United States Environmental Protection Agency
Office of Water Washington, D.C.
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Combined Sewer Overflow Technology Fact Sheet
Floatables Control

DESCRIPTION

This fact sheet describes various technologies for controlling discharges of floatable materials from combined sewer overflows (CSOs). Control of floatable material is an important component of the U.S. Environmental Protection Agency's (EPA's) CSO Control Policy.

Combined sewer systems (CSSs) are wastewater collection systems designed to carry both sanitary sewage and storm water runoff in a single pipe to a wastewater treatment plant. CSOs generally occur during wet weather periods when the hydraulic capacity of the CSS becomes overloaded. Floatables control technologies are designed to reduce or eliminate the visible solid waste that is often present in CSO discharges.

Example floatables control technologies include:

- Baffles
- Screens and trash racks
- Catch basin modifications
- Netting
- Containment booms
- Skimmer vessels

Baffles

Baffles are simple floatables control devices that are typically installed at flow regulators within the CSS. They consist of vertical steel plates or concrete beams that extend from the top of the sewer to just below the top of the regulating weir. During an overflow event, floatables are retained by the baffles while water passes under the baffles, over the regulator, and into the receiving water body. When the flow recedes below the bottom of the baffle, floatable material is carried downstream to the wastewater treatment plant. Figure 1 presents an example of a typical baffle in a CSO regulator.

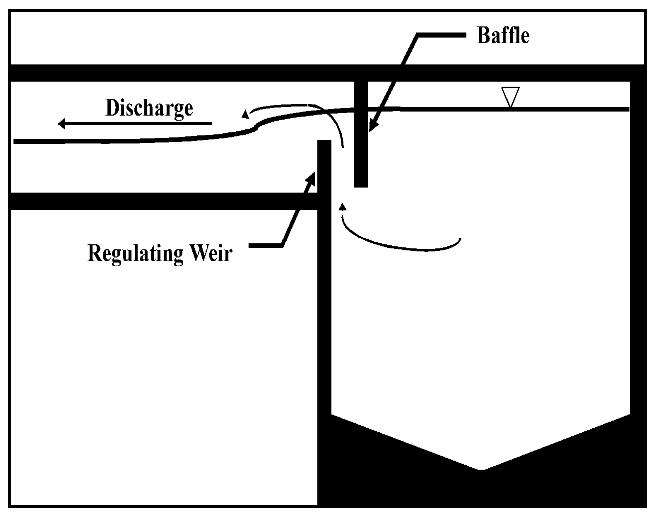

FIGURE 1 BAFFLE IN CSO REGULATOR

Screens and Trash Racks

Screens and trash racks consist of a series of vertical and horizontal bars or wires that trap floatables while allowing water to pass through the openings between the bars or wires. Screens can be installed at select points within a CSS to capture floatables and prevent their discharge in CSOs. Screens used for CSO control include mechanically cleaned permanent screens, static screens, traveling screens, or drum screens. Screens can also be divided into three categories according to the size of floatable material they are designed to capture. These are:

> Bar screens (> 2.5 centimeter [1 inch] openings)
>
> Coarse screens (0.5 - 2.5 centimeter [0.19 - 1 inch] openings)
>
> Fine screens (0.01 - 0.5 centimeter [0.004 - 0.19 inch] openings)

The screens most commonly used to control CSOs are trash racks (a type of bar screen primarily used as an end-of-pipe control) and coarse screens. See EPA's fact sheet "Screens" (EPA 832-F-99-027) for additional information on screens for CSO control.

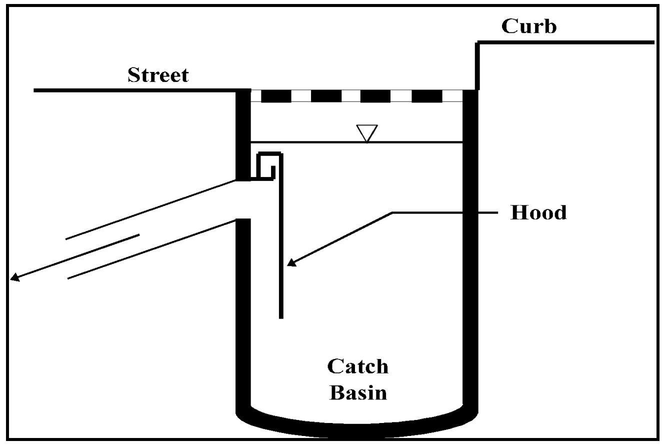

FIGURE 2 MODIFIED CATCH BASIN WITH HOOD

Catch Basin Modifications

Catch basins are surface-level inlets to the sewer system that are often used to allow runoff from streets and lawns to enter the CSS. These basins are often modified to prevent floatables from entering the system. Inlet grates installed at the top of the catch basins reduce the amount of street litter and debris that enters the catch basin. If floatables enter the basin through these grates, they can be collected in colander-like structures called trash buckets installed in the basin beneath the grate. These structures retain floatables while letting water flow through to the CSS.

Other catch basin modifications, such as hoods, submerged outlets, and vortex valves, alter outlet pipe conditions and keep floatables from entering the CSS. Hoods are vertical cast iron baffles installed in catch basins. Submerged outlets are located below the elevation of the CSS and are connected by a riser pipe. The original intent of both hoods and submerged outlets was to serve as gas traps, but they have also proven to be effective barriers for retaining litter and other floatables within catch basins. A vortex valve is a discharge throttling device that is able to reduce the frequency and the volume of CSO events. Vortex valves have also proven capable of controlling floatables. A typical modified catch basin with hood is presented in Figure 2.

Netting

Two types of netting systems can be used to collect floatables in a CSS: in-line netting, and floating units.

In-line netting can be installed at strategic locations throughout the CSS. The nets would be installed in underground concrete vaults containing one or more nylon mesh bags and a metal frame and guide system to support the nets. The mesh netting is sized according to the volume and types of floatables targeted for capture. The CSO flow carries the floatables into the nets for capture. Bags are replaced after every storm event.

Floating units consist of an in-water containment area that funnels CSO flow through a series of large nylon mesh nets. Mesh size depends on the volume and type of floatables expected at the site. This system is passive and relies on the energy of the overflow to carry the floatables to the nets. However, nets must be located some distance from the outfall (often 15 meters [50 feet] or more) to allow floatables entrained in the turbulent CSO flow to rise to the flow surface and be captured. The nets are single use, and after an overflow, the nets are typically removed and taken to a disposal area. Additional information on one type of floating unit, the TrashTrap™ system, is provided in a separate fact sheet (EPA 832-F-99-024).

Containment Booms

Booms are containment systems that use specially fabricated floatation structures with suspended curtains designed to capture buoyant materials. Booms can also be designed to absorb oils and grease. They are typically anchored to a shoreline structure and the bottom, and they can be located downstream of one or more outfalls. Booms are sized based upon the expected volume of floatables released during a design-storm event. After a storm event, material captured in the boom can be removed manually, or with a vacuum truck or a skimmer vessel.

Skimmer Vessels

Skimmer vessels are specially-designed boats used to collect floating debris, including material contained behind booms. Skimmer vessels almost always require companion equipment, including a shore conveyor for offloading, a truck for disposal, and a trailer for land transport. Floatables are brought on board the skimmer vessel with moving screens on a conveyor belt system, or by lowering large nets into the water. Skimmer vessels are used primarily in lakes, harbors, and bays. Figure 3 shows a schematic diagram of a skimmer vessel.

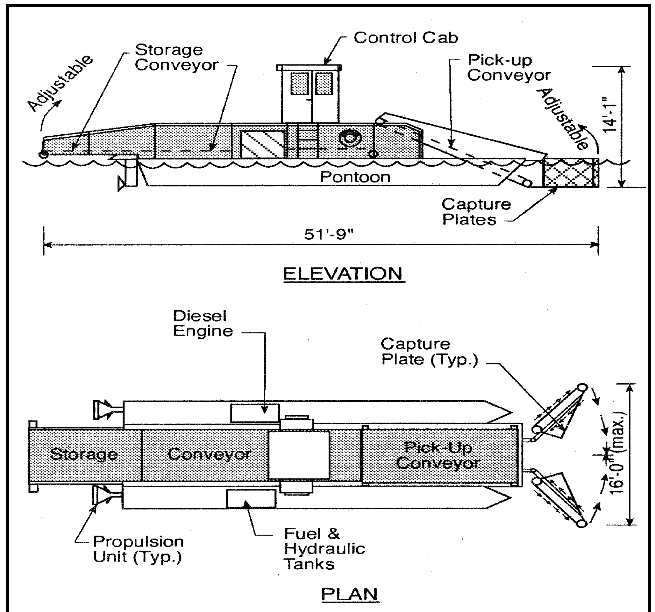

FIGURE 3 TYPICAL SKIMMER VESSEL

APPLICABILITY

Baffles

The effectiveness of baffles depends on the design of the flow regulator. Baffles should be considered if new regulators are being designed and constructed. Baffles can also be retrofitted to existing regulators in many collection systems. In some situations, baffles may restrict access to regulating structures, making maintenance more difficult. However, baffles are considered a low maintenance alternative, and require only occasional cleaning to remove debris and reduce odors.

The city of Columbus, GA, uses baffles for CSO control in parts of its sewer system. The city has installed concrete baffles at the CSO outfalls for each of its 12 new diversion structures. These baffles retain floatables during high flows, and then release the floatables to the treatment plant through a vortex box during low flows. The city has found that the baffles effectively remove most floatable material from the overflow, with minimal costs.

Screens and Trash Racks

Trash racks and coarse screens can be used effectively for CSO control because they capture a significant amount of aesthetically undesirable floating debris and trash contained in the CSS. Removal efficiencies are tied closely to the design size, and can range from 25-90 percent of the total solids. Finer screens have higher removal efficiencies, but are more susceptible to clogging and tearing and may require maintenance after each overflow event. The effectiveness of screening units is reduced significantly by the presence of oil and grease in the flow.

Catch Basin Modifications

The ability of catch basins to control floatables ultimately depends upon their regular maintenance and cleaning. While most catch basins need to be cleaned only once per year, catch basins that have been modified to trap floatables may require cleaning and maintenance after each storm event.

The physical placement of the inlet grates is important to their efficiency. For example, installing basin gratings with openings parallel to flow direction will optimize the flow hydraulics. However, grates of this type may be hazardous to bicyclists.

Hoods or submerged outlets can be included as key components in standard catch basin design. Hoods can also be retrofitted in catch basins in many situations.

Containment Booms

Containment boom efficiency can range from 60 to 90 percent. Site conditions such as receiving water velocity and CSO flow velocity should be considered when evaluating containment boom design, placement, and anchoring. Although booms will float and therefore accommodate water level fluctuations, high river velocities and winds may dislodge them. Booms cannot be employed during the winter in waters that are subject to freezing.

Maintenance requirements for booms are moderate relative to other floatables control technologies. Containment booms must be cleaned after storm events, and this can be costly. Special consideration should be given to booms located in highly visible public areas. Booms potentially create unsightly conditions near the outfalls, and may therefore be inappropriate in areas with waterfront development. In addition, resource and regulatory agencies may have concerns about the presence of floating booms within the natural boundaries of waterways.

Netting

The netting system most appropriate for a given situation depends on three sizing requirements: the absolute peak flow expected, the maximum flow velocity, and the volume of floatable material per million gallons of CSO. In-line units are widely applicable, and can be adapted to most combined systems. Floating units are more suitable for use in lakes, estuaries, and tidal waters at outfalls or close to the water level. Since floating units collect floatables after they enter the receiving water, they can potentially create unsightly conditions near the outfall, and may be inappropriate in areas with waterfront development. In addition, resource and regulatory agencies may have concerns about floating units that lie within the natural boundaries of waterways.

Netting systems require a high amount of maintenance. The frequency with which bags must be changed depends on site-specific conditions, including the frequency and volume of overflows, the volume of floatables, and the overall water quality. In some places, bags may need to be changed as frequently as 30 to 60 times per year. In many instances bags are changed to remove captured waste before it gets old and moldy, rather than because the bags are full. It can take 30 minutes to two hours to service each unit, depending on the number and size of the netting bags. Field test results indicate netting can provide removal efficiencies of up to 90 percent for floatables.

Skimmer Vessels

Skimmer vessels are a very visible floatables control method that are easy for the general public to understand and support. Skimmer vessels are typically used to clean broad areas of open water. As a result, the floatable debris and litter collected comes from a variety of sources including CSOs, separate storm water systems, and upstream sources. Financial assistance from sources other than the owner and operator of the CSS may be warranted.

Although the U.S. Coast Guard does not require a specific license in order to operate a skimmer vessel, operation requires considerable skill. Most skimmers require a crew of two, and usually do not fare well in high winds, in the wakes of other vessels, or in strong currents. Ice impedes navigation and the collection of floatables. It is also important to be aware of minimum depth and clearance height requirements specific to each vessel.

PERFORMANCE

Baffles

Columbus, GA uses baffles as part of their CSO control system. However, their specific performance is not tracked. See below for a discussion of the overall performance of Columbus' CSO controls.

Bar Screens and Trash Racks

Columbus, GA uses bar screens and trash racks in both of its treatment plants to mitigate the effects of CSOs. Columbus' Uptown Park CSO facility, which receives flow from the Cooks Branch line of its combined sewer system, has enhanced its CSO system as part of a CSO demonstration project for EPA. The Uptown Park CSO facility uses bar screens and trash racks to filter CSOs, as well as to retain floatables released to the plant after storms from baffles in other parts of the system. During storms, all flow (including excess flow) in the Cooks Branch line is filtered through the bar screens and trash racks located at the Uptown Park CSO facility, and overflows go directly to the receiving water body. Floatables from the Cooks Branch line are retained on the bar screens and trash racks and are taken by conveyor to a dumpster for characterization and disposal. In addition, floatables originally retained during storms by baffles in other parts of the system are eventually released to the Uptown Park CSO facility, where they are removed by the trash racks.

Both the bar screens and the trash racks at the Columbus facility have 3.8 centimeter (1.5 inch) openings. The system effectively captures large solids and floatables, and the facility meets its permit requirements for floatables and fecal coliform. The screens and trash racks are self-cleaning, and so maintenance is minimal. Annual maintenance costs are below $15,000 for the entire sewer system.

Catch Basin Modifications

As part of a city-wide floatables study in New York City, the amount of litter released to the CSS was compared for catch basins with and without hoods, under identical flow regimes. The hooded catch basins retained approximately 85 percent of the litter delivered to the CSS, while unhooded catch basins captured only 30 percent of the litter.

Netting

End-of-pipe netting was installed by New York City at the Fresh Creek outfall, a tributary to Jamaica Bay. Fresh Creek is one of the city's largest CSO outfalls. The floating netting system, using a total of eight bags, removed an average of 295 kilograms (650 pounds) of floatables for every 37.85 million liters (10 million gallons) of CSO filtered. The net is designed to trap material 1.3 centimeters (0.5 inches) or greater in size, and has a capture efficiency of 90 to 95 percent.

In Kentucky, the Louisville and Jefferson County Metropolitan Sewer District (MSD) installed three in-line netting units in their CSS at a total capital cost of $75,500. City personnel changed the bags after two to three overflow events. They found that even though the bags were not always full after three events, they become clogged with dried materials and needed to be replaced. The MSD estimates that the operation and maintenance costs associated with changing the bag(s) in a unit approaches $900, including personnel, machinery, and disposal fees. Additionally, the local landfill does not accept the bags until they have been dewatered, which requires a suitable location for the bags to drain overnight.

Containment Booms

A four-boom containment system was tested by New York City during a two-year pilot study in Jamaica Bay, NY. Floatables were contained by the booms and collected using a skimmer vessel. An assessment of the effectiveness of the booms was made by measuring the quantities of floatable material in the waters and on the shorelines of the Bay before and after installation of the booms. Results showed substantial improvements from the pre-boom conditions, and indicated that containment booms provide a floatables retention efficiency of approximately 75 percent. During the two-year test period, more than 40,640 kilograms (40 tons) of trash were removed from the containment area.

Skimmer Vessels

The Anacostia Floatable Debris Removal Program in Washington, DC ,employs five full-time workers and uses two skimmer boats to maintain more than ten miles of shoreline. In 1998, the skimmer vessels removed 406,400 kilograms (400 tons) of debris from Washington waterways. Overall, the program has removed 3.02 million kilograms (2,975 tons) of debris from waterways since 1992. The program has enjoyed marked success and is hoping to expand in the future. Two additional personnel were hired into the program in late 1998, and the program plans to purchase another skimmer vessel in 1999.

COSTS

Baffles

Capital costs for baffles depend on the size of the structure and the design storm. Sewers that are retrofitted with baffles typically employ stainless steel or aluminum curtains at an average cost of less than $10,000 each. Concrete baffles can be considerably less expensive, but are usually reserved for use in new construction. In complex situations where proper installation requires substantial structural alterations, costs may exceed $25,000 per outfall.

Screens and Trash Racks

Screen installation, operation, and maintenance costs vary widely, and depend upon the flow rate and the type of screen selected. Construction costs for screen systems include costs for installing a specialized housing unit for the screen within the pipe. This may require costly structural alterations to regulators and outfalls. In general, screens and trash racks have moderate maintenance requirements. All units need regular inspection and cleaning. However, these costs are generally low, especially for self-cleaning units. For example, Columbus, GA, spent approximately $15,000 on maintaining their CSO abatement system in 1998. These costs included costs for cleaning screens at the Cooks Branch treatment facility, as well as maintaining other CSO treatment works in other parts of the system.

Catch Basin Modifications

The costs associated with different modifications vary greatly. Trash buckets can cost as little as $100, while installing vortex valves in catch basins can cost as much as $700 per basin. Additionally, the modified basins require regular maintenance at $50 to $150 per unit, including equipment and labor costs.

Netting

Typical purchase, construction, and installation costs for commercially available netting systems range from $25,000 to $150,000 per site. Operating and maintenance costs are estimated at $1,000 per changeout, including $100 for the disposable netting bags.

Containment Booms

The installed cost of a containment boom can run as high as $100,000 to $150,000 per site. Capital costs for the 4-boom system pilot-tested in New York City (excluding engineering costs) were $240,000, while O&M costs were $5,000 over eighteen months. This figure does not include expenses incurred when removing floatables from behind the boom. This was done using a skimmer vessel, and costs for skimmer vessels are discussed elsewhere in this fact sheet. Disposal costs for removing floatables are heavily dependent on the type of system used for removal, the boom's accessibility, the travel time between locations, and fuel use.

Skimmer Vessels

Skimmer vessels can range in cost from $300,000 to almost $700,000, including shore conveyors for off-loading, and a trailer for transporting the vessel from site to site. Annual operating costs average $75,000 to $125,000 per boat and include vessel maintenance and repair, crew wages, fuel, insurance, and land disposal fees for the collected matter. Operating costs for the eighteen month New York City study were $280,000. Of these operating costs, $26,000 in costs related to offloading collected floatables were recorded in 9 months.

Skimmer vessels can be expensive to maintain. For example, while the skimmer vessel program in Washington, D.C. has been very successful, the vessel itself has required a great deal of mechanical maintenance. Maintaining the vessel requires mechanics who are knowledgeable in repairing boats.

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ADDITIONAL INFORMATION

City of Columbus, GA
Cliff Arnett
Columbus Water Works
1501 13th Avenue
Columbus, GA 31902

Fresh Creek Technologies, Inc.
Richard Turner
P.O. Box 1184
West Caldwell, NJ 07007-1184

Jefferson County Metro Sewer District
Dan Knowles
700 West Liberty Street
Louisville, KY 40203

Massachusetts Water Resources Authority
David Kubiak
Senior Program Manager, CSOs
Charlestown Navy Yard
100 First Avenue
Boston, MA 02129

City of New York, New York
Eric Delva
Bureau of Clean Water
New York City Department of Environmental Protection
96-05 Horace Harding Express Way
Corona, NY 11368

City of Washington, DC
Regis Dunbar
Bureau of Sewer Services
125 O Street, SE
Washington, DC 20003

For more information contact:

Municipal Technology Branch
U.S. EPA
Mail Code 4204
401 M St., S.W.
Washington, D.C., 20460

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