INDICATOR 4

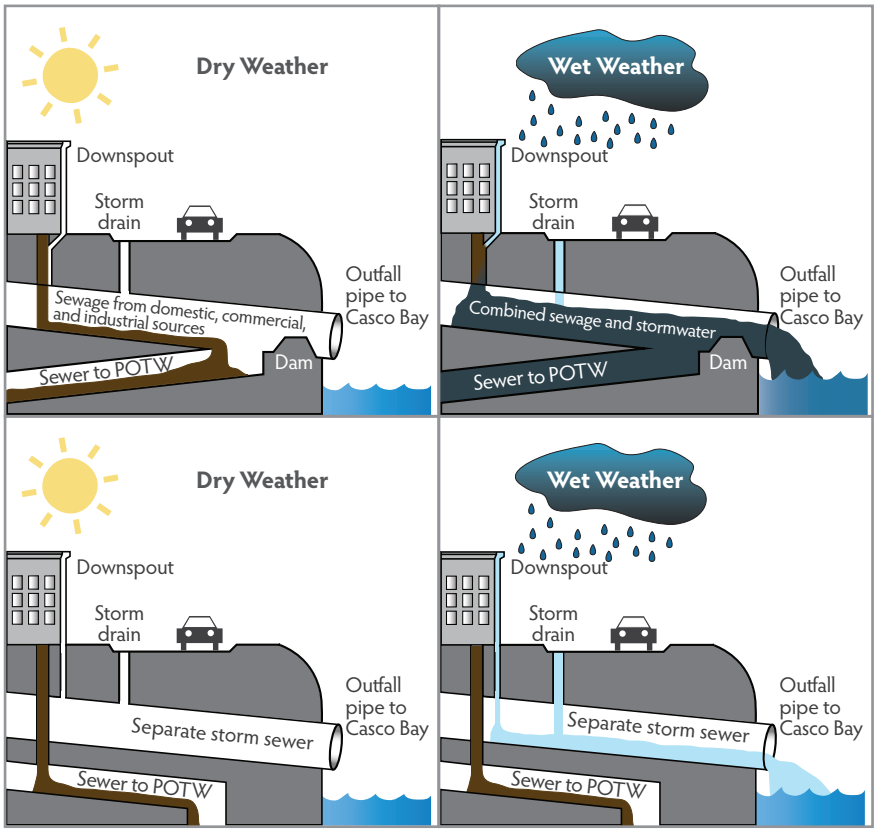
Are combined sewer overflow discharges in Casco Bay declining?

CBEP Goal: Minimize the loading of pathogens, toxics, nutrients, and sediments from stormwater and combined sewer overflows to Casco Bay.

Why Is It Important to Monitor Combined Sewer Overflow Discharges?

When a community's sanitary waste and stormwater runoff flow in the same underground pipes, the system is called a combined sewer. During rainfall events, stormwater can overwhelm the capacity of such sewers or sewage treatment plants, causing direct discharge of untreated sewage mixed with stormwater into Casco Bay waters. Such discharges are called combined sewer overflows (CSOs), a term that refers both to the locations at which such events occur, and to the events themselves.

Typical of older cities nationwide, Portland and some surrounding communities laid only a single set of pipes when their wastewater infrastructures were established more than a century ago. Those pipes serve two purposes: carrying human waste – sewage– away from individual homes; and transporting stormwater runoff away from communities. While combined sewers reduced the initial costs of establishing urban water infrastructure, the resulting plumbing system has distinct disadvantages. When wastewater treatment plants or underground pipes lack the capacity to handle the volume of water from a storm, wastes such as pathogens, nutrients, toxic chemicals, and pharmaceuticals are discharged directly to coastal waters. However, a combined sewer system does provide limited treatment for the pollutants in stormwater from small volume storms, which would otherwise flow untreated to the stormwater system and into the receiving waters (see diagram).



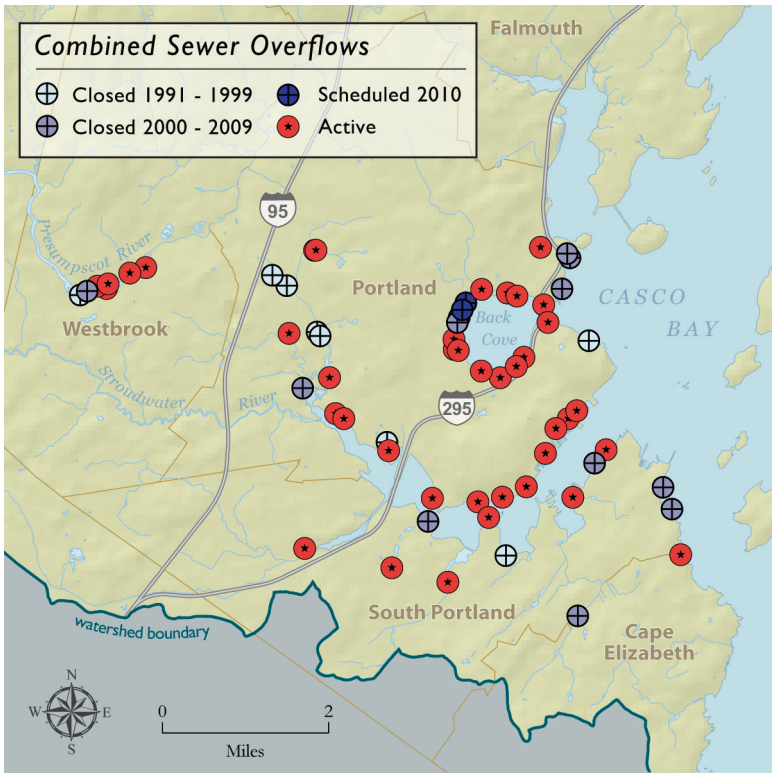
How Combined Sewer Systems Work. During rain events, stormwater in combined sewer systems (upper panels) is mixed with runoff, which can generate enough water to overwhelm sewer systems or sewage treatment systems, leading to discharges to surface waters. In separated systems (lower panels), runoff and sewage are never mixed, eliminating the problem. "POTW" is publicly owned treatment works.

Illustration by Waterview Consulting adapted from EPA

Unfortunately, traditional solutions to the CSO problem, while conceptually straightforward, don't come cheap. The prospect of re-plumbing an entire city to provide separate pipes for stormwater and human waste is daunting, and such fully separated systems typically provide no treatment for stormwater pollutants. Less comprehensive solutions separate sanitary and stormwater systems in certain neighborhoods, or take steps to reduce the frequency or severity of CSO events.

Status

National, state, and local efforts at CSO abatement are having an effect in Casco Bay. Portland is in the midst of "Phase II" of a three-part CSO abatement effort, for which it is receiving funding under the American Reinvestment



Casco Bay CSO Discharges by Municipality (2009)

Community	2009 Discharges (Millions of gallons)	Percentage
Cape Elizabeth	3.5	0.4%
Portland	872.8	97.5%
South Portland	12.2	1.4%
Westbrook	7.1	0.8%
TOTAL	895.6	100.10%

In 2009, an estimated 895.6 million gallons of combined stormwater and sewage were discharged from 45 different outfalls in the region. Despite the city's efforts, Portland's discharges have accounted for more than 95 percent of all CSO discharges in the watershed over the last decade, dwarfing those from other Casco Bay communities. (Percentages do not sum to 100 because of rounding.)

and Recovery Act. The city has invested more than $29 million in Phase II over the past several years, and has permanently eliminated seven CSO outfalls, while reducing expected discharges at others. Overall, the city has spent over $47 million on the CSO program since abatement efforts began in 1993, the majority of which has been borne directly by the city's sewer ratepayers (see sidebar). While the total number of active CSO discharge points in the Casco Bay watershed has declined by about one third in the past 15 years, Portland, South Portland, Westbrook and Cape Elizabeth still have active CSOs. The Portland Water District plays a major role in addressing CSO challenges throughout the region.

Trends

Over the last two decades, the number of CSO outfalls across the watershed has dropped from 80 in 1990 to 45 at the end of 2009. South Portland eliminated half of its CSO locations by the mid 2000s and Yarmouth eliminated its single outfall in the mid 2000s. Portland and Westbrook have been making progress at their CSO outfalls as well. Several of Portland's CSOs are slated to be eliminated in 2010 based on construction work the city has recently undertaken. Once that occurs, the

Portland's CSO Abatement Program

Portland and PWD are currently in the process of updating their long-term control plan (LTCP). The update will investigate the effectiveness of the city's efforts to date in reducing CSOs, and will develop a "Tier III" plan that will guide further efforts to eliminate CSO outfalls, and significantly reduce system-wide overflows. As part of that effort, Portland and PWD are updating the model of the city's stormwater and sanitary waste collection system to better simulate existing conditions. That model update is based on extensive flow monitoring data (see sidebar p. 17) and will help select strategies for further CSO abatement. The current model suggests that to date, Portland has reduced CSO volumes by approximately 28 percent on an average annual basis since 1997, primarily by applying extensive sewer separation efforts throughout the city (CDM 2010). The Tier III LTCP update will investigate additional technologies to further reduce CSO frequency and volumes. Those technologies may include storage facilities to capture excess wet weather flows before they become overflows, and then return those captured flows to the collection system for secondary treatment at the wastewater treatment plant. Other possible strategies under consideration are high rate clarification, and application of LID strategies. LID techniques not only control wet weather flows but can also improve property values while reducing flooding. The LTCP update is scheduled for completion by June 2011.

total number of CSO discharge points in the watershed should stand at 38.

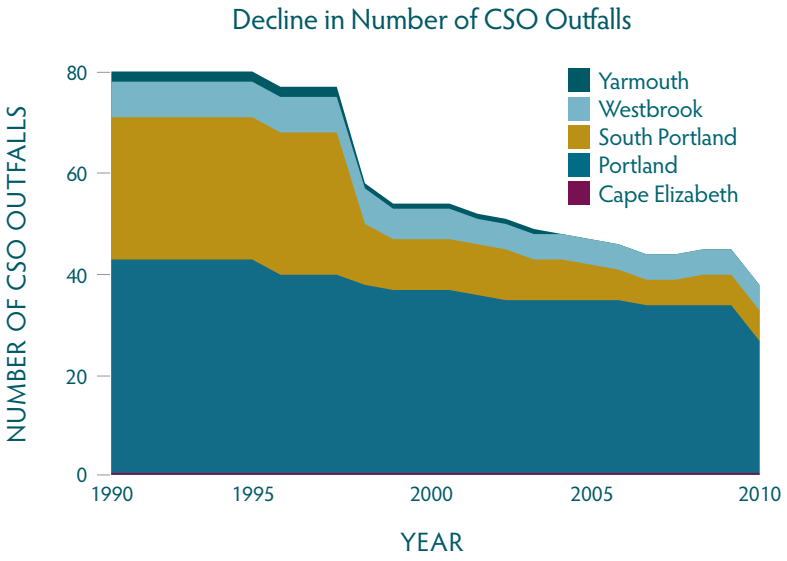
The number of CSO discharge points does not tell the whole story, however. The volume of CSO discharges is of primary importance to downstream aquatic ecosystems, including the Presumpscot River, Portland Harbor, and Back Cove. Despite community efforts at CSO reduction, total CSO discharges have not dropped consistently over the past decade. CSO discharge volumes are strongly influenced by precipitation. During wet years, significantly more overflow is discharged into Casco Bay than in dry years. Recent years have been especially wet, increasing discharges. Year to year variation in precipitation thus partially masks the beneficial effects of efforts by Portland, South Portland, Westbrook, and Yarmouth to reduce CSO volumes.

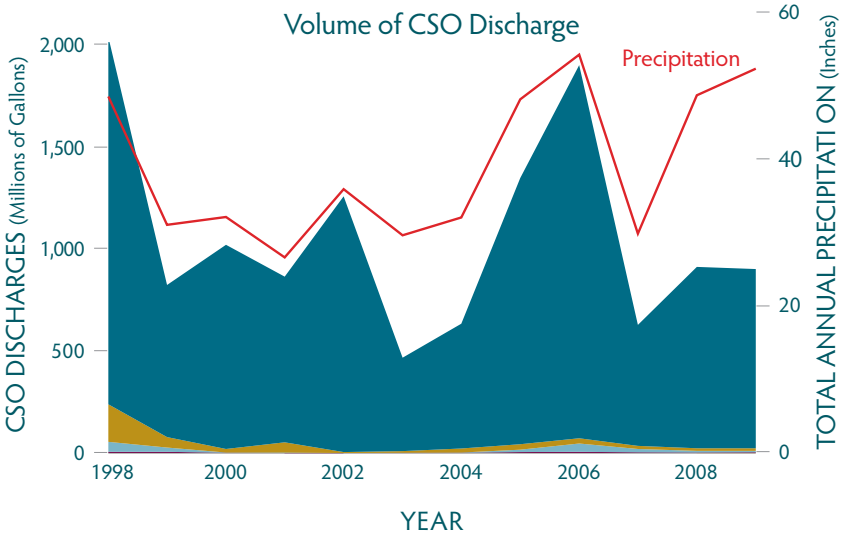
Just how beneficial have local efforts been to reducing CSO volumes? Casco Bay currently receives about 16 or 17 million gallons of CSO discharge for each inch of rain that falls over the course of a year. A decade ago, each inch of rain brought a discharge of closer to 30 million gallons. Thus local efforts do appear to be reducing discharges, despite the high rainfall the region has experienced in recent years. While the decline is uneven, varying with the volume, type, and timing of storms over the course of a year, the downward trend is statistically significant, and amounts to a decline in discharges of about 1.36 million gallons each year per inch of annual rainfall as measured at the Portland Jetport.

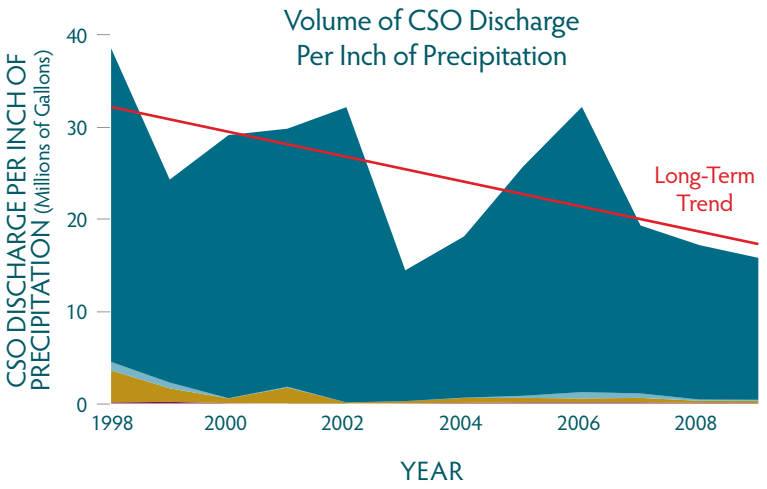
Solution and Actions

Casco Bay communities continue to work on reducing CSO volumes through a combination of better monitoring, engineering improvements, and better stormwater management practices. For example, in the last few years, Portland's CSO program has separated stormwater systems and sanitary sewers in a number of neighborhoods to reduce combined sewer overflows and eliminate CSO outfalls. Portland is also in the process of updating its long-term control plan (see sidebars) to assess the accomplishments of CSO elimination efforts to date, and to identify actions necessary to significantly reduce remaining CSOs.

CSO discharges are directly related to stormwater management efforts as well. Since CSOs occur when urban runoff exceeds the capacity of sewer pipes or sewage treatment systems, reducing the volume of urban runoff in areas served by combined sewer systems translates directly into fewer CSO events, and lower total CSO discharges. Reducing







stormwater volumes in areas served by combined sewers is likely to require applying Low Impact Development technologies, reducing the area of impervious surfaces, and installing stormwater control devices.

It is difficult to overstate the importance of coupling CSO remediation with improved stormwater management. Separation of storm and sanitary sewers – the focus of many CSO abatement efforts – helps alleviate CSOs, but doing so may exacerbate the negative effects of stormwater runoff. In combined sewer systems, polluted runoff from small storms, and from the "first flush" of larger storms, gets routed to a sewage treatment plant, where it receives at least some treatment to remove pollutants. As CSOs are eliminated by separating sewers, more polluted stormwater will find its way to local streams, rivers, and the Bay. While urban stormwater is on a per unit volume basis generally less harmful to the Bay than CSO discharges, it is not benign. So as CSO separation progresses, work should continue simultaneously to reduce stormwater pollution.

Reference

CDM. 2010. *Baseline Report to City of Portland/Portland Water District.* April 7, 2010.

Combined sewer overflow at Capisic Brook in Portland.

Portland Water District CSO Monitoring

PWD has been monitoring flows in the collection system and at CSO outfalls since 2007. The goal is to monitor each CSO: to date PWD is monitoring 88 percent of CSOs in Portland. PWD is also monitoring rainfall to supplement rainfall data collected at the Portland Jetport. The resulting data have allowed PWD to substantially increase the accuracy of CSO estimates, which are reported to Maine DEP each year. The monitoring data have also been critical to Portland's LTCP update modeling effort: PWD data were used to calibrate the city's stormwater models, substantially improving their accuracy.

The monitoring data also allow PWD to take a look at what is happening in combined sewer pipes in real, or near-real, time. Flow data are collected remotely through cellular technology so staff can review them even as rain events are occurring. The in-pipe data have proven valuable for improving maintenance of sewer pipes. The system can display flow changes at any time, and send alarms to PWD staff if flows reach an unusually high level. Thus crews can respond to a potential problem before any dry-weather overflow events can occur.

Example monitoring data from the monitored CSO at Mackworth Street. Vertical axis shows inches of water in the pipe, a measure which is directly related to flow. The site alerts PWD staff when the water reaches slightly less than five inches (green line), even though an actual CSO would occur only when the water depth rises to nearly eight inches (red line). (The data are from March 2010.)