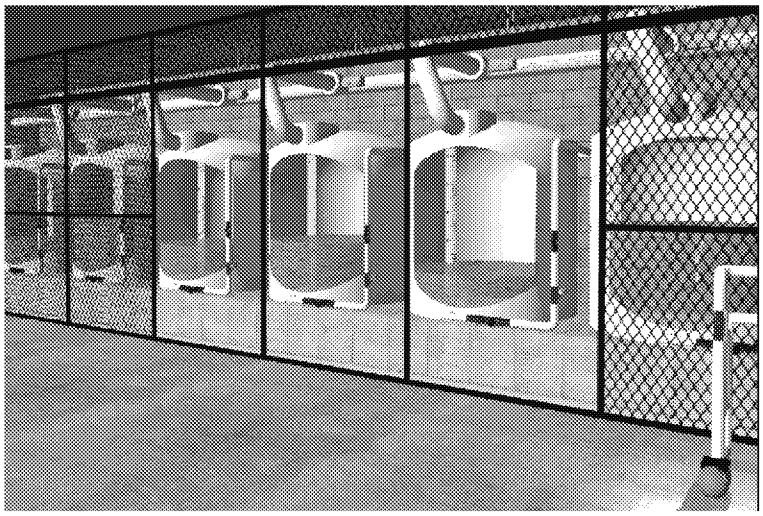
Washington, DC: Real Time Controls for Rainwater Harvesting and Combined Sewer Overflow Control



OWNER
U.S. Environmental Protection Agency
LOCATION
Washington, DC
INCEPTION
2014

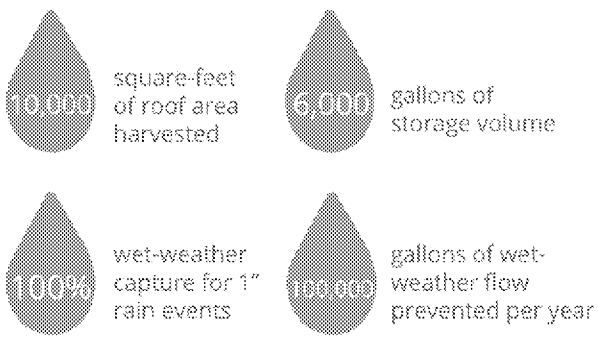
KEY FEATURES

- Real-time controls to retain water for on-site irrigation and to reduce wet weather discharge to the combined sewer.
- Captures 100 percent of all 1-inch and less rain events, preventing approximately 100,000 gallons of wet weather flow from entering the combined sewer each year.

PROJECT DESCRIPTION

EPA and General Services Administration sought to upgrade an existing 6,000-gallon rainwater harvesting system at EPA headquarters in Washington, D.C. Two competing priorities needed to be addressed: minimizing wet weather discharge while also maintaining water availability for irrigation on site. Uncaptured wet weather flows contributed to the local combined sewer system, increasing the potential for CSOs and poor water quality in the Chesapeake Bay.

To monitor storage volumes and expected storage needs based on weather, the rainwater harvesting system was retrofitted with a continuous monitoring and adaptive control (CMAC) technology. The cloud-based platform automatically monitors the weather forecast and calculates expected runoff volume from future storms. The system then automatically opens the discharge valve in advance of the storm and releases a predicted volume equal to the potential runoff. As the forecast changes, the system adjusts intelligently. Before the storm begins the system closes the valve, capturing rain to refill the cistern. The valve remains closed until another rain event is in the forecast, ensuring that water is available for reuse.



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A 1-inch solenoid valve was installed to allow the CMAC technology to control water draining to the combined sewer system. The CMAC technology also monitors discharge flow, irrigation flow, and air temperature and activates a freeze protection system during cold weather. The addition of CMAC technology to the existing rainwater harvesting system eliminated the need to install additional storage volume to meet otherwise competing objectives.

Since deployment in 2014, the advanced rainwater harvesting system at EPA headquarters has proven be a low-cost, high-performance solution for meeting stormwater management goals. The increased data transparency and opportunities for adaptive management can achieve a range of stormwater management objectives.

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Wilmington, Delaware: Real-Time Control to Reduce Combined Sewer Overflow Discharges

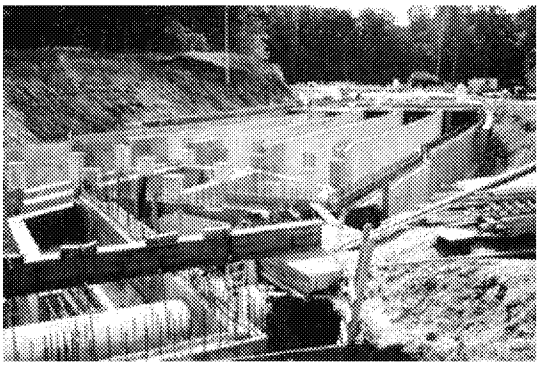
OWNER
City of Wilmington
LOCATION
Wilmington, Delaware
COST
$12M

KEY FEATURES

- Anticipated increase of Wilmington's average annual wet weather capture from 50 percent to more than 85 percent.
- Overall cost savings estimated at $87 million from the original CSO long-term control plan (LTCP).
- Fully automated operation, with remote supervision and manual override capacity at all times by treatment plant operators.

PROJECT DESCRIPTION

Since the early 1990s, the City of Wilmington has initiated a series of improvement projects to reduce CSO events and increase the annual average flow intercepted at the wastewater treatment plant. These projects included the upgrade of treatment plant capacity, the construction of the 2.7 million-gallon Canby Park CSO Storage Basin, the elimination of certain CSOs, other specific collection system improvements, and public outreach.



As part of its enhanced long-term control plan (ELTCP), Wilmington implemented a coordinated system-wide real-time control (RTC) solution. The RTC system provides efficient flow management to reduce CSOs along the Brandywine Creek and the Christina River and optimizes the capacity available in the interceptor and pump stations. Overall, the ELTCP will increase the average annual percent capture from 50 percent to more than 85 percent, meeting the CSO control objective via a presumptive approach. Wilmington's green

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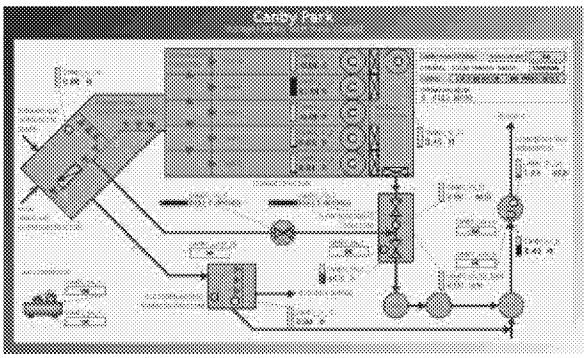
infrastructure program is expected to meet the total maximum daily load (TMDL) objectives by increasing the wet weather capture rate to over 90 percent.



The city has adopted an adaptive management approach whereby site-specific system improvement, such as localized separation and additional green infrastructure, will be determined based on post-construction performance of implemented projects.

The RTC project encompasses the design, retrofitting, and implementation of four flow control stations, the control of Canby Park CSO Storage Basin, the control of the three existing siphons, and the design and implementation of a network of data collection and measuring sites (equipped with flowmeters and rain gauges) for monitoring purposes. All of the local stations are linked to the central station via a telemetry system and automatically managed under a global optimal and predictive RTC approach from the central station, under the supervision of operators. Smart use of RTC technology has allowed the City of Wilmington to significantly reduce overall costs of the LTCP.

Technology description: The RTC system is fully automated, with remote supervision and manual override capacity at all times by treatment plant operators.

The system consists of four major components:

- A monitoring system including level, flow, and rainfall.
- Local control facilities equipped with control elements (gate and pumps), programmable logic controllers (PLC), and remote telemetry units (RTUs) with backup power.
- A supervisory control and data acquisition (SCADA) system for data acquisition of sensor information and control facility status, as well as for communication of control set points.
- A central station which manages and coordinates the various components, including data management and archiving, RTC control algorithms and optimization, hydrologic and hydraulic models, and weather forecasting.

As conditions are monitored, acknowledged, and controlled, Wilmington's RTC system accounts for current and future flow distribution throughout the system based on rain forecasts, measurements, and sewer simulations in real time. It provides continuous and strategic adjustment of control devices to optimize flow conveyance, storage, release, and transfer according to the available capacity in the entire system.

Cost-benefit analysis: The evaluation of RTC feasibility studies identified a relatively low unit cost of $0.07 per gallon of CSO reduction per year by maximizing the existing collection and treatment system, a cost four times lower than traditional approaches of building additional storage. The overall cost savings is estimated at $87 million from the original CSO LTCP cost of $114 million, for a final LTCP cost of $27 million.

Advantages: The RTC technology is scalable and flexible, and involves all levels of control—from static to local to global—to provide system-wide optimization. Additionally, new control sites can be added and control logics modified based on performance monitoring as part of adaptive management.

The RTC system design and operation takes into account equipment and sensor failures and provides fail-safe control for a robust performance system in real time.

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The RTC approach enables the system to meet multiple objectives in a predefined priority order: 1) flood protection, 2) CSO minimization with local priorities, 3) minimal retention time with local priority order, and 4) minimal gate movements.

The use of an online model reduces the number of sites and the extent of the monitoring network required for system-wide optimization. The RTC system provides the city with greatly enhanced capability to monitor, analyze, assess, and report on CSO discharges and collection system performance (capture rate) on an annual basis. This has been useful for reporting to the regulating agency and for integrating adaptive management into LTCP planning.

Disadvantages: The RTC approach relies on an online model and real-time rain gauges to provide predictions of upcoming inflows and their spatial distribution. This requires the calibration and update of the hydrologic and hydraulic model to represent the wastewater system adequately. The control strategy and decisions need to account for inaccuracy in rainfall distributions and real-time monitoring data.

Lessons Learned: The lessons learned from this project include the following:

- The adoption of RTC technology requires organizational commitmentand staff buy-in.
- The utility needs to consider O&M issues and constraints when selecting the appropriate level of RTC at the outset.
- It is important to involve system operators early in the planning and design, and to identify and communicate roles and responsibilities at every stage, from design, construction, and commissioning, to post-construction performance monitoring.
- Documentation such as standard operation procedures and post-event analysis is critical to properly operate, maintain, and improve the RTC system.
- Achievement of the anticipated performance was delayed until initially unidentified system collection anomalies were resolved. These included pipes obstructed with up to 50 percent sedimentation or root blockages, and pump station control logic that deviated from the reported operational condition.
- Key to the project has been the City of Wilmington and its designated operator taking ownership of the instrumentation and control (I&C) and SCADA system to maintain equipment and instrumentation in a proactive manner.

RTC Project Cost: The project cost is $12 million, including retrofit, construction, monitoring, information technology, etc. The current RTC system includes the use of one retention basins (2.7 million gallons) for CSO control, an additional 2.0 million gallons of inline storage, the management of three siphons, and the operation of a 135 MGD pumping station.

"We'd have to tear up several parks in the city to build more tanks, I'm not a scientist, but we knew there had to be ways to divert the way water flows in pipes. We are among the selected communities that have utilized Real Time Control that makes optimum use of our sewer capacity to manage and minimize overflows. This plan is cheaper, quicker and actually increases the amount of overflow we're trying to catch. The Enhanced LTCP would increase the CSO capture and treatment rate to 87% or higher, reduce CSO control costs by more than $87 million and accelerate implementation by ten years."

– Mayor James M. Baker,
City of Wilmington, Delaware

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