Climate-Resilient Water Infrastructure in New York City

October 27, 2022



About the NYC Department of Environmental Protection (DEP)

DEP is the largest combined water and wastewater utility in the United States.

WATER SUPPLY

- Deliver 1.1 BGD of water to 9.6 million New Yorkers every day and maintain 7,000 miles of water mains
- Protect approximately 2,000 square miles of watershed, including 19 reservoirs and three controlled lakes

WASTEWATER TREATMENT

- Treat 1.3 BGD of wastewater each day
- Operate and maintain 14 plants, 96 pumping stations, and over 7,500 miles of sewers

AIR, NOISE, AND HAZARDOUS WASTE

 Update and enforce the Air Code to reduce local emissions, and regulate hazardous waste and noise pollution







NYC temperature, precipitation, & sea level are increasing



Mean annual **precipitation** has increased 0.71 inches per decade. Year-to-year variability has become more pronounced since the 1970s.



Mean annual **temperature** has increased at a rate of 0.25°F per decade.



Sea level rise has averaged 1.2 inches per decade, nearly twice the observed global rate.

NYC must prepare for the full range of climate threats



MORE FREQUENT, MORE DESTRUCTIVE HURRICANES

INCREASED TIDAL FLOODING + GROUNDWATER TABLE RISE

FLOODING IN NON-COASTAL AREAS

LONGER, MORE DANGEROUS HEAT WAVES

NYC water is provided through a flexible network



The water system is subject to periodic droughts



Cannonsville Reservoir, Delaware County, NY:

Normal conditions (left)

Drought conditions (2001, right)





Extreme rain poses another challenge



August 2011: Water spills over the Gilboa Dam following Tropical Storm Irene, Gilboa, NY

Watershed protection is the first line of defense





- New York City received its first Filtration Avoidance Determination (FAD) in 1993
- Catskill and Delaware systems have remained unfiltered since then
- 2017 FAD is for 10 years and raised the total program commitments to \$2.7 billion
 - Key FAD programs include:
 - Land Acquisition Program
 - Septic Repair & Replacement
 - Wastewater Upgrade Program
 - Farm Program
 - Stream Management Program
 - Forestry Program

Water efficiency helps optimize our supply

Current water demand is at a historical low, even as population has increased.



* 2021: U.S. Census Bureau, Population Estimates Program (Vintage 2021)

2020 & 2010: U.S. Census Bureau Decennial Census

2011-2019: Cornell Program on Applied Demographics, 2021 County and Economic Development Regions Population Estimates

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Tapping into the highest quality water



A new connection between the Catskill and Delaware Aqueducts, known as the Shaft 4 Connection, will allow DEP to divert Delaware System water into the Catskill Aqueduct.

Data help optimize which water to use and when



The Operations Support Tool's look-ahead capability provides system analysts, operators, and managers with information to support decisions concerning reservoir diversions and releases.

Draining NYC streets and protecting our Harbor

Sewage is conveyed to 14 wastewater treatment plants, located along the Harbor. Combined sewers serve Manhattan and large areas of Brooklyn, Bronx, & Queens.





Treatment facilities are subject to coastal flooding



after Superstorm Sandy, Brooklyn, NY

DEP is floodproofing critical infrastructure

Critical equipment is being designed and retrofitted for climate change per the City's Climate Resiliency Design Guidelines.





Investing money now saves money later

\$1.1 billion of vital infrastructure is at risk. Investing **\$315 million** in construction of strategic fortification can save the City **\$2.5 billion** in emergency response costs over the next 50 years.



Overflow to the Harbor can occur when it rains

The combined sewer system serves approximately 60% of New York City (by land area), and is a legacy of previous sewage conveyance and treatment technologies





Capturing rain before it enters the sewers



NYC Green Infrastructure Program



NYC Green Infrastructure Program



NYC Green Infrastructure Program



Record Breaking Rains in 2021

Tropical Storm Elsa: July 8-9

Max 1-hr rainfall rate: 2.75 to 3 in/hr

Tropical Storm Henri: August 21-23

• Central Park reported 4.45 inches of rain on Aug. 21 alone, with 1.94 inches falling between 10 to 11pm.

Tropical Storm Ida: September 2

• The Central Park rain gauge set a new record for 1-hour rainfall with 3.15 inches (previously 1.94 in. from Tropical Storm Henri)



NYC Stormwater Flood Maps

Three scenarios:

Moderate Stormwater Flood with Current Sea Levels

Moderate Stormwater Flood with 2050s Sea Levels

Extreme Stormwater Flood with 2080s Sea Levels





What is Cloudburst Management? Cloudburst Management is a way of absorbing, storing, and transferring stormwater to minimize flooding from heavy rain events. Cloudburst Management uses a combination of grey infrastructure, like drainage pipes and underground tanks, and green infrastructure, like trees and rain gardens. These projects consider larger volume storage, building for the future 10-yr (2.3 inches/hour) and provide CSO reduction benefits as well as stormwater resilience.

During heavy rain events, Cloudburst Management can minimize damage to property and infrastructure by reducing pressure on the sewer system.



What are examples of Cloudburst Management projects?

The City considers different Cloudburst Management projects to absorb, store, and transfer

stormwater.



Projects that allow for surface water to enter the soil or ground

These include green infrastructure like, porous pavement and rain gardens. Pictured here is an example of a rain garden project in Brooklyn.



Projects that hold rainwater

These include water squares, tanks, and dry ponds. Pictured here is an example of an underground storage system in Jamaica, Queens.



Projects that move water from one place to another

These include on-site drainage and re-grading streets. Pictured here are catch basins use to convey runoff from the street in Gowanus, Brooklyn.



South Jamaica Houses

South Jamaica Houses includes 8 city blocks in South Jamaica, Queens and is home to around 2,600 residents. South Jamaica Houses were chosen to provide relief upstream to allow for more flow to enter the sewer system downstream and reduce flooding.

This project will maximize storm water capture for up to 2.3 inches of rainfall per hour. Aside from flood mitigation, this pilot shows how cloudburst infrastructure can offer many co-benefits to communities.

As of September 2022, this project has reached 100% design and is proceeding to construction.

Open spaces can be used for recreation during dry days



And then for flooding when during heavy rain



Drainage pipes will be diverted from the sewer



New designs blend form and function



What have we learned so far?

- Resiliency requires many layers:
 - Implementing redundancy, flexibility and optimizing existing resources
 - recalibrating standards and retrofitting at-risk infrastructure
 - Utilizing nature-based solutions and designing for flooding
 - Adapting our approaches and learning from our peers