Stopping Sewage Overflows in Harrisburg

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ENVIRONMENTAL INTEGRITY PROJECT

Lower Susquehanna RIVERKEEPER ASSOCIATION

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THE ENVIRONMENTAL INTEGRITY PROJECT

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Executive Summary:

In 2021, Pennsylvania's state capital discharged 1.1 billion gallons of sewage and stormwater into the Susquehanna River, the Chesapeake Bay's largest tributary. [1] Harrisburg's antiquated, more than century-old combined sewage and stormwater system has 58 outfalls that pipe raw human waste – including from the state Department of Environmental Protection (DEP) headquarters -- into the river whenever it rains or the system suffers from a backup, which happens on average more than once a week. [2] In total, Harrisburg captured and treated only 43 percent of the sewage mixed with rainwater flowing through its combined pipe system and allowed 57 percent of its wastewater to flow into the Susquehanna.[3] That 43 percent capture rate was the worst on record for Harrisburg since at least 2015, when public reporting of the figure began, and it was about half of the 85 percent capture standard required by the U.S. Environmental Protection Agency for combined sewage and stormwater (CSO) systems.[4]

Harrisburg's sewage and wastewater treatment system is managed by Capital Region Water (CRW), a municipal authority that serves about 130,000 people from the city of Harrisburg, as well as the surrounding townships of Susquehanna, Swatara, and Lower Paxton, and the Penbrook, Paxtang, and Steelton boroughs.[5]

After a rainfall, the Susquehanna River just downstream from Harrisburg flows muddy brown with pollution, including from runoff and sewage overflows.

To push Capital Region Water to end the illegal overflows, in 2015 EPA and DEP sued the agency for violating the federal Clean Water Act and got CRW to sign a partial consent decree. However, the 2015 decree contained few specific requirements with hard deadlines. For example, the decree did not include a deadline for when Harrisburg must stop piping raw sewage into the Susquehanna River. The decree did not order specific measures to eliminate combined sewage overflows – such as closing outfalls or the construction of underground storage tanks to temporarily hold excess stormwater mixed with sewage during storms so it can be later treated. However, after legal action by the Lower Susquehanna Riverkeeper and Environmental Integrity Project, EPA and DEP strengthened the consent decree. In early 2023, federal and state regulators submitted to the courts a modification to the 2015 partial consent decree that includes a firm new deadline: Harrisburg Capital Region Water must develop an updated Long Term Control Plan by December 31, 2024 that meets EPA's standards for controlling combined sewage overflows.[6] Over the next two years, Capital Region Water will be studying the cost and effectiveness of alternative strategies for updating Harrisburg's grossly outdated plumbing, and then must propose a solution that complies with the federal Clean Water Act.

The Susquehanna River near Harrisburg is so polluted it is classified as "impaired" for water contact recreation because of high levels of pathogens (including fecal bacteria), meaning that it is not safe for swimming or kayaking. The waterway is also impaired for fish consumption and aquatic life. [7] Combined sewer overflows are not the sole source of the river's impairments, with agricultural runoff and other sources also playing major roles. However, Harrisburg – and, more importantly, the state government that owns large swaths of the city's land and buildings – bear responsibility for ending its chronic sewage overflows that are posing a risk to human health.

Fortunately, Harrisburg does not have to reinvent the wheel. At least 700 cities and towns across the country have antiquated combined sewage and stormwater systems.[8] Over the last three decades, dozens of these cities – big and small -- have built effective infrastructure upgrades to reduce or eliminate their combined sewage overflows. Harrisburg needs only to look to the following examples as case studies on how cities can upgrade their infrastructure to halt CSOs:

- **Saginaw, MI**: This city of nearly 44,000 people – smaller than Harrisburg, and with a higher poverty rate -- also had a chronic problem with sewage and stormwater overflows. But starting in the 1990s, Saginaw built a series of six retention basins (four of them below ground) that provide preliminary treatment and chlorine disinfection before transporting water to the city's wastewater treatment facility for full treatment or discharge into the Saginaw River. Prior to the $110 million project, [9] Saginaw discharged up to three billion gallons of combined sewage and stormwater each year. The city no longer discharges any untreated combined sewer overflows. All discharges now receive at least primary treatment and disinfection.[10]
- **Bremerton, WA**: In 1994, this city of a little more than 44,000 people – smaller than Harrisburg – started construction of its CSO reduction plan to install new separate sewer lines, new sewage pumping stations, and upgrades to existing pump stations. The cost of the program totaled about $50 million and included the construction of a wet-weather combined sewage overflow treatment facility and upgrades to the city's wastewater treatment plant. In the early 1990s, Bremerton averaged more than 600 overflow events each year. The city's efforts reduced overflow volume and frequency by at least 99 percent since completion of its CSO reduction program.[11]

- **Grand Rapids, MI:** After sewage overflows harmed downstream water quality and triggered negative media coverage, this city of almost 200,000 people launched a $400 million sewer improvement project between 1990 and 2015 that eliminated all combined sewage overflows. The main components of the project were a 30-million-gallon retention treatment basin and sewer separations on the west and east sides of Grand River. In 1987, the city discharged almost two billion gallons of combined sewage and stormwater into the Grand River.[12] Today, there are no combined sewer overflows. Any discharge of wastewater to the Grand River comes from a retention treatment basin, which partially treats any overflow before release.[13]
- **Boston, MA**: Boston Harbor was notorious for its sewage. But during the 1990s, the city built a combination of improvements to solve the problem. These included a large underground tunnel to temporarily store stormwater and sewage during wet weather, sewer separations, upgrades to existing CSO treatment facilities, and a new CSO treatment facility. Before its approximately $1 billion overflow reduction program, Boston discharged 3.3 billion gallons of combined sewage and stormwater into nearby waters each year. As of 2021, the city discharged almost 90 percent less – 414 million gallons, most of which received treatment.[14]
- **Portland, OR**: Portland also had a chronic sewage and stormwater overflow problem. But from 1991 to 2011, the city reduced its overflows by building three massive underground storage pipes, with the $1.4 billion in costs spread to a population about five times Harrisburg's service area. Portland also performed sewer separations and disconnections of private downspouts from the sewer system. As a result, Portland decreased its combined sewage overflow volumes to the Willamette River by 94 percent.[15]

These are only a few examples. Scores of cities across the U.S. have improved their waterfronts, economies, and public health by reducing sewage overflows through upgrades to infrastructure. Over the next two years, Harrisburg Capital Region Water will be studying alternatives and designing a workable plan to end the sewage overflows that are creating health hazards in the Susquehanna River. Harrisburg – and the state government, which should play a major role in funding any upgrades that serve the state capital -- would be well advised to follow the examples of cities mentioned in this report that solved their CSO nightmares with public works projects.

So far, on its website, Harrisburg Capital Region Water has been emphasizing a "green infrastructure" approach – such as planting trees and rain gardens to help absorb stormwater, combined with some modest improvements to pumps, old pipes, and other so-called "gray infrastructure."[16] "A key component of our … plan is green infrastructure: trees, gardens, and other technologies designed to help reduce stormwater runoff by absorbing or storing for slow release," Capital Region Water's website proclaims.[17] Other cities, such as Philadelphia[18] and Lancaster, Pa.,[19] have integrated green infrastructure into their CSO control plans. But these newer approaches – while valuable, in some ways -- have a less proven and less dependable track record in permanently stopping sewage overflows than the more traditional gray infrastructure upgrades that worked in the cities highlighted in this report. Green infrastructure is useful for absorbing rainwater, reducing stormwater pollution, increasing urban tree canopies, and beautifying city neighborhoods. Cities would be wise to incorporate more natural landscapes into their development. But tree plantings will never completely solve the underlying problem of antiquated sewer systems that deliberately pipe raw human feces and urine into public waterways. For this reason, green infrastructure should be employed as an addition to – and not as a substitute for – the kinds of below-ground improvements in sewage and stormwater pipes, tanks, and treatment systems detailed in this report.

Harrisburg, PA

Sewage overflows have been an ongoing problem in Pennsylvania's state capital, which has a more than century-old combined sewage and stormwater system. For example, in the summer of 2022, the combined sewage and stormwater system overflowed into the Susquehanna River, on average, four out of every 10 days during June, July, and August. To determine the extent of the bacteria contamination in the river, the Lower Susquehanna Riverkeeper for the last four years has been collecting water samples and testing for *E. coli* and fecal coliform along both the Susquehanna and a tributary, Paxton Creek, around Harrisburg during the summer. Lab testing of the samples shows that the average bacteria concentrations in the river along the city's waterfront are consistently far higher than what is safe for swimming or water contact recreation.

In terms of *E. coli* averages in the summer of 2022, bacteria levels just downstream from an outfall leading from the Capitol Complex averaged 348 colony forming units (CFU)/100 mL, which is more than 2.6 times the state's swimming water standard.[20] Those results suggest worsening bacteria conditions in this location, compared to the average of 269 CFU in the summer of 2021 and 150 CFU in 2020. Other locations show somewhat declining numbers, but the average was 56 percent more *E. coli* along the Harrisburg waterfront than would be safe for water-contact recreation in 2022.

Children often play along the waterfront at Harrisburg's City Island Park beach, even though the beach is closed to swimming because of high fecal bacteria levels.

Summer 2022 Bacteria Monitoring in Susquehanna River at Harrisburg

Monitoring Site	Average (geometric mean) of E. coli (CFU)*	Number and % above the swimming standard average (126 CFU)	Number and % above the 'not to exceed' swimming standard (410 CFU)
1. Upstream of Harrisburg north of I-81	66	5 of 20 (25%)	4 of 20 (20%)
2. Governor's Residence	154	8 of 20 (40%)	6 of 20 (30%)
3. End of State Street	348	14 of 20 (70%)	11 of 20 (55%)
4. City Island Beach	337	15 of 20 (75%)	9 of 20 (45%)
5. Wormleysburg at Market St. Bridge	227	12 of 20 (60%)	7 of 20 (35%)
6. Dock Street Dam	86	8 of 20 (40%)	5 of 20 (25%)
7. Steelton Boat Launch	134	7 of 20 (35%)	6 of 20 (30%)
8. Paxton Creek at HACC	449	16 of 20 (80%)	9 of 20 (45%)
9. Paxton Creek at Shanois St.	1047	19 of 20 (95%)	17 of 20 (85%)
10. Paxton Creek at Walnut St.	743	18 of 20 (90%)	16 of 20 (80%)
Susquehanna Average in Harrisburg**	198	45 of 80 (56%)	31 of 80 (39%)
Paxton Creek Average in Harrisburg***	882	37 of 40 (93%)	33 of 40 (83%)

*E. coli levels are expressed as the number of colony forming units (CFU) per 100 ml of water. Pennsylvania uses two standards for swimming and water contact recreation in summer months: 1) The maximum E. coli level shall have a geometric mean of less than 126 CFU/100 ml. And 2) no more than 10% of the total samples taken during a 30-day period may exceed 410 per 100 ml. *E. Coli samples were not diluted. E. coli was analyzed up to 2,419.6 CFU. Six sampling days in June and five sampling days in July included samples that were ≥ 2,419.6, which means the average is artificially low. ** Excludes control sites #1, 5 and 7. *** Excludes #8.*

In response to chronic sewage overflows in Harrisburg, the Pennsylvania Department of Environmental Protection (DEP) and EPA in 2015 sued Harrisburg Capital Region Water and signed a consent decree meant to address the sewage issue.[21] However, the agreement was only a "partial" consent decree – meaning it did not fully solve the problem.[22] The 2015 agreement did not impose any requirements on the water authority to close sewage outfalls, or invest in additional pipes or underground storage tanks to contain overflows during rains. This made the Harrisburg consent decree unlike sewage control agreements EPA signed with other regional cities with antiquated CSO systems, such as Scranton, Pa., Washington D.C., and Arlington, Va. Harrisburg's agreement does not require the city to stop combined sewage and stormwater releases by a certain date or conduct any testing for bacteria along the city's waterfront to make sure that its pollution control efforts work. Instead, Harrisburg's 2015 agreement required Capital Region Water authority to merely develop a long-term plan to reduce (but not eliminate) combined sewage overflows.

The Capital Region Water authority's original CSO control plan, released in 2018, proposed that Harrisburg area ratepayers pay $315 million over 20 years to improve the maintenance of the existing combined sewage and stormwater pipes and make other minor improvements. [23] The plan included upgrading a pumping plant, improving outfall regulation devices, planting trees and rain gardens, and creating other green infrastructure to help absorb rainwater.[24] In theory, the results were supposed to reduce the amount of sewage mixed with stormwater flowing into the Susquehanna by a little more than half. However, EPA concluded that Harrisburg's "City Beautiful H2O"[25] plan would not meet EPA's standards of capturing 85 percent of overflows or meeting water quality standards, and EPA rejected the 2018 plan.

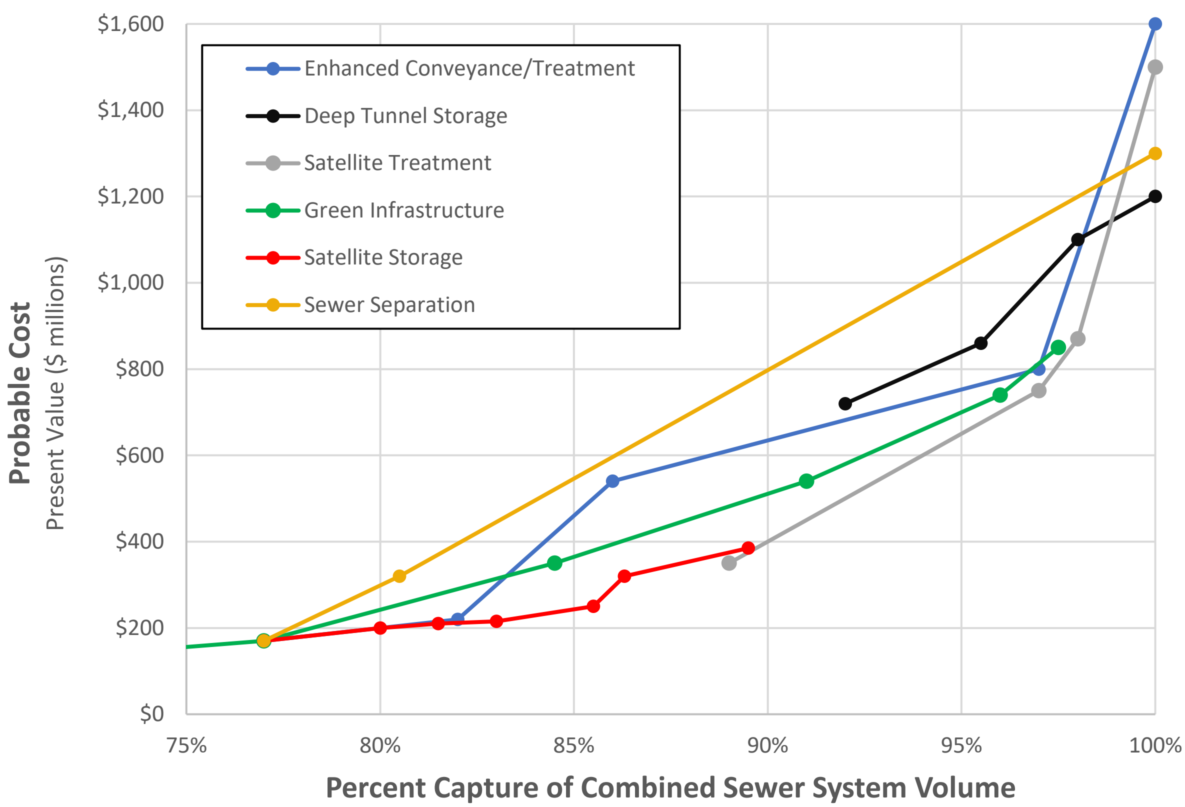
The Pennsylvania State Capitol complex (shown in background) and other state buildings pipe human waste directly into the Susquehanna River. But the state government refuses to contribute any grants to fix the combined sewage and stormwater system in Harrisburg, or even to pay the stormwater control fees that all businesses and homeowners must pay.

Because of Harrisburg's lack of progress in stopping its sewage overflows, on May 6, 2021, the Lower Susquehanna Riverkeeper and Environmental Integrity Project took legal action. The groups filed a complaint in federal court and asked to intervene in EPA's and DEP's 2015 lawsuit against Harrisburg.[26] On December 20, 2021, Judge Christopher C. Conner approved the intervention and criticized Capital Region Water for years of delays. "The partial consent decree contemplates an approvable long-term control plan having been submitted by April 1, 2018," Judge Conner wrote in a decision.[27] "Approaching four years later, Capital Region Water has been unable to meet this deliverable."

EPA and DEP are now trying to move the process forward by amending the partial consent decree. The amendment, which was submitted to the court in December 2022, requires that Capital Region Water produce an evaluation of infrastructure improvement alternatives by March 31, 2024, and an assessment of Harrisburg's financial capability to build these improvements by June. Most importantly, Capital Region Water must submit a new long-term control plan by December 31, 2024, that is robust enough to meet EPA's requirements for controlling combined sewage overflows. The amendment allows EPA to impose penalties of $500 to $1,500 per day if Capital Region Water fails to submit a timely and adequate CSO control plan and meet other milestones.

Public records obtained through an open records request show that Capital Region Water considers the construction of underground CSO storage tanks at locations scattered around the city to be the most cost-effective way of meeting EPA's requirements of an 85 percent capture rate.[28] Such a "satellite storage" system would temporarily hold sewage and stormwater overflows during rainstorms, before the wastewater would be treated in the city's sewage treatment plant. This system would likely cost roughly $250 million, according to this preliminary evaluation, which could be replaced over the next year as CRW updates its alternatives analysis. That $250 million cost would not include additional costs for a backlog of deferred maintenance on the city's sewer system to bring leaky and poorly maintained pipes up to a working status, which CRW is currently working on.

ESTIMATED COSTS FOR REDUCING COMBINED SEWAGE OVERFLOWS IN HARRISBURG



The above chart from Harrisburg Capital Region Water shows that the building of underground storage tanks for sewage and stormwater scattered around the city – the so-called "satellite storage" method -- would be the most affordable strategy for reducing sewage overflows into the Susquehanna River. To achieve the 85 percent CSO capture rate required by EPA, underground satellite storage tanks would cost about $250 million. A green infrastructure approach would cost about $350 million and separating the sewage and stormwater lines would cost more than $500 million.

According to this analysis, a strictly green infrastructure approach would cost more – approximately $350 million (on top of the costs of catching up with deferred maintenance), while the cost of separating all the sewage and stormwater lines would exceed $500 million (on top of the deferred maintenance costs.)

CRW is exploring the possibility of building a combination of the "satellite storage" system and the green infrastructure approach. The agency calls this a "decentralized, gray/green" approach, according to the CRW website.[29] This could mean constructing a series of underground CSO storage tanks around the city, perhaps with some located under city parks, combined with creating more greenspace, planting trees, and creating more rain gardens and permeable pavement to absorb rainwater. "While the primary purpose of green stormwater infrastructure is to manage stormwater, we cannot ignore its transformative nature," CRW says on its website.[30] "Not only are the region's waterways poised to benefit from a green stormwater infrastructure master plan, but so are Harrisburg's residents, businesses, and visitors."

Underground sewage and stormwater holding tanks could potentially be built in scattered sites around Harrisburg as part of a second phase that would occur after (and on top of, in terms of costs) CRW's current 20-year, $315 million plan to contain sewage overflows. The current plan focuses in part on ending a maintenance backlog in the city's poorly maintained sewer system and bringing the pipes up to working condition. Between now and the end of 2024, Capital Region Water will be examining both "gray infrastructure" alternatives (such as underground storage tanks and pipes) and "green infrastructure" components (trees, parks, and rain gardens, etc.). CRW may combine the two strategies – building underground tanks, as well as rain gardens – as it formulates a revised CSO Long Term Control Plan for approval by EPA and DEP.

Below are some examples of what other cities around the country – both small and large – have done to successfully upgrade their antiquated sewage and stormwater infrastructure and halt or dramatically reduce overflows:

Saginaw, MI

Saginaw, a city that sits about 90 miles northwest of Detroit, began controlling combined sewage overflows after changes to state and federal regulations. Michigan adopted new overflow regulations in 1988 and plans for new combined sewer overflow controls were under way later that year.[31] Before Saginaw implemented its overflow reduction plan, 36 outfalls dumped as much as three billion gallons of combined sewage and stormwater into the Saginaw River every year.[32] Major infrastructure upgrades were needed to meet new regulations, and with a plan in place, Saginaw was well on its way.

Saginaw's sewer system has about 300 miles of sewer lines, covering an area of approximately 14 square miles within the city, the majority of which are combined sewers. The sewer system also collects wastewater from about 33 square miles in surrounding communities, including Carrolton Township, Zilwaukee, and parts of Saginaw Township, though combined sewers are less common in these areas. Sewage flows to a single wastewater treatment plant, located at the northeastern edge of the city.[33] Rainfall events often overwhelmed the treatment plant's capacity, causing unacceptable volumes of combined sewer overflows.

Saginaw, MI, skyline from the banks of the Saginaw River next to Genesee St.

Throughout the 1990s the city carried out a plan that improved the health of the Saginaw River. The plan consisted of constructing six combined sewage retention treatment basins (four of them, located below ground; two above ground) that provide storage and treatment capacity.[34] Controls were put in place to divert combined sewage to retention basins when the treatment plant was overwhelmed by high flow volumes. Storage capacity was further increased with new collection sewers. By 2001, six new retention treatment basins were ready to reduce the amount of raw sewage emptied into the Saginaw River.[35]

The city's treatment basins and associated collection sewers provide approximately 60 million gallons of storage. The largest basin serves an area of about 4.2 square miles and can hold 16.1 million gallons of combined sewage. Saginaw's smallest retention treatment basin has a capacity to hold 2.2 million gallons and collects runoff and sewage from an area of about half a square mile.[36]

The retention treatment basins function as emergency combined sewer overflow storage and treatment plants. During rainstorms that do not cause treatment basins to reach capacity, water in each basin is stored, partially treated, then pumped to the wastewater treatment plant for full treatment once capacity is available. The wastewater treatment plant has a dry-weather capacity of 32 million gallons per day and a maximum wet-weather capacity of 70 million gallons per day.[37] If heavy rain causes the wastewater treatment plant and retention treatment basins to reach capacity, the basins discharge partially treated water into the Saginaw River.

Treatment in basins begins as combined sewage runs through screens to filter out larger debris (primary treatment). Simultaneously, the basin fills with a chlorine-based disinfectant to kill pathogens that threaten human health. Different substances in the sewage settle and separate. Skimmers remove floatable material, like oils. Higher density materials (sludge/feces) sink towards a drain that flushes sludge to the wastewater treatment plant once wet weather subsides. If no capacity is available at the wastewater treatment plant and retention basin, partially treated water is discharged into surface waters.[38]

As recently as 2021, a report from the Michigan Department of Environment, Great Lakes, and Energy, stated that discharges from Saginaw's retention treatment basins do comply with water quality standards to protect public health.[39] Partially treated discharges do not sound ideal, but for the city of Saginaw, retention treatment basins were the most cost-effective method of reducing combined sewage overflows. Most importantly, human waste no longer flowed directly from toilets into the Saginaw River. And local residents have not complained about any odors from the retention basins. "I have worked with the City of Saginaw for a little over 16 years and have never heard of any complaints regarding odors surrounding the tanks. It is our policy to drain and flush each RTB as quickly as possible after each rain event," said John Frollo, Superintendent with the Saginaw Wastewater Treatment Plant.[40]

In total, the treatment basins, and associated infrastructure cost $110.1 million. The highest cost of any single retention treatment basin was $29.4 million. The least expensive retention basin was $5.5 million.[41] Sewer utility bill increases funded the project. Immediate funds were sourced from 10 Clean Water State Revolving Fund loans amounting to $106.1 million.[42]

Funding is a major obstacle to implementing a combined sewer overflow reduction plan, especially in areas with declining populations and higher than average poverty rates. But Saginaw proves it is possible. In the 1960's nearly 100,000 people called Saginaw home.[43] By 2000, just over 60,000 people remained. In 1999 – amid implementation of the sewer overflow reduction program – 28.5 percent of Saginaw's population lived in poverty.[44] Data from the U.S. Census Bureau indicates Harrisburg has a poverty rate of 26.5 percent.[45] Although Harrisburg's current situation cannot be wholly equated to Saginaw's in the late 1990s, their similarities suggest that Harrisburg could implement a similar plan to control combined sewer overflows.

Raw sewage no longer flows from outfalls along the nearly seven miles of Saginaw's riverfront in the heart of the city. Yes, partially treated discharges do occur. In 2020, Saginaw reported nearly 400 million gallons of partially treated discharge.[46] That sounds alarming, but it is a far cry from the nearly three billion gallons of combined sewer overflows that were discharged annually prior to its overflow reduction program. Water quality has improved enough that the Saginaw River is now said to be an ideal location to fish for walleye (yellow pike) in the U.S.[47] Partial treatment does meet public safety water quality standards. Moderate rainstorms that would have caused combined sewer overflows in decades past are often handled without any discharge. Saginaw officials are pleased to say that there are now zero gallons of *untreated* sewage intentionally piped into the river.

Bremerton, WA

Bremerton, Washington, located west of Seattle on the shores of Puget Sound's Sinclair Inlet and Port Washington Narrows, initiated a combined sewer overflow reduction program in response to 1986 Washington state regulations calling for no more than one combined sewage overflow event per outfall per year.[48] After developing its first plan, a 1993 lawsuit with the Puget Soundkeeper Alliance quickened the pace of the combined sewer overflow reduction program. That same year, Washington's Department of Ecology issued a consent order that set a schedule for project implementation.[49] Construction of the earliest projects began in 1994. The final project required under the consent order was finished by 2009.[50] In February 2011, Washington's Department of Ecology deemed that Bremerton met combined sewer overflow reduction goals established by the consent order.[51]

Bremerton's initial plan to reduce overflows relied heavily on sewer separations. After reevaluating the sewer system in 1998, the city changed its plans. In Bremerton's case, separations alone could not cost-effectively reduce overflows. Sewer separations, construction of a new CSO treatment plant, new pumping stations, upgrades to the existing pump stations and treatment plant, and a city-wide downspout disconnection effort were all essential components of Bremerton's overflow reduction plan.[52]

Sinclair Inlet and Port Washington Narrows tidal strait in Bremerton, WA, facing west.

Removing stormwater inputs to the sewer system was the first priority. Sewer separations were underway in 1994. Separation projects continued in the late 1990s and early 2000s. A total of 12.5 miles of new sanitary and stormwater sewers were installed.[53] Bremerton continued to diminish stormwater flows into the sewer system with an adjustment to city municipal code. As of Jan 1, 2005, the city prohibits stormwater downspouts to wastewater system connections. Properties not abiding by the rule receive a fee on their utility bill. Residents that are unsure of how to disconnect their downspouts can receive free site assessments and technical assistance to avoid extra sewer utility fees.[54]

Efficient transport of sewage to treatment facilities is key to avoiding combined sewer overflows. To improve transport, 18 pump stations received upgrades between 1994 and

February 2011, two new pump stations were installed in 1994 and 2003, and three additional pumps were constructed in 2010.[55] Pumping rates and reliability of the sewage conveyance system greatly improved. For example, according to a 2021 report, pumping capacity to the main wastewater treatment plant increased by 10,000 gallons per minute, or about 14.4 million gallons per day. Other upgrades generally included new monitoring equipment, control systems, and emergency power generators.[56]

Satisfying the consent order meant further work. Bremerton needed to build a second wastewater treatment plant to back-up its main treatment facility (the west side plant) that has served the entire city since 1985.[57] During dry weather, the west side treatment plant was able to treat all sewage it received, but a new treatment facility was needed to treat wet weather flow volumes. In 2002, the eastside combined sewer overflow treatment plant cleaned its first gallons of wastewater. The plant only operates when the west side plant is overwhelmed, typically less than ten days each year. Approximately 100,000 gallons of storage is available at the east plant.[58] High-rate primary treatment systems remove larger solids and sludge. Afterwards, water is disinfected using ultra-violet light. The plant has a peak capacity of 20 million gallons per day.[59]

To reduce overflows, Bremerton spent $50.3 million, with 85 percent of the program's funding sourced from ratepayers. The city avoided sharp increases in utility rates with loan programs, including Public Works Trust Fund Loans of $26.8 million (53 percent), Clean Water State Revolving Fund Loans and Centennial Clean Water Fund Loans worth $8.3 million (16 percent), and a bond program that yielded $2.9 million (6 percent). $4.8 million was sourced directly from rate increases (10 percent). The remaining $7.5 million (15 percent) was provided through state and federal grants. Loan debt is set to be paid off in 2029.[60]

Bremerton's overflow reduction program is highly successful. Compared to overflow baseline data recorded in 1996, combined sewage overflow volume and frequency have decreased by 99 percent.[61] At one time, more than 600 overflow events occurred over the course of a year. That number has dropped to an average of less than one overflow event per outfall per year. Less than 10 years after construction first broke ground, shellfish beds, closed since the 1960s, were reopened for harvest in 2003.[62] Bremerton received nearly 45 inches of rain in 2001, causing approximately 19 million gallons of combine sewer overflows across 62 overflow events. In 2021, more than 50 inches of rain fell on Bremerton, yet the city discharged just 30,000 gallons of combined sewage overflows during three overflow events.[63] The city is in compliance with federal and state combined sewage overflow regulations.

Grand Rapids, MI

The Grand River in Michigan is significantly cleaner today because the City of Grand Rapids built a retention basin to catch sewage and stormwater overflows.

In 1988, Michigan adopted stricter CSO regulations to reduce the amount of raw sewage entering state waterways. That same year, Grand Rapids began planning phases of what would be known as the Sewer Improvement Project.[64] Regulation changes were not the sole motivation for the project, Grand Rapids received steady pressure from news outlets and city residents to clean up the raw sewage entering Grand River.[65] Torrential rainstorms that caused high volumes of CSOs even degraded water quality 30 miles downstream in Grand Haven, MI.[66] The project began in 1990 and continued until 2015 when the city eliminated the last of its combined sewer overflow outfall points three years ahead of schedule. Grand Rapids is now free of combined sewer overflows.[67]

The Grand Rapids Sewer Improvement Project involved three major components: Construction of a large retention treatment basin for temporary storage and partial treatment, west-side sewer separations, and east-side sewer separations.

The first project to be constructed was the Market Avenue Retention Basin, known as MARB. Construction started in 1990, the facility was operational by 1993. MARB can store 30 million gallons of sewage. [68] Typically, all water stored in the retention basin flows to the city's wastewater treatment plant for full treatment prior to being discharged into Grand River. If MARB reaches capacity and sewage must be discharged, wastewater receives primary treatment to remove debris and solids, then chlorine disinfectant kills dangerous pathogens like *E. Coli.* Discharges from MARB are quite rare. The last significant discharge from MARB occurred in 2013, after a major rainstorm forced the city to discharge 436 million gallons of partially treated sewage into Grand River.[69]

After MARB's construction, Grand Rapids shifted focus to sewer separations. Tearing up city streets for sewer separations may be disruptive, even so, Grand Rapids predicted the temporary inconveniences of street-by-street construction would be well worth it. In total, 119 miles of new sanitary and stormwater sewer pipes were installed.[70] Grand Rapids now has a separated sewer system.

The first separation projects were underway in 1993 throughout neighborhoods on the west side of the Grand River. The west side was prioritized because the elevation is about 60 feet lower than the city's east side, causing floods and basement backups to be more common in this area. By 1999 when the west side projects were finished, more than 50 individual separation contracts were completed.[71]

Construction took a momentary pause as the city studied its east side sewer system. East side sewer separations began in 2005 and continued until 2014. About 20 sewer separation contracts were carried out, projects were less expensive compared to those on the west side.[72]

Total cost of the sewer improvement project was $400 million. Ratepayer bills will finance the project's cost until 2042.[73]

In 1987, just before the sewer improvement project's inception, Grand Rapids discharged 1.96 billion gallons of combined sewer overflows into Grand River.[74] That number fell to 340 million gallons in 1992, and down to 19 million gallons in 1994.[75] Come July 2015, the last of 59 untreated outfall points was eliminated.[76] There are no combined sewer overflows in Grand Rapids. Water discharges enter Grand River from the main treatment plant or from the Market Avenue Retention Basin, after receiving treatment to remove solids and kill pathogens. In 2020, rain led to one discharge event of 7 million gallons from the retention basin.[77]

The water quality of Grand River has improved, and its ecosystem is bouncing back. "By eliminating CSO's, our citizens are more inclined to use the river for recreation" said Charles Schroeder, P.E. Assistant Environmental Services Manager for the City of Grand Rapids. "Anglers and kayakers are much less hesitant to get into the river. There's a big push to remove dams in the river and restore it, and its rapids, to a more natural state."[78]

Boston, MA

Boston's combined sewage overflow cleanup efforts began in the 1980s, as one part of a wider initiative to clean up the city's water, famously known as the Boston Harbor case. The scope of this report is limited to improvements focused on combined sewer overflows. In 1983, the Conservation Law Foundation filed a lawsuit against Boston for Clean Water Act violations and EPA became involved in 1985. [79] That same year the Massachusetts Water Resource Authority was created to develop a long-term control plan to reduce combined sewer overflows. The long-term control plan adopted by the Massachusetts water authority included 35 combined sewer system improvement projects to bring Boston into compliance with federal and state water quality standards. Components of the plan included: construction of a new combined sewage overflow treatment plant, upgrades to existing overflow treatment plants, sewer separations, CSO outfall repairs and construction of a large combined sewage storage tank.[80]

The Boston skyline seen from the Charles River. The historic river is a popular location for kayaking, sailing, and famous duck boat tours.

The Massachusetts Water Resource Authority performed eleven sewer separation projects. Sewer separation projects reduced annual combined sewage discharges by approximately 124.96 million gallons. Approximately 83 miles of new stormwater or sanitary sewers pipes were installed. Costs for each project ranged from $400,000 to nearly $120 million. The total cost of sewer separation projects was more than $390 million.[81]

To further reduce the impacts of sewage overflows, Boston upgraded treatment capabilities at five existing sewage overflow treatment facilities and added a new combined sewage overflow treatment facility with 2 million gallons of CSO storage to an existing pump station (Union Park Detention/Treatment Facility). The $49.5 million facility reduced annual sewage discharge volume by about 60 million gallons. Treatment methods at this facility include fine screens to remove debris from water, chlorine disinfectant, and de-chlorination to avoid chlorine contamination of natural environments.[82]

Once water is treated at combined sewer overflow facilities, it is typically transported to the Deer Island treatment plant for further treatment before being discharged. If Deer Island treatment plant is at capacity, sewage overflow treatment facilities discharge partially treated water.

Boston's largest combined sewer overflow project was the North Dorchester Bay storage tunnel (also known as the South Boston storage tunnel) and related facilities. Construction began in 2007 [83] and was completed in 2011.[84] The tunnel is 2.1 miles long with a diameter of 17 feet and has enough capacity to store up to 19 million gallons of combined sewage, which is pumped to a treatment facility once space is available.[85] To support the tunnel, MWRA constructed an odor control facility, a pump station capable of pumping 15 million gallons per day, and a force main pipe to convey water to the Deer Island treatment plant.[86]

Prior to construction of the North Dorchester tunnel, seven sewage overflow outfalls discharged combined sewer overflows into North Dorchester Bay about 17 times in a typical year, corresponding to approximately 8.6 million gallons. Polluted stormwater would also discharge into south Boston beaches more than 90 times a year, equating to about 144 million gallons.[87] The Massachusetts Water Resource Authority described Boston Harbor as "the dirtiest harbor in America," noting that "beaches were frequently closed for days, even after the most modest rain events." After completion of the tunnel, CSO and stormwater discharges were to south Boston beaches were eliminated, assuming a typical year of rainfall.[88]

The tunnel can be viewed as a turning point for Boston's beachgoers. The Boston-based nonprofit, Save the Harbor/Save the Bay, releases annual water quality report cards for the city's beaches. Report card scores are based on the percentage of water samples that comply with Massachusetts Department of Public Health's sample limit for fecal bacteria (104 cfu/100 mL). According to Save the Harbor/Save the Bay's report, average scores between 2016 and 2021 indicate that at least 98 percent of water samples collected at beaches next to the storage tunnel (Pleasure Bay, M Street Beach, Carson Beach) complied with Massachusetts health department water quality standards.[89]

In total, Boston's combined sewer overflow long-term control plan of 35 projects cost the city and surrounding municipalities approximately $911 million.[90]

Since the 1980s, combined sewage overflow volume has dropped considerably. Boston discharged 3.3 billion gallons of combined sewage overflow into its waters in 1988, only half of those discharges received treatment. In 2021, the city discharged 414 million gallons, an 87 percent reduction, and nearly 93 percent of the remaining discharges received treatment prior to release.[91]

Portland, OR

Portland's combined sewage overflow program is known as the Big Pipe Project. The city initiated the program in April 1991, after it was sued by the nonprofit Northwest Environmental Advocates for Clean Water Act violations. By August 1991, the city approved a plan to reduce combined sewer overflows. The plan was revised in 1993, and fully implemented by 2011.[92]

An inside view of Portland's Big Pipe's east side tunnel. This section of tunnel is known as Opera Shaft, as the tunnel sits below the property of the Hampton Opera Center.

While the project is termed "The Big Pipe Project", it involves more than one large pipe. The city installed three large storage pipes and constructed the Swan Island combined sewage overflow pump station. However, prior to breaking ground on costly pipe construction, Portland searched for ways to cut down the volume of stormwater entering the sewer system. The result was use of "cornerstone projects", relatively inexpensive projects designed to prevent stormwater runoff from reaching the sewer system.

Starting in 1994, several cornerstone projects were initiated. A downspout disconnection effort was the most widely implemented. More than 56,000 downspouts were disconnected, decreasing the average annual volume of stormwater flow that entered sewers by approximately 1.2 billion gallons.[93]

Other cornerstone projects included a stream diversion, installation of stormwater sumps, and sewer separations. According to Portland Environmental Services, cornerstone projects prevent approximately 2.2 billion gallons of water from reaching combined sewer systems each year.[94] Following implementation of cornerstone projects, Portland moved on to big pipes.

In 1997, Portland began construction of the Columbia Slough Big Pipe to prevent combined sewage discharges from entering the Columbia Slough, a slim waterway that connects to the Columbia River in northern Portland. The tunnel, completed in 2000, is 3.5 miles long.

Each year, the pipe prevents an estimated 300 million gallons of combined sewage from entering the Columbia Slough.[95]

The second pipe to be built was the West Side Big Pipe. Construction was underway in 2002 and lasted until 2006. It measures 3.5 miles in length and 14 feet in diameter. The pipe collects combined sewage from outfalls along the west side of the Willamette River, then transports polluted water to the Swan Island pump station.[96]

Swan Island pump station was constructed in two phases. Phase 1 completion corresponds to completion of the west side pipe, phase 2 the east side pipe. From the pump station a force main (pressurized pipe) carries combined sewage to the city's Columbia Boulevard Wastewater Treatment Plant.[97]

To complete the combined sewage overflow reduction program, Portland took on the largest sewer construction project in city history: the East Side Big Pipe. The pipe is six miles long and 22 feet in diameter. Construction began in 2006, by Fall 2011, the east side pipe was operational.[98] Sewage outfalls on the east side of the Willamette River no longer discharge directly into the waterway. Overflows are stored in the tunnel, transported to Swan Island pump station, then pumped to the water treatment plant. Once connected to the east and west side pipes, Swan Island pump station could pump 220 million gallons of combined sewage per day to the wastewater treatment plant.[99] Portland's Big Pipes can collectively store up to 119 million gallons of sewage.[100]

Other sewage improvements included upgrades to the Columbia Boulevard wastewater treatment plant and installation of green infrastructure. The treatment plant was expanded to accommodate greater flow volumes from big pipes and a facility to remove disinfectant from treated water was added to prevent harsh chemicals from entering natural environments. Additions of green infrastructure help to keep 2.3 billion gallons of stormwater from flowing into Portland's sewers each year.[101]

The west side pipe cost $293 million, the east side pipe $426 million.[102] The entirety of the Big Pipes project cost the city $1.4 billion, funded by utility bill rate increases.[103] Nearly ten years after completion of big pipes, a spokesperson from Portland's Bureau of Environmental Services highlighted the positive impact of the project saying, "…as sewage has gone out of the system and out of the river, people have come in and started swimming and paddling and playing."[104]

Before Big Pipes, 50 overflows events would release 6 billion gallons of combined sewage into the Willamette River and Columbia Slough each year. Since completion of the projects, the average number of overflow events to occur each year between 2012 and 2021 is just 3.3.[105] According to a 2021 report, 150.9 million gallons of combined sewage was released into the Willamette River in fiscal year 2021.[106] A stark difference compared to 6 billion gallons. Overall, Big Pipes helped Portland decrease combined sewer overflows to the Willamette River by 94 percent, overflows to the Columbia Slough dropped by 99 percent.[107]

Conclusion

Although Harrisburg, Pennsylvania, suffers from chronic sewage overflows and dangerously high bacteria levels at its waterfront because of its antiquated sewage and stormwater system, cities across the U.S. – some smaller and poorer than Harrisburg – have solved this problem through infrastructure upgrades. Saginaw, Michigan, for example, has a higher poverty rate and smaller ratepayer base than Harrisburg. But it ended its sewage overflows by building a relatively affordable system of retention basins that temporarily hold combined sewage during rainstorms and then provide treatment before releasing the water to the river. Another small city -- Bremerton, Washington -- installed new sewage pumping stations, upgraded others, and separated some of its sanitary sewer lines from its stormwater pipes. Grand Rapids, Michigan, has brought the waterway that flows through its center back to life in part by building a 30-million-gallon retention basin that keeps sewage overflows out of the Grand River. Larger cities like Boston and Washington D.C., also greatly improved the economic viability of their waterfronts by investing public funds in underground storage tunnels, tanks, and other projects to hold and treat CSO's during and after storms.

So far, Harrisburg Capital Region Water has argued that it cannot afford this kind of transformative infrastructure upgrade. And so far, the state of Pennsylvania has not provided any grants to help with its capital's sewage overflow problem, even though a large portion of the buildings and land in Harrisburg are owned by the state. The significant contribution of thousands of state toilets – including those used by the governor and lawmakers – provides a clear argument that the state of Pennsylvania has an obligation to provide funding to help Harrisburg modernize its plumbing. Elsewhere in the Chesapeake Bay region, Virginia and the federal government have provided large grants to solve combined sewage overflow problems in Virginia's state capital and in Washington, D.C. There is no reason Pennsylvania's state government should not follow these examples and help improve the health and waterfront of its state capital.

Since 2018, Harrisburg has been planning several "green infrastructure" projects to address its sewage overflow problem, along with improved maintenance of decaying pipes and a new pumping station. No one disputes that tree plantings and rain gardens will improve the quality of life in Harrisburg. However, they should not be a substitute for upgrading the antiquated pipe system that continues to pipe raw human feces and urine into the Susquehanna River. Green infrastructure has many benefits, including absorbing stormwater and reducing runoff pollution. But it should not be seen as a replacement for the kinds of long-lasting and proven infrastructure improvements detailed in this report. Everyone who uses Harrisburg's beautiful riverfront, or who fishes, boats and swims downstream, deserves a proven method of protecting water quality and ending the sewage nightmare in Pennsylvania's capital.

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