment quality criteria from a variety of environmental programs. The SQC User's Guide will contain technical information on the equilibrium partitioning approach for deriving sediment quality criteria and its relationship to other methodologies used to evaluate sediment quality as well

as case studies. It will also provide implementation guidance to clarify how sediment quality criteria values can be used in the following programs: Water Quality Standards, NPDES permitting, Superfund (site assessment and remediation), and RCRA site investigations. The draft User's Guide will be submitted for public review and comment.

10.3.2 Development of Sediment Quality Criteria for Metals

In January 1995, the SAB reviewed research and data to support the use of acid volatile sulfide (AVS) and interstitial water concentrations of cadmium, copper, lead, nickel, and zinc to predict the bioavailability of these metals in sediments. In this approach, AVS, a principal binding phase for divalent metals, is quantified using a cold acid extraction method. The simultaneously extracted metals (SEM) from this cold acid extraction are compared to the concentration of AVS. If the molar concentration of AVS is greater than the molar concentration of SEM, the sediment is predicted to be non toxic with respect to these five metals. Based on its review and knowledge of the literature, the SAB concluded that the SEM/AVS approach is the best technology available for assessing the significance of the five metals in sediments. They also found that the SEM/AVS methodology is based on sound theory and has been verified by considerable experimental evidence. They did, however, identify some limitations to the application of the methodology and additional research that will be required to support the development of metals criteria. A complete discussion of the SAB's findings and recommendations is published in a report entitled *An SAB Report: Review of the Agency's Approach for Developing Sediment Criteria for Five Metals,* (EPA-SAB-EPEC-95-020, 1995).

Based on the SAB recommendations, the Agency is moving forward in developing the proposed sediment criterion for the five metals, providing the technical assistance necessary to support their appropriate implementation, and the research necessary to address limitations to the current knowledge and applicability.

10.3.3 Field Validation Studies for Sediment Quality Criteria

To validate the equilibrium partitioning approach on which the proposed sediment quality criteria are based, ORD is conducting field and laboratory studies. ORD has selected a variety of field sites to verify sediment criteria and other sediment assessment methods. At selected sites, contaminant concentrations, sediment toxicity, bioaccumulation, and alterations of benthic communities will be investigated along sediment pollution gradients. Levels of sediment contamination will be compared with sediment criteria to identify sites where adverse ecological

effects would be predicted by the criteria. The actual condition of the benthic community, degree of sediment toxicity, extent of bioaccumulation, and partitioning of contaminants among phases will then be compared with predicted conditions. Based on these studies, benthic and fish assemblages at the population, community, and ecosystem levels will be used to evaluate the efficacy of sediment criteria to protect benthic and fish assemblages.

Biological effects elicited by some sediment contaminants are associated with accumulation of the contaminant in the biota. Progress is being made in predicting the bioaccumulation of nonionic organic chemicals in benthic organisms through the use of biota-sediment accumulation factors (BSAFs), the lipid-normalized concentration in organisms divided by the organic carbon normalized concentration in the sediment. These BSAFs provide a link between sediment contaminant levels, observed effects, and associated tissue residue concentrations. Currently BSAF theory is being examined for its limitations with respect to contaminant concentrations.

10.4 DEVELOPMENT AND EVALUATION OF CONTAMINATED SEDIMENT RISK MANAGEMENT STRATEGIES

10.4.1 Remediation Methods for Contaminated Sediments

Sediments requiring treatment, or some other risk management approach, may be the result of historical or continuing pollution that may have led to the contamination of sediments in a river, lake, or harbor. These sediments may serve as a significant continuing source of organic contaminants in many freshwater and marine ecosystems. Removal and/or treatment of the sediments may be necessary in order to guarantee the future health of the ecosystem. In the course of keeping shipping and docking channels open, sediments may be dredged which are considered too contaminated for open water disposal.

Characteristics unique to sediments present numerous difficulties for existing remediation technologies developed principally for contaminated soils. These characteristics (e.g., high moisture content, small particle size, and significant organic fraction), coupled with the relatively low contaminant concentrations and large volumes requiring treatment, may make some technologies impractical from either an operational or economic point of view. For that subset of technologies which could handle these sediment characteristics, a number were tested at the bench and/or pilot scale. The testing of these technologies showed that they were effective in treating sediments, but the cost of such treatment was generally more than it would be for a similarly contaminated soil.

In addition to evaluating the effectiveness of existing technologies developed primarily for soil treatment, ORD is developing and evaluating innovative and cost-effective risk management approaches specifically for contaminated sediments. The following are areas where ORD intends to focus its remediation research: development and/or evaluation of treatment and containment approaches to *in situ* management—specifically development of technologies for removal, recovery, and eventual reuse of metals from sediments; development and/or evaluation of technologies for containing and treating contaminated sediments within confined disposal facilities (CDFs); research into the fate and transport of contaminants in sediments—specifically how intrinsic processes influence risk management decisions; and development and/or evaluation of affordable *ex situ* technologies for the treatment of maintenance-dredged contaminated sediment.

ORD's research activities consider both freshwater and marine sediments and address hydrophobic organic contaminants, such as PCBs and PAHs, as well as heavy metals. EPA and the COE will cooperate on some of the research efforts related to treatment of dredged materials.

ORD is also doing research aimed at reducing the load of contaminants to urban waterways. In many cases, these contaminants eventually partition to sediments where they can pose long-term risks to aquatic ecosystems. In addition, remediation of contaminated sediments is also being evaluated as a necessary part of the restoration of aquatic ecosystems.

The National Research Council's (NRC's) Commission on Engineering and Technical Systems has convened a Committee on Contaminated Marine Sediments. The committee assessed the Nation's capability for cleaning up and remediating or managing contaminated marine sediments. The public NRC report (National Research Council, 1997) on this subject: 1) assesses the best management practices and current and emerging technologies for remediation that have been identified and tried for reducing adverse environmental impacts of contaminated sediments; 2) identifies and appraises interim control measures to be used at contaminated sediment sites, determining their applicability to classes of problems, their affordability, and practicality; 3) addresses how information about risks, costs, and benefits can be used and communicated to guide decision-making concerning the management of contaminated sediments; and 4) assesses existing knowledge and identifies research needs that are critical for enhancing the use of existing technologies in contaminated sediment management and in developing new technologies. EPA will carefully consider the findings of the NRC report as the Contaminated Sediment Management Strategy is implemented.

10.4.2 Resiliency and Natural Attenuation of Aquatic Benthic Ecosystems

As stated in this Strategy, EPA will consider a range of risk management alternatives to reduce the volume and effects of existing contaminated sediment, including in-situ containment, contaminated sediment removal, and natural attenuation. To assist the EPA program offices in developing criteria for determining when natural attenuation is the appropriate remedial alternative, ORD intends to conduct research to determine the rates of recovery of benthic communities under different environmental conditions and stresses. Factors which control recovery rates would be identified (e.g., community type, physical factors, and types of stress). Intact benthic communities would be studied in microcosms receiving uncontaminated water; research would include monitoring rates of recovery at selected field sites.

10.5 COMPLETION OF RESEARCH AND TECHNOLOGY TRANSFER

10.5.1 ORD Clients

In completing the research described in this Strategy, ORD will work closely with its clients to ensure that the methods, tests, and models it develops are useful to EPA program offices and other identified users of research products. ORD will draw upon the technical expertise available in other government agencies, academia, and industry. Major clients who will use ORD research products include the EPA program offices, EPA Regional offices, the Great Lakes National Program Office, the Gulf of Mexico Program Office, National Estuary Program Management Conferences, the Chesapeake Bay Program, and State and local regulatory agencies. In addition, other Federal agencies including the COE, NOAA, USFWS, and USGS, will use ORD research results. ORD will coordinate its research programs with the ongoing activities of these clients.

10.5.2 Technology Transfer

ORD intends to take the following actions to ensure that the results of its contaminated sediment research programs are available to users:

1. ORD intends to sponsor, and cosponsor with the EPA program offices, workshops and training sessions on such topics as remediating contaminated sediments, use of sediment bioassays, and the use of various sediment contaminant transport and partitioning models.

2. ORD intends to publish research results in peer-reviewed scientific, technical, and engineering journals.

3. ORD scientists and engineers intend to present research results at platform and poster sessions at major national and international conferences and at workshops.

4. ORD intends to work with OST to provide regulatory agencies and the regulated community with methods and protocols for assessing and remediating contaminated sediments.

11. OUTREACH STRATEGY

Outreach is a critical component of EPA's Contaminated Sediment Management Strategy. Public understanding of the ecological and human health risks associated with sediment contamination, and of solutions to the problem, is key to successful implementation of this Strategy. OST therefore intends to initiate an outreach program in support of Strategy objectives. In implementing the outreach program, EPA will draw upon the experiences of successful outreach efforts in the Chesapeake Bay Program, the Great Lakes Program, the Gulf of Mexico Program, the NEP, EPA public-private partnership programs, and the RCRA public outreach program.

Chapter Highlights

- Communication Themes
- Coordination and Alliances with Other Agencies, Industry, and the Public
- Target Audiences for Outreach
- Outreach Activities and Principles

The primary goal of EPA's outreach program for this Strategy is to educate key audiences about the risks, extent, and severity of contaminated sediments, the role of the Strategy in solving contaminated sediment problems, and the way in which stakeholders will be involved in Strategy implementation. The outreach program described below has four key elements: 1) defining key Strategy themes or messages; 2) identifying target audiences and needs; 3) developing appropriate materials such as guidance documents, brochures, and videos; and 4) providing channels to facilitate two-way communication on Strategy issues.

11.1 COMMUNICATION THEMES

Four themes of the strategy, closely linked to the Strategy's goals, will be conveyed by EPA to target audiences through outreach activities described below. The first theme is that sediment contamination comes from many sources, which must be identified, and that source control options must be evaluated according to risk reduction potential and effectiveness. The second theme is that sediment contamination poses threats to human health and the environment. The risks must be identified and effectively communicated to the public. Third, sediment contamination can be effectively managed through assessment, prevention, and remediation. And fourth, EPA's strategy for managing contaminated sediment relies on interagency coordination and building alliances with other agencies, industry, and the public.

EPA's Outreach Strategy is built around four communication themes.

11.2 INTERAGENCY COORDINATION AND ALLIANCES WITH OTHER AGENCIES, INDUSTRY, AND THE PUBLIC

Communication with other Federal, State, and local agencies and industry will be an important part of EPA's outreach program. EPA's outreach program will be designed to ensure that all agencies effectively characterize the risks of sediment contaminants; consistent assessment and sediment testing methods are applied; consistent decisions are made at the Federal, State, and local levels; and optimal use of financial and technical resources occurs.

EPA will also work with other Federal agencies to promote remediation and prevention practices consistent with the Contaminated Sediment Management Strategy. These agencies will include USDA, U.S. Department of Transportation (DOT), DOD, and DOE. EPA will develop memoranda of understanding and agreement with these and other agencies to promote these practices.

11.3 TARGET AUDIENCES FOR OUTREACH

To effectively implement the outreach plan, EPA will seek to communicate with large and highly diverse audiences, educate and involve the general public in EPA's decision-making processes, and target information to both broad audiences as well as subgroups within those audiences. In designing and targeting its outreach messages, EPA will determine the information needs of each audience by assessing the extent of its knowledge about the topic. The positions and concerns of the audience about the topic will be determined as well as the audience's level of interest, and methods to increase interest and attention will be developed. It will be necessary to determine whether the primary purpose of EPA's message is to inform the audience, change its attitude, or to encourage the audience to take action.

In assessing and managing contaminated sediments, EPA intends to continue to improve coordination of research and regulatory activities among other Federal agencies, State agencies, international organizations, and private parties.

The audiences that EPA will target to receive its outreach materials and messages are to be categorized as follows:

1. The general public.

2. Environmental and public interest groups.

3. The scientific community, including academia, laboratories, and professional societies.

4. Congressional representatives and government groups.

5. Federal agencies, including the COE, DOE, DOD, DOT, USDA, and other agencies whose policies and operations directly contribute to the Strategy or affect its goals.

6. State and local agencies.

7. EPA Regional and Headquarters personnel.

8. The regulated community, including businesses and industrial trade associations, POTWs, and the agricultural community.

9. News media, including printed media, television, radio, trade and industry journals, and environmental magazines.

11.4 OUTREACH ACTIVITIES

Outreach activities to support implementation of the Strategy will be coordinated by OST, but will include actions taken by a number of different EPA program offices.

11.4.1 Regulatory Actions and Guidance Documents

EPA intends to prepare guidance documents and reports in support of the Agency's regulatory requirements and policies for contaminated sediment assessment, prevention, and remediation. Guidance documents and reports will focus on issues such as sediment quality assessment methodologies, sediment toxicity testing methods, use of sediment quality criteria, assessment of human health and ecological risks of sediment contamination, and Superfund contaminated sediment remedy selection. EPA's initial outreach efforts will focus on preparation of the following guidance documents and reports:

1. OST and ORD are preparing guidance documents on methods to be used by all EPA program offices in conducting standardized sediment toxicity tests. The offices have published guidance documents on acute bioassays and bioaccumulation tests,

and intend to publish documents on chronic sediment toxicity test methods. EPA also intends to continue developing other methods beyond those currently available.

2. OST and OERR will prepare guidance documents on evaluating and selecting techniques for remediation of contaminated sediment. ORD and other EPA offices intend to develop guidance documents on technologies for contaminated sediment remediation.

3. OST and OWM intend to develop guidance for deriving NPDES permits that protect sediment quality.

4. OST intends to provide technical support on the use of models for sediment quality-based NPDES point source permits.

5. EPA intends to develop guidance for nonpoint source controls to help prevent sediment contamination from nonpoint sources of pollution.

6. EPA intends to develop guidance on regulatory and associated enforcement actions to address contaminated sediment source control and remediation.

7. OST intends to develop guidance on designing and implementing monitoring programs for sediment contaminants. The office also is developing a technical basis document on sediment sampling, handling, and manipulation.

8. EPA intends to develop guidance for trade associations on pollution prevention issues, including the contamination of sediments from point and nonpoint sources of pollution.

9. In 1997, EPA produced the first *National Sediment Quality Survey Report to Congress* identifying sites and sources of sediment contamination as required by WRDA. EPA plans to update the report biennially and, as part of the biennial update, produce status reports on sediment management activities.

10. Within the Great Waters Program, EPA will continue to assess environmental and human health effects attributable to atmospheric deposition on waters of the United States. In June 1997, EPA completed the *Deposition of Air Pollutants to the Great*

Waters, Second Report to Congress (U.S. EPA, 1997g). The presence of pollutants in sediments is discussed in the report. EPA will continue to issue periodic reports called for under Section 112(m) of the CAA.

11.4.2 Outreach Publications

Aquatic Vegetation

EPA intends to prepare outreach publications and support other agencies in developing their own technical and general audience publications on sediment contamination. EPA intends to develop journal articles, pamphlets, brochures, fact sheets, slide shows, and other multimedia materials to inform a variety of technical and nontechnical audiences about issues and problem solutions related to sediment contamination. These materials would be distributed through advertising in bulletins such as the Contaminated Sediments News or at public meetings, workshops, and national conferences on pollution prevention or contaminated sediment.

11.4.3 Advisory Groups, Databases, Clearinghouses, and Other Activities

EPA intends to take the following actions to establish advisory groups, databases, clearing houses, and other programs in support of the Contaminated Sediment Management Strategy:

1. EPA intends to re-establish the Sediment Steering Committee to oversee implementation of the Agency's Contaminated Sediment Management Strategy. In this role, the committee will track and monitor all aspects of strategy implementation. Documentation of Agency-wide contaminated sediment activities will be included in the biennial *National Sediment Quality Survey Report to Congress.*

2. EPA will prepare the *National Sediment Quality Survey Report to Congress* on a biennial basis and will ensure that the report and all underlying data are available to the public.

3. EPA intends to regularly sponsor conferences on contaminated sediments.

4. EPA intends to hold a series of workshops to educate the public about the risks of sediment contamination.

5. EPA intends to submit scientific and technical guidance and related materials to ad hoc expert peer review or to SAB for review. SAB reviews will be announced in the Federal Register as well as other relevant EPA publications.

6. EPA will continue to publish a newsletter three times a year to promote information exchange among EPA Headquarters, Regions, and other agencies involved with contaminated sediments and related activities, including dredging. The newsletter, Contaminated Sediments News, is distributed to a large mailing list of readers and recently became available on the Internet at http://www.epa.gov/ost.

11.5 OUTREACH PRINCIPLES

EPA recognizes that implementation of the Contaminated Sediment Management Strategy must be a partnership among many organizations. EPA will therefore adopt a number of principles to implement its contaminated sediment management outreach program.

1. EPA will involve the public, including the private sector as well as the general public, as early as possible in the strategy planning process. Community participation will be emphasized.

2. EPA will clearly state its expectations for sediment clean-up efforts at the outset of program implementation. Issues such as cost, the time frame for clean-up, and how local situations compare to sediment clean-up efforts nationwide will all be addressed in the initial planning stages of clean-up efforts.

3. EPA will focus on "keeping the momentum" going with respect to citizen involvement. Short-term goals will be created to highlight accomplishments.

4. Wherever possible, EPA will tie the issue of sediment contamination to tangible effects such as fish consumption advisories.

5. EPA will demonstrate the Agency's commitment and accountability to sediment management efforts through consistent involvement of the public in reviewing major actions under the Strategy.

6. EPA will utilize existing information networks and communication systems as mechanisms for public involvement and information dissemination.

7. EPA will provide guidance, information, and support to the States but will, where possible, allow the States flexibility in making decisions and adapting the outreach information to local conditions.

8. EPA will prepare written materials and guidance on sediment contamination, but will also use workshops and face-to-face contact in disseminating information.

9. EPA will provide the public with a balanced risk framework that is understandable and includes information about comparative risks.

10. EPA will provide public information at a level of detail that allows the public to formulate decisions.

11. EPA will work toward building consensus among all of its audiences.

12. EPA will work toward developing a management framework of institutions that will be self-sustaining and will carry the work of sediment management into the future.

12. CASE STUDIES

Well-documented cases of human health and ecological effects caused by sediment contamination have been published in the peer-reviewed literature. This section contains a few case examples that reflect both human health and ecological effects which may be expected at sites where severe sediment contamination is evident.

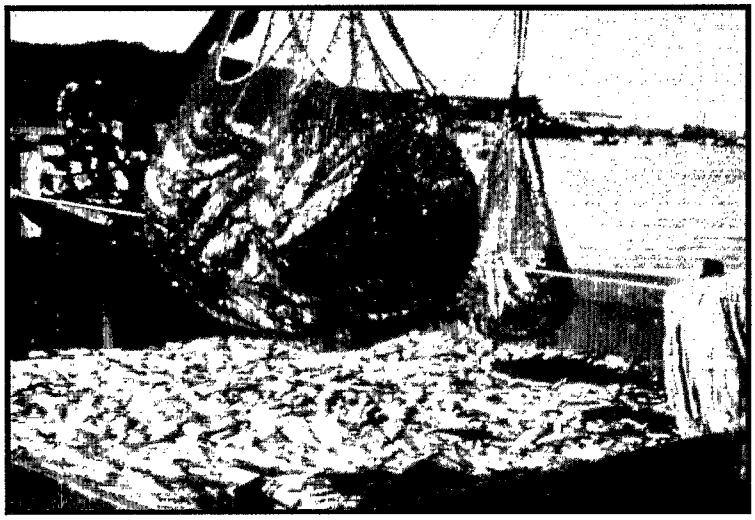
12.1 CASE STUDIES OF HUMAN HEALTH RISKS

For the purposes of this Strategy, risk is defined as the probability of harm or likelihood of an adverse consequence or effect caused by the presence of contaminants in the environment. Various EPA programs have different acceptable risk levels, generally ranging from 10^{-4} to 10^{-6}. Therefore, "unacceptable risk" determinations must be made on a program-specific basis.

Chapter Highlights

- Human Health Risks
- Ecological Effects/Risks

In 1987, EPA completed a study entitled *Unfinished Business: A Comparative Assessment of Environmental Problems* (U.S. EPA, 1987b). Toxic chemicals in sediments, included as a category of nonpoint source pollution, were ranked as the eleventh most significant environmental problem of 32 identified in the report. In 1989, EPA Administrator William Reilly asked the SAB to review *Unfinished Business*. The SAB is a public advisory group that provides scientific information and advice to EPA. In a report entitled *Reducing Risk: Setting Priorities and Strategies for Environmental Protection,* SAB supported EPA's ranking of the human health risks posed by contaminated sediments (U.S. EPA, 1990b). In this report, SAB indicated that cancer and non-cancer illnesses can be caused by bioaccumulation of toxic chemicals from sediments in fish and shellfish which are then consumed by humans. Both EPA and SAB gave contaminated sediments a medium risk score as a causative agent of non-



Commercial Fishing Operation

cancer illnesses. SAB judged that consumption of contaminated fish posed a low cancer risk, but noted that bioaccumulation in fish of chemicals in contaminated sediments was the primary route of human exposure to carcinogens in surface waters.

In comparative risk analyses performed by EPA Regions 1, 2, 3, 5, and 10, sediment contamination was given a medium-high score for cancer risks to consumers of fish and shellfish (U.S. EPA, 1989c). Since actual risks may be higher for certain ethnic groups due to fish consumption patterns, environmental justice concerns have been raised in certain parts of the country. In 1996, there were 2,193 waterbodies with fish consumption advisories in the United States, with sediments identified as a potential source of contamination at many sites. This number of advisories is a 26 percent increase from 1995 and a 72 percent increase since 1993.

12.1.1 Quincy Bay and New Bedford Harbor, Massachusetts

In June 1988, EPA released a report, completed at the request of Congress, entitled *Assessment of Quincy Bay: Summary Report* (U.S. EPA, 1988b). The study investigated the types and concentrations of pollutants in Quincy Bay, Massachusetts; the incidence of abnormalities in marine life; and the potential public health implications of consumption of seafood exposed to contaminated sediments. Study results indicated that levels of PCBs, polycyclic aromatic hydrocarbons, and metals were elevated in sediments and in the marine species studied. Winter flounder and soft-shelled clams were found to exhibit an extremely high incidence of conditions believed to be associated with environmental stress: cancerous lesions; liver, intestinal, and pancreatic pathologies; and neoplasms.

The human health risk assessment concluded that regular consumption of tomalley (hepatopancreas) from Quincy Bay lobsters posed a high cancer risk. The maximum upper bound estimated lifetime cancer risk for the maximally exposed individual consuming a mixed diet of clams, flounder, lobster meat, and lobster tomalley from Quincy Bay was calculated to be 2.3×10^{-2} (U.S. EPA, 1988b). The lifetime cancer risk of a typical local consumer of the same mixed diet was calculated to be 1.3×10^{-3} (U.S. EPA, 1988b).

At the New Bedford Harbor Superfund site in Massachusetts, PCB concentrations in sediments range from a few parts per million (ppm) to over 100,000 ppm. PCB levels as high as 10 ppm in fish tissue have been measured in certain areas at the site; 10 ppm is five times the FDA's action level of 2 ppm for PCBs. Thousands of acres have been closed to the harvesting of shellfish, finfish, and lobsters since New Bedford Harbor's appearance on the NPL in 1982. Many

individuals regularly consumed seafood from the area before the extent of contamination was known, however, and some residents still harvest both finfish and shellfish for personal consumption.

A human health risk assessment was conducted for consumption of lobster, flounder, and clams using an 8 ounce meal size (G. Garman, 1993). PCB levels in edible lobster tissue (including tomalley) of 2.3 ppm produced a lifetime cancer risk of 1×10^{-2} for weekly consumption (52 meals/year) and 2.5×10^{-3} for monthly consumption (12 meals/year). PCB levels in flounder tissue of 0.37 ppm produced a lifetime cancer risk of 1.7×10^{-3} for weekly consumption and 3.9×10^{-4} for monthly consumption. The fish were taken from an area of intermediate contamination. PCB levels in clam tissue of 0.23 ppm produced a lifetime cancer risk of 1.1×10^{-3} for weekly consumption and 2.4×10^{-4} for monthly consumption.

12.1.2 Puget Sound, Washington

Another comprehensive study was completed on consumption of seafood taken from Puget Sound (Puget Sound Estuary Program, 1988). A high background incidence of cancer was observed and it was determined that 25 percent of the individuals in the Puget Sound region would develop cancer during their lifetimes. The health risk assessment predicted that two additional cases of cancer would be added to the 2,500 cases expected per 10,000 individuals consuming an average quantity of seafood (a risk level of 2×10^{-4}), and 40 additional cases of cancer would be added to the 2,500 expected per 10,000 individuals consuming a large quantity of seafood (a risk level of 4×10^{-3}). The principal carcinogens identified in this study were PCBs in fish and polycyclic aromatic hydrocarbons in seaweed.

12.1.3 Los Angeles-Long Beach Harbor, California

Following a risk assessment analysis of toxic contaminants in fish, the California Department of Health Services issued a health advisory concerning the consumption of local sport fish from the Santa Monica Bay, Palos Verdes Peninsula, and Los Angeles-Long Beach Harbor areas (Gossett et al., 1989). Sediments in these areas are contaminated with PCBs, DDT, and DDT metabolites which were discharged in the 1960s and early 1970s. Analysis showed that the bottom-feeding white croaker was particularly contaminated, and cancer risks to the population consuming white croaker were significantly higher than levels generally considered to be acceptable. (Cancer risk levels on the order of 10^{-3} to 10^{-4} were calculated.) In the Los Angeles

area, significantly higher levels of DDT and its metabolites were found in the blood serum of local and sport fishermen who ate their catch than in the blood serum of nonconsumers.

12.1.4 Lake Michigan

In the mid-1970s, PCB levels as high as 20 ppm were found in fish from Lake Michigan (Swain, 1992). Human exposure to PCBs was determined using data from extensive epidemiological studies of two matched cohorts of exposed individuals (Swain, 1988). One cohort consisted of sport anglers, and the other cohort consisted of mothers and their newborn infants. These groups were exposed to significant quantities of PCBs from consumption of contaminated freshwater fish from Lake Michigan.

A 1974 study of 178 adult sport anglers showed that the longer the period of time during which anglers consumed fish from Lake Michigan, the higher their PCB body burdens (Swain, 1988). A study of 991 adults in 1982 showed that persons consuming fish from Lake Michigan had higher PCB body burdens than did non-fish-eating individuals (Humphrey, 1987). Risk analyses were not performed as part of these studies.

A study of mothers and their newborn infants showed that as the period of time over which fish was consumed from the lake increased, so did the mothers' body burdens of PCBs (Swain, 1988). Exposed mothers were found to have increased levels of PCBs in whole blood serum and breast milk. The higher the PCB body burdens, the more intense were the effects exhibited by the infants (Fein et al., 1984; Jacobsen and Fein, 1985). Infants of highly exposed mothers were born at reduced birth rates and reduced gestational ages, had smaller head circumferences, and exhibited neuro-motor effects. A study published in the New England Journal of Medicine showed that children of these mothers had learning and reading difficulties as well as lowered IQ scores (Jacobsen, 1996).

12.1.5 New York

The New York Department of Environmental Conservation's Clean Water Act Section 304(l) list states that contaminated sediments cause more than 20 percent of all river miles in New York to fail to meet their designated uses under CWA authority. Many of New York's major rivers are affected, including the entire 38-mile length of the Niagara River, the entire 109-mile length of the St. Lawrence River lying in New York, and the entire 180-mile reach of the Hudson River from Fort Edward in the Upper Hudson to the Battery at Manhattan. The sediment

contaminants identified include DDT, chlordane, and mercury. Fish consumption advisories or bans have been issued for several or all species at each site.

Based on site-specific assessments of contaminants in fish, about 30,000 acres of New York's lakes are also a problem for fish consumers. Fish consumption advisories have been issued for these waters. In addition, all fresh waters and some marine waters at the mouth of the Hudson River are under a fish consumption advisory to protect against contaminants that have not been tested. These contaminants include PCBs, mercury, chlordane, dioxin, and others.

12.1.6 Pago Pago, American Samoa

In 1991, the American Samoan government issued a public health directive instructing the public not to eat any fish or shellfish caught in inner Pago Pago Harbor. A ban on the sale of fish from the inner harbor was also issued. The directive was based on the results of a study which examined chemical concentrations in water, sediment, and fish (American Samoa Department of Health, 1991). Sediments were reported to be highly contaminated with PCBs, oil and grease, and heavy metals.

EPA Region 9 analyzed the data for health risks and identified the following risks of greatest concern: 1) Potential brain damage. If lead contamination alone were considered, lead concentrations in fish could reach levels that would cause 70 percent to 80 percent of children who regularly eat 3 to 4 fish meals per week to suffer a permanent reduction in intelligence. 2) Increased cancer risk. Consuming fish from the inner harbor at a rate of 3 to 4 fish meals per week over a lifetime would significantly increase the risk of cancer due to arsenic contamination. 3) Increased non-cancer health risks. Using a hazard index in which non-cancer health risks occur at levels greater than a value of "1," EPA Region 9 calculated the hazard index at 1-3 for adults consuming inner harbor fish and at 2-3 for children consuming inner harbor fish (Baker, 1993). Ongoing studies of water, sediment, and fish may result in rescinded fish advisories. The greatest risks of concern associated with fish contamination in this case study were identified on the basis of an analysis conducted by EPA's Region 9 office in San Francisco.

12.1.7 Great Lakes

As part of EPA's ARCS Program, baseline human health risk assessments were performed at five Great Lakes Areas of Concern (Crane, 1996). A variety of exposure pathways were examined in conducting these risk assessments. The predominant carcinogenic risks at all five

sites resulted from the consumption of contaminated fish. This study provided a comparison of the risks associated with consuming fish from the Ashtabula River, OH; Buffalo River, NY; Grand Calumet River, IN; Saginaw River, MI; and Sheboygan River, WI. Each of these locations has a significant contaminated sediment problem, with elevated concentrations of organics and metals.

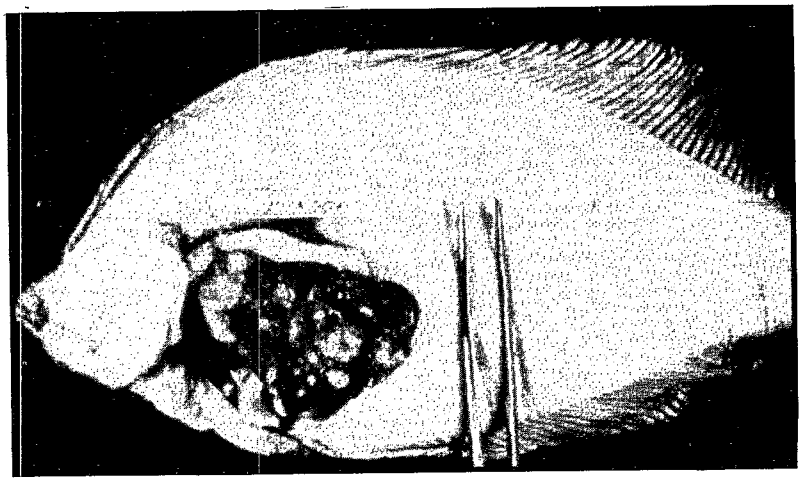
Anglers and their families were at risk of developing cancer over their lifetime as a result of consuming certain fish species from each area of concern. For anglers consuming a typical fish diet (19.2 grams per day), the probability of developing cancer exceeded one person in 1 million (i.e., 1×10^{-6}) for most cases. The carcinogenic risks increased by approximately an order of magnitude for recreational anglers (54 grams per day). People who relied on fish as a subsistence diet (132 grams per day) increased their risk an additional order of magnitude over recreational anglers.' In calculating these risks, it was assumed that only a portion of the total fish consumed was contaminated fish from the AOC. The risks obtained from this study should be used in a relative fashion to compare the risks between different sites and different rates of fish consumption, more so than as absolute numbers. The first risk estimates must be interpreted in the context of all the uncertainties associated with each step in the risk assessment process.

12.2 CASE STUDIES OF ECOLOGICAL EFFECTS/RISKS

In the SAB and EPA Regional comparative risk studies, contaminated sediments received a high score for their potential to cause adverse ecological effects on both local and regional scales. The studies also determined that the "recovery period" for areas with sediment contamination may be decades or longer. Several documented cases of adverse ecological effects due to contaminated sediments are presented below.

12.2.1 Elizabeth River, Virginia

The Elizabeth River is a subestuary of the Chesapeake Bay and is heavily contaminated with a variety of pollutants, particularly PAHs. Sediment gradients of PAHs were measured in the following studies: Hargis et al., 1984; Bieri et al., 1986; and, O'Connor and Huggett, 1988. Examination of



Tumor in Flat Fish (Flounder)

benthic communities in the Elizabeth River suggests that contaminated sediments have adverse effects. Uptake of organic compounds in fish has been observed by assaying bile from exposed fish. Bioaccumulation of PAHs in commercially fished, resident crabs has also been documented. In addition, the frequency and intensity of neoplasms, cataracts, enzyme induction, finrot, and other lesions observed in fish populations (mainly Leiostomus xanthurus, spot) have been correlated with the extent of sediment contamination (Van Veld et al., 1990). Laboratory studies have been conducted to elucidate whether the sediments were responsible for the observed effects (Van Veld et al., 1990). Fish maintained in the laboratory in contact with sediments taken from the Elizabeth River exhibited several of the symptoms observed among fish populations in the field. Additional laboratory studies have implicated contaminants from sediments as causal agents for other effects, such as immune system dysfunction.

12.2.2 Commencement Bay, Washington

Field and laboratory studies were the basis for a comprehensive assessment of ecological risks caused by toxic sediments in Commencement Bay (U.S. EPA, 1993c). Using amphipod and oyster larvae bioassays, investigators determined that sediments from 24 of 52 stations caused significant toxicity compared to a reference area. Benthic infauna measurements were also used to determine chronic effects. This investigation was the basis for one of the case studies reviewed by EPA's Ecotoxicity Subcommittee charged by the Agency's Risk Assessment Council with responsibility for the development of ecological risk assessment guidelines.

12.2.3 Great Lakes

In the Great Lakes, PAH contamination of sediments has been linked to increased incidence of tumors in certain fish (Baumann, 1989). Brown bullheads from the industrialized Black River in Ohio exhibited higher levels of organic contaminants, particularly PAHs, and a higher incidence of skin, liver, and lip tumors than bullheads taken from a nearby reference site (Baumann et al., 1987). By applying criteria established for human epidemiological studies to the data from numerous reports on the Black River, a cause-and-effect relationship can be determined between the presence of PAHs in the sediment and the occurrence of liver cancer in native fish populations (Baumann et. al., 1987). In 1990, PAH-contaminated sediments were dredged from the Black River. Additional work by Baumann demonstrated a short-term but dramatic increase in liver cancer in the brown bullhead population in the river coinciding with the dredging. This appears to have peaked in 1992, and preliminary data indicate that the tumor incidence rate is declining.

Also in the Great Lakes region, organochlorine contaminants have been linked to reproductive problems in Forster's tern and to reproductive failure and mortality in mink. The reproductive success of Forster's terns inhabiting contaminated Green Bay on Lake Michigan was significantly lower than that of terns inhabiting relatively uncontaminated Lake Poygan in Wisconsin (Kubiak et al., 1989). Reproductive failures have been linked to intrinsic factors (e.g., egg viability) and extrinsic factors (e.g., parental attentiveness), both of which are affected by sediment contaminants. Reproductive problems in mink were first reported in the 1960s at mink farms that fed the mink Great Lakes fish; high levels of PCBs in the fish were identified as the cause (Auerlich et al., 1973). These two examples are indicative of the risks to fish-eating birds and mammals posed by a PCB-contaminated food chain, and may provide clues to explain why certain fish-eating birds and mammals may have disappeared or become rare in ranges where they were historically found.