Chapter 5 : Combined Sewer Overflows (CSOs)

5.1 Introduction & Trends

To benchmark wet weather regulations related to CSOs, U.S. Environmental Protection Agency (EPA) Headquarters (HQ) and Regional contacts, as well as State CSO personnel were surveyed on their CSO programs, including control methods and funding sources.

The following 32 agencies responded to one or more questions in the CSO survey: U.S. EPA Region 1, U.S. EPA Region 9, AZ, CA, CT, FL, GA, IN, IA, KY, LA, MD, ME, MA, MI, MN, MO, MT, NV, NH, NJ, NY, ND, OH, OR, RI, TX, VA, WA, WV, WI, WY. In some cases, the survey responses were supplemented with internet based research. Information for agencies not listed above is based solely on internet research and indicated with an asterisk. Of the agencies listed above, Arizona, California, Florida, Louisiana, North Carolina, Texas, and Wyoming stated that they do not have CSOs.

Both Montana and North Dakota have eliminated all their CSOs. Of the remaining states with CSOs, 27% (8 of 30 agencies) have eliminated more than half and 59% (17 of 29 agencies) have eliminated less than half. Common CSO control methods include full sewer separation, chlorine disinfection, storage basins, and additional treatment plant capacity. 44% of respondents (12 of 27 agencies) indicated the existence of green infrastructure practices in their state or region, the most common examples are: green roofs, rain gardens, bioswales, permeable pavement and rain barrels. 92%, 65%, and 12% of the respondents identified State Revolving Fund (SRF) loans, federal grants, and CSO bonds from the permitting agency as CSO funding sources, respectively.

5.2 CSO Control Methods

U.S. EPA HQ*

U.S. EPA's 1994 CSO Control Policy requires the permittee to develop a comprehensive monitoring program that measures "frequency, duration, flow rate, volume and pollutant concentration of CSO discharges and assesses the impact of the CSOs on the receiving waters."[1] The monitoring program must include effluent and ambient monitoring and must address abatement alternatives such as sewer separation, storage & pump back, and treatment at satellite facilities.[2]

U.S. EPA Region 1

U.S. EPA Region 1 has used the following CSO control methods: full sewer separation, additional treatment plant capacity, treatment, and storage basins with pump back to treatment plant.[3] Where disinfection is used, very high chlorine doses are used in combination with at least 15 minutes detention, and dechlorination before discharge. Storage basin design varies widely, with a volume designed to capture a particular storm, typically a 3-month storm. Region 1 has also implemented screening to capture floatables and total solids, typically of one quarter inch in diameter.

U.S. EPA Region 9

U.S. EPA Region 9 has implemented treatment, skimming, storage basins, and disinfection to control CSOs.[4] For example, 50 foot deep underground storage basins in San Francisco have a 200 million gallon storage capacity; primary treatment (settling of solids and screening of floatables) also occurs in

these storage basins. When the storage basins fill to capacity during intense and prolonged storm events, there are 36 different discharge points through which the overflow of combined stormwater and sewage is discharged.[5]

Connecticut

Connecticut follows the U.S. EPA's standards for control of CSOs.[6] Methods employed include full sewer separation, additional treatment plant capacity, and treatment. Treatment methods include storage basin for primary clarification and chlorine disinfection. The chlorine concentration is required to meet water quality standards after blending with the secondary treatment process.

Georgia

Georgia Department of Natural Resources (GA DNR) follows U.S. EPA's model for control of CSOs.[7] Control methods include treatment, storage basins, and additional treatment plant capacity. Treatment methods include UV disinfection, chlorine disinfection, and primary treatment.

Indiana

CSO control methods endorsed by Indiana Department of Environmental Management (IDEM) include full sewer separation, additional treatment plant capacity, storage basins (30 minute detention time), and treatment to meet water quality standards (including dechlorination, if chlorine is used for disinfection).[8]

Iowa

Iowa Department of Natural Resources (IA DNR) does not follow U.S. EPA's model for control of CSOs.[9] Control methods include full sewer separation, additional treatment plant capacity, overflow temporary storage basins (that feed into treatment plants when flows become lower), and treatment by disinfection (system to be installed in 2009).

Kentucky

Kentucky Department of Environmental Protection (KY DEP) follows U.S. EPA's model for control of CSOs.[10] Control methods used by some communities are sewer separation and additional treatment plant capacity. KY DEQ has consent agreements with Kentucky's 17 CSO communities. There is also pilot testing occurring with various disinfection agents (e.g., paracetic acid).

Maine

Maine Department of Environmental Protection (ME DEP) follows U.S. EPA's model for control of CSOs.[11] Control methods employed include full sewer separation, additional treatment plant capacity, treatment, and wet weather storage basin (with solids settling and floatables captured) followed by treatment. Disinfection is the primary treatment method, and the following bacteria limits exist: 200 colony forming units (CFU) fecal coliform/100 ml for coastal waters; *E. coli* maximum daily limit of 236 CFU/100 ml & geometric mean of 64 CFU/100ml for Class B Freshwater; *E. coli* maximum daily 236 CFU/100 ml & geometric mean of 126 CFU/100 ml for Class C Freshwater.
Total residual concentrations range from 0.1 mg/L to 1.0 mg/L depending on dilution, with 1.0 mg/L permitted for dilutions greater than 100.

Maryland

Maryland Department of Environment (MDE) follows U.S. EPA's model for control of CSOs.[12] Control methods include additional treatment plant capacity and full sewer separation

Massachusetts

Massachusetts Department of Environmental Protection (MA DEP) follows U.S. EPA's model for control of CSOs.[13] Control methods include: full sewer separation; additional treatment plant capacity (Deer Island Wastewater Treatment Plant); treatment (with a 15 minute contact time and residual concentration of 0.02 mg/L at peak flow); storage basin with screening, disinfection, and return to a publicly owned treatment work (POTW) for treatment. At one Massachusetts' facility, retention time for a one year storm is 60 minutes in two 1.25 million gallon per day (MGD) storage basins. Massachusetts Water Resources Authority (MWRA) operates the Cottage Farm CSO facility, which screens, disinfects, and chlorinates the flow before discharging into the Charles River.[14]

Michigan

Michigan Department of Environmental Quality (MI DEQ) does not follow U.S. EPA's model for control of CSOs.[15] Instead, the use of an adequate treatment definition has been used to control the State's CSOs. Adequate treatment is defined as follows: retention (for full treatment at the treatment plant) of combined sewage flows for the 1 year, 1 hour storm; primary treatment (30 minutes of detention time or the equivalent if settling, skimming, and disinfection are used) of flows for the 10 year, 1 hour storm; treatment to the maximum possible extent for storms greater than the 10 year, 1 hour storm. Where disinfection is used, a dose of 10 to 15 mg/L is required, and the residual disinfectant goal is 1 mg/L. MI DEQ has also implemented full sewer separation, and additional treatment plant capacity to control CSOs.

Minnesota

Minnesota Pollution Control Agency (MPCA) follows U.S. EPA's model for control of CSOs.[16] Minnesota's initial CSO permits were issued in the 1970s and have requirements similar to U.S. EPA's nine minimum controls. The primary control method has been full sewer separation, which began in the Twin Cities area (Minneapolis-St. Paul) in the 1960s. Over 98% of the State's sewers have been separated, and only 8 potential discharge points remain out of a total of 85 in 1984. No overflows have occurred in over 2 years.

Missouri

Missouri Department of Natural Resources (MO DNR) follows U.S. EPA's model for control of CSOs.[17] Control methods include full sewer separation, additional treatment plant capacity, treatment, and solids skimming.

Montana

Montana Department of Environmental Quality (MT DEQ) follows U.S. EPA's model for control of CSOs and has eliminated all CSOs using full sewer separation.[18]

Nevada

Nevada Department of Environmental Protection (NV DEP) follows U.S. EPA's model for control of CSOs.[19] NV DEP has utilized full sewer separation to control CSOs and requires that all WWTP influent be treated as sewage.

New Hampshire

New Hampshire Department of Health & Environmental Services (NH DES) follows U.S. EPA's model for control of CSOs.[20] Control methods include full sewer separation, storage basin (at Nashua Wastewater Treatment Facility), disinfection, as needed to meet 1000 CFU *E.coli*/100ml and as required by U.S. EPA to meet 9 minimum controls. As New Hampshire does not have NPDES primacy, CSO treatment requirements are dictated by U.S. EPA with State input.

New Jersey

New Jersey Department of Environmental Protection (NJDEP) requires all CSO points to have Solids/Floatables Control, with no bypassing of facilities, and 20% of New Jersey's CSO points have been eliminated to date.[21] NJDEP follows U.S. EPA's model for control of CSOs.

New York

Less than half of New York's CSOs have been eliminated. New York State Department of Environmental Conservation (NYSDEC) follows U.S. EPA's model for control of CSOs.[22] Methods employed include full sewer separation, additional treatment plant capacity, skimming, swirl concentrator to remove floatables (in New York City and Onondaga County), in-stream aeration to increase dissolved oxygen levels, deep tunnel for temporary storage, and treatment. Treatment methods include chlorine disinfection based on use of the specific water body and off-line storage basins used in New York City programs. Storage basins are completed in Flushing Bay and Paerdegat, and the Alley Creek CSO tank is currently under construction.

North Dakota

All North Dakota's CSOs have been eliminated using full sewer separation.[23]

Ohio

Ohio EPA follows the U.S. EPA's model for control of CSOs.[24] Control methods include full sewer separation, additional treatment plant capacity, treatment, and storage within collection system and at publicly owned treatment works, or POTWs (detention time is site specific with a target of 4 or fewer events per year). Treatment methods include ultraviolet (UV) or chlorine disinfection and ballasted flocculation processes (minimum treatment requirement is 80% solids removal).

Oregon

Oregon Department of Environmental Quality (OR DEQ) follows the U.S. EPA's model for control of CSOs.[25] In order to control CSOs, Oregon uses full sewer separation, additional treatment plant capacity, reduced inflow and infiltration, and treatment. Treatment methods include chlorine disinfection and use of a storage basin as a primary clarifier. Ferric chloride or another coagulant is added to encourage clarification, or settling of solids. Specifically, the Columbia Boulevard Wastewater Treatment Plant added treatment capacity to reduce CSOs.

Pennsylvania*

Pennsylvania Department of Environmental Protection (PA DEP) has developed a general permit for wet weather overflows from municipal combined sewer systems that serve fewer than 75,000 people.[26] CSOs that occur when the design capacity of the pipe system or treatment facilities of the system is not exceeded are not permitted.[27] The requirements of the permit vary for each community or CSO location, but may include effluent limitations and some type of acute whole effluent toxicity testing on the overflows.[28]

Rhode Island

Rhode Island Department of Environmental Management (RI DEM) follows U.S. EPA's model for CSO control, using treatment, temporary storage, and eventual return to the treatment facility.[29]

Vermont*

Vermont does have CSOs, and control methods employed include full sewer separation (St. Johnsbury) and additional treatment plant capacity (several municipalities).[30]

Virginia

Virginia Department of Environmental Quality (VA DEQ) follows U.S. EPA's model for CSO control.[31] Most municipalities in Virginia eliminated CSOs independent of VA DEQ intervention, and there are just 3 localities with CSOs remaining. These 3 localities are permitted and have implemented and are executing their long term control plans (LTCPs).

Washington

Washington has 11 municipalities with CSOs. Washington Department of Ecology (WA DOE) follows U.S. EPA's model for CSO control, using full sewer separation, additional treatment plant capacity, and treatment (sedimentation followed by disinfection) as control methods.[32] King County has installed 2 CSO treatment facilities that operate only during high intensity storm events and provide primary treatment, disinfection, and dechlorination of CSOs. King County has also partially separated its combined sewer system.[33]

West Virginia

West Virginia Department of Environmental Protection (WV DEP) follows the U.S. EPA's model for control of CSOs.[34] Control methods include: Full sewer separation, additional treatment plant capacity, disinfection treatment, skimming.

Wisconsin

Wisconsin Department of Natural Resources (WI DNR) follows the U.S. EPA's 1994 CSO policy.[35] Wisconsin only has two communities with CSOs, Milwaukee Metropolitan Sewerage District (MMSD) and the City of Superior. Since 1994, MMSD has used deep tunnel storage to control CSOs. MMSD has considered full sewer separation, but analysis indicates that the cost of sewer separation would be greater than $3 billion and would result in little to no improvement in water quality, as over 90% of stormwater is currently treated at MMSD's treatment plants. MMSD's storage tunnel has been expanded twice since 1994. Before tunnel construction, there were 50 to 60 overflows per year; since 1994, there has been an average of less than 3 overflows per year. Water quality monitoring in Milwaukee's CSO affected areas

indicates that the primary cause of non-attainment of water quality standards is nonpoint source pollution and that CSOs account for less than 10% of non-attainment.

Wyoming
Wyoming Department of Environmental Quality (WY DEQ) has eliminated all CSOs through full sewer separation.[36]

5.3 Green Infrastructure

U.S. EPA Region 1: None.

U.S. EPA Region 9
San Francisco has implemented green infrastructure including bioswales, green roofs, bioretention, and pervious pavement.[37] The San Francisco Public Utilities Commission also encourages rain barrels and provides relevant educational materials.[38]

Connecticut
Hartford Metropolitan District Green Capitols Project will reduce the amount of stormwater entering combined sewers by implementing various green infrastructure projects in the Hartford area.[39]

Georgia: None

Indiana: None

Iowa: None

Kentucky
Two of Kentucky's CSO communities, Louisville and Northern Kentucky Sanitation District #1 (Counties of Boone, Campbell, Kenton) are employing significant green infrastructure. In addition, Louisville Metropolitan Sewer District is encouraging the use of rain barrels.

Maine: None

Maryland: None

Massachusetts
"Recent construction projects include power shaving for pumps, lighting, and the use of green materials for buildings, retro-fits, and glass. Heating and cooling evaluations include analysis for maximum efficiency, and suggested vegetation requires less water and maintenance.[40] In addition, design of parking areas maximizes the implementation of green infrastructure.

Michigan: None

Minnesota: None

Missouri
Green infrastructure is being utilized in Missouri. Details were not provided, but an internet based search yielded the following information: Kansas City, Missouri included green infrastructure in its Overflow Control Plan, with a 100 acre distributed storage area in the Middle Blue River Basin planned as a pilot project. [41]

Montana: None

Nevada: None

New Hampshire
The City of Portsmouth will implement best management practice (BMP) retrofits over time for new construction and redevelopment as well as for some sewer separation projects.

New Jersey: None

New York
In Syracuse, green infrastructure is currently proposed for the Metro wastewater treatment plant (WWTP) drainage basin.[42]

North Dakota: None

Ohio
Green infrastructure is used in the Metropolitan Sewer District of Greater Cincinnati (MSDGC). The initial demonstration project was planned for Lick Run in the Mill Creek Watershed, a representative CSO tributary with a variety of soil and land use types.[43]

Oregon
Green infrastructure techniques include: bioswales, green roofs, permeable pavement, enhanced runoff capture and infiltration to groundwater.[44] Specifically, the City of Portland's Sustainable Stormwater Program, implemented through the Bureau of Environmental Services, has replaced impervious surfaces in parking lots with porous underlying soils with pervious pavement in several different locations.[45]

In East Holladay Park, the city of Portland replaced impervious pavement in parking lots whose underlying soils are porous, with pervious pavers to allow stormwater to infiltrate and recharge groundwater. In the absence of an underlying layer of porous soil, a gravel base below the pervious pavers would be required.[46]

Four different blocks in North Portland have been reconstructed, using both pervious asphalt and pervious concrete (North Gay Avenue). With pervious concrete, the mixing process appears to be significant, as some reports indicate that incorrect construction techniques can cause a denser product than desired, leading rainfall to gather on the surface rather than infiltrate. In another area of Portland (Westmoreland), pervious concrete paving blocks were also used.[47]

Rhode Island
Low Impact Development (LID) construction and design has been implemented to control Rhode Island's CSOs.

Virginia: None.

Washington
A city in Washington State has used a local initiative to encourage the use of green roofs to reduce the volume of runoff entering its combined sewer system. Seattle Public Utilities also promotes the use of rain barrels, and has them available for sale to the public, along with free educational materials on their website.[48] Seattle has an impervious surface reduction credit, for NPDES stormwater dischargers that install porous pavement, green roofs, or otherwise reduce the impervious surface area.[49] The Flow Control Technical Requirements Manual (reference 49) describes the specific requirements needed to receive the credit.

West Virginia
West Virginia has used green roofs, rain gardens, vegetated swales, permeable pavement and rain barrels to reduce the quantity of stormwater entering its sewage collection systems.

Wisconsin
Milwaukee, Wisconsin has implemented and promoted green infrastructure, including downspout disconnection, rain gardens, and rain barrels.[50]

5.4 Other Innovative Control Practices

U.S. EPA Region 1: None

U.S. EPA Region 9
San Francisco has implemented innovative CSO control practices, mostly in the form of LID.[51]

Connecticut: None

Georgia
The City of Atlanta, under a consent decree from GA DNR and U.S. EPA, is required to implement different control and treatment methods, including sewer separation of two basins and one sub basin, deep rock tunnel storage, and "near secondary treatment". Full details of Atlanta's required CSO controls can be found at http://cleanwateratlanta.org/ConsentDecree/Elements/Plan.pdf.

Indiana: None

Iowa: None

Kentucky: None

Maine: None

Maryland: None

Massachusetts: None

Michigan
MI DEQ has encouraged innovative approaches to CSO control by applying a statewide stringent standard and time frame for all CSOs. The development of the Rouge River Wet Weather Demonstration Project, which included comprehensive field studies on wet weather impacts in the River, has also served as an innovative model for other CSO areas.[52]

Minnesota: None

Missouri: None

Montana: None

Nevada: None

New Hampshire: None

New Jersey: None

New York:
New York City installed in-stream aeration in Newtown Creek to bring dissolved oxygen up to water quality standard levels. The City of Rochester constructed a deep tunnel to capture all CSOs.[53]

North Dakota: None

Ohio: None

Oregon
The City of Portland implemented the Big Pipe Project to replace the previous pipe system with pipes that are 22 feet in diameter on the east side of the Willamette River to 14 feet in diameter on the west side of the River, allowing the sewer system to accommodate a larger quantity of water.[54]

The City of Portland has also implemented innovative conveyance systems that direct water from rooftop downspouts away from impervious surfaces in multiple commercial locations, including the Mississippi Commons and New Seasons Market.[55, 56]

Pennsylvania*
The City of Philadelphia, as part of its LTCP, has installed a 13.5 foot inflatable rubber dam in the Schuylkill River that is connected to the main relief and interceptor sewers of the city's primary wastewater treatment plant.[57] The dam is capable of retaining 4 million gallons of water.[58]

Rhode Island: None, other than LID mentioned in the previous section.

Virginia: None

Washington: No response.

West Virginia
The City of Pennsboro has implemented innovative control practices including additional influent pump capacity, UV disinfection, a metering flume, and an outfall structure.[59]

5.5 CSO Funding Sources

U.S. EPA Region 1
Federal grants, SRF loans.

U.S. EPA Region 9
Federal grants, SRF loans, wastewater service charges, and city bonds.[60]

Connecticut
Connecticut funds CSO projects with the Clean Water Fund, "which contains a small EPA grant and the remainder of the funds are from the State of Connecticut. CSO projects receive a 50% grant and a 50% loan at 2% over 20 years." [61]

Georgia
State and city bonds fund CSOs.

Indiana
Federal grants, SRF loans.

Iowa
Federal grants, SRF loans.

Kentucky
Federal grants, SRF loans, federal stimulus funds consisting of low interest loans and grants, and a range of financing by the sewer utilities, including sewer service fees.

Maine
Federal grants, SRF loans, and CSO bonds from ME DEP.

Maryland
Federal grants, SRF loans, Chesapeake Bay Restoration Fund grants & loans.

Massachusetts
Federal grants, SRF loans, and special state legislation provide funding for Massachusetts' CSOs.

Michigan
SRF loans, CSO bonds from MI DEQ.

Minnesota
Currently, only SRF loans exist. In 1984, the Minnesota State Legislature enacted a program to separate the remaining sewers in 10 years, providing more than $100 million in grants. The Federal grants program was still active at this time and provided more than $30 million for CSO programs.

Missouri
Federal grants, SRF loans.

Montana
Federal grants, SRF loans.

Nevada
SRF loans.

New Hampshire
SRF loans.

New Jersey
Federal grants, state grants, SRF loans.

New York
SRF loans are used to fund CSOs in NY.[62]

North Dakota
Federal grants, SRF loans.

Ohio
Federal grants, SRF loans, and any funds available for other wastewater infrastructure projects. Wastewater infrastructure funds include: municipal bonds from the Ohio Water Development Authority (OWDA), Ohio Public Works Commission loans, Community Development Block Grants (CDBGs).[63]

Oregon
CSOs in Oregon are funded using SRF loans, federal grants, and CSO bonds from OR DEQ.[64]

Rhode Island
SRF loans.

Virginia
SRF loans.

Washington
Federal grants, SRF loans.

West Virginia
Federal grants, SRF loans, Small Cities Grants & Loans.

** Indicates information obtained solely from the Internet.*

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