Alexia Martinez
LAW 568- Spring 2013

The Emergence of Green Infrastructure as a Solution to Combined Sewer Overflows

Combined sewer systems (CSS) are essential to the underground urban framework. CSS' are responsible for the transport of wastewater to waste treatment facilities. Unfortunately, like many man-made structures, complications arise in extreme conditions. During periods of heavy precipitation, the sewer systems become saturated with wastewater and stormwater runoff, causing overflows. Stormwater runoff is a source of water pollution that comes off rooftops, pavements, and lawns. Along the way it picks up pollutants from commercial, industrial, and natural sources. It's a problem because pollutants are often pesticides, fertilizers, and other hazardous chemicals. [1] The CSS' overflow into designated overflow piping, combined sewer overflows (CSOs). [2] Once CSOs are overtaxed with stormwater and wastewater, they discharge their contents directly into local waterways such as creeks, streams, and lakes. The water discharged from CSOs is completely untreated waste, materials, and stormwater. [2] It's often referred to as "urban wet weather discharge". [3] Although CSS' are designed to overflow and discharge into nearby waters, it can cause significant impairment and degradation of waterways. Water pollution is a concern for 772 cities in the United States, CSOs only perpetuate that issue. [3] In the Niagara River, fish is deemed inedible due to the pollutants discharged from CSOs. CSOs at the Hamburg drain dump raw sewage in Erie Canal's commercial slip. Consequently, recreational activities suffer. In times of heavy rainfall, Lake Erie often closes due to dangerously high levels of e. coli, making the lake unsuitable for swimmers. [4]

CSOs are consideration point source pollution, thus they are regulated under the Clean Water Act. The Clean Water Act (CWA), effective in 1972, regulates the nation's waterways mainly via permitting under the National Pollutant Discharge Elimination System (NPDES). [5] Section 301(a) of the CWA prohibits the discharge of pollutants (not including dredged or fill material) from point sources into waters of the United States without a permit. Under the NPDES, discharges from municipal storm water systems are directly accountable to be properly permitted. Pollutant is defined under section 502(6) to include sewage, sewage sludge, biological material, industrial waste, municipal waste, and agricultural waste. [6] [7]

In addition to federal regulations under the CWA and NPDES, state and local governments play a role in executing and regulating terms listed within the statute. New York State has 76 CSO permit holders with 966 outfalls. [2] In New York State, Stormwater Pollution Prevention Plans (SWPPP) are a necessary step in obtaining and maintaining permits. They comprise preventative measures and means

of mitigating the effects of polluted discharge. Plans typically contain an approach to reduce pollutants from released stormwater, including methods of spill prevention and appropriate responses. The New York Department of State also includes “temporary and permanent structural and vegetative measures to be used for soil stabilization, runoff control, and sediment control…” as proposals within the SWPPP. Existing data pertaining to stormwater’s hydrologic characteristics and comparisons of post- and pre-development conditions are also included. [8]Phosphorus and coliform analyses are contained within the hydrologic characteristics. The SWPPP must have enough required information to be placed into a Notice of Intent under the New York State Department of Environmental Conservation. [9] Without an extensive SWPPP, the Buffalo Pollution Discharge Elimination System will not issue a permit. [8]

As a result of CSO issues and increased pollutant issues, the Environmental Protection Agency’s (EPA) Office of Water issued a National Combined Sewer Overflow Control Strategy on August 10, 1989 (in 54 Federal Register 37370). The strategy affirmed the requirement of CSOs to obtain permits and outlined three main 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; and Minimize the impacts of CSOs on water quality, aquatic biota, and human health.” [2] [10]

Five years later, the EPA enacted the CSO Control Policy in continuation of the goals set in 1989. The policy was published in the 59 Federal Register 18688 on April 19, 1994. The goal of the policy was to provide additional goals in the regulation and permitting of CSOs. The Policy provided additional guidance to permitees in regards to CSOs and NPDES permitting. It ensured public involvement in the process and contained additional principles to abide by. The Policy’s principles placed emphasis on setting distinct control levels in order to meet health and environmental standards. It also constructed a phased approach to implement necessary CSO controls. [10] The Policy set January 1, 1997 as the deadline for the submission of documentation for achieving the necessary controls in CSOs. [11] The CSO Control Policy was then inserted into the CWA under section 1342 (q). After December 21, 2000, each permit, order, or decree issued for discharge of a municipal CSS or CSO needed to conform to the CSO Control Policy. [5] The CSO Control Policy became the new measure in which municipalities would structure their CSS’.

Long Term Control Plans (LTCP) goes hand in hand with the CSO Control Policy. LTCPs are procedures put in place by municipal officials to successfully achieve the goals outlined in the Policy. LTCPs are developed in line with the key principles of the CSO Control Policy. [10] [12] They characterize CSS’ and monitor the influence of CSOs on waterways. [13] An emerging and vital role within LTCPs is the utilization of green infrastructure to abate the adverse effects of CSS’ overflowing into CSOs. Typically, grey infrastructure had been the primary means for managing stormwater overflow into CSOs. Grey infrastructure refers to overflow solutions such as separating sanitary lines from storm lines or increasing the size of CSOs. The problem with grey infrastructure is it still sends untreated, polluted water to waterways when there’s a significant precipitation event. Grey infrastructure is also expensive to construct and provides no environmental benefits. It is a solution that is only marginally effective on wet weather days and impractical on dry weather days. [4] To compliment and potentially replace grey

infrastructure, the EPA has been promulgating the use of green infrastructure within LTCPs. Green infrastructure uses natural materials and processes to address urban and stormwater runoff in order to keep it out of CSOs and waterways. Green infrastructure is an environmentally sound alternative to grey infrastructure. Permeable pavements are alternatives to typical asphalt or concrete roads. Permeable pavements are porous and absorb the precipitation rather than diverting it to CSS'. Rain gardens and planter boxes are effective ways to capture, absorb, and utilize rainfall in an efficient yet cost-effective manner. Downspout disconnection reroutes water from gutters and pipes; the water is diverted to rain barrels or permeable soils. [14] Green infrastructure is being incorporated into LTCPs to maximize both environmental benefits and the health of waterways. The EPA anticipates that with increasing amounts of green infrastructure, grey infrastructure will be downsized. [12] The goals of Buffalo's LTCP include utilizing additional green infrastructure. The LTCP hopes to reduce stormwater flow into CSOs utilizing green infrastructure. The Buffalo-Niagara Riverkeeper suggested developing a new sewer system model to predict stormwater input more efficiently and use green infrastructure to counteract overflows. [4]

The EPA has implemented multiple policies, programs, and projects to promulgate green infrastructure within municipalities. The EPA created new stormwater regulation and improved existing ordinances to require new green infrastructure practices and support existing practices. Codes have been reviewed and amended in order to make it easier for developers in municipalities to meet all necessary requirements in green infrastructure. Pilot programs and demonstrations have helped to introduce green practices to communities and educate the public. Stormwater fee discounts and other incentive programs have also been established to encourage green infrastructure. [15] Stormwater fee discount encourage retrofitting existing structures along with constructing new structures. The percentage discount is based on the level of performance of the structure or per square foot. Along with stormwater fee discounts, a range of other monetary incentives are being utilized such as grants, rebates, installation financing, and other awards and recognition. Local governments are encouraging green practices both on public and private properties. [16]

Along with incentives, the EPA is also employing enforcement action on entities for failure to comply with the new policies and regulations. Enforcement action is implemented by means of injunctive relief or monetary penalties. With injunctive relief, actions are taken against the defendant to bring them back into compliance. As for monetary penalties, they are being issued to account for violations and environmental harm. [17] The EPA continues to pursue fresh ways and ideas to go about promoting green infrastructure. In 2009, the EPA's Office of Enforcement and Compliance Assurance created an outreach program to garner support and suggestions for green initiatives for the 2011-2013 fiscal years. They hoped to reach out to other programs, regions, and associations to find innovative ways to use green infrastructure to reduce CSO discharges. [18]

Many cities across the U.S. have successfully begun to implement green infrastructure initiatives as a result of LTCPs and the CSO Control Policy. Chicago's Green Permit Program was started in 2005 from the Department of Buildings in Chicago, IL. The program provided incentives for builders and developers to build using green techniques. As an incentive, the permitting process was expedited and fees were reduced up to $25,000. [15] Milwaukee, WI has also taken a leap into the world of green infrastructure. Along with some grey infrastructure, they've started using downspouts into rain barrels,

rain gardens, and porous parking lots. [19] By 2030, the King County Wastewater Treatment Division in Oregon has made a goal to control 38 CSOs to average no more than one overflow per year. [20] Philadelphia, PA was issued a consent order by the EPA and it has resulted in an extensive LTCP. They will be spending up to $1 billion on green infrastructure within the coming years. They hope minimize CSO discharge by 85% and convert 34% of drainage areas to "greened acres" to manage the first inch of rainfall. [6]

Green infrastructure is still a fairly new and emerging solution to CSOs in the U.S. The EPA and municipalities are exploring new and innovative ways to implement green infrastructure on a wider scale. However, barriers remain in some regions. Existing requirements in certain zoning codes may be ambiguous and require clarification or amending. Audits will need to be conducted for various codes and ordinances as well. [21] Green infrastructure is a cost-effective and environmentally friendly way to overcome the adverse effects of CSOs and impaired waterways. With ongoing support and outreach, the EPA will hopefully introduce it to more of those 772 cities with water pollution issues. [3]

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