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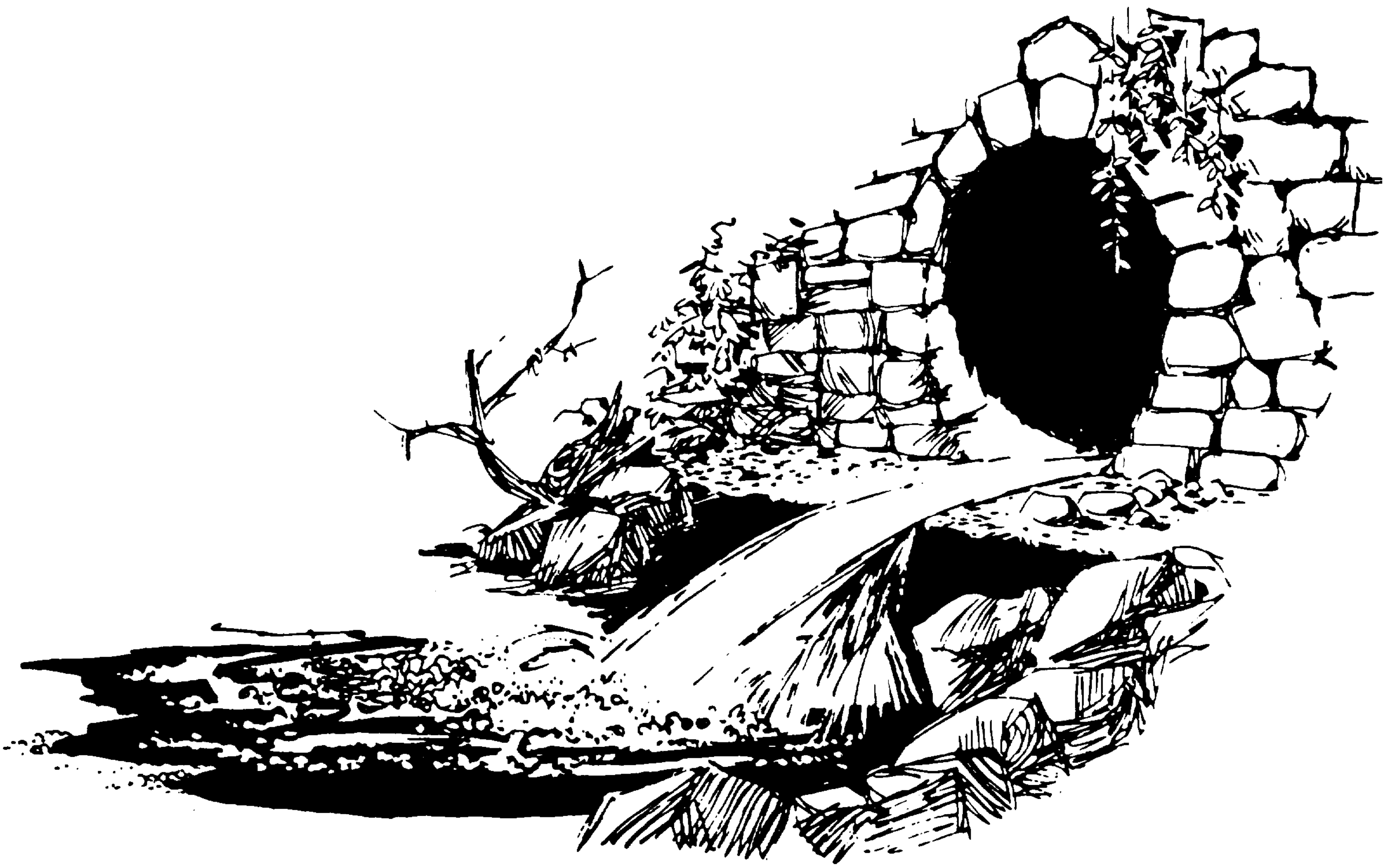
Combined Sewer Overflows

Guidance For Nine Minimum Controls



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OFFICE OF WATER

MEMORANDUM

SUBJECT: Guidance for Nine Minimum Controls

FROM: Michael B. Cook, Director (4201) Michael B Cook
Office of Wastewater Management

TO: Interested Parties

I am pleased to provide you the Environmental Protection Agency's (EPA's) guidance document on the implementation of the nine minimum controls for correction of combined sewer overflows (CSOs). This document is one of eight being prepared to foster implementation of EPA's CSO Control Policy. The CSO Control Policy, issued on April 11, 1994, establishes a national approach under the National Pollutant Discharge Elimination System (NPDES) permit program for controlling discharges into the nation's waters from combined sewer systems.

To facilitate implementation of the CSO Control Policy, EPA is preparing guidance documents that can be used by NPDES permitting authorities, affected municipalities, and their consulting engineers in planning and implementing CSO controls that will ultimately comply with the requirements of the Clean Water Act.

The nine minimum controls are identified in the CSO Control Policy as minimum technology-based controls that can be used to address CSO problems without extensive engineering studies or significant construction costs, prior to the implementation of long-term control measures. This document has been prepared to provide guidance to municipalities on how to implement the nine minimum controls and how to document their implementation. Documentation should be completed as soon as practicable but no later than January 1, 1997.

This guidance has been reviewed extensively within the Agency as well as by municipal groups, environmental groups, and other CSO stakeholders. I am grateful to all who participated in its preparation and review, and believe that it will further the implementation of the CSO Control Policy.

If you have any questions regarding the manual or its distribution, please call Norbert Huang in the Office of Wastewater Management, at (202) 260-5667.

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ACRONYM LIST

Acronym	Term
BAT	Best Available Technology Economically Achievable
BCT	Best Conventional Pollutant Control Technology
BMP	Best Management Practice
BPJ	Best Professional Judgment
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
CWA	Clean Water Act
DWO	Dry Weather Overflow
EPA	Environmental Protection Agency
I/I	Infiltration/Inflow
LTCP	Long-term Control Plans
NMC	Nine Minimum Controls
NPDES	National Pollutant Discharge Elimination System
O&M	Operation & Maintenance
POTW	Publicly Owned Treatment Works
WQS	Water Quality Standards

CHAPTER 1
INTRODUCTION

1.1 Background

Combined sewer systems (CSSs) are wastewater collection systems designed to carry sanitary sewage (consisting of domestic, commercial, and industrial wastewater) and storm water (surface drainage from rainfall or snowmelt) in a single pipe to a treatment facility. CSSs serve about 43 million people in approximately 1,100 communities nationwide. Most of these communities are located in the Northeast and Great Lakes regions. During dry weather, CSSs convey domestic, commercial, and industrial wastewater. In periods of rainfall or snowmelt, total wastewater flows can exceed the capacity of the CSS and/or treatment facilities. When this occurs, the CSS is designed to overflow directly to surface water bodies, such as lakes, rivers, estuaries, or coastal waters. These overflows—called combined sewer overflows (CSOs)—can be a major source of water pollution in communities served by CSSs.

Because CSOs contain untreated domestic, commercial, and industrial wastes, as well as surface runoff, many different types of contaminants can be present. Contaminants may include pathogens, oxygen-demanding pollutants, suspended solids, nutrients, toxics, and floatable matter. Because of these contaminants and the volume of the flows, CSOs can cause a variety of adverse impacts on the physical characteristics of surface water, impair the viability of aquatic habitats, and pose a potential threat to drinking water supplies. CSOs have been shown to be a major contributor to use impairment and aesthetic degradation of many receiving waters and have contributed to shellfish harvesting restrictions, beach closures, and even occasional fish kills.

1.2 History of the CSO Control Policy

Historically, the control of CSOs has proven to be extremely complex. This complexity stems partly from the difficulty in quantifying CSO impacts on receiving water quality and the site-specific variability in the volume, frequency, and characteristics of CSOs. In addition, the financial considerations for communities with CSOs can be significant. The U.S. Environmental

Protection Agency (EPA) estimates the CSO abatement costs for the 1,100 communities served by CSSs to be approximately $41.2 billion.

To address these challenges, EPA's Office of Water issued a National Combined Sewer Overflow Control Strategy on August 10, 1989 (54 *Federal Register* 37370). This Strategy reaffirmed that CSOs are point source discharges subject to National Pollutant Discharge Elimination System (NPDES) permit requirements and to Clean Water Act (CWA) requirements. The CSO Strategy recommended that all CSOs be identified and categorized according to their status of compliance with these requirements. It also set forth three objectives:

- Ensure that if CSOs occur, they are only as a result of wet weather
- Bring all wet weather CSO discharge points into compliance with the technology-based and water quality-based requirements of the CWA
- Minimize the impacts of CSOs on water quality, aquatic biota, and human health from CSOs.

In addition, the CSO Strategy charged all States with developing state-wide permitting strategies designed to reduce, eliminate, or control CSOs.

Although the CSO Strategy was successful in focusing increased attention on CSOs, it fell short in resolving many fundamental issues. In mid-1991, EPA initiated a process to accelerate implementation of the Strategy. The process included negotiations with representatives of the regulated community, State regulatory agencies, and environmental groups. These negotiations were conducted through the Office of Water Management Advisory Group. The initiative resulted in the development of a CSO Control Policy, which was published in the *Federal Register* on April 19, 1994 (59 *Federal Register* 18688). The intent of the CSO Control Policy is to:

- Provide guidance to permittees with CSOs, NPDES permitting and enforcement authorities, and State water quality standards (WQS) authorities

- Ensure coordination among the appropriate parties in planning, selecting, designing, and implementing CSO management practices and controls to meet the requirements of the CWA
- Ensure public involvement during the decision-making process.

The CSO Control Policy contains provisions for developing appropriate, site-specific NPDES permit requirements for all CSSs that overflow due to wet weather events. It also announces an enforcement initiative that requires the immediate elimination of overflows that occur during dry weather and ensures that the remaining CWA requirements are complied with as soon as possible.

1.3 Key Elements of the CSO Control Policy

The CSO Control Policy contains four key principles to ensure that CSO controls are cost-effective and meet the requirements of the CWA:

- Provide clear levels of control that would be presumed to meet appropriate health and environmental objectives
- Provide sufficient flexibility to municipalities, especially those that are financially disadvantaged, to consider the site-specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements
- Allow a phased approach for implementation of CSO controls considering a community's financial capability
- Review and revise, as appropriate, WQS and their implementation procedures when developing long-term CSO control plans to reflect the site-specific wet weather impacts of CSOs.

In addition, the CSO Control Policy clearly defines expectations for permittees, State WQS authorities, and NPDES permitting and enforcement authorities. These expectations include the following:

- Permittees should immediately implement the nine minimum controls (NMC), which are technology-based actions or measures designed to reduce CSOs and their effects on receiving water quality, as soon as practicable but no later than January 1, 1997.

- Permittees should give priority to environmentally sensitive areas.

- Permittees should develop long-term control plans (LTCPs) for controlling CSOs. A permittee may use one of two approaches: 1) demonstrate that its plan is adequate to meet the water quality-based requirements of the CWA ("demonstration approach"), or 2) implement a minimum level of treatment (e.g., primary clarification of at least 85 percent of the collected combined sewage flows) that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise ("presumption approach").

- WQS authorities should review and revise, as appropriate, State WQS during the CSO long-term planning process.

- NPDES permitting authorities should consider the financial capability of permittees when reviewing CSO control plans.

Exhibit 1-1 illustrates the roles and responsibilities of permittees, NPDES permitting and enforcement authorities, and State WQS authorities.

In addition to these key elements and expectations, the CSO Control Policy also addresses important issues such as ongoing or completed CSO control projects, public participation, small communities, and watershed planning.

1.4 Guidance to Support Implementation of the CSO Control Policy

To help permittees and NPDES permitting and WQS authorities implement the provisions of the CSO Control Policy, EPA has developed the following guidance documents:

- *Combined Sewer Overflows - Guidance for Long-Term Control Plan* (EPA 832-B-95-002)

- *Combined Sewer Overflows - Guidance for Nine Minimum Controls* (EPA 832-B-95-003)

- *Combined Sewer Overflows - Guidance for Screening and Ranking Combined Sewer System Discharges* (EPA 832-B-95-004)

Exhibit 1-1. Roles and Responsibilities

Permittee	NPDES Permitting Authority	NPDES Enforcement Authority	State WQS Authorities
• Evaluate and implement NMC • Submit documentation of NMC implementation by January 1, 1997 • Develop LTCP and submit for review to NPDES permitting authority • Support the review of WQS in CSO-impacted receiving water bodies • Comply with permit conditions based on narrative WQS • Implement selected CSO controls from LTCP • Perform post-construction compliance monitoring • Reassess overflows to sensitive areas • Coordinate all activities with NPDES permitting authority, State WQS authority, and State watershed personnel	• Reassess/revise CSO permitting strategy • Incorporate into Phase I permits CSO-related conditions (e.g., NMC implementation and documentation and LTCP development) • Review documentation of NMC implementation • Coordinate review of LTCP components throughout the LTCP development process and accept/approve permittee's LTCP • Coordinate the review and revision of WQS as appropriate • Incorporate into Phase II permits CSO-related conditions (e.g., continued NMC implementation and LTCP implementation) • Incorporate implementation schedule into an appropriate enforceable mechanism • Review implementation activity reports (e.g., compliance schedule progress reports)	• Ensure that CSO requirements and schedules for compliance are incorporated into appropriate enforceable mechanisms • Monitor compliance with January 1, 1997, deadline for NMC implementation and documentation • Take appropriate enforcement action against dry weather overflows • Monitor compliance with Phase I, Phase II, and post-Phase II permits and take enforcement action as appropriate	• Review WQS in CSO-impacted receiving water bodies • Coordinate review with LTCP development • Revise WQS as appropriate: Development of site-specific criteria Modification of designated use to - Create partial use reflecting specific situations - Define use more explicitly Temporary variance from WQS

- *Combined Sewer Overflows – Guidance for Monitoring and Modeling* (EPA 832-B-95-005)
- *Combined Sewer Overflows – Guidance for Financial Capability Assessment* (EPA 832-B-95-006)
- *Combined Sewer Overflows – Guidance for Funding Options* (EPA 832-B-95-007)
- *Combined Sewer Overflows – Guidance for Permit Writers* (EPA 832-B-95-008)
- *Combined Sewer Overflows – Questions and Answers on Water Quality Standards and the CSO Program* (EPA 832-B-95-009)

1.5 Goal of this Guidance

The goal of this document is to help the CSO community, particularly municipal public works officials or planning and engineering consultants, evaluate, understand, and implement, as well as document, the NMC. The examples presented in this document illustrate different measures available to address a particular control. Appropriate control measures will be site-specific and a municipality may select from several available measures to effectively implement each minimum control. EPA encourages municipalities to be creative and to explore innovative and cost-effective measures in implementing the NMC to address their specific CSO problems. The NMC are not necessarily distinct and separate from one another. Many control measures can address and facilitate more than one of the controls at the same time (e.g., street sweeping can address both the "Control of Solids/Floatables" and the "Pollution Prevention" controls). With the assistance of this guidance document, municipalities with CSOs should plan and pursue control measures that can achieve the ultimate goal of reducing overall CSO impacts in a holistic manner.

1.6 The Nine Minimum Controls

As described in the CSO Control Policy, municipalities should immediately implement best available technology economically achievable (BAT) or best conventional pollutant control technology (BCT). At a minimum, BAT/BCT should include the nine minimum controls (NMC), which are determined on a best professional judgment (BPJ) basis by the NPDES permitting authority. The NMC are controls that can reduce CSOs and their effects on receiving

(NMC), which are determined on a best professional judgment (BPJ) basis by the NPDES permitting authority. The NMC are controls that can reduce CSOs and their effects on receiving water quality, do not require significant engineering studies or major construction, and can be implemented in a relatively short period (e.g., less than approximately two years). Implementation of the NMC is among the first steps a municipality is expected to take in response to EPA's CSO Control Policy. EPA recognizes that many municipalities have made significant progress in implementing the NMC as a result of the 1989 CSO Strategy.

The NMC are as follows:

1. Proper operation and regular maintenance programs for the sewer system and CSO outfalls
2. Maximum use of the collection system for storage
3. Review and modification of pretreatment requirements to ensure that CSO impacts are minimized
4. Maximization of flow to the POTW for treatment
5. Elimination of CSOs during dry weather
6. Control of solid and floatable materials in CSOs
7. Pollution prevention programs to reduce containments in CSOs
8. Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts
9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

Each of the following chapters in this manual describes one of the NMC, its intended objectives, examples of control measures, considerations for implementation, and suggested documentation. In addition, where available, the chapters present case studies and performance and cost data.

1.7 Concurrent Efforts

When evaluating and implementing the NMC, the municipality should also be undertaking the following activities:

- Initiating the process to develop a long-term control plan (LTCP), including characterizing the CSS, CSOs, and receiving waters
- Meeting with the NPDES permitting authority and State WQS authority to discuss:
  - The materials expected to document implementation of the NMC
  - Monitoring, regulatory, and planning requirements that will affect the preparation of the LTCP.

1.8 Related Activities

The NPDES permitting authority should undertake, among other efforts, the following activities:

- Develop and issue Phase I NPDES permits requiring CSO communities to implement the NMC, within two years of notice from the NPDES permitting authority, but no later than January 1, 1997
- Develop and issue Phase II NPDES permits requiring continued implementation of the NMC and implementation of an LTCP.

If implementation of the NMC in Phase I and Phase II permits is determined to meet the technology-based requirements, the permit writer should not need to develop other technology-based effluent limitations.

Therefore, implementing the NMC is among the first steps a municipality should take to reduce CSO impacts. Minimum controls are *not* temporary measures; they should be a part of long-term efforts to control CSOs. A community that has already implemented a CSO control program will likely have made substantial progress in implementing the NMC. Such a community is still expected to provide documentation to the NPDES permitting authority to demonstrate how its program addresses each minimum control. The NPDES permitting authority should then evaluate the extent to which each minimum control is satisfied.

The LTCP should describe the approaches for implementing and integrating the NMC into the long-term CSO control program. On a preliminary basis, the LTCP should describe the effectiveness of the NMC in reducing the frequency and magnitude of CSOs and in reducing impacts on receiving waters. Monitoring conducted under the NMC will likely provide such information as the number of overflow events or receiving water impacts, including fish kills or beach closures. Other impacts, such as pollutant load reductions and receiving water concentrations, will be ascertained through monitoring associated with LTCP development.

1.9 Documentation

The CSO Control Policy states that the municipality should submit to the NPDES permitting authority documentation on the implementation of the NMC. Documentation should include information that demonstrates:

- The alternatives considered for each minimum control
- The actions selected and the reasons for their selection
- The selected actions already implemented
- A schedule showing additional steps to be taken
- The effectiveness of the minimum controls in reducing/eliminating water quality impacts.

Each chapter of this manual presents examples of the information that should be documented for the minimum control presented in that chapter. The discussion is presented in the form of suggestions and objectives because each NPDES permitting authority (EPA Regional office or State agency) will likely have different implementation and documentation requirements. Meeting as early as possible with the NPDES permitting authority to determine its particular expectations will facilitate the NMC implementation process.

Generally, however, the documentation burden imposed by the NPDES permitting authority should be the minimum necessary to demonstrate that proper NMC measures are in place. The burden may vary according to the NPDES permitting authority's customary practices and the municipality's compliance record, among other factors. The NPDES permitting authority may choose to require the municipality to keep some records of NMC implementation on-site rather than requiring all documentation to be submitted. In these cases, NPDES inspectors can review NMC documentation that is on file during inspections.

CHAPTER 2

PROPER OPERATION AND REGULAR MAINTENANCE PROGRAMS

The first minimum control, proper operation and regular maintenance of the CSS and CSO outfalls, should consist of a program that clearly establishes operation, maintenance, and inspection procedures to ensure that a CSS and treatment facility will function in a way to maximize treatment of combined sewage and still comply with NPDES permit limitations. Implementation of this minimum control will reduce the magnitude, frequency, and duration of CSOs by enabling existing facilities to perform as effectively as possible. Essential elements of a proper operation and maintenance (O&M) program include maintenance of suitable records and identification of O&M as a high management priority.

The municipality should already have an established O&M program for its publicly owned treatment works (POTW). It may be very formal, with written manuals and operating forms and logs, or it may be informal, with few or no written manuals or established recordkeeping procedures. In either case, the steps involved in implementing this minimum control are the same: 1) assess how well the existing O&M program is being implemented, 2) determine whether or not the O&M program needs to be improved to satisfy the intent of the CSO Control Policy, 3) develop and implement the improvements to address CSOs, and 4) document any actions and report them to the NPDES permitting authority.

2.1 Elements of a Proper Operation and Maintenance Program

For the purposes of the CSO Control Policy, a proper O&M program generally should include the following:

- The organizations and people responsible for various aspects of the O&M program
- The resources (i.e., people and dollars) allocated to O&M activities
- Planning and budgeting procedures for O&M of the CSS and treatment facilities

- A list of the facilities (e.g., tide gates, overflow weirs) critical to the performance of the CSS
- Written procedures and schedules for routine, periodic maintenance of major items of equipment and CSO diversion facilities, as well as written procedures to ensure that regular maintenance is provided
- A process for periodic inspections of the facilities listed previously
- Written procedures, including procurement procedures, if applicable, for responding to emergency situations
- Policies and procedures for training O&M personnel
- A process for periodic review and revision of the O&M program.

2.1.1 Organizational Structure

The organizational structure can be shown with an organizational chart or other documents. The chart (or supplemental documents) should provide the names and telephone numbers of key personnel, the chain of command, and the relationships among various program components. In addition, the organizational structure should establish clear lines of communication, authority, and responsibility.

2.1.2 Budget

The O&M program records should show the resources currently available for O&M and the procedures for preparing and approving the annual O&M budgets. The budget should provide sufficient funds and personnel for routine O&M and a reasonable contingency amount for emergencies. Individuals responsible for day-to-day O&M should have the opportunity to participate in the budget preparation process so that the officials responsible for final budget preparation and approval are aware of O&M needs.

2.1.3 Critical Facilities

The O&M program should include an agreed-upon list of the most critical elements of the CSS and demonstrate that they receive an appropriate amount of attention. "Critical elements" are those facilities that affect the performance of the CSS, CSO volumes, or CSO pollutant levels. The list should include regulator structures, tide gates, pumping stations, diversion structures, retention basins, sections of the sewer system prone to sedimentation, all CSO outfalls included (or to be included) in the NPDES permit, and wastewater treatment plants if they are used to treat a significant portion of the wet weather flows. The list and supplemental documents should include a physical description of each facility and its location.

2.1.4 Procedures for Routine Maintenance

The existing O&M program for a particular POTW should include documentation of procedures for routine maintenance of the major elements of the CSS. Only the critical elements identified above need to be included to document implementation of this minimum control. The program should focus on preventative maintenance to avoid failures during critical times, such as a period of heavy rainfall.

2.1.5 Non-Routine Maintenance and Emergency Situations

The O&M program should describe response procedures for emergency situations, particularly those requiring funds outside the approved annual budget. The NPDES permitting authority will expect to see that response can be quick, without unnecessary processes and procedures. It would be a good practice to establish a protocol for responding to emergencies at night, on holidays, or on weekends. The protocol should include the names and telephone numbers of employees or others designated to respond to the emergency.

Depending on the sensitivity of the receiving waters, the permittee might need to notify the NPDES permitting authority and the State public health agency during overflow events. It would be a good practice to maintain a list of people, organizations, and telephone numbers for appropriate regulatory agencies.

2.1.6 Inspections

The O&M program should describe the procedures for inspecting critical elements of the CSS. The NPDES permitting authority will expect the municipality to have an established program for periodic inspections. The appropriate frequency of inspections will depend on the type of facilities, historical records of performance and failure, sensitivity of nearby surface waters to CSOs, adequacy of the maintenance program, and other factors.

The O&M personnel should have check sheets, operating logs, and other easy-to-complete forms readily available. The forms should prompt field personnel to check critical items, record their observations, and recommend corrective actions, if necessary. For example, an inspection should identify whether there has been an overflow, whether debris has accumulated and needs to be removed, whether the device would operate correctly during the next storm, and whether any items need repair. In addition, inspections could be conducted of regulator devices and interceptors, trunks, and combined sewers during dry weather for blockages, excessive deposition of solids, excessive infiltration/inflow, and structural deterioration that needs to be corrected.

The municipality should also have an established process for the review of the completed inspection forms by supervisory and management personnel, submittal to the NPDES permitting authority, if required, and retention of the forms. In addition, the municipality should have a process for ensuring that necessary follow-up maintenance and repair actions, indicated by the inspection reports and operating logs, are scheduled and carried out.

2.1.7 Training

New employees should be trained in operation and safety procedures as soon as they begin duty, and opportunities for training and re-training of long-time employees should be available. Training includes an appropriate blend of classroom training and on-the-job training. The objective is to have well-trained employees who know their duties and how to report problems that require attention from CSS managers. EPA encourages the development of and adherence to a written policy on training.

2.1.8 Periodic Review of O&M Plans

O&M practices should be reviewed periodically and modified as necessary. It is good practice to involve field O&M personnel in this process. The O&M plan will likely be revised after completion of the LTCP to include agreed-upon long-term CSO controls. (See *Combined Sewer Overflows - Guidance for Long-Term Control Plan.* EPA, 1995c.)

2.2 Considerations

Frequent inspection, regular maintenance, and the timely repair of facilities, including tide gates and regulators, are cost-effective ways to improve the control of CSOs. The elimination of obstructions will increase the effective storage capacity of the system and the quantity of wet weather flows that can be delivered to the treatment plant.

The effective organization of overall O&M operations, a specific commitment of resources for maintenance of the collection system, the assignment of sufficient personnel and equipment for inspection and maintenance at the appropriate frequency, and timely repairs might require increases in O&M budgets. In some cases, reorganization of the operational structure might be necessary. Ultimately, the effectiveness of an O&M program depends on the resources allocated and the extent to which the CSOs are caused by conditions that can be mitigated by O&M practices.

2.3 Examples of Implementation

The following list provides examples of O&M program approaches used by several different municipalities:

- Lansing, Michigan, has 40 regulators that are inspected twice per week and immediately following any wet weather event.
- Jersey City, New Jersey, has tide gates and 31 regulators that are inspected in sequence by two assigned crews, enabling each regulator to be inspected at least twice per month. Crews perform cleanings and minor repairs when possible. Each inspection is documented.

- Elizabeth, New Jersey, has a CSS with 41 regulators of varying design. All syphons, regulators, and tide gates in the system are inspected daily. All syphons are jet-cleaned monthly.

- New York City has more than 450 regulators that are inspected on a regular schedule. Certain regulators identified as critical are inspected more often. Pump stations, most of which have overflow points, are inspected daily. Of the 183 people who maintain these elements of the sewer system, about 50 are assigned specifically to regulator and tide gate maintenance and inspection, and the remainder are involved with pump station operation. The city also has a shoreline inspection program and has mapped all discharge points, including CSO outfalls, storm water outfalls, industrial outfalls, and highway drains. Several vessels patrol the shorelines on a regular basis. If a dry weather overflow is suspected or observed, the maintenance crews will attempt to correct the problem immediately.

2.4 Documentation

The following elements are examples of documentation that could be submitted to the NPDES permitting authority to demonstrate that appropriate O&M activities to reduce the impacts of CSOs have been considered and have been or will be implemented:

- An identification of CSS components requiring routine operation and maintenance

- An evaluation of operation and maintenance procedures to include regular inspections; sewer, catch basin, and regulator cleaning; equipment and sewer collection system repair, or replacement where necessary

- An operation and maintenance manual and/or procedures for the CSS and CSO structures

- Resources allocated (manpower, equipment, training) for maintenance of the CSS and CSO structures

- A summary of inspections conducted and maintenance performed.

CHAPTER 3

MAXIMIZATION OF STORAGE IN THE COLLECTION SYSTEM

As the second minimum control, maximum use of the collection system for storage means making relatively simple modifications to the CSS to enable the system itself to store wet weather flows until downstream sewers and treatment facilities can handle them. The municipality should evaluate more complex modifications (e.g., those requiring extensive construction) as part of the LTCP.

The first step is to identify possible locations where minor modifications can be made to the CSS to increase in-system storage. O&M personnel should be able to identify these sites; the concurrent effort to characterize the system as part of the LTCP should also help. Possible modifications should then be analyzed to ensure that they will not cause other problems such as street or basement flooding. Modifications should be implemented and efforts documented for the NPDES permitting authority.

3.1 Control Measures

This section briefly discusses simple measures that can be implemented to increase the storage capacity of a CSS, thus decreasing the magnitude, frequency, and duration of CSOs. A number of these measures can also be applied to implementation of other minimum controls. For example, inspection and maintenance activities that increase the use of the collection system will also reduce dry weather overflows and increase flows to the POTW.

- **Collection System Inspection**—This will enable identification of serious deficiencies that restrict the use of the system's available storage capacity. Deficiencies that can be corrected by proper maintenance or structural repairs, or by modifications that do not require comprehensive engineering design and facility construction, should be remedied as soon as possible. For example, O&M staff can remove accumulations of debris or sediment and replace sections of pipe that are obviously undersized in relation to upstream and downstream line sizes. In addition, inspection programs can identify malfunctioning regulators or broken regulator weirs for repair.

- **Tide Gate Maintenance and Repair**—Leaking tide gates can admit significant volumes of water into the conveyance system, thereby occupying system storage and conveyance capacity that would otherwise be available during wet weather periods. A tide gate inspection and maintenance program can use sensors placed inboard of the gate to detect tidal intrusions during dry weather periods and alert maintenance crews. The sensors can also be used to detect dry weather overflows, which are addressed under a different minimum control.

- **Adjustment of Regulator Settings**—Many regulating devices, with simple modifications, can be used to increase in-system storage of wet weather flows. In some cases, stop planks or brick/concrete weirs can be raised to increase in-system storage. In addition, interactive controls can be used to temporarily induce in-line storage of wet weather flows (e.g., a regulator setting can be manipulated automatically in response to depth or flow in an interceptor).

- **Retard Inflows**—By using special gratings or Hydrobrakes (or comparable commercial devices), O&M staff can modify catch basin inlets to restrict the rate at which surface runoff is permitted to enter the system. Slowing inflow will enable the CSS to transport more flow overall by spreading out the flow over time. Eliminating the direct connection of roof drains and sump pumps to the collection system is also possible where sufficient land area is available for drainage.

- **Localized Upstream Detention**—Using localized detention in appropriate upstream areas could provide effective short-term storage (e.g., upstream parking areas could be used for temporary storage of some storm water during storm events).

- **Upgrade/Adjustment of Pump Operations at Interceptor Lift Stations**—Increased pumping rates might be possible through repair, modification, or augmentation of lift stations. This would increase the available capacity in upstream portions of the system but would depend on the available hydraulic capacity of downstream portions of the collection system, as well as the processing capability of the POTW, to accept the increased flow rates.

- **Removal of Obstructions to Flow**—This can include maintenance activities to remove and prevent accumulations of debris and sediment that restrict flow. Where flow obstruction is caused by sediment accumulations in sections with low gradients, sewer flushing might be an effective control measure. When a section of the conveyance system routinely accumulates sediment deposits at a substantial rate, design and installation of a permanent flushing station or an in-line grit chamber might be the most cost-effective approach and should be considered as part of the LTCP.

3.2 Considerations

Maximizing the use of existing facilities is a cost-effective way to improve the level of CSO control without the difficulties associated with land acquisition, construction, and community impacts of some other control methods. Appropriate techniques, costs, and the degree of improvement will vary substantially with system characteristics. In cases where collection system maintenance has been neglected, where there are blockages or other hydraulic bottlenecks, or where excess capacity is available, corrective action may provide significant improvements in CSO control.

Risk of upstream (street, basement) flooding goes up with increased use of the collection system for storage. The application of measures to expand storage capacity in the collection system will increase O&M requirements, and for some techniques (e.g., check dams with telemetering and real-time control) the increase may be significant. Storing wet weather flows within the collection system is likely to increase deposition through settling of suspended matter. Additional O&M may be necessary if subsequent flows do not resuspend and remove sedimentation.

Topography and other site conditions will also limit the volume of combined sewage that can be stored in the system regardless of whether simple or more elaborate modifications are undertaken. For example, where the entire system is relatively flat, wet weather flows might back up relatively far into the head of the system. In addition, such a system would normally be designed with relatively large combined sewers to convey runoff away from city streets. As a result, an area with relatively flat topography can expect greater storage capacity in the collection system. An area with relatively steep slopes, on the other hand, would flood downstream areas before much of the upstream storage capacity could be used and, thus, would have limited storage capacity.

3.3 Example of Implementation

The city of Detroit installed inflatable dams in two long, large-diameter lines that extend from the collection system to the shoreline discharge point. The system layout prevented any risk of upstream adverse effects, and installation was relatively straightforward and inexpensive. Detailed monitoring data are not available to quantify the benefits, but these devices are often effective in completely containing overflows from smaller storms and can reduce the number of overflows. Maintenance is minimal because contained flows drain back into the collection system following the storm, and no real-time operation of the devices is necessary. The dams simply provide more effective use of existing excess capacity within the system.

3.4 Documentation

The following elements are examples of documentation that could be submitted to the NPDES permitting authority to demonstrate the municipality's efforts to implement this control, as well as the control's effectiveness in reducing CSO impacts:

- An analysis/study of alternatives to maximize collection system storage
- A description of procedures in place for maximizing collection system storage
- A schedule for implementation of minor construction associated with maximization of collection system storage
- Documentation of actions taken to maximize storage
- Identification of any additional potential measures to increase storage in the existing collection system, but which require further analysis, and which will be evaluated in hydraulic studies conducted as part of the LTCP.

CHAPTER 4

REVIEW AND MODIFICATION OF PRETREATMENT REQUIREMENTS

Under the third minimum control, the municipality should determine whether nondomestic sources are contributing to CSO impacts and, if so, investigate ways to control them. The objective of this control is to minimize the impacts of discharges into CSSs from nondomestic sources (i.e., industrial and commercial sources, such as restaurants and gas stations) during wet weather events, and to minimize CSO occurrences by modifying inspection, reporting, and oversight procedures within the approved pretreatment program. Once implemented, this minimum control should not require additional effort unless CSS characterization and modeling indicate that a pollutant from a nondomestic source is causing a specific health, water quality, or environmental problem.

This review can be conducted as part of a municipality's pretreatment program. If a community does not have an approved local pretreatment program, it should still determine whether nondomestic sources are contributing to CSO impacts. A municipality with no known nondomestic sources should implement this minimum control by periodically reevaluating whether it has nondomestic discharges. All municipalities should provide documentation to the NPDES permitting authority on the assessment of nondomestic source impacts and on efforts to mitigate any impacts from such sources, as appropriate.

4.1 Control Measures

The following steps are appropriate for municipalities with local pretreatment programs as well as municipalities that receive nondomestic discharges but are not required to develop a formal pretreatment program.

4.1.1 Inventory Nondomestic Discharges to the Combined Sewer System

The municipality should first prepare an inventory of all nondomestic discharges to the collection system. The inventory should include information on the volume of flow and the pollutant types and concentrations in the discharge. By identifying the locations where nondomestic discharges enter the CSS on a map of the system, the potential impact of the nondomestic discharge on the CSO will be more clear. Municipalities with existing pretreatment programs should have all of this information readily available because as part of approved pretreatment programs, they are required to identify and locate all possible industrial users (in accordance with 40 CFR 403.8(f)(2)(i)).

If the number of nondomestic users is large enough to preclude review of all facilities, the municipality should focus on the facilities with the greatest potential impact with regard to CSOs. This determination can be based on the size of the discharge, the concentration of pollutants that might be contributing to water quality criteria exceedances, or the proximity of the nondomestic user's discharge point to the CSO outfall.

4.1.2 Assess the Impact of Nondomestic Discharges on CSOs

The second measure is to assess the impact of nondomestic discharges on CSOs by comparing the total quantity of nondomestic flow to the total flow from all sources. When nondomestic facilities are concentrated in certain areas, the comparison should be based on flows from areas contributing to specific overflow points.

When appropriate, this assessment can also include the identification of nondomestic sources that are significant contributors of specific pollutants implicated in water quality problems. A more detailed assessment may be appropriate for cases in which nondomestic discharges contribute significantly to discharge volume and pollutant loading.

4.1.3 Evaluate Feasible Modifications

The third measure is to evaluate feasible modifications to the approved pretreatment program if the assessment indicates that nondomestic sources might contribute significantly to CSOs. Both the feasibility and the effectiveness of modifications are site-specific. The prohibition of batch discharges or a requirement for some form of detention to prevent discharges during wet weather events should be considered. Once such controls are in place, a procedure for scheduling releases might be necessary to avoid post-event overflows. If such procedures are necessary, scheduled releases can be included in the semi-annual monitoring reports of significant industrial users and the need for industrial slug discharge control plans required in 40 CFR 403.8(f)(2)(v).

All POTWs with approved pretreatment programs are required to notify and obtain approval from the approval authority for all substantial pretreatment program modifications. Substantial modifications include changes to legal authorities, local limits (if made less stringent), and control mechanisms. In addition, POTWs with approved pretreatment programs must notify the approval authority of any nonsubstantial pretreatment program modification. Section 403.18 of the General Pretreatment Regulations contains more information on the requirements for pretreatment program modifications.

4.2 Performance and Cost

The degree to which pretreatment program modifications can reduce CSOs will be highly variable and site-specific. The costs for conducting an inventory of nondomestic sources and reviewing existing pretreatment program requirements are expected to be nominal because most of the required information is readily available. The affected nondomestic dischargers will incur most of the costs for implementing modified requirements. Where delayed-release volume control is employed, however, regulating and inspecting release schedules will add to the municipality's O&M responsibilities.

4.3 Considerations

Industrial and commercial sites in CSO areas might have limited space available for temporary on-site storage of process wastewaters. Such situations might warrant development of appropriate release schedules and operational controls.

Where the relative contribution of nondomestic flow to the total dry weather flow is small, or where the fraction of the CSS service area dedicated to nondomestic use is small, the effect of increasing pollutant control might be insignificant. When nondomestic users contribute a problem pollutant in a substantial quantity and effective pretreatment modifications are feasible, modification of the pretreatment program might improve CSO control significantly.

4.4 Documentation of Actions Taken

The NPDES permitting authority will need documentation demonstrating diligent effort to evaluate this control. The NPDES permitting authority will also need a clear understanding of the planned modifications and expected pollution control benefits. The following list provides suggested documentation:

- If the municipality does not have any significant nondomestic dischargers or is not authorized to administer its own pretreatment program, it should provide information sufficient to substantiate this fact.
- If the municipality does not have any significant nondomestic dischargers and is authorized to administer its own pretreatment program, it should provide:
  - An inventory of nondomestic dischargers
  - An assessment of the impact of nondomestic discharges on CSOs and receiving waters
  - An assessment of the value and feasibility of modifications to existing pretreatment programs.
- If modification of the pretreatment program is appropriate, the municipality should provide the following information:
  - A description of the modification
  - A schedule for implementing the modifications, including amending sewer use ordinances, if needed
  - An estimate of the loading reduction expected from the modification in pounds of biochemical oxygen demand and suspended solids, or other pollutants of concern.
- If modifications to the pretreatment program are not proposed, the permittee should provide justification.

CHAPTER 5

MAXIMIZATION OF FLOW TO THE POTW FOR TREATMENT

The fourth minimum control, maximizing flow to the POTW, entails simple modifications to the CSS and treatment plant to enable as much wet weather flow as possible to reach the treatment plant. The objective of this minimum control is to reduce the magnitude, frequency, and duration of CSOs that flow untreated into receiving waters. Municipalities should identify and evaluate more complex CSS and POTW modifications as part of their LTCPs.

5.1 Examples of Control Measures

EPA suggests that the following minimum measures be considered in implementing this control:

- Determine the capacity of the major interceptor(s) and pumping station(s) that deliver flows to the treatment plant. Ensure that the full capacity is available by using the O&M suggestions presented in Chapter 2.

- Analyze existing records to compare flows processed by the plant during wet weather events and dry periods and determine the relationships between performance and flow.

- Compare the current flows with the design capacity of the overall facility, as well as the capacity of individual unit processes. Identify the location of available excess capacity.

- Determine the ability of the facility to operate acceptably at incremental increases in wet weather flows and estimate the effect on the POTW's compliance with the effluent limits in its permit. Increased flows may upset biological processes, for example, and decrease performance for an extended period after the wet weather flows have subsided.

- Determine whether any inoperative or unused treatment facilities on the POTW site can be used to store or treat wet weather flows.

- Develop cost estimates for any planned physical modifications and any additional O&M costs at the treatment plant due to the increased wet weather flow.

5.2 Considerations

Implementation of this control requires particular attention to regulatory considerations as well as treatment and capacity considerations. Although many POTWs have the physical capacity to accept increased flows during wet weather events, the following regulatory and technical issues must be addressed, however, in order to ensure that flow maximization provides a net environmental benefit.

5.2.1 Regulatory Considerations

POTWs are generally subject to EPA's secondary treatment regulations (40 CFR Part 133), which specify numeric effluent limits for biochemical oxygen demand and total suspended solids, as well as a minimum removal percentage (85 percent) for secondary treatment. Secondary treatment requirements are enforceable conditions in POTW permits.

Section 133.103(a) and (e), however, provide relief for POTWs with CSSs that process elevated flows (and more dilute influents) by allowing for the possibility of a waiver of the percentage removal requirement. (Waivers are not available from effluent concentration limits, however.) The decision to apply a waiver and the recalculation of the removal percentage are made on a case-by-case basis.

The CSO Control Policy states that a bypass of secondary treatment may be justified when the LTCP identifies the cut-off point at which the flow will be diverted from secondary treatment and demonstrates that conveyance of wet weather flow to the POTW for primary treatment is more beneficial than other CSO abatement alternatives. Section 122.41(m) outlines the criteria under which a bypass may be allowed.

5.2.2 Technical Considerations

Maximizing the use of existing facilities to treat wet weather flows that would otherwise overflow without treatment is a desirable element of a control program, especially when CSOs to sensitive areas are eliminated or reduced. The more effectively existing facilities are utilized, the less total CSO control costs are likely to be under the LTCP. Some increases in the cost of operating the POTW can be expected, but the result is likely to be more cost-effective than control efforts at upstream overflow locations.

Plant performance will degrade somewhat at a certain point because of the increased influent flow. The optimal volume of wet weather flow might be constrained by provisions of existing discharge permits and the ability to obtain modified provisions for increased flows during wet weather events. An engineering study will usually be necessary to determine the ultimate effects of increased flow on the plant's treatment capacity and effluent quality.

5.3 Documentation

The municipality should submit documentation demonstrating a diligent effort to evaluate alternatives for increasing flow to the POTW. The municipality should also describe any measures being implemented. The following list provides some examples of documentation that could be submitted:

- A description of any planned physical changes that are part of this control
- A cost estimate and implementation schedule for each of the changes listed above
- An estimate of the expected decrease in frequency and magnitude of CSOs and, when possible, an estimate of the loading reduction in pounds of biochemical oxygen demand and suspended solids, as well as other pollutants of concern
- A description of the additional studies and analyses, if any, that will probably be performed during LTCP development.

CHAPTER 6

ELIMINATION OF CSOs DURING DRY WEATHER

The fifth minimum control, elimination of CSOs during dry weather, includes any measures taken to ensure that the CSS does not overflow during dry weather flow conditions. Since the NPDES program prohibits dry weather overflows (DWOs), the requirement for DWO elimination is enforceable independent of any programs for the control of CSOs. DWO control measures include improved O&M (see Chapter 2), as well as physical changes to regulator and overflow devices as described in this Chapter.

6.1 Control Measures

Control measures that can be implemented to eliminate CSOs during dry weather flow conditions include inspection of the system to identify DWOs, correction of the DWOs, notification to the NPDES permitting authority when a DWO has occurred, and submittal of a description of the corrective actions taken.

6.1.1 Identification

In order to record and enumerate DWOs, a visual inspection program of sufficient scope and frequency is needed to provide reasonable assurance that any occurrence will be detected. Details of program methods and frequency of inspections will vary, depending on the size of the service area, characteristics of the CSS, number of overflow points, and past history of DWOs at particular locations. DWOs can be identified by O&M crews or the public.

Regulators should be a principal focus of inspection activity since they are probably the most common originating point for DWOs. Inspection at accessible locations in the outfall line or at the outfall itself could be sufficient, however, if the tide or river stage does not obscure results. Because regulator mechanisms are subject to blockage or damage that might cause them to malfunction, they should be inspected repeatedly for the presence of DWOs. Observations should be scheduled to coincide with higher flow periods in the diurnal dry weather flow cycle.

O&M plans should include explicit procedures for inspecting DWOs. Although the frequency of inspections depends on site-specific factors, EPA recommends biweekly inspections, as well as inspections after wet weather events. Monthly observations might be adequate for potential DWO locations where the regulator mechanism is in good repair and the system has adequate hydraulic capacity to reduce the likelihood of DWOs in the absence of regulator malfunction. In contrast, at locations where the system's hydraulic capacity is limited or where the regulator's design, age, and state of repair are questionable, inspection several times a week may be warranted.

A number of techniques can support visual inspection activities. Some techniques, such as chalking, block testing, or use of mechanical devices, can also be used to document CSO occurrences (refer to Chapter 10). These relatively simple techniques provide some flexibility when visual observation cannot be made. The physical presence of an observer on an appropriate schedule is still necessary to maintain and reset mechanical devices, however.

For large systems that have many overflow points, automatic devices can indicate DWO events by activating each time the water level reaches a predetermined point. Such devices, when connected to a central location, can also be used as remote alarms for the maintenance crew. Installation of automatic detection devices, particularly for large CSSs, can significantly reduce the cost of visual observation and O&M.

If an outfall is located far from a regulator, sanitary sewer connections might be downstream of the regulator chamber. In such a case, the presence of a DWO cannot be determined from observations at a regulator. This situation should be checked by reference to as-built drawings, by observations at appropriate manholes, or where possible, by direct observation of the outfall.

Shoreline inspections can be made from a boat or on foot in cases where outfall pipes are exposed above the surface of the receiving water. Inspections should be conducted, therefore, at low tide in estuarine water bodies or at the low river stage in rivers subject to large variations in river stage. Personnel familiar with the locations of CSO outfalls and other permitted outfalls should conduct inspections during periods of dry weather flow when CSO outfalls are expected to be dry.

6.1.2 Correction of DWOs

Dry weather overflows caused by operational problems can generally be alleviated by one or several of the following methods:

- **Adjustment of Regulator Settings**—Population growth in an area tributary to a regulator can result in flows greater than the design flow of the regulator. Some regulators can simply have a gate adjusted/raised or a weir elevated to pass the peak dry-weather flow to the interceptor. In other circumstances, a regulator might have to be replaced.

- **Repair/Rehabilitation of Regulators**—Frequently, regulators with hydraulically or mechanically actuated gates can become stuck in the bypassing position because of damage, deterioration, or inadequate maintenance. This may allow dry weather flows to enter the outfall. Simple repairs can correct some of these problems.

- **Maintenance of Regulators**—The orifice through which dry weather flows pass from the regulator to the interceptor can become blocked with trash and refuse and result in a DWO. Routine inspection and maintenance will eliminate such blockages. Debris and relatively large items can be removed manually. Jet washing with a hose can remove grease, sediment, and fiber buildup from relatively small orifices.

- **Maintenance of Tide Gates**—Tide gates can fail to close properly because of obstruction by trash or timber, corroded or warped gates, or deteriorated gaskets. As a result, receiving water can enter the CSS and increase the dry weather flow sufficiently to produce DWOs at downstream locations. Routine inspections, removal of obstructing debris, and prompt repair of defective tide gates can correct this cause of DWOs.

- **Interceptor Cleaning**—Sediments, tree roots, and other items can restrict flow and result in DWOs at upstream locations in interceptors. Restrictions can be removed through sewer flushing, power rodding, balling, jetting, power bucket machines, or other common maintenance methods.

- **Sewer Repair**—Ground water can enter the sewer system by infiltration and, when combined with peak sanitary sewage flow, can exceed the capacity of the regulator. Where specific DWO problem locations can be linked to defects in localized sewer segments, repair may be appropriate as a minimum control measure. For widespread infiltration problems, a comprehensive infiltration/inflow (I/I) control program would likely be a necessary component of the LTCP.

Unlike DWOs caused by operational problems, DWOs caused by structural problems (e.g., insufficient interceptor capacity) may require long-term construction that is addressed through the LTCP.

6.1.3 Notification

The municipality should establish a procedure to promptly notify the NPDES permitting authority that a DWO has occurred. The timing for such notification might vary given the characteristics of the CSS and the frequency of DWOs. NPDES regulations (40 CFR 122.41(1)(6)) require NPDES permits to contain provisions that require permittees to report within 24 hours any noncompliance that can endanger health or the environment.

The municipality should prepare and submit DWO summary reports at regularly scheduled intervals. EPA suggests a quarterly reporting schedule during the initial stages of CSO control to assist in documenting initial conditions and identifying trends. A less frequent basis might be appropriate after the first or second year, once the main features of the DWO situation have been established. These reports should document the DWOs that occurred during the reporting period, causes and problems noted by the inspections, corrective actions taken, results of such actions, and the status of ongoing inspection and remediation activities.

6.2 Example of Implementation

A study by the city of New York determined that DWOs from its CSS were caused primarily by clogging or blockage of regulators employing weirs, orifices, and drop pipes, as well as by mechanical failure of automatic regulators. The city implemented a regulator improvement program in 1988, based on a first phase effort that developed an inventory of the system and problems and recommended actions to reduce DWOs. Implementation of the program reduced DWOs by about 94 percent, from approximately 2 to 0.12 percent of the total dry weather flows (DEP 1991). Principal elements of the program were the reorganization of maintenance operations to clarify the responsibilities between treatment plant and collection system operations, an increase in collection system maintenance staff from 33 to 50, and the acquisition of additional vehicles and equipment (jet flushers, vactors). These actions, coupled with timely inspection and maintenance of regulators, have improved the city's DWO problem dramatically.

6.3 Documentation

The following suggested documentation should demonstrate to the NPDES permitting authority a municipality's efforts to correct DWOs:

- A summary of alternatives considered and actions taken to identify and correct DWOs
- A description of the procedures for notifying NPDES permitting authorities of DWOs and a summary of reports submitted
- A summary of periodic reports on progress toward eliminating DWOs
- A plan for complete elimination of all DWOs as part of the LTCP.

CHAPTER 7

CONTROL OF SOLID AND FLOATABLE MATERIALS IN CSOs

The sixth minimum control is intended to reduce, if not eliminate, visible floatables and solids using relatively simple measures. Simple devices including baffles, screens, and racks can be used to remove coarse solids and floatables from combined sewage, and devices such as booms and skimmer vessels can help remove floatables from the surface of the receiving water body. In addition, as discussed in the next chapter, pollution prevention measures such as street sweeping can prevent extraneous solids and floatables from entering the CSS.

Several other minimum controls (e.g., increased use of the collection system for storage and maximization of flow to the POTW) are also likely to reduce solids and floatables on an incidental basis. The NPDES permitting authority might require evaluation and implementation of some measures specifically aimed at reducing coarse solids and floatables in any CSOs. The LTCP will need to address the effectiveness of the minimum control measures and evaluate other methods (e.g., swirl concentrators and mechanically cleaned screens) for removing solids and floatables.

7.1 Methods for Removing Solids and Floatables from Combined Sewage

Several simple measures can be used to remove solids and floatables from combined sewage before they reach the receiving stream. These include baffles, screens, catch basin modifications, and nets.

7.1.1 Baffles

Floatables can be captured relatively easily within the collection system with baffles placed at overflow locations (Figure 7-1). The effectiveness of baffles will depend on the specific design of the diversion points for the overflows. Baffles are generally simpler than screens and other methods, and have lower capital and O&M costs. Their removal effectiveness is likely to be lower, however, because turbulence in the flow stream tends to entrain floatables, especially those that are relatively close to neutral buoyancy.

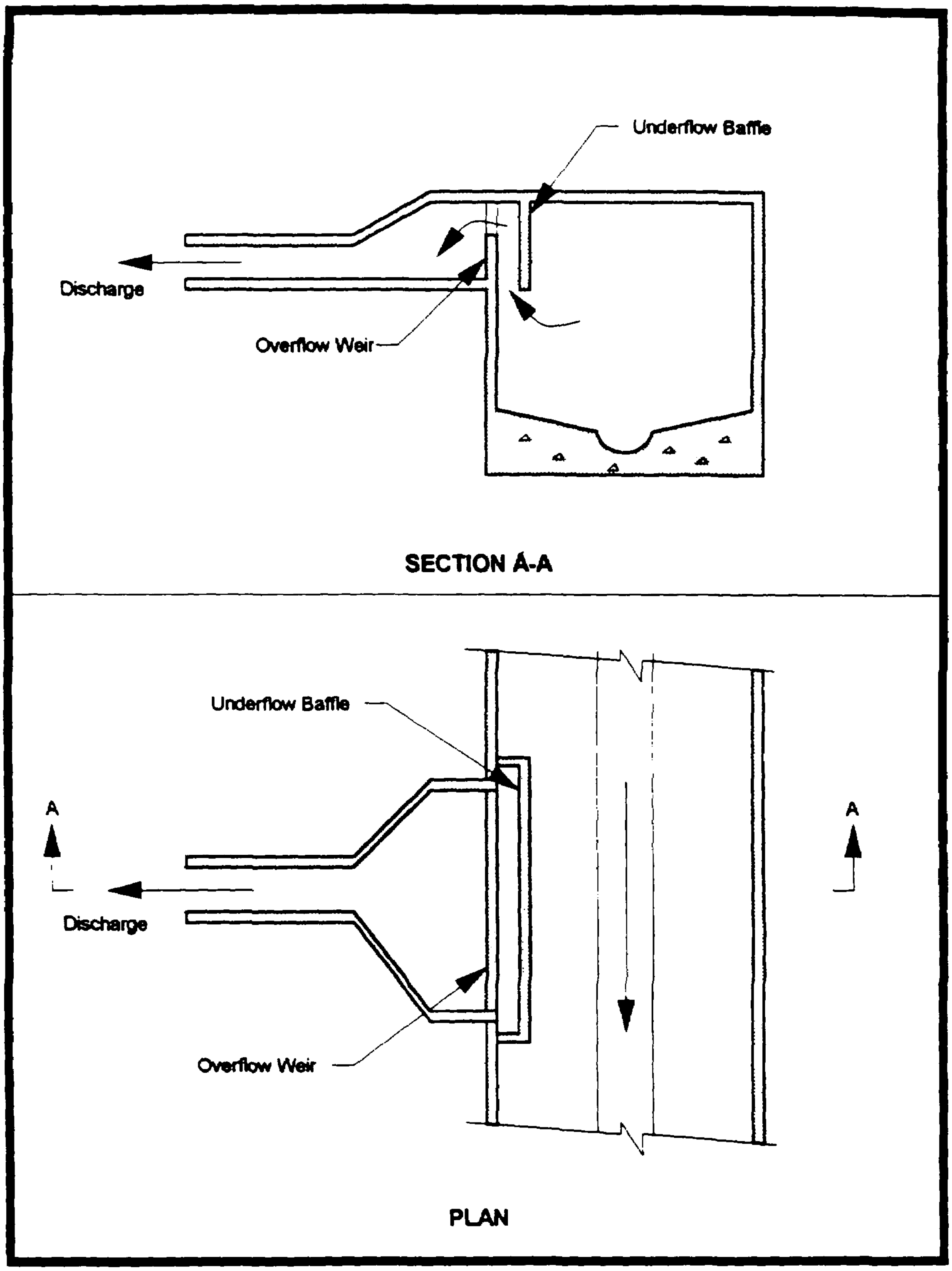

Figure 7-1. Baffles

7.1.2 Trash Racks

A trash rack is a set of vertical bars designed to remove coarse and floating debris from CSOs (Figure 7-2). Trash racks are usually used to prevent floatables from exiting storm water detention ponds and from entering and clogging the pond outlet pipes. Trash racks can be used in a similar manner for CSO floatables, as long as enough outfall pipe or land space is available for a small structure and the outfall is high enough above the receiving water to facilitate regular maintenance.

7.1.3 Static Screens

Static screens (usually vertical bar racks) are manually cleaned screens similar to trash racks (Figure 7-3). Static screens are typically used in sewage treatment plants for preliminary treatment and at pump stations for the removal of debris to protect facility pumps and other internal working areas. They can be used to control coarse solids and floatables in areas where adequate construction space exists and where the outfalls are above the water level of the receiving water body to facilitate maintenance.

7.1.4 Catch Basin Modifications

Catch basin modifications include the installation of horizontal grating restrictions, catch basin outlet restrictors (e.g., hanging traps, hoods), and vertical throat restrictions (Figure 7-4). Restricting the amount of flow that enters the catch basins will also reduce the amount of street litter that enters the catch basin and the CSS. Before modifying catch basins, it is necessary to evaluate whether restricting the catch basin inflow rate will cause unacceptable street flooding. In addition, regular maintenance is necessary to remove trapped floatables and other debris from the catch basin.

7.1.5 End-of-Pipe Nets

Nets can be used to separate floatables from CSOs (Figure 7-5). In general, simple placement of a net across the face of an outfall is not practical because factors such as the discharge velocity and receiving water currents can threaten the integrity and influence the

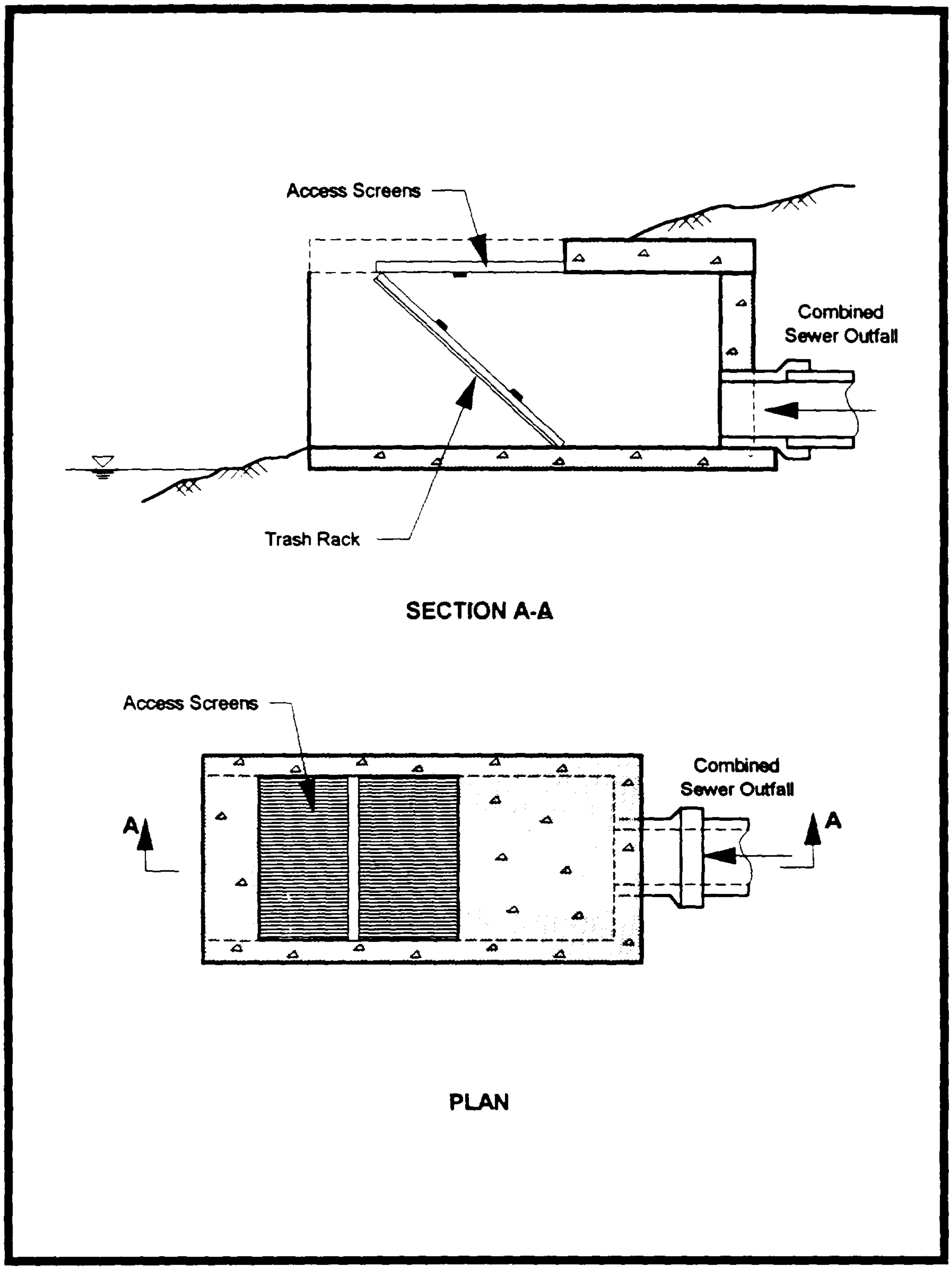

Figure 7-2. Trash Racks

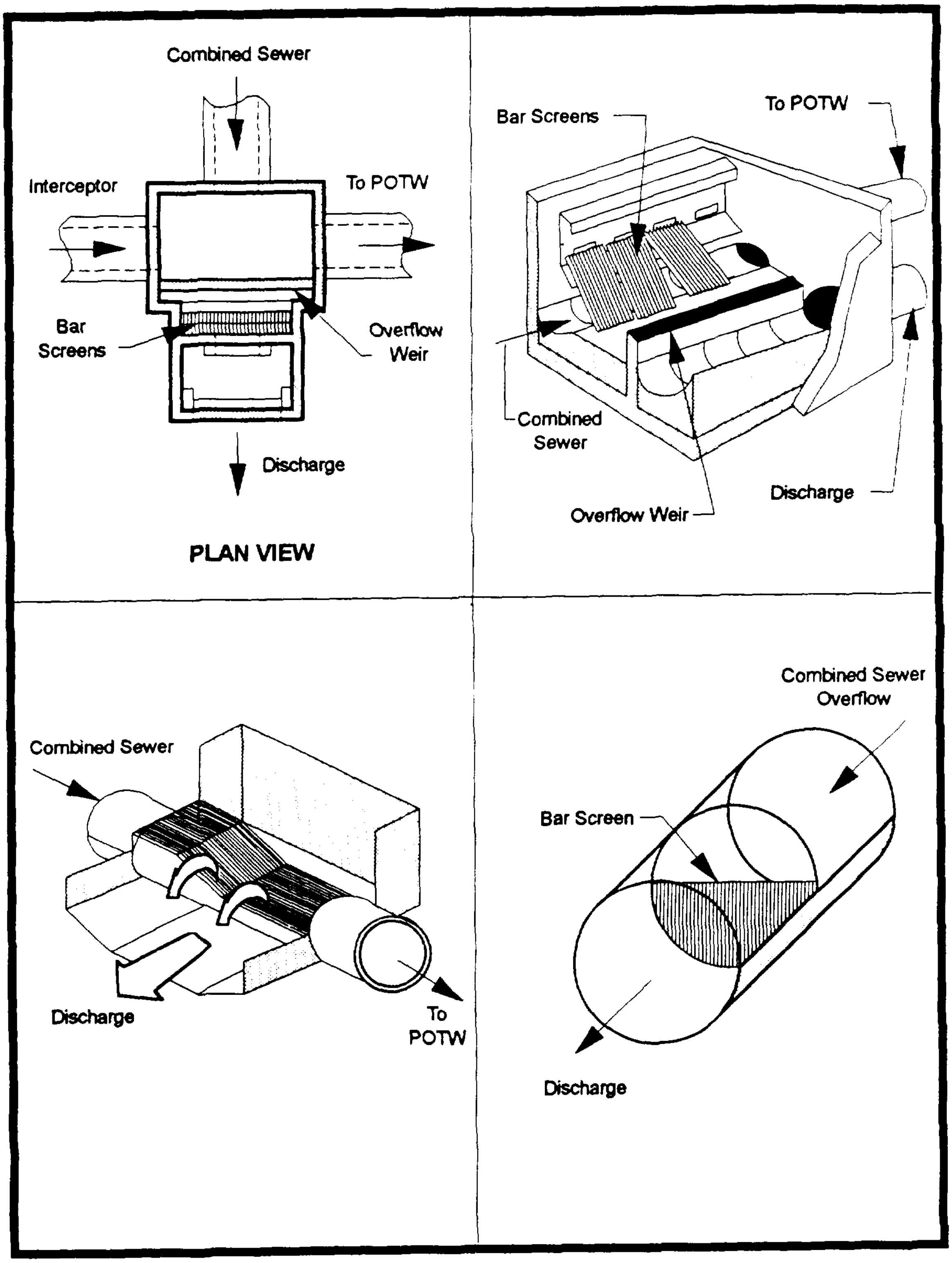

Figure 7-3. Static Screens

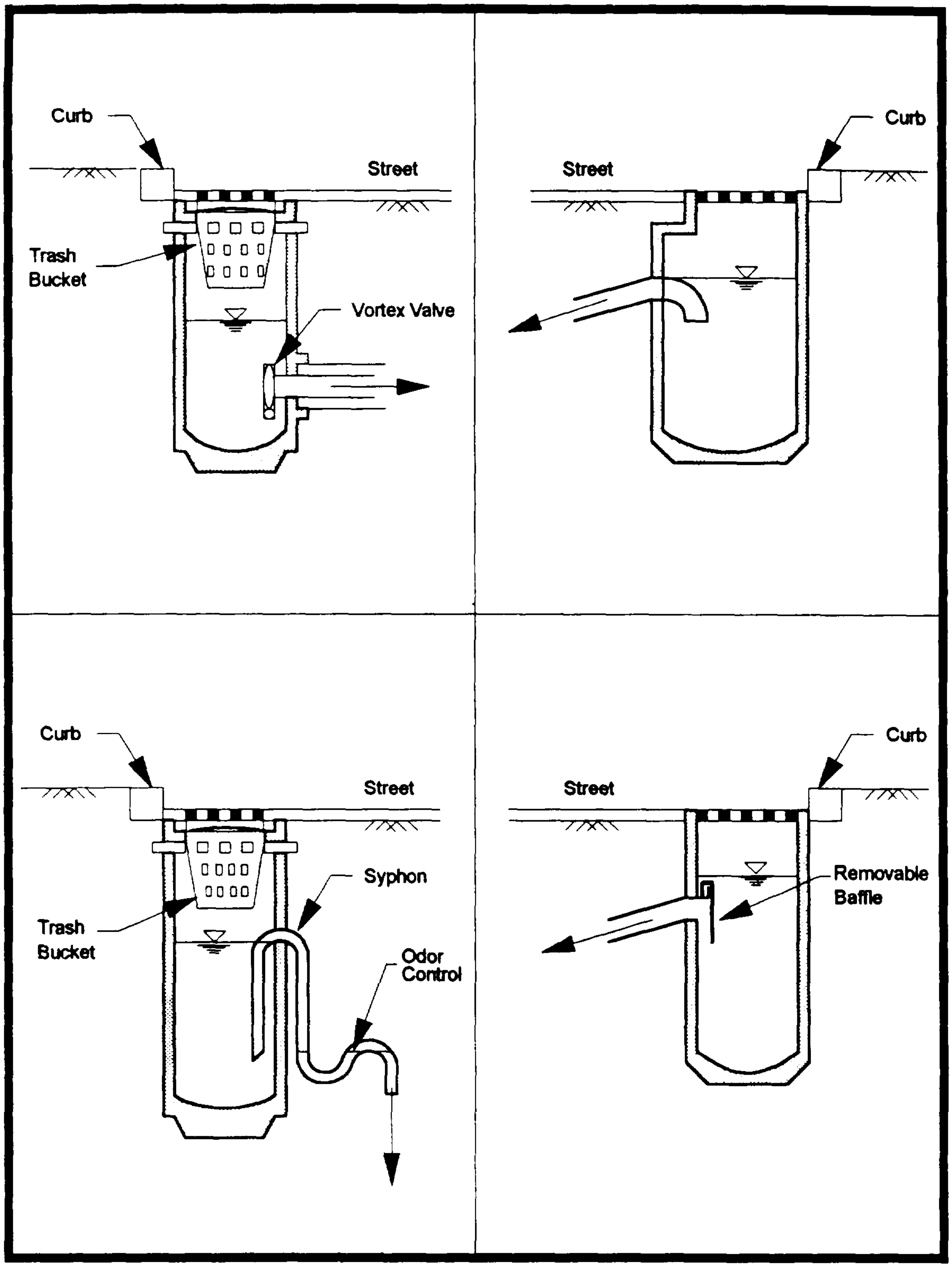

Figure 7-4. Examples of Catch Basin Modifications

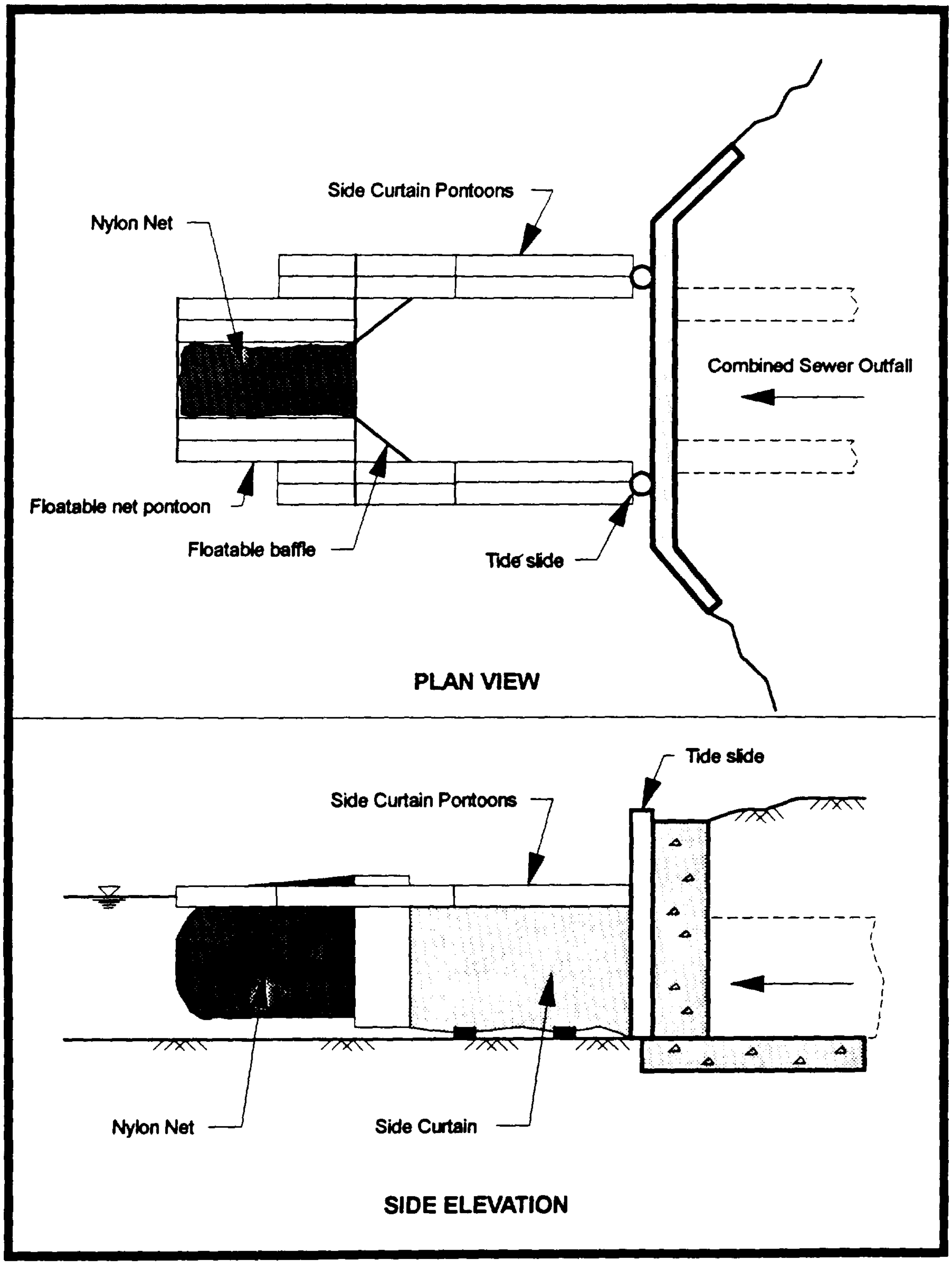

Figure 7-5. Nets

efficiency of a netting system. Usually, a netting installation takes the form of an in-water containment area deflecting CSO flow through a set of netted bags. Floatables are retained in the bags and removed for disposal. The containment system should be sized to handle the volume and force of the CSO. Nets have the potential to work well in lake, tributary, or quiescent estuarine waters at least a few feet deep with an outfall at or close to the level of the water surface. Because these devices are constructions within the natural boundaries of the waterway, however, some NPDES authorities might not approve them.

7.2 Considerations in Removing Solids and Floatables from Combined Sewage

The principal advantage of the removal devices described in Section 7.1 is that they remove larger visible materials from CSOs. One or more of the illustrated screening methods could be considered as a control measure where physical site conditions permit.

The principal disadvantage of these devices is the demand on existing O&M program personnel and budget resources for regular and timely maintenance to clean the screens and dispose of retained materials. Clogged screens will either result in unplanned discharges at other overflow points or produce backups, which cause street or basement flooding. Clogged screens will also cause head loss in the sewer system or act as a barrier in the system and cause surcharges.

7.3 Methods for Removing Floatables from the Surface of the Receiving Water Body

Solids and floatables can also be removed from the receiving water body after discharge. This section briefly describes two commonly-used devices.

7.3.1 Outfall Booms

Simple vinyl oil collection booms, or more elaborate containment systems with specially fabricated flotation structures and suspended curtains, can be placed in the water around outfalls to contain materials with positive buoyancy (which remain on the surface even in turbulent pipeline flows) and materials with neutral buoyancy (which will surface only under the relatively quiescent conditions of the containment zone) (Figure 7-6). Once contained behind booms,

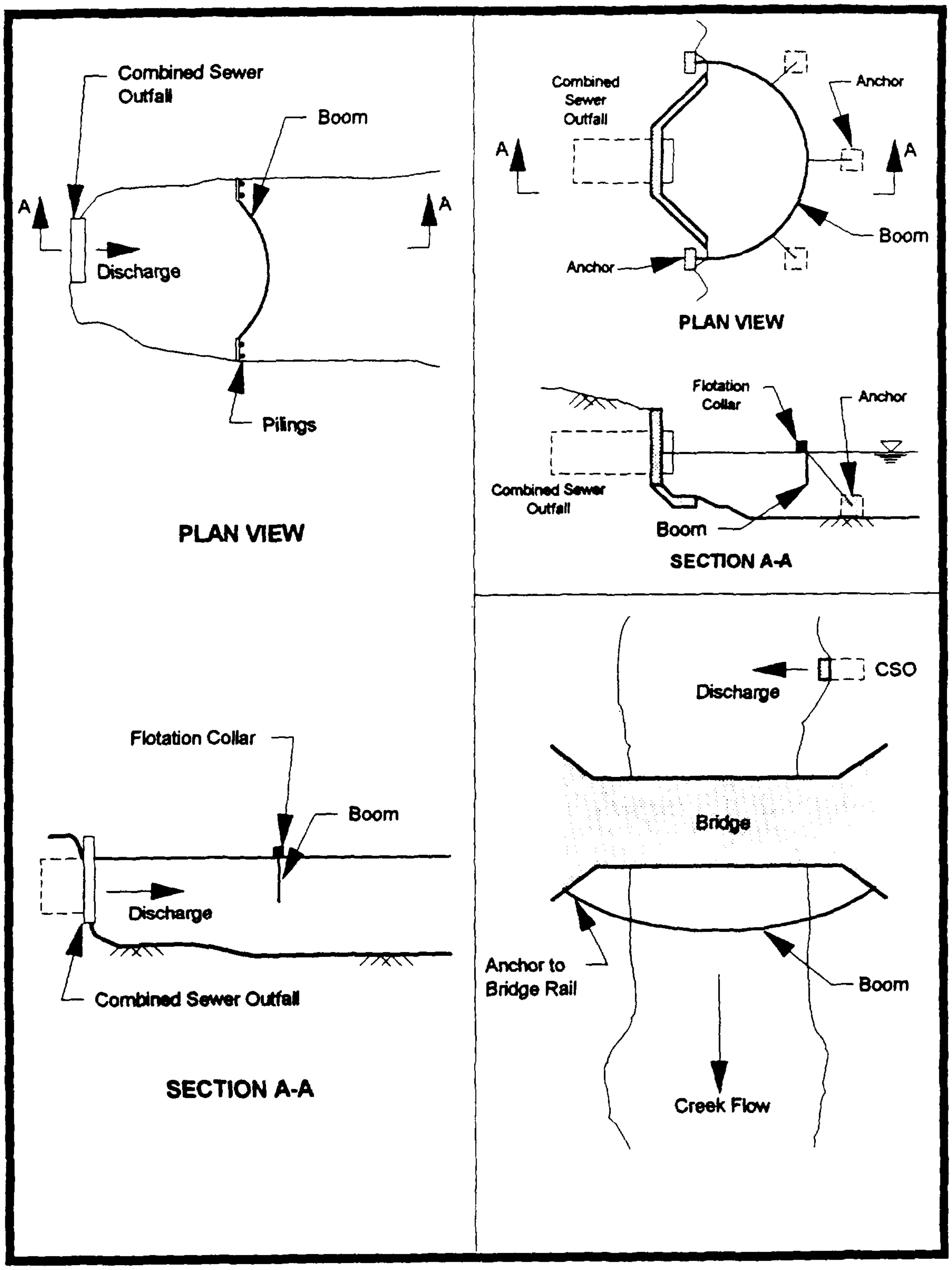

Figure 7-6. Outfall Boom

floatables can be removed by hand, skimmer vessels, or vacuum trucks. Booming systems can also be deployed downstream of one or several outfalls in a river.

Site-specific conditions should be considered in the evaluation, design, and placement of any boom system. Ambient water velocity, CSO exit velocity, provision for a stilling area, allowance for submerged material to rise to the surface, selection of a cleanup method, and the anchoring of the system are all important factors. Because booms are constructions within the natural boundaries of the waterway, however, some NPDES permitting authorities might not approve them.

7.3.2 Skimmer Boats

Skimmer boats remove floating materials within a few inches of the water surface and are being used in cities including New York, Baltimore, and Chicago (Figure 7-7). These vessels range from less than 30 feet to more than 100 feet in length. They can be equipped with moving screens on a conveyor belt system to separate floatables from the water or can lower a large net into the water to collect the materials. Skimmer vessels can be used in water bodies, including back embayments, lakes, reservoirs, and sections of harbors, where currents do not carry floatables away from the CSO outfall area. They might not be effective in areas where fast-moving river or estuary currents rapidly carry floatables downstream or where other conditions impede retrieval. Vessels can also be employed in open water areas where slicks from floatables form due to tidal and meteorological conditions.

7.4 Considerations in Removing Floatables from the Surface of the Receiving Water Body

Simple outfall booms are relatively inexpensive. If the shoreline geometry is favorable, they can be effective in preventing floatables from reaching areas of the water body of higher visibility and sensitivity. More elaborate containment systems, although much more expensive, might be appropriate if CSO outfalls are large but few in number.

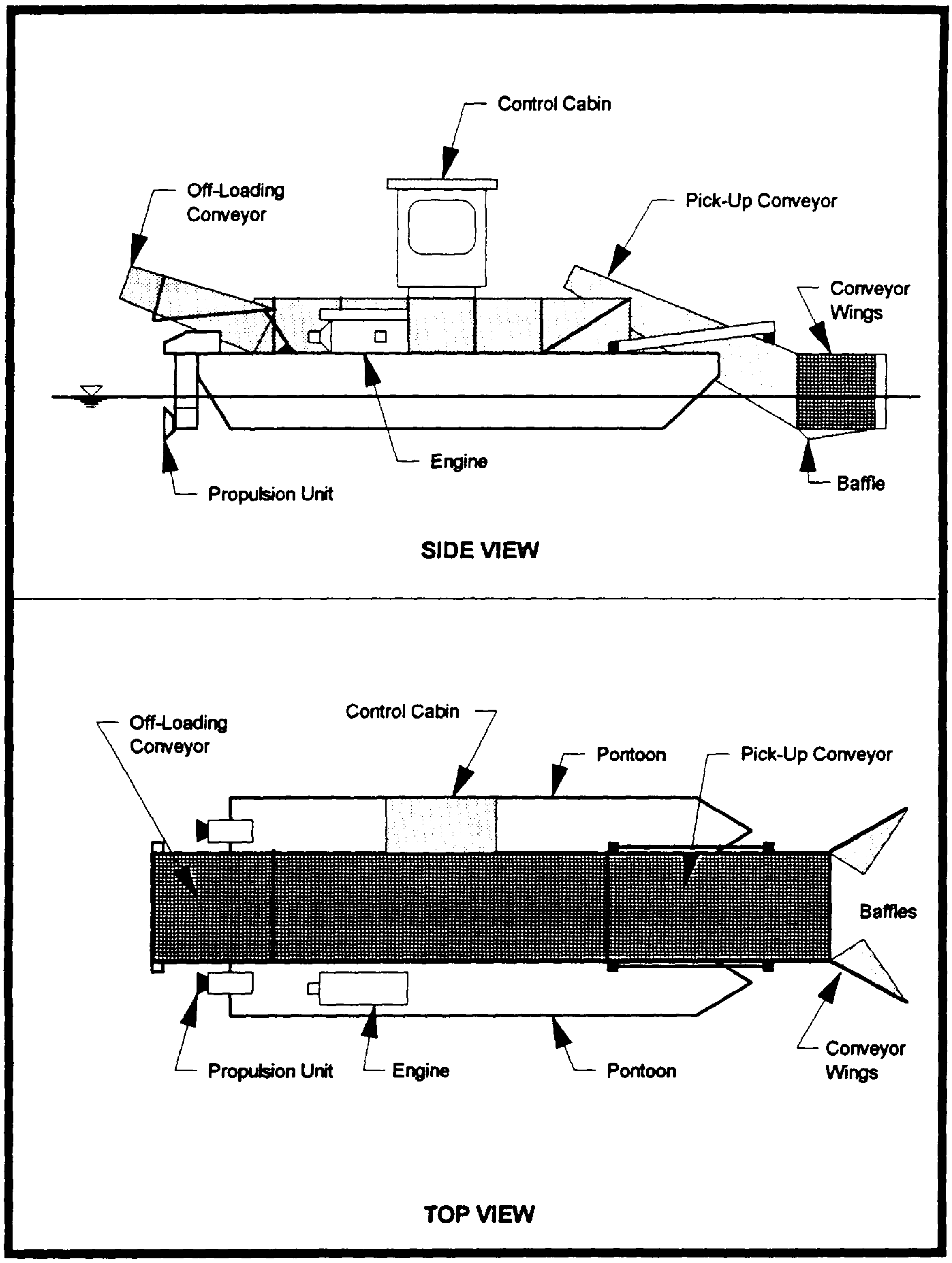

Figure 7-7. Skimmer Boats

Skimmer boats are relatively expensive to purchase and operate. They might satisfy minimum technology criteria if they provide an alternative to the individual control of a large number of widely-dispersed CSO outfalls. In addition, skimmers might be a feasible alternative if geometry and currents make it possible to intercept the floatables before they reach sensitive waterfront areas and beaches. A single skimmer could be used in a cost-effective manner, for example, to clean several containment systems and to recover slicks in open waters.

The principal disadvantage of booms and skimmer boats is that floatables enter the receiving water before removal. The more effective the containment, the more unsightly the appearance of the containment area. Containment can temporarily downgrade the conditions of the receiving waters between cleanings. Therefore, the systems must be cleaned frequently and as soon as possible following overflow events. As mentioned previously, capital and O&M costs for skimmer boats might exceed minimum technology criteria but provide a cost-effective interim program.

7.5 Methods to Prevent Extraneous Solids and Floatables from Entering the CSS

An extensive monitoring program conducted by the city of New York suggests that most floatables in CSOs (about 95 percent) originate as street litter. The remainder includes personal hygiene items flushed down toilets, which are some of the more objectionable material causing beach closings (Figure 7-8).

Accordingly, source control programs that address the prevention or removal of street litter and the proper disposal of personal hygiene materials can contribute greatly to the control of floatables. The next chapter identifies practices to reduce the introduction of such materials into the CSS.

7.6 Considerations in Preventing Extraneous Solids and Floatables from Entering the CSS

Source control techniques for reducing floatables can offer a relatively cost-effective method for preventing floatable materials from appearing in overflows. Citizen action or

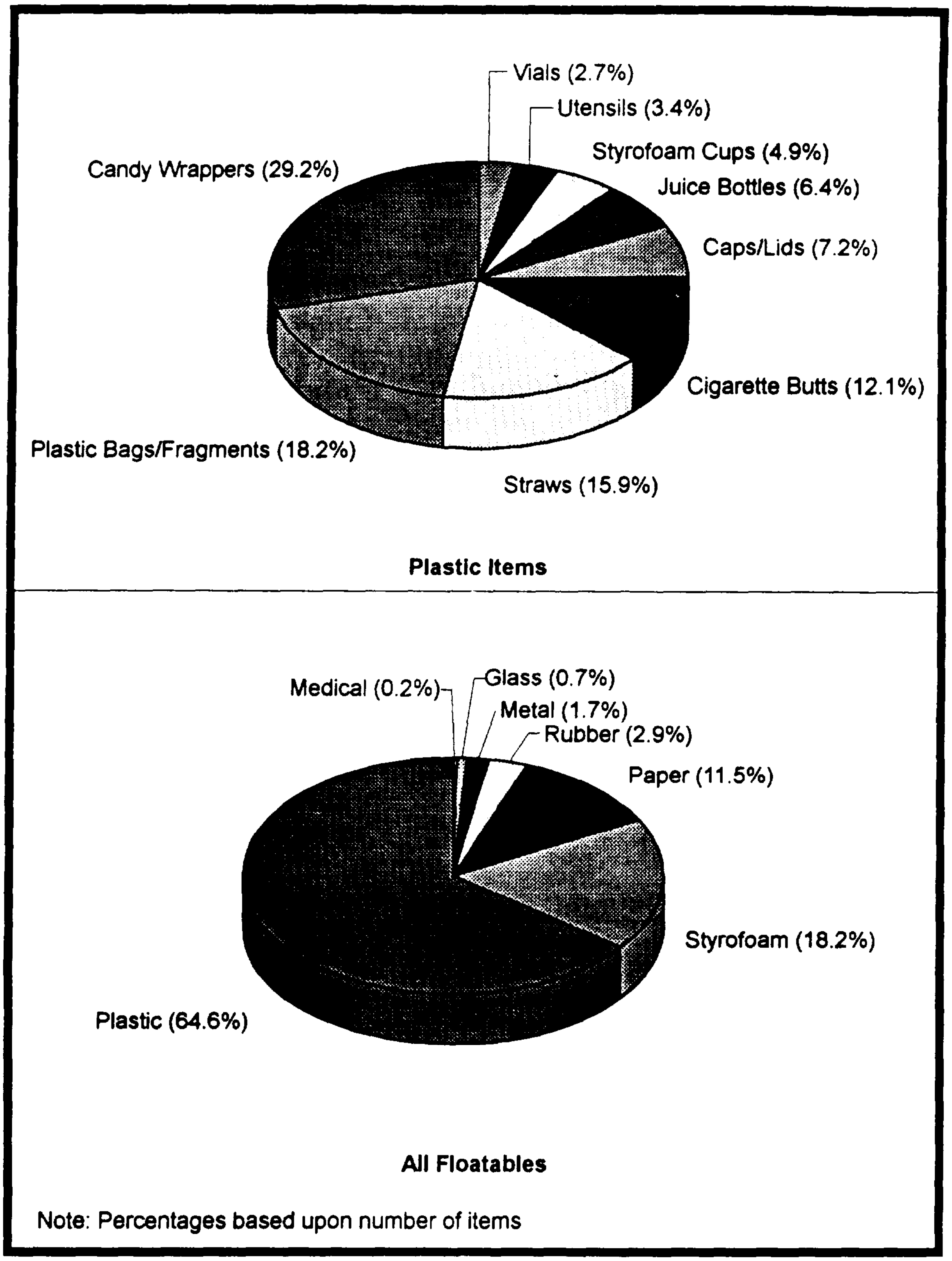

Figure 7-8. Floatable Material in New York City CSOs

education programs can also raise public awareness of the problems associated with CSOs and of the need for the broader control programs.

7.7 Documentation

The following list provides examples of documentation that could be submitted to demonstrate diligent effort in evaluating this minimum control and a clear understanding of the measures being implemented:

- An engineering evaluation of procedures or technologies considered for controlling solid and floatable materials
- A description of CSO controls in place for solid and floatable materials
- A cost estimate (including resource allocation) and implementation schedule for each of the control measures being implemented
- An estimate of the decrease in solids and floatables expected from the minimum control efforts
- Documentation of any additional controls to be installed or implemented.

CHAPTER 8

POLLUTION PREVENTION PROGRAMS TO REDUCE CONTAMINANTS IN CSOs

The seventh minimum control, pollution prevention, is intended to keep contaminants from entering the CSS and thus receiving waters via CSOs. Congress enacted the Pollution Prevention Act of 1990 to establish a national strategy for pollution prevention. Section 6602(b) of the Act establishes the following hierarchy for pollution management efforts:

- Pollution should be prevented or reduced at the source whenever feasible.
- Pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible.
- Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible.
- Disposal or release of pollution into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

The objective of this minimum control is to reduce to the greatest extent possible the amount of contaminants that enter the CSS. Most of the suggested measures involve behavioral change rather than construction of storage or treatment devices.

8.1 Control Measures

Pollution prevention measures such as street cleaning, public education programs, solid waste collection, and recycling can keep contaminants from entering the CSS.

8.1.1 Street Cleaning

Street litter can be removed by mechanical or manual street cleaning or by street flushing during dry weather periods. Daily street cleaning in critical areas might be necessary to significantly reduce CSO floatables. Street cleaning will not control litter from off-street areas. Parked cars prevent the removal of litter and other materials from curbsides. Enforced parking regulations (e.g., alternate side of street parking at different days of the week) and public awareness about the necessity of street cleaning are necessary for effective litter removal.

8.1.2 Public Education Programs

Anti-litter campaigns can reduce the amount of street litter and household items that enter CSOs and storm water outfalls. Public education programs can encourage the proper disposal of sanitary and personal hygiene items, which cause the greatest public concerns and can close beaches. Education programs can also advise the public about proper application of fertilizers, pesticides, and herbicides.

Education methods can include public service announcements, advertising, stenciling of street drain inlets, and distribution of information with water or sewer bills. In addition, these programs can also include elements that focus on commercial and industrial establishments.

8.1.3 Solid Waste Collection and Recycling

Trash receptacles along city streets should reduce the amount of litter on streets, if the receptacles are properly placed, maintained, and cleaned. Street litter in some key densely populated areas can be reduced by collecting domestic curbside garbage more frequently. Recycling programs can reduce the amount of street litter.

8.1.4 Product Ban/Substitution

Many materials that foul beaches, including polystyrene, do not degrade in the environment. Some oceanfront communities have banned the sale of certain food products packaged with these materials. In various areas nationwide, cities and environmental groups have worked with businesses to eliminate the production and sale of fast food items packaged with these materials.

8.1.5 Control of Product Use

Public facilities or public agencies can control the use of problem materials (e.g., fertilizer and pesticides in parks, application of de-icing salt in areas where discharges occur to fresh water bodies).

8.1.6 Illegal Dumping

Public education, notices in appropriate places, and enforcement programs can be used to control illegal dumping of tires, used motor oil, and other materials into waterways, storm drain inlets, catch basins, or onto the ground.

8.1.7 Bulk Refuse Disposal

Designated municipal disposal facilities accept materials such as home renovation debris that are not accepted by normal curbside garbage collection. Commercial establishments can be encouraged to accept used or waste materials including used crankcase oil, worn tires, and dead batteries.

8.1.8 Hazardous Waste Collection

Designated areas should be established, either on a permanent or periodic (annual or semi-annual) basis, where any type of household hazardous waste can be brought for collection and environmentally safe disposal. Permanent disposal sites can be established for collection of hazardous wastes.

8.1.9 Water Conservation

Water conservation will reduce dry weather sanitary flow and increase the volume of combined sewage that can be retained in the CSS and treated at the POTW treatment plant. Water conservation at larger industrial facilities might reduce dry weather flow significantly. Unless dry weather flows represent a large portion of the combined sewer flow causing overflows, however, the effect of this activity might be limited.

8.1.10 Commercial/Industrial Pollution Prevention

Municipalities should actively promote pollution prevention for commercial and industrial establishments located in their combined sewer areas. Such establishments, particularly those with waste oil or hazardous waste storage, can be required through the local sewer use ordinance or sewer use rules and regulations to develop and implement an appropriate pollution prevention plan and apply best management practices (BMPs) to minimize pollutant discharges into storm drains in the combined sewer areas.

The EPA guidance, *Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices* (EPA, 1992) can be used as a reference. Another EPA document, *Municipal Wastewater Management Fact Sheets - Storm Water Best Management Practices* (EPA, 1993), provides useful guidance on pollution prevention practices.

8.2 Performance and Cost

The degree to which pollution prevention can reduce contamination of receiving water bodies through CSOs is not known. In theory, the costs for each unit of pollution reduced through prevention should be less than it would be to collect and physically treat that same unit at the CSO. In some circumstances, however, source control measures sufficient to provide effective pollution control over a diffuse area could be more costly than control measures at CSO outfalls. For example, the effectiveness and overall costs for street cleaning depends on the frequency of cleaning, the number of cars on the street, the degree of enforcement of alternate-side-of-the-street parking regulations, and the volume of litter. In some cases, it would be more cost-effective to screen CSOs at a centralized location than to clean the streets often enough to effectively control pollutants.

8.3 Considerations

Frequently, the actions that prevent or reduce the introduction of specific pollutants into a CSS will be cost-effective in reducing the amount of pollution discharged in CSOs.

Even in cases where pollution prevention measures provide limited tangible benefits, they can have two important ancillary benefits. Reductions in the quantity of pollutants entering the conveyance system will reduce the O&M effort on any overflow control that may be implemented as part of a CSO control program. In addition, public participation in pollution prevention programs will serve to heighten awareness of CSO issues and might increase public support for the overall program.

The measures discussed above generally involve the cooperation of the general public. Many measures involve changes in such habits as to how materials are generated and disposed. The municipality can educate and encourage the public but will have limited control over the degree of implementation and, hence, limited control over the actual pollutant reductions.

8.4 Example of Implementation

Eugene, Oregon, has a comprehensive public outreach effort to raise community awareness of storm water management issues. This effort involves telephone surveys to determine community awareness, quarterly newsletters mailed to all city residents (more than 69,000 copies of each issue), educational events, civic and club presentations, and handouts. Although Eugene's effort focuses on storm water, similar efforts can be implemented to inform the public about CSO problems to improve the effectiveness of pollution prevention programs.

8.5 Documentation

The following list presents examples of documentation that could be submitted to demonstrate diligent effort in evaluating this minimum control and a clear understanding of the measures being implemented:

- A summary of the alternatives considered
- A list and description of the measures planned for implementation and the name of the individual or department responsible
- A cost estimate and the implementation schedule

- An estimate of the benefits expected from the minimum control actions
- Samples of the public educational materials planned for use
- A list of pollution prevention plans that have been developed, if appropriate.

CHAPTER 9

PUBLIC NOTIFICATION

The intent of the eighth minimum control, public notification, is to inform the public of the location of CSO outfalls, the actual occurrences of CSOs, the possible health and environmental effects of CSOs, and the recreational or commercial activities (e.g., swimming and shellfish harvesting) curtailed as a result of CSOs. Public notification is of particular concern at beach and recreation areas directly or indirectly affected by CSOs. Potential risk is generally indicated by the exceedance of relevant water quality criteria.

The most appropriate mechanism for public notification will probably vary with local circumstances, such as the character and size of the use area and means of public access. The measure selected should be the most cost-effective measure that provides reasonable assurance that the affected public is informed in a timely manner.

9.1 Examples of Control Measures

The following list highlights potential measures for notifying the public about CSO events:

- **Posting at Affected Use Areas**—Posting at the affected use areas (e.g., along a beach front) might be most appropriate when use restrictions are temporary.
- **Posting at Selected Public Places**—Posting at selected public places (e.g., a public information center at a park or beach) might be appropriate in the case of longer-term restrictions or where a relatively narrow segment of the public is likely to be affected and can be reached via the public places selected for display.
- **Posting at CSO Outfalls**—Posting at CSO outfalls is advisable where outfalls are visible and the affected shoreline areas are accessible to the public.
- **Notices in Newspapers or on Radio and TV News Programs**—Newspaper or radio/TV notices might be appropriate for situations that are not routine or are unusually severe in terms of impact or public sensitivity, such as beach closings.

- **Letter Notification to Affected Residents**—Letters to affected residents would be appropriate primarily for situations that reflect longer-term restrictions and that do not require prompt notification. This approach is most likely to reach all potentially affected parties and provides an opportunity to give more detailed information.

- **Telephone Hot Line for Interested Citizen Calls**—A telephone hotline might be appropriate in cases where restrictions on a use (e.g., beach closures) occur relatively frequently, affect a large number of people, and might change daily.

9.2 Performance and Cost

As a minimum control, public notification actions have no direct effect on reducing overflows and pollutant loads from CSO systems, or on minimizing water quality impacts. Notification, however, will diminish the potential risk of adverse public health effects. Such actions will also increase public awareness and might increase public support for CSO control programs.

The cost of an adequate public notification procedure will vary with the method(s) employed and with the size of the potentially affected population. In general, costs should be nominal. For example, many areas already have programs for beach postings. The media might provide newspaper or TV announcements as a public service. Letter notifications are usually appropriate only in a few situations. Although a telephone hot line might be more costly, this might be an effective public service in certain situations.

9.3 Considerations

The principal advantage of a notification program is the reduced exposure of the general public to potential public health risks.

Limitations associated with this minimum control are related to the degree of assurance that the notification method(s) selected will provide the necessary information to the appropriate audience. Many municipal agencies probably have the staff and mechanisms for implementing this control; others will have to develop the necessary organizational arrangements and allocate other resources to comply effectively.

Posting at CSO outfalls might be more difficult in cases where outfalls are on private property.

9.4 Documentation

Following are examples of documentation that could be used to demonstrate diligent effort in evaluating this minimum control and a clear understanding of the measures considered:

- A list and description of the measures planned for implementation and the name of the individual or department responsible
- The procedures or protocol for issuing notices
- Samples of the public educational materials (e.g., circulars or notices) used or planned for use and a photograph of a typical sign, if applicable
- A list of the locations where signs are posted (or will be posted)
- A log of CSO occurrences and associated public notification.

CHAPTER 10

MONITORING TO CHARACTERIZE CSO IMPACTS AND THE EFFICACY OF CSO CONTROLS

The ninth minimum control involves visual inspections and other simple methods to determine the occurrence and apparent impacts of CSOs. This minimum control is an initial characterization of the CSS to collect and document information on overflow occurrences and known water quality problems and incidents, such as beach or shellfish bed closures, that reflect use impairments caused by CSOs. Changes in the occurrences of such incidents can provide a preliminary indication of the effectiveness of the NMC.

This minimum control is the precursor to the more extensive characterization and monitoring efforts to be conducted as part of the LTCP to assess changes in pollutant loadings or receiving water conditions. EPA's manual *Combined Sewer Overflows - Guidance for Monitoring and Modeling* (EPA, 1995d) addresses monitoring and modeling program requirements associated with the LTCP. The manual provides detailed guidance on how to plan, design, and implement a monitoring program that will enable determination of pollutant loadings, receiving water quality impacts, and design of structural CSO controls to implement the LTCP.

10.1 Examples of Characterization Measures

This section describes how to characterize the CSS, determine the frequency of overflows, and identify CSO impacts.

10.1.1 General Characteristics of the Combined Sewer System

The municipality should first obtain maps, tables, and other general information on the characteristics of the system, including the layout of the CSS, the population served (including percent associated with the combined portion of the system), locations of CSO outfalls, and locations and designated uses (e.g., swimming, shellfishing) of receiving waters. This will provide a spatial reference for records of overflows and use-related incidents developed under this minimum control.

10.1.2 Overflow Occurrences

The municipality should record the number of CSO overflows at as many outfalls as feasible. Small municipalities with few outfalls should be able to document overflows at each outfall. Large systems should work with the NDPES permitting authority to select a percentage of outfalls that represents the entire drainage area and sensitive locations. EPA's monitoring and modeling guidance (EPA, 1995d) provides more detailed information on selecting an appropriate number of outfalls for monitoring.

The municipality should record the date and time of each overflow event through visual observation or by an appropriately placed flow or level sensor. In addition, the municipality should measure and record the total daily rainfall, using a suitably placed rain gage.

At a minimum, monitoring under this minimum control should develop information on the frequency of overflows at individual points in the system. EPA also recommends the development of information on the duration and magnitude of overflow events, where feasible. Such information can enhance the implementation of CSO controls and can enable measurement of the effectiveness of particular control measures.

Monitoring of flow and quality at the level necessary to calibrate models and/or estimate pollutant loadings is addressed in EPA's monitoring and modeling guidance (EPA, 1995d), as well as the monitoring/modeling section of the *Combined Sewer Overflows – Guidance for Long-Term Control Plan* (EPA, 1995c), and may be beyond the intended scope of minimum control monitoring.

In cases where a calibrated model of the CSS exists (or when one becomes available), model projections may be used to determine the frequency and location of overflow events.

The following measures can be applied to detect overflows:

- **Visual Inspection**—This requires the physical presence of an observer at each CSO point during each storm event. An extended presence during long rainfall events would be necessary, unless a history of the types of storm events producing overflows provides a reliable basis for selective visual inspection. This technique may be appropriate for very small CSSs with only a few outfalls. In general, however, some type of visual inspection aid will be necessary.

- **Visual Inspection with Inspection Aids**—Techniques such as chalking and block testing can lower the personnel requirements for detecting overflows. Observations at each overflow location are necessary before and after a forecasted event.

  - A chalk mark can be drawn on a wall of a regulator chamber, leading, for example, from the top of an overflow weir to the top of the chamber. The mark will wash off when the water level rises high enough to overflow the weir. This provides a crude indication of maximum water level.

  - Wood blocks are placed in positions where an overflow will displace them. The blocks can be anchored with retrieval lines for repeated use. This technique is particularly suitable for use with weirs.

  - Simple mechanical or electrical counting devices, designed to be activated by water level or movement of a valve or gate, are installed at appropriate locations. The device is triggered each time some physical condition associated with an overflow takes place. Inspection before and after every event is not necessary to develop an accurate count of the number of overflow events.

- **Automatic Measurement**—Automatic monitoring equipment records the output on strip charts and provides the output in digital form. This reduces personnel requirements but can add significantly to monitoring costs. The equipment is relatively sophisticated and requires a knowledge of the system's hydraulic characteristics. In cases where automatic flow or level sensing devices are used with automatic samplers, monitoring efforts may be coordinated with a sampling program. Automatic devices can be either connected to an electrical power supply or battery operated, and backup power supplies should be provided. Automatic devices can be installed at remote or difficult-to-reach locations to reduce personnel requirements.

  - Velocity meters can be placed in outfall lines and will record results on strip charts or data cards. They are useful in less-than-ideal conditions, including outfall lines with leaking tide gates or uncontrolled discharges. They can be calibrated to distinguish tidal velocities from velocities during overflow events. The flow direction can also be determined with appropriate units. Multiple meters, set at different depths and installed along with a level recorder, have been used to monitor discharge quantities in very large outfall lines.

- Level recorders may be placed in manholes or pipes or behind weirs to provide information on overflow depth. When properly calibrated for the site and with the level recorded in real time on strip charts, the magnitude and duration of an overflow can be determined. Some devices store the data in memory for later downloading to a personal computer for analysis of data and preparation of reports.

10.1.3 Incidents Relating to CSO Impacts

The municipality should develop a routine report to record and summarize information available from other sources (e.g., the Coast Guard, local volunteer groups) on the water quality or use of waters affected by the CSOs. The report may include information on the following activities:

- Beach closings or postings
- Shoreline washup of floatables
- Fish kills
- Hazards to small boat navigation
- Street/basement flooding.

10.2 Performance and Cost

The inspection and reporting activities involved in implementation of this control will generally be applicable to other minimum controls. Therefore, limited incremental costs or additional personnel requirements are expected.

This minimum control should provide useful information on the general performance of the CSS and the effect of control measures. It also will assist in characterizing the nature and relative severity of receiving water impacts.

As part of the LTCP, the municipality will probably need to develop a comprehensive monitoring program. The monitoring approaches described here should be incorporated into this comprehensive monitoring program. The cost of such a program will vary widely with location, depending on the size and characteristics of both the combined sewer system and the affected water bodies.

10.3 Considerations

The information collected under this control should provide a perspective on existing conditions and a basis for identifying progress that has been achieved by the application of other minimum control measures. Reports of receiving water impacts will assist in providing some indication of the actual, potential, or suspected adverse impacts due to CSOs. Furthermore, if a comprehensive inspection or monitoring program is already part of an LTCP, it might be considered adequate to meet the objectives of this minimum control.

Potential limitations include the cost of monitoring programs and the possibility that overly ambitious monitoring requirements might compete for resources otherwise available for implementation of CSO controls. An appropriate balance should be the objective in all cases. It is essential, however, that a monitoring program measure existing conditions and assess the performance of the minimum control measures.

10.4 Documentation

The municipality should consider the following items for inclusion in documentation for the NPDES permitting authority to demonstrate diligent effort in implementation of this minimum control:

- Identification of CSO locations in the CSS
- A summary of observed incidents (i.e., the number and location of overflow events, as well as duration, volume, and pollutant loadings, if available)
- A summary of existing water quality data for receiving water bodies
- A summary of receiving water impacts that are directly related to CSOs (e.g., beach closing, floatables wash-up episodes, fish kills)

- An assessment of the effectiveness of any CSO control measures already implemented (e.g., reduction of floatables, fish kill incidents)

- Development of a long-term monitoring plan for the LTCP, as appropriate.

ADDITIONAL REFERENCES

New York City Department of Environmental Protection. 1991. *Regulator Improvement Program: Annual Analysis of Bypassing.*

U.S. Environmental Protection Agency. 1992. *Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.* EPA 832-R-92-005.

U.S. Environmental Protection Agency. 1992. *Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices.* EPA 832-R-92-006.

U.S. Environmental Protection Agency. 1993. *Investigation of Inappropriate Pollutant Entries Into Storm Drainage Systems: A User's Guide.* EPA 600/R-92/238.

U.S. Environmental Protection Agency. 1993. *Municipal Wastewater Management Fact Sheets - Storm Water Best Management Practices.* EPA 832-F-93-013.

U.S. Environmental Protection Agency. 1993. *Manual - Combined Sewer Overflow Control.* EPA 625/R-93/007.

U.S. Environmental Protection Agency. 1995a. *Combined Sewer Overflows - Guidance for Financial Capability Assessment* (EPA 832-B-95-006)

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U.S. Environmental Protection Agency. 1995c. *Combined Sewer Overflows - Guidance for Long-Term Control Plan* (EPA 832-B-95-002)

U.S. Environmental Protection Agency. 1995d. *Combined Sewer Overflows - Guidance for Monitoring and Modeling* (EPA 832-B-95-005)

U.S. Environmental Protection Agency. 1995e. *Combined Sewer Overflows - Guidance for Nine Minimum Controls* (EPA 832-B-95-003)

U.S. Environmental Protection Agency. 1995f. *Combined Sewer Overflows - Guidance for Permit Writers* (EPA 832-B-95-008)

U.S. Environmental Protection Agency. 1995g. *Combined Sewer Overflows - Guidance for Screening and Ranking Combined Sewer System Discharges* (EPA 832-B-95-004)

U.S. Environmental Protection Agency. 1995h. *Combined Sewer Overflows - Questions and Answers on Water Quality Standards and the CSO Program* (EPA 832-B-95-009)