Chapter 3

Methodology

This chapter documents the methodology EPA used to prepare this Report to Congress. It presents EPA's study objectives and analytical approach, and summarizes the steps EPA has taken to compile information on the impacts and control of CSOs and SSOs. This chapter describes EPA's data sources, explains information collection methods, and outlines the steps EPA took to involve stakeholders in the development of this report. The chapter also summarizes data considerations and quality assurance measures used to enhance the accuracy and precision of results.

3.1 What Study Objectives and Approach Did EPA Use to Prepare this Report?

The overall objective for this report is to respond to Congress with a current characterization of the volume, frequency, and location of CSOs and SSOs; the extent of human health and environmental impacts caused by CSOs and SSOs; the resources spent by municipalities to address these impacts; and the technologies used to address these impacts. Some new data were obtained through interviews in the development of this report, but EPA did not undertake surveys or field monitoring to characterize CSOs, SSOs, and their impacts. Instead, EPA primarily emphasized the collection, compilation, and analysis of existing data.

EPA used a two-tiered approach to address the questions posed by Congress. The first tier focused on national assessments, drawing on existing data collected by EPA and other federal agencies to the fullest extent possible. These data were supplemented with select data from non-governmental organizations that were also national in scope. The second tier focused on the use of anecdotal data to provide site-specific examples of impacts, costs, and technology applications, and to demonstrate the significance of CSOs and SSOs at the local level. Site-specific examples were largely drawn from state and local interviews and reports.

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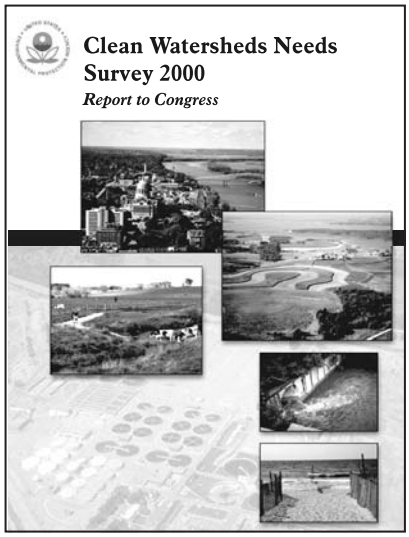


3.2 What Data Sources Were Used?

EPA developed a comprehensive list of potential data sources that could be used to characterize CSOs and SSOs, including environmental and human health impacts from the discharges, technologies used to control the discharges, and the costs of the control measures. This list included:

- Federal data sources
- NPDES authority and other state program data sources
- Community-level data sources
- Non-governmental organization data sources

The following sections describe specific data sources EPA used to develop this report.

3.2.1 Federal Data Sources

EPA researched its own files and library of CSO- and SSO-related documents for data that could be used to characterize CSOs and SSOs. Data and reports relevant to CSOs and SSOs developed by EPA's permitting, compliance and enforcement, research and development, and water quality assessment programs were among those reviewed. Specific EPA data sources used in the analysis for this Report to Congress include:

Beaches Environmental Assessment and Coastal Health (BEACH) Program. The BEACH Program focuses on improving public health and environmental protection programs for beachgoers and providing the public with information about the quality of beach water.

Clean Watersheds Needs Survey (CWNS). The CWNS summarizes estimated capital costs for water quality projects including projects to control CSOs and SSOs.

Enforcement and Compliance Docket (ECD). The ECD is the central archive for all documents related to EPA's enforcement and compliance activities. It contains regulatory, case settlement, and other policy related information.

EPA's 2001 *Report to Congress–Implementation and Enforcement of the Combined Sewer Overflow Control Policy*. The 2001 Report to Congress provides a comprehensive national inventory of active CSO permits.

Government Performance and Results Act (GPRA). EPA selected the CSO program as a GPRA pilot program for tracking programmatic benefits in 1997.

Municipal Technology Fact Sheets. EPA maintains a series of more than 100 technology fact sheets, including more than 20 with application to the control of CSOs and SSOs.

National Water Quality Inventory (NWQI). The biennial NWQI Report to Congress is the primary vehicle for informing Congress and the public about general water quality conditions in the United States.

Office of Research and Development (ORD) projects. ORD works with industry, universities, and other agencies to develop technologies and

techniques for protecting the nation's freshwater and coastal resources and human health.

Permit Compliance System (PCS). PCS provides information on point sources holding NPDES permits, including permit issuance and expiration dates, discharge limits, and discharge monitoring data.

EPA also researched the programs and files of other federal agencies to ensure that relevant data from other federal programs and activities were assessed and included in this report, as appropriate. The agencies consulted included:

- Centers for Disease Control and Prevention (CDC)
- Congressional Budget Office (CBO)
- Government Accounting Office (GAO)
- National Institutes of Health (NIH)
- National Oceanic and Atmospheric Administration (NOAA)
- United States Geological Survey (USGS)

3.2.2 NPDES Authority and Other State Program Data Sources

Individual NPDES authorities and associated state programs were the primary sources of data on the location of CSO outfalls as well as the frequency, volume, and cause of SSO events. EPA conducted interviews with states to assess the availability of data. State program data and interviews with program staff were also used to identify site-specific CSO- and SSO-related examples of environmental and human health impacts such as fish kills, beach closures, and outbreaks of waterborne disease.

3.2.3 Community-Level Data Sources

EPA identified relevant community-level data to supplement the national data and drew on local planning and monitoring studies, such as CSO LTCPs, to illustrate site-specific impacts and common technologies used to control CSOs and SSOs. Municipalities were interviewed to obtain additional data to characterize the volume, frequency, and constituents of CSO and SSO discharges; to identify the types of controls implemented and results achieved; and to quantify the resources spent.

3.2.4 Non-Governmental Organization Data Sources

EPA also reviewed reports prepared by non-governmental organizations that contained national-level data relevant to the objectives of this report. These included:

- American Public Works Association (APWA)
- American Society of Civil Engineers (ASCE)
- Association of Metropolitan Sewerage Agencies (AMSA)
- The Ocean Conservancy
- Water Environment Federation (WEF)
- Water Environment Research Foundation (WERF)

3.3 What Data Were Collected?

Data collection involved identification and compilation of existing information. The primary data sources for this report were federal databases and reports as well as interviews with states and municipalities. In addition, EPA performed a comprehensive literature search and applied national assessment models, where appropriate.

In compliance with the Paperwork Reduction Act, EPA prepared and submitted Information Collection Request 2063.01, which was approved by OMB on September 16, 2002 (OMB No. 2040-0248).

The following sections describe data collection and the key assessments carried out by EPA.

3.3.1 Characterization of CSOs and SSOs

This report characterizes CSOs and SSOs by addressing the following key questions:

- *What pollutants are in CSOs and SSOs?*
- *What factors influence the concentrations of these pollutants in CSOs and SSOs?*
- *What other point and nonpoint sources might discharge these pollutants to waterbodies receiving CSOs and SSOs?*
- *What is the universe of combined sewer systems?*
- *What are the characteristics of CSOs?*
- *What is the universe of sanitary sewer systems?*
- *What are the characteristics of SSOs?*
- *How do the volumes and loads from CSOs and SSOs compare to those from other municipal point sources?*

To address these questions EPA used NPDES permit files, state databases for tracking CSO and SSO events, and interviews with state and municipal officials. Specific efforts included updating data on the location of CSSs and CSO outfalls from the 2001 *Report to Congress–Implementation and Enforcement of the Combined Sewer Overflow Control Policy* (EPA 2001a), and compiling SSO volume, frequency, and cause data. This allowed assessment of:

- Pollutants found in CSOs and SSOs
- Location of CSSs and individual CSO outfalls
- Volume and frequency of CSOs and SSOs
- Causes of SSOs
- Comparison of pollutant loads from CSOs and SSOs with other municipal point sources

EPA relied on existing Agency data systems wherever possible. These include PCS, the CWNS, and NWQI. EPA data systems were the principal source of information used to locate CSSs, CSO outfalls, and SSSs. Data on the concentration of pollutants found in CSO and SSO discharges were developed from a number of sources, including engineering and scientific literature, EPA studies,

municipal reports including CSO LTCPs, and interviews with municipal sewer system owners and operators. EPA applied the GPRACSO model to calculate the annual volume of CSOs. Documentation of the GPRACSO model is included as Appendix E of this report. EPA used statistical techniques to develop national estimates of the frequency and volume of SSOs based on data reported electronically by states. Documentation of the statistical techniques is included in this report as Appendix G.

3.3.2 Extent of Environmental Impacts Caused by CSOs and SSOs

This report's analysis of the extent of environmental impacts caused by CSOs and SSOs addresses the following key questions:

- *What is EPA's framework for evaluating environmental impacts?*
- *What overall water quality impacts have been attributed to CSO and SSO discharges in national assessments?*
- *What impacts on specific designated uses have been attributed to CSO and SSO discharges in national assessments?*
- *What overall water quality impacts have been attributed to CSO and SSO discharges in state and local assessments?*
- *What impacts on specific designated uses have been attributed to CSO and SSO discharges in state and local assessments?*
- *What factors affect the extent of environmental impacts caused by CSOs and SSOs?*

EPA used federal reports and data as the primary bases for reporting on environmental impacts from CSOs and SSOs on a national level. The assessment included identification of water quality impairments and environmental impacts associated with CSOs and SSOs with respect to:

- Impaired stream segments
- Impaired lakes
- Impaired estuaries
- Impaired ocean shoreline
- Impaired Great Lakes shoreline
- Beach closures
- Shellfish bed closures

EPA also reviewed national resource assessments from NOAA and non-governmental organizations such as the Ocean Conservancy.

CSS location and individual CSO outfall information published in the 2001 *Report to Congress–Implementation and Enforcement of the Combined Sewer Overflow Control Policy* was updated for this Report to Congress by contacting states and EPA regions to confirm active CSO permit data. The data system developed as part of the 2001 report effort contains latitude and longitude information for over 90 percent of the CSO outfalls currently permitted under the NPDES program. Having the latitude and longitude of the CSO outfalls allowed individual permitted outfalls to be associated with specific waterbody segments (called "reaches") within

Water quality data from state 305(b) reports were used in gathering information on the environmental impacts of CSOs.

Photo: P. Macneill

the National Hydrography Dataset (NHD). The NHD is a comprehensive set of digital spatial data of surface water features that enables analysis of water-related data in upstream and downstream order. Associating CSO outfall locations with the NHD-indexed assessed waters allowed for comparison of the outfalls to known impairments reported by states, as required under Clean Water Act Sections 303(d) and 305(b), and to the location of protected resources and sensitive areas. Additional detail on the CSO analysis using the NHD-indexed assessed waters is documented in Appendix F.

SSOs are generally considered unpermitted discharges, and SSO locations are not typically included in NPDES permits. As described in Chapter 4, SSOs occur for a variety of reasons and at many locations within the sewer system, including manholes, roadways, and pump stations. Further, some SSOs discharge to land and not to waters of the United States. For these reasons, it was not possible to conduct a parallel analysis for SSOs using the NHD. EPA, however, did develop a simple model for estimating the likely impact of SSO events on streams and rivers based on reasonable assumptions about SSO event duration, pollutant concentrations, and waterbody characteristics. Additional detail on the model is provided in Appendix H.

National level assessments are unable to convey the circumstances that surround an individual CSO or SSO event, the nature of site-specific environmental impacts, and the consequences with respect to water quality criteria and designated uses. To account for these localized impacts, EPA used state and community-level data to document site-specific environmental impacts including water quality standards violations, shellfish bed closures, and fish kills. These examples are not comprehensive but are presented to illustrate the potential of CSOs and SSOs to cause or contribute to impacts and impairments.

3.3.3 Extent of Human Health Impacts Caused by CSOs and SSOs

This report's analysis of the extent of human health impacts caused by CSOs and SSOs addresses the following key questions:

- *What pollutants are present in CSOs and SSOs that can cause human health impacts?*
- *What exposure pathways and reported human health impacts are associated with CSOs and SSOs?*
- *Which demographic groups face the greatest risk of exposure to CSOs and SSOs?*
- *Which populations face the greatest risk of illness from exposure to the pollutants present in CSOs and SSOs?*
- *How are human health impacts from CSOs and SSOs prevented, communicated, and mitigated?*
- *What factors contribute to information gaps in identifying and tracking human health impacts from CSOs and SSOs?*

- *What new assessment and investigative activities are underway?*

EPA began its effort to document human health impacts from CSOs and SSOs with a literature review. EPA searched on-line databases including PubMed, Toxline, LexisNexis, and the Washington Research Libraries Consortium for relevant reports and articles. A series of waterborne disease outbreak case studies developed from published literature is provided in Appendix I. EPA gathered data on the general incidence and characteristics of waterborne diseases as well as on other impacts associated with the pollutants found in CSO or SSO discharges. The primary source of data on the incidence of waterborne disease in the United States is a joint surveillance system operated by the CDC, EPA, and the Council of State and Territorial Epidemiologists (CDC 2002). Summaries of data collected by CDC are published periodically and divided into waterborne-disease outbreaks resulting from drinking water, recreational waters, or, in some cases, cruise ships. EPA also reviewed reports from non-governmental organizations for data related to human health impacts.

EPA identified experts in the fields of epidemiology, public health policy, and waterborne disease research and invited them to attend a workshop in August 2002. Experts represented EPA, CDC, local health departments, and academia. This workshop did not constitute an advisory committee under the Federal Advisory Committees Act. Rather, it solicited individual expert opinions and provided a forum for information exchange related to this Report to Congress. EPA shared the results of its initial data collection at this workshop, received feedback on and refined the study methodology, and sought to ensure that gaps and redundancies in the research effort did not exist. An abstract of this workshop is provided in Appendix B; the summary of this workshop was published separately (EPA 2002b).

EPA also estimated the illness burden resulting from exposure to CSOs and SSOs at beaches recognized by state authorities using data from the BEACH Program's annual survey (BEACH Survey) and other sources. EPA analyzed data from responses to the 1999-2002 BEACH Surveys including the number of CSO and SSO events, number of swimmers, bacterial concentrations, and CSO and SSO event duration. An illness rate derived by Cabelli et al. (1983) and Dufour (EPA 1984a) was applied to estimate the number of swimmers who contract gastrointestinal illnesses. Additional details describing this methodology are included in Appendix J.

EPA also conducted interviews with public health personnel, including state or territorial epidemiologists and local public health officials. States and communities were selected from each EPA region in an attempt to ensure geographic, climatic, and population variability among communities interviewed. Nevertheless, the sample is intentionally biased, targeting communities that were likely to have health data related to CSOs and SSOs, or that employed noteworthy water quality monitoring or waterborne

disease outbreak tracking techniques. The results of the interviews are provided in Appendix I.

3.3.4 Evaluation of Technologies Used by Municipalities to Address Impacts Caused by CSOs and SSOs

This report's evaluation of the technologies used by municipalities to address impacts caused by CSOs and SSOs addresses the following key questions:

- *What technologies are commonly used to address CSOs and SSOs?*
- *How do CSO and SSO controls differ?*
- *What are effective technology combinations?*
- *What are emerging technologies for CSO and SSO control?*

EPA conducted a literature review and collected reports on CSO and SSO abatement efforts to evaluate technologies used by municipalities to address the impacts of CSO and SSO discharges. These data included existing EPA fact sheets, technical reports covering relevant research, and wet weather demonstration studies. EPA also reviewed technical guidance manuals developed by states, as well as documentation of local programs, including CSO LTCPs. The literature review was supplemented with discussions of CSO and SSO programs in interviews with municipal sewer system owners and operators.

The analysis conducted by EPA included:

- Development of 23 technology descriptions, included as Appendix L of this report, that summarize available technologies and the factors that influence their applicability and effectiveness.
- Identification of common and promising technologies used by municipalities to control CSOs and SSOs.

EPA and non-EPA experts were called upon to provide peer review of technology descriptions, costs, and performance. It is anticipated that technology data gathered and presented in this report's technology descriptions will support development of the technology clearinghouse required by the Wet Weather Water Quality Act of 2000 (P.L.106-554).

3.3.5 Assessment of Resources Spent by Municipalities to Address Impacts Caused by CSOs and SSOs

This report's assessment of resources spent by municipalities to address impacts caused by CSOs and SSOs addresses the following key questions:

- *What federal framework exists for evaluating resources spent on CSO and SSO control?*
- *What are the past investments in wastewater infrastructure?*
- *What has been spent to control CSOs?*
- *What has been spent to control SSOs?*
- *What does it cost to maintain sewer systems?*

- *What are the projected costs to reduce CSOs?*
- *What are the projected costs to reduce SSOs?*
- *What mechanisms are available for funding CSO and SSO control?*

EPA used several of its own reports and reviewed data from other federal agencies (e.g., CBO, GAO, and Census Bureau), states, and non-governmental organizations to assess the national investment in wastewater infrastructure and future needs. EPA also reviewed data collected for the 2000 CWNS (EPA 2003b). EPA used a variety of reports to quantify the resources spent by municipalities to control CSOs and SSOs, including:

- EPA's 1996 *Clean Water Needs Survey* (EPA 1997a) and 2000 CWNS (EPA 2003b)
- EPA's *Clean Water and Drinking Water Infrastructure Gap Analysis* (EPA 2002a)
- Clean Water State Revolving Fund (CWSRF) records
- Negotiated enforcement actions
- Interviews with municipal owners and operators of sewer systems
- CSO LTCPs
- Recent AMSA, ASCE, and WERF reports

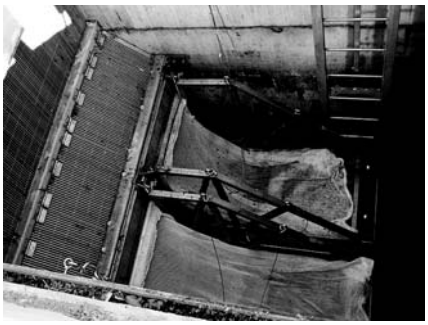
EPA also used a variety of sources to assess available mechanisms for funding CSO and SSO control, including:

- EPA's *Clean Water and Drinking Water Infrastructure Gap Analysis* (EPA 2002a)
- EPA's 2001 *Report to Congress–Implementation and Enforcement of the Combined Sewer Overflow Control Policy* (EPA 2001a)
- EPA's Fact Sheet: *Financing Capital Improvements for SSO Abatement* (EPA 2001c)
- EPA's *Combined Sewer Overflows: Guidance for Funding Options* (EPA 1995a)
- GAO reports
- CSO LTCPs

3.4 How Were Stakeholders Involved in the Preparation of this Report?

EPA consulted and worked with a broad group of stakeholders for this report. EPA conducted site visits to several EPA regions and six states; developed a series of 23 technology descriptions in cooperation with municipalities; and sought review of sections of the report from experts internal and external to EPA. States and municipalities featured in this Report to Congress were provided the opportunity to review information specifically pertaining to them.

Throughout 2002 and 2003, EPA met with representatives from key stakeholder groups such as AMSA, NRDC, and WEF. During these meetings, EPA presented an overview of the congressional directive and the Agency's planned response. EPA then solicited feedback on its progress. The comments and suggestions of the stakeholder groups were incorporated into the preparation of this report.



In 1999, North Bergen Municipal Utilities installed numerous mechanical screen bars and netting systems to control solids and floatables in CSOs. The facilities cost $3.3 million and annually cost $57,373 to operate and maintain (2002 dollars).

Photo: NJDEP

As described in Section 3.3.3, EPA facilitated a workshop for public health experts in Arlington, Virginia. Experts represented EPA, CDC, local health departments, and academia. Observers of the workshop included representatives of many stakeholder groups.

EPA also sponsored stakeholder meetings during development of this report in Washington, DC (June 2003), and in Huntington Beach, CA (July 2003). Participants included representatives from EPA regions; states; municipal sewer system owners, operators, and consultants; national and local environmental organizations; professional associations; and public health experts. The purpose of these meetings was to:

- Provide a preliminary description of the report methodology and findings
- Discuss the implications of preliminary findings
- Describe data availability and limitations
- Solicit additional data on impacts, costs, and technologies

EPA presented preliminary data on all aspects of the report, received comments on data sources and data interpretation, and received input on the context within which these findings should be viewed. A summary of the stakeholder meetings is provided in Appendix B of this report. EPA also made presentations at numerous national meetings and conferences to provide progress reports and updates to stakeholders.

3.5 What Data Considerations Are Important?

The information collection strategy used to support this report includes several important data considerations. First and foremost, EPA based this report on the collection, compilation, and analysis of existing data and program information. No surveys or field monitoring were conducted to quantify pollutant concentrations or environmental and human health impacts. Similarly, EPA did not undertake new research or analysis in the assessment of technologies or evaluation of costs.

Another important data consideration is state-to-state differences in the definition of "CSO event" and "SSO event" related to threshold volumes and duration of events that last beyond midnight or for more than 24 hours. EPA also found that wastewater backups into buildings, including private residences, are not typically tracked by or reported to NPDES authorities.

A third consideration is that often the pollutants present in CSOs and SSOs have numerous sources within a given watershed. These sources include municipal wastewater treatment plants, storm water runoff, decentralized wastewater treatment systems, runoff from agricultural areas, and wildlife and domesticated animals. It can be difficult, if not impossible, to differentiate environmental and human health impacts caused by CSO and SSO discharges from those caused by these other sources.

A fourth consideration is the potential underreporting of waterborne disease outbreaks. Existing systems for tracking these outbreaks often lack sufficient information on the cause of the outbreak to establish whether CSOs or SSOs are a suspected source.

A final data consideration is that the nature of many CSO and SSO control activities makes it difficult to separate their costs from routine municipal wastewater infrastructure expenditures. Further, local and state governments currently fund the majority of wastewater infrastructure costs. Mechanisms for compiling comprehensive national level information on expenditures on CSO and SSO control do not exist. The CWSRF is the most comprehensive source of information on state and local spending on wastewater projects. There are, however, several important limitations to using data from the CWSRF. First, operation and maintenance (O&M) costs are not reported. Second, many CSO communities do not participate in the CWSRF. Third, the CWSRF has no separate accounting categories for SSO control. Moreover, although many communities and states are making concerted efforts to report additional needs for CSO and SSO control, very few report the cost of implementing technologies.

Although the above considerations shaped the approach used to develop this report, the basic objectives—to respond to Congress with an accurate characterization of the volume, frequency, and location of CSOs and SSOs; the extent of human health and environmental impacts caused by CSOs and SSOs; the resources spent by municipalities to address these impacts; and the technologies used to address impacts—never varied.

3.6 What Quality Control and Quality Assurance Protocols Were Used?

EPA applied a detailed data verification and interpretation process following data collection. Federal and state data sets were evaluated for missing and inconsistent data. Follow-up phone calls were made to data providers to verify the accuracy and completeness of EPA's records. Likewise, site-specific examples of impacts and technology application were reviewed by local officials.

The data taken from reports prepared by external sources, such as ASCE and AMSA, were not obtained directly by EPA and were used as reported. These data were not subjected to the same quality control as data collected and compiled directly by EPA.

3.7 Summary

Chapters 4 through 9 provide a detailed assessment of the data and materials collected in support of this Report to Congress. The compilation of existing data led to development of several new analyses that previously did not exist. These include:

- National estimates of the frequency and volume of SSOs
- Analysis of causes of SSOs

- National modeling of SSO events to estimate violations of water quality standards
- Updated CSO permit information with latitude and longitude for over 90 percent of CSO outfalls
- Analysis linking CSO outfall locations with impaired waters and sensitive areas through the NHD
- Modeling to estimate the number of gastrointestinal illnesses resulting from exposure to CSOs and SSOs at BEACH Survey beaches