New York City Department of Design and Construction (DDC)

The City of New York
NYC Department of Environmental Protection—NYC's public water and wastewater utility NYC Water Board NYC Municipal Water Finance Authority
NYC entities with capital assets and/or policy role in water and wastewater resiliency and sustainability under conditions of climate change: *NYC Department of Transportation* *NYC Department of Parks and Recreation* *NYC Department of City Planning* *NYC Emergency Management* *NYC Department of Buildings* *NYC Mayor's Office of Climate and Environmental Justice (Office of Long-Term Planning and Sustainability)*
NYC Department of Design and Construction—NYC's design and construction manager of sponsor agency capital projects   **Town+Gown:NYC @ NYC DDC**

General. The City created DDC in 1996 as a single consolidated construction agency to permit greater coordination on all construction projects between the City and utility companies, among NYC agencies, and with community representatives and the private sector. In addition to the benefits of greater coordination in reducing disruption in neighborhoods affected by construction projects and containing costs, DDC, as a single design and construction management agency, has attracted high-quality engineers and architects for infrastructure and public building design as well as the most capable contractors to build the city's infrastructure and public building projects.

DDC is responsible for the coordination management of NYC capital construction projects, which consists of the design, construction and alteration of streets and highways, bridges and tunnels, parks and recreational facilities, sewers and sewage disposal plants, water supply and distribution structures, waste management facilities, correctional facilities and all other public

buildings, structures and facilities. (NYC Charter Section 1202 a) The NYC mayor may assign the operations and functions related to a particular construction project or particular category or class of construction projects to another agency (NYC Charter Section 1202 a). Thus, for example, DDC manages the design and construction of the NYC Department of Environmental Protection's (**DEP**) subsurface water and wastewater distribution systems, while DEP handles the design and construction of its wastewater resource recovery plants and its upstate watershed facilities. DDC manages sponsor agencies' capital projects with capital funds from the sponsor agencies and is functionally divided between an Infrastructure Division and a Public Buildings Division.

All sustainability and resiliency policies leading to actual capital projects require leading edge designs and construction technology. Policies aside, capital project design and construction matter on—and under—the ground. With its scope, authority and city-wide purview, DDC provides implementation experience to water and wastewater resiliency and sustainability issues under conditions of climate change.

Green Infrastructure on NYC Infrastructure Projects and Public Buildings Projects

Under the Consent Decree by the City, through DEP, with the NYS Department of Conservation (**NYS DEC**) under the federal Clean Water Act (**the Consent Decree**), the City is obligated to "implement measures to address discharges through the City's combined sewer overflow (**CSO**) outfalls which, during periods of heavy rainfall, release a combination of stormwater and sewage that bypasses treatment into the City's waterways."[1] The City's combined sewer system serves approximately 60–70% of NYC. The City's Green Infrastructure program is "an approach to managing stormwater and improving water quality by reducing the frequency of CSO events through a wide variety of practices at multiple scales to manage stormwater, maintain and restore natural hydrology and ecological function by infiltration, evapotranspiration, capture and release of stormwater, filtration and detention that includes the restoration of historic streambeds, construction of rainwater capture facilities such as bioswales and green roofs, cloudburst structures and permeable pavement."[2]

The Consent Decree defines "green infrastructure" as including "a wide array of practices at multiple scales to manage and/or treat stormwater, maintain and restore natural hydrology (including restoration of historic stream beds and ravines associated with reconnecting previously existing stormwater hydrology) and ecological function by infiltration, evapotranspiration, capture and reuse of stormwater, filtration, and detention. On a larger

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[1] NYC Municipal Water Finance Authority, Official Statement, dated April 17, 2024 (Official Statement), pp. 21-22.
[2] *Ibid.*, p. 22.

scale, green infrastructure includes, but is not limited to, ecological systems, both natural and engineered, and protection and enhancement of riparian buffers and floodplains and daylighting, bluebelts, coupled with policies to regulate new development and redevelopment for stormwater management. On the local scale green infrastructure consists of site and neighborhood-specific practices, including cloudburst management. Such practices essentially result in runoff reduction, peak flow reduction through slow-release orifice controls where necessary, and/or establishment of habitat areas with significant utilization of soils, vegetation, and engineered media where feasible, rather than traditional centralized hardscape collection, conveyance and storage structures. Some examples include green roofs, trees and tree boxes, pervious pavement, rain gardens, vegetated swales, planters, stormwater harvesting and reuse systems, and surface and subsurface stormwater storage systems that either perform as retention or slow-release detention systems. Related sewer conveyance needed to connect a green infrastructure asset to sewer infrastructure is included as part of the "Green Infrastructure."[3]

Planned Capital Improvement Program investments in the City's Green Infrastructure Program over the 2024-2033 period total $986,242,000 and in the City's Bluebelt program over the same period total $534,319,000. The aggregate $1,520,561,000 sum of these planned investments represents 5 percent of DEP's total city funded planned Capital Improvement Program for the City's water supply and supply, water distribution, water pollution control, sewers and equipment investments over the ten-year period.[4]

The Consent Decree also permits green infrastructure installations for NYC's municipal separate storm sewer system (**MS4**) to be qualifying expenditures for meeting the City's obligations under the Consent Decree.[5] The MS4 system is a publicly-owned conveyance or system of conveyances (including but not limited to streets, ditches, catch basins, curbs, gutters, and storm drains), serving approximately 30–40% of NYC, which was designed or used for collecting or conveying stormwater and that discharges to the city's surface waters.   NYSDEC renewed the City's MS4 Permit in 2022. The recently released Unified Stormwater Rule (USWR) expands the use of porous pavements on NYC streets and changes requirements for stormwater management on new and redevelopment properties, with Guidelines for the Design and Construction of Stormwater Management Systems in development.[6]

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[3] ORDER ON CONSENT (CSO Order Modification to C02-20000107-8) DEC Case No. C02-20110512-25, pp. 5-6. See 2012 CSO Modification Order on Consent (ny.gov).
[4] Official Statement, p. 20.
[5] Consent Decree, p. 9.
[6] See Unified Stormwater Rule - NYC DEP.

DDC + NYC Infrastructure. DDC delivers roadway, sewer and water main construction projects in all NYC's five boroughs, providing quality infrastructure. This infrastructure includes sidewalks, street reconstruction, pedestrian bridges, water mains, sewers, public plazas, pedestrian ramps, and most of these projects include various green infrastructure installations, which are essential for a resilient and sustainable city under conditions of climate change. As NYC's primary capital construction project manager, DDC shares and implements NYC's goals to invest in reliable and resilient infrastructure that improves and strengthens communities.

NYC's subsurface water mains deliver water from the upstate watershed to homes, schools, hospitals, and businesses throughout the five boroughs in New York City. Some of these mains and pipes are over 100 years old and they need to be replaced as they age. Working with DEP, DDC installs new pipes and replaces old pipes to deliver high-quality water for decades to come.

NYC's sewer system protects public health and safety, and DDC works in every neighborhood to improve, install, and repair NYC's sewer system for DEP. DDC installs new sewers to replace older sewers, makes upgrades to the sewer system to increase local capacity when an area grows, or usage is expected to increase, and installs storm sewers that can handle more stormwater to reduce flooding on city streets.

In connection with sewer system projects in certain areas of the city, DDC works with DEP to expand the use of the award-winning "Bluebelts", which is a form of nature-based solutions that preserve natural drainage corridors such as streams, creeks, and ponds, while optimizing them from an engineering perspective to help control and filter stormwater from surrounding neighborhoods and providing important open spaces that serve as habitats for diverse wildlife. Nearly 75 separate Bluebelt installations across Staten Island manage stormwater and have improved nearby property values. The projects included the addition of new catch basins and storm sewers to improve roadway drainage and wetlands to naturally filter the stormwater. In addition, new water mains and fire hydrants were added along with new sanitary sewers, which allows hundreds of homes to connect to the City sewer system and discontinue the use of septic tanks. DEP provided the funding for the projects and DDC managed their design and construction.

The NYC Department of Parks and Recreation (**DPR**), with the NYC Department of Transportation (**DOT**), launched the **Greenstreets** program in 1996 to convert paved, vacant traffic islands, and medians into green spaces filled with trees, shrubs, and groundcover in an effort to capture stormwater and in 2010 became part of the City's Green Infrastructure Plan.[7] This program aims at changing unused road areas into green spaces that beautify neighborhoods,

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[7] Green Infrastructure : NYC Parks (nycgovparks.org)

improve air quality, reduce air temperatures, and calm traffic. DDC, working with DEP, designs and installs Greenstreets projects throughout the City.   Since its beginning, over 2,500 Greenstreets have been built citywide. DPR works with DEP to determine Stormwater Greenstreet (SGS) and Right-of-Way Bioswale (ROWB) locations according to hydraulic analysis, site survey, existing conditions, and the DOT traffic safety standards. We also require soil borings and soil permeability tests at each location to determine whether the subsoil is suitable to infiltrate stormwater.

The **BIG U** proposal[8] developed from a collaborative planning and design effort in response to 2012 Super Storm Sandy that aimed at ideas to protect Lower Manhattan from floodwater, storms, and other climate change impacts. Super Storm Sandy significantly damaged Lower Manhattan, the site of an important NYC central business district and where many people live, with a significant core of public housing developments, all cut off from electricity, water, transportation, and communication services.[9] This proposal envisioned a protective system from West 57th Street, going down to The Battery, and then back up to East 42nd Street, consisting of approximately 10 miles.[10] The proposal sought to develop separate resiliency projects (initially, East River Park; Two Bridges and Chinatown; and Brooklyn Bridge to The Battery) that responded to neighborhood typologies and community-desired amenities, which would provide for integrated social and community planning processes.[11]

For the East River Park, the proposal included a bridging berm to protect the area from storm surges and rising sea levels, while offering waterfront access with accessible routes over the FDR highway and resilient urban landscaping. For Two Bridges and Chinatown, the proposal included deployable walls attached to the underside of the elevated FDR highway to flip down to mitigate flooding. The wall panels, decorated by neighborhood artists, would function as ceiling designs when not in use, and integrated lighting would assist with perceptions of safe access and function as a community asset. For the Brooklyn Bridge to the Battery project, the proposal envisioned another berm that weaved an elevated path with various landscape designs and included transforming existing nearby structures to align programmatically with the project.[12]

From these Big U ideas, NYC has developed several coastal resiliency projects that are underway for which DDC has managed the design and/or construction. For a complete list of contemplated coastal resiliency projects in Manhattan, see also Background - LMCR (nyc.gov) and Lower_Manhattan_Climate_Resilience_March_2019.pdf (edc.nyc).

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8 675.pdf (rebuildbydesign.org)
9 PROJECT PAGES: THE BIG U - Rebuild by Design
10 *Idem*
11 *Idem*
12 *Idem*

- The East Side Coastal Resiliency Project (**ESCR**), begun in 2020, is a coastal protection project, jointly funded by NYC and the federal government that aims at reducing flood risk due to coastal storms and sea level rise on Manhattan's East Side from East 25th Street to Montgomery Street. The ESCR project boundaries correspond with the natural "pinch-points" in the 100-year floodplain, which are areas where the land is higher along the coastline that make it easier to close the system off from water entering from the north and south. The project design integrates flood protection into the community fabric, improving waterfront open spaces and access, rather than walling off the neighborhood. The ESCR project was selected to receive an Envision Gold Award for sustainability from the Institute for Sustainable Infrastructure (ISI) because the project achieved a heightened range of sustainability and resilience outcomes and created a cohesive and comprehensive response to climate resiliency goals that protected the community while enhancing public space and amenities and developing a robust community engagement program that considers the diversity of stakeholders.[13]

- The Brooklyn Montgomery Street Coastal Resilience (**BMCR**) project in the Two Bridges neighborhood, DDC is engaged in the installation of a combination of flood walls and deployable flip-up barriers to protect the neighborhood from a 100-year storm surge in the 2050s, while also maintaining access and visibility to the waterfront. For this project, which will extend along the waterfront from the Brooklyn Bridge to Montgomery Street, the NYC Economic Development Corporation (**NYC EDC**) led the design, which was completed in 2021. The BMCR project will reduce flooding risk – from both sea level rise and storm surge – for thousands of residents, while continuing to preserve views and access to the waterfront. The deployable barriers will be permanent infrastructure that is hidden until they are flipped up in the event of a storm. The location of the flood walls and posts has been designed to minimize conflict with subsurface infrastructure and to maximize integration of public space amenities such as open-air seating, fitness equipment, and athletic courts.[14]

Super Storm Sandy also impacted low-lying areas outside Lower Manhattan, such as Red Hook in Brooklyn, in a manner similar to what happened in Lower Manhattan. The Red Hook Coastal Resiliency (**RHCR**)[15] project is a coastal protection project funded by NYC, the Federal Emergency Management (FEMA) and the New York State Department of Emergency and Homeland Security Services (DSHES), that aims at reducing flood risks due to coastal storm

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13 https://www.nyc.gov/site/escr/index.page
14 https://www.nyc.gov/site/lmcr/progress/brooklyn-bridge-montgomery-coastal-resilience.page
15 Formerly called that Red Hook Integrated Flood Protection System Project.

surge and sea level rise along Red Hook's waterfront, while also integrating with the community fabric, and improving the long-term resiliency of the neighborhood. DDC manages the design and construction of the RHCR project. Red Hook, like Lower Manhattan, has a significant core of public housing developments. Adding some complexity to the RHCR project, in May 2024, the NYC Mayor, the New York Governor and the Port Authority of New York and New Jersey (the **Port Authority**) announced an agreement in principle among the City, the State, the Port Authority, and NYC EDC to swap control of two marine terminals—one in the Red Hook area, with more than 100 acres of the Brooklyn waterfront, and one in Staten Island--that would enable the City to transform the Brooklyn Marine Terminal into a modern maritime port and vibrant mixed-use community hub.[16] This site is adjacent to the RHCR project site. The City plans $80 million of investments in the Red Hook port and the State plans to invest $15 million to "create a cold-storage facility at the port, which would allow for the delivery of perishable products by water rather than via trucks."[17]

In October 2023, DEP created a new leadership structure for coastal resiliency infrastructure projects that will centralize the planning, implementation and operations of the City's coastal resiliency project in one agency.[18] A goal of the City's *PlaNYC: Getting Sustainability Done* agenda, DEP BCR will play a centralized role in making neighborhoods more resilient to extreme weather. NYC has, over the years, accomplished many projects aimed at resilience to floods from whatever source, but the historical lack of consistent and centralized oversight has been an impediment to a city-wide "baseline state of good repair" effort that is essential to keep these and future projects continuing to function for their life cycle duration.[19] These existing challenges will also be exacerbated by future climate change events contributing to flooding. To enable the City to consider flooding from all sources holistically, considering compounding risks, DEP BCR will collaborate with a variety of agencies with oversight or jurisdiction over waterfront sites (e.g., DPR, NYC EDC, DDC, DOT, among others), which agencies have planned capital investments in flood resilience projects under conditions of climate change. This creation of a centralized point of long-term management will ""unify long-term planning and funding, increase coordination and efficiency, and improve maintenance of flood resilience projects."[20]

NYC's roadways are a vital network maintained by DOT. When these roads need comprehensive reconstruction due to aging infrastructure, neighborhood rezoning, street conditions, or community concerns, DDC manages the roadway rebuilding process to ensure

16 [Mayor Adams Announces Plan to Transform Brooklyn Marine Terminal | City of New York (nyc.gov)](#)
17 [New York Announces $95 Million Revitalization of Port in Red Hook - The New York Times (nytimes.com)](#)
18 [Laurian Farrell Appointed Deputy Commissioner for Coastal Resilience at the DEP | City of New York (nyc.gov)](#)
19 [PlaNYC-2023-Full-Report.pdf (cityofnewyork.us)](#), p. 44.
20 *Idem*

new streets are as safe as possible, the underground infrastructure will continue to serve everyone, and that the result will last for decades. DDC's roadway projects support neighborhood connections and safety and contribute to increased resiliency and sustainability under conditions of climate change**.**

NYC has dozens of public plazas for residents and visitors to use and enjoy. DDC builds and revitalizes these spaces, working in partnership with DOT. DDC creates new plazas, sometimes converting existing streets and sidewalks into vibrant public spaces, and also upgrades informal gathering spaces into enduring plazas, all of which implement the City's goal to make more public space available and accessible to everyone. Green infrastructure installations are part of these plaza projects.   In its Third Edition, DOT's Street Design Manual is NYC's comprehensive resource for street design standards, guidelines, and policies that include sustainability and resilience elements in addition to public safety elements.[21] The Street Design Manual is the "foundation for designs for all projects that impact public and private streets in New York City, including roadways, sidewalks, and plazas."[22]

DDC + Public Buildings

As the City's primary capital construction project manager, DDC builds many of the civic facilities New Yorkers use every day. DDC's design and construction management services lead to new or renovated structures such as firehouses, libraries, police precincts, courthouses, senior centers and more that serve NYC's communities. To successfully manage DDC's portfolio of Public Building projects, DDC collaborates with other City agencies, as well as with emerging and world-renowned architects and consultants.

DDC designs and builds new buildings as well as major rehabilitations and renovations, from restoring station façades to making libraries ADA-accessible. DDC also manages essential system upgrades including fire alarms and heating systems.   DDC projects for the New York Public Library, Queens Public Library, and Brooklyn Public Library range from minor alterations of existing neighborhood branches to new buildings that become enduring and accessible community assets. Through managing projects for the NYC Department of Cultural Affairs, DDC renovates, upgrades, and constructs cultural institutions, including museums, botanical gardens, theaters, dance studios, zoos, and smaller non-profits. For the Fire Department of New York, DDC manages upgrades to over 220 firehouses, as well as numerous EMS stations, rescue companies, training academies, and other support facilities. DDC also designs and builds new support facilities and stations that meet current needs. For the New York City Police

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[21] Street Design Manual | NYC Street Design Manual and Purpose and Applicability | NYC Street Design Manual.
[22] Purpose and Applicability | NYC Street Design Manual

Department, DDC manages construction for the facilities that enable the NYPD to uphold public safety and enforce the law. DDC manages upgrades to the headquarters at One Police Plaza, designs and constructs new precincts around the city, and renovates training facilities, storage structures, and more. DDC manages construction and building upgrades in every neighborhood for over two dozen City agencies, supporting Public Building projects from courthouse renovations to ball field upgrades. For DEP, these projects include wastewater facilities and sewer treatment facilities, storage garages and fueling stations, as well as nature walks and administrative buildings. For the NYC Department of Sanitation, these projects include maintenance facilities, garages, and marine transfer stations.

Guided by DDC's Design and Construction Excellence Principles, DDC aims to design and construct Public Building projects that are community-oriented, inclusive, healthy, resilient, and durable. DDC constructs and renovates Public Buildings to provide equitable access for everyone, including persons with disabilities and these projects also incorporate strategies that encourage activity and physical health. DDC designs with resilience in mind to deliver buildings that can withstand extreme events, including flooding and storms.

DDC has published many ground-breaking manuals,[23] many focusing on sustainability, over the years, which is consistent with its role as the City's primary design and construction agency:

Sustainable Guides, Manuals and Reports

Sustainable New York
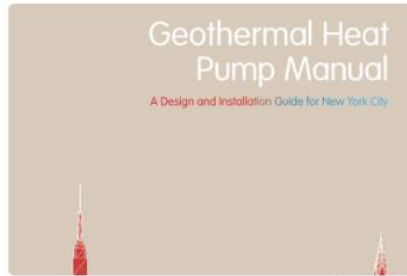
Geothermal Heat Pump Manual

Water Matters

High Performance Building Guidelines

High Performance Infrastructure Guidelines

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[23] Publications - Department of Design and Construction (nyc.gov) Publications - Department of Design and Construction (nyc.gov)

Buildings themselves constitute a system that interacts with the infrastructure systems that manage water in (including stormwater) and water out. The City's Climate Resiliency Design Guidelines (the **Guidelines**),[24] developed collaboratively by all NYC agencies, apply to NYC Public Building projects. The Guidelines are intended to help designers of NYC Public Building projects move beyond existing building code and standards, which are now informed with historic climate data, to look at "specific, forward-looking climate data for use in the design of City facilities."[25] Via the Guidelines, agencies during the project planning process and designers during the design process "will assess risks to climate hazards in the context of the project's purpose, asset type, site location, and funding, and then determine the appropriate resilient design strategies using the Guidelines," which apply to all City capital projects with some exceptions.[26] Incorporating "forward-looking climate change data in the design of City capital projects" will correct for historic climate data in existing codes and standards to enable designs for "the projected severity and frequency of future storms, sea level rise, heat waves, and precipitation" during the long life cycle duration of NYC capital projects.[27]

Finally, DDC works hard to keep all stakeholders, including those in the communities where construction happens, informed while construction is underway. DDC has long had its Office of Community Outreach and Notification that communicates with residents, businesses, and institutions, which also has a cadre of trained Community Construction Liaisons work on behalf of DDC to inform neighbors of construction activities and quickly resolve any project-related impacts.

DDC + DEP Research

DEP has a tradition of conducting innovative research that builds on its tradition of long-term planning. DEP's long-term planning generates a broad range of research[28] using many academic-practitioner engagement models ranging from the City's partnership with its public university system to procurements for faculty-directed research via the Town+Gown Master Academic Consortium Contract with 14 academic institutions (**Town+Gown Master Contract**), as any City agency is able to do,[29] or "stand-alone" solicitations.

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[24] CRDG-4-1-May-2022.pdf (nyc.gov)
[25] Guidelines, p. 5.
[26] *Idem*
[27] *Idem*
[28] See DEP Bureau of Water Supply 2024-2025 research agenda and the 2021-2022 DEP Agency-Wide Research Summary Report at https://www.nyc.gov/assets/dep/downloads/pdf/environment/science-research/dep-research-summary-2021-2022.pdf
[29] See Faculty-Directed Research (nyc.gov).

Innovative research within DEP's Bureau of Engineering Design and Construction (BEDC) supports DEP capital projects, many of which DDC designs and constructs, through "scientific analysis of constructed works."[30] Instead of the traditional faculty-directed research method, BEDC, working with ideas generated by DDC, which also has a long tradition of capital project-based research, conducts research during the construction process as part of the construction process. BEDC's In-House Design Division also conducts similar research. These research projects support DEP and DDC in their implementation of city-wide policies such PlaNYC's sustainability goals and the Mayor's Clean Construction Executive Order 23 of 2023 and help make NYC's subsurface distribution infrastructure more environmentally sustainable and more resilient to the impacts of climate change.[31]

Among the reported DEP + DDC research collaborations[32] are:

- Infrastructure—Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe Viability for DEP Sewer Installations[33]
- Infrastructure—Evaluation of Various Innovative and Non-Standard Piles for Sewer/Water Main Installation Projects[34]
- Infrastructure—Pilot Study: Spray Applied Polyurethan and Heat Shrink Sleeves for Trunk Water Mains[35]
- Infrastructure—Carbon Fiber System Lining for Water Main Rehabilitation[36]

BEDC In-House Design Division research involved evaluation of pipe rehabilitation technologies to renew the life of an existing large-diameter pressurized pipeline.[37]

See below for DEP's model-related research.

DEP, among all NYC agencies, is the largest user of the Town+Gown Master Contract, as shown in the chart below.[38] For a discussion of DEP's many academic-practitioner engagement

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[30] DEP Agency-Wide Research Agenda, p. 19.
[31] *Idem*
[32] For all DEP innovation research projects, see DEP Agency-Wide Research Agenda, pp. 32-39.
[33] DEP Agency-Wide Research Agenda, p. 32.
[34] *Idem*
[35] *Ibid.*, p. 33.
[36] *Ibid.*, p. 34.
[37] *Ibid.*, p. 19. The DEP presentation at Theme 3 also involves research done within BEDC In-House Design Division.
[38] town-gown-rfps (nyc.gov)

models, in addition to the Town+Gown Master Contract, please see the Bureau of Water Supply Research Agenda.[39]

Archived Town+Gown RFPs		
Agency	RFP	Due Date
DEP	NYC DEP Regional Scale Nutrient Assessment for the NYC Water Supply Watersheds Project RFP, Under the Consortium Contract Transmittal Memorandum Addendum #1 Addendum #2	03/22/2024
DOC	DOC Logistics Optimization Project RFP Under the Consortium Contract Transmittal Memorandum Addendum #1	12/18/2023
OTI, Mayor's Office of Operations	NYC OTI Citywide Soils Model Interpolation Methodology Research Project RFP Under the Consortium Contract Transmittal Memorandum Addendum #1 Addendum #2	11/22/2023
DOT	NYC DOT Neighborhood Loading Zone Evaluation Study RFP under the Consortium Contract Transmittal Memorandum Addendum #1	4/13/2022
DCAS, MOCR	Climate Vulnerability, Impact, and Adaptation Analysis (VIA RFP) under the Consortium Contract Addendum #1 Addendum #2	1/28/2022
DOT	NYC DOT Overweight Truck Impact Study Addendum #1	12/12/2021
DEP	NYC Carbon Trading Study Transmittal Memorandum Consortium Contract Appendix A Addendum #1	10/18/2019
DEP	Hemlock Woolly Adelgid Biological Control Transmittal Memorandum Consortium Contract Appendix A	10/2/2019
DEP	Croton Water Filtration Plant Study Addendum #1	5/30/2019
DEP	BWS RFP Addendum #1	2/1/2019
DEP	Energy Infrastructure – Pathways to Achieve 80x50 Study Addendum #1 Addendum #2	10/24/2018
DEP	Citywide Stormwater Resiliency Study Attachment 1 Attachment 2-4 Attachment 5 Addendum #1	02/08/2018
DOB	Risk Assessment RFP	01/27/2017
DOT	Traffic Analytics Symposium	11/14/2016
DOB	Wind Study RFP	04/15/2016
DDC	Service Design RFP	07/31/2015
DDC	Healthy Living RFP	07/31/2015
DDC	Equity Lens RFP	07/31/2015
DDC	BIM RFP	07/31/2015
DOT	BQE Charrette	03/20/2015

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[39] Faculty-Directed Research (nyc.gov), pp. 18-21.

Climate Models, Other Models and Model-related Research

NPCC. NYC created the New York City Panel on Climate Change (**NPCC**) in 2009, as codified in 2012 (Local Law 42), "an independent advisory body that regularly publishes assessment reports that synthesize several years of scientific research and analysis on climate change and advises City policymakers on local resiliency and adaptation strategies to protect against rising temperatures, increased flooding, and other hazards."[40] The NPCC consists of 19 "leading independent climate and social scientists" producing projections in their regular reports that "form the basis for the City's and DEP's climate resiliency planning, which involves coordination and cooperations among multiple public and private stakeholders, and expansion of ongoing maintenance and development of municipal infrastructure as well as specific initiatives" listed below:

- October 2013: NYC Wastewater Resiliency Plan and Phase 1 Assessment of the Climate Change Integrated Modeling Project
- May 2021: NYC Stormwater Resiliency Plan
- July 2022: Rainfall Ready NYC[41]

NPCC's recommendations also supported development of PlaNYC 2023, "which addresses some of the biggest risks to the City associated with climate change including extreme heat and flooding from extreme rainfall, coastal storms and tidal flooding due to sea level rise."[42] DEP, like all City agencies described above, integrates "climate resiliency into capital planning through the NYC Climate Resiliency Design Guidelines, which translate future-looking climate change projections into technical guidance to inform the design of roads, buildings, sewer systems, hospitals, public housing and other pieces of critical public infrastructure. Starting in 2027, all City projects, including those overseen by DEP, will be required to meet a stringent set of requirements that will certify their preparedness for extreme weather events."[43]

Modelling for Consent Decree Compliance. As part of compliance with the Consent Decree, the City published the NYC Green Infrastructure Plan in 2010 (**GI Plan**),[44] "which relies on modeling to project CSO reductions based on information available to data, that would result from managing stormwater equivalent to one inch of rainfall on 10% of available impervious surfaces

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[40] New York City Panel on Climate Change (NPCC) - NYC Mayor's Office of Climate and Environmental Justice (cityofnewyork.us)
[41] Official Statement, p. 54.
[42] *Ibid.*, p. 55.
[43] *Idem*
[44] 82601396-NYCGreenInfrastructurePlan_HighRes.pdf

in the city's combined sewer areas by 2030. Potential projects advanced in the GI Plan . . . to attain City-wide CSO volume reductions include public and private stormwater control projects, the application of stormwater control performance standards to public and private development, and projects funded by grants to individuals, organizations or entities. [The City and DEP] intend to incorporate elements of the . . GI Plan into the CSO [Long Term Control Plans] by establishing baseline CSO volume reduction credits associated with the GI Plan's application rates. [DEP and the City] may achieve the City-wide CSO application rates by using the principles of adaptive management, which refers to the principle that experience from implementation of actual projects and changing conditions will inform future approaches o green infrastructure in an iterative process for continuous improvement."[45]

DEP built on an InfoWorks model, used to prepare its 2007 Facility Plans, to develop the model for Consent Decree compliance. DEP customized a commercially available mathematical modeling software for urban hydrology, which is accepted by regulators and utilities, "to account for the unique flow characteristics of New York City's sewer system," using data from "25,000 catchments, 7,500 pipes, 6,000 manholes, regulators and other features, and predicts overland runoff routing in New York City's topography."[46]   This model, "tested and calibrated against past rainfall events to develop the best possible estimate of CSO flows," permits DEP to evaluate the impact of "two different infrastructure investment strategies for reducing CSOs—a Green Strategy and a Grey Strategy" and "assess the future performance of capital projects."[47]

The Grey Strategy modelled two elements—cost-effective grey infrastructure investments and potential tanks, tunnels and expansion--while the Green Strategy modelled three—cost-effective grey infrastructure investments, system optimization and reduced flow, and green infrastructure.[48] DEP's system optimization efforts, of which this modelling is a part, aims at reducing CSOs "by increasing the capacity of the system to handle wet weather flows," and institutionalizing "a higher level of system optimization . . . will complement the major capital improvements" under the Consent Decree.[49] A cost estimation methodology is a key element of this technical modelling effort to reduce CSO under the Consent Decree.[50] As of the date of the GI Plan, "DEP's modelling [predicted] greater overall CSO reductions from the Green Strategy compared to the Grey strategy" with higher performance "in the nine watersheds where a tank or tunnel [was] not under consideration."[51]

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[45] Order on Consent, p. 4.

[46] GI Plan, p. 19

[47] *Idem*

[48] *Ibid.*, p. 20.

[49] *Idem*

[50] *Ibid.*, pp. 21-24.

[51] *Ibid.,* p. 25.

For a more detailed description of the InfoWorks model for Consent Decree compliance with a focus on green infrastructure, see GI Study, pp. 131-141 and 19-33.

Other Models and Model-Like Research. Among the reported DEP research projects are several that involve modelling and/or research leading to future modelling.

- Modeling—Development of Integrated Model and Graphical User Interface/Decision Support Tool for Long Island Sound

  The United States Environmental Protection Agency (EPA) has awarded DEP a $6M grant to develop an integrated model for Long Island Sound (LIS). The model includes the development of new hydrodynamic and water quality model components. The new hydrodynamic model is intended to better understand and predict how wind, tide, salinity, river discharges, and other factors affect water circulation within LIS. The new water quality model is also intended to better understand the physical, chemical, and biological processes that are influenced by nutrients and other constituents discharged to LIS from point and non-point sources. In addition, this information can be used to predict how discharges cause oxygen levels to drop, thereby affecting living resources. Ultimately, the Graphical User Interface/Decision Support Tool will enable DEP and other stakeholders to run management scenarios, for example, predicting the effects of climate change on water quality. The integrated model will also link to the Living Resources model to allow for a better analysis of how current and future changes in water quality impact oysters or aquatic plants, or to test whether it is feasible to use living resources to remove nutrients in water. The work is being overseen by BOS and will be completed over a 4-to-5-year period. The project will update and improve the model used to develop the 2,000 total maximum daily load reduction for nitro gen. It is also intended to ensure that any new efforts imposed upon DEP and other LIS stakeholders in the future, as part of EPA's next generation nitrogen strategy, is based on the latest science and builds upon the extensive data collection efforts undertaken by various stakeholders in the two decades since the 2,000 total maximum daily load nitrogen reduction requirements were finalized.[52]

- Wetlands—Light Detection and Ranging (LiDAR) Mapping of Wetlands
  The objective of this BWS project was to increase the accuracy and completeness of wetland data for the watershed by using modern automated techniques and light

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[52] dep-research-summary-2021-2022.pdf (nyc.gov), p. 23.

detection and ranging (LiDAR) data as compared to traditional photo interpretation-based methodologies. LiDAR data provides accurate topographic information that complements aerial photography. The East of Hudson and West of Hudson watersheds were analyzed, and wetlands mapped in collaboration with the University of Vermont Spatial Analysis Laboratory, with input from the U.S. Fish and Wildlife Service National Wetlands Inventory. The results were manually reviewed for accuracy and the final product is a fully classified National Wetland Inventory (NWI)-compliant map for the watersheds. The study found that wetland acreage nearly doubled as compared to the previous NWI maps West of Hudson and increased by 70% East of Hudson. This project also analyzed how wetlands connected to other wetlands or waterbodies. These connections were digitized using LiDAR surface data and aerial photos. The end result was an updated map with over 400 miles of new connecting features. Ultimately, the percentage of wetlands estimated to be unconnected to the stream network decreased from 10% to 2% East of Hudson, and from 8% to 3% WOH. BWS will complete an in-house accuracy assessment to evaluate the results and how they may be applied to watershed protection programs.[53]

- Modeling—Watershed Runoff and Nutrient Modeling

  The BWS modeling and analysis group has completed the application and validation of the Soil and Water Assessment Tool model for the West of Hudson watersheds. This includes the simulation of hydrology and nutrient loads into the reservoirs. A similar application to the East of Hudson watershed is underway. Once developed these models can support evaluation of watershed protection programs and climate change impacts and may also help identify land and watercourse management strategies. In 2022, the modeling and analysis group initiated a research project to develop the capability to simulate dissolved organic carbon (DOC) in streams of West of Hudson watersheds. Initial testing of the watershed carbon model is being carried out for the Neversink watershed. Once developed these models can help understand the sources and pathways of DOC and support disinfection byproduct research in the watersheds.[54]

- Climate Change—Citywide Stormwater Resiliency Planning
  In 2018, BOS initiated a stormwater resiliency study with the Mayor's Office of Resiliency to model floodprone areas under different storm scenarios and with current and future climate projections. Local Law 127 of 2018 requires the City to provide maps of areas most vulnerable to flooding, and to develop a mitigation plan that reflects existing and

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[53] *Ibid.*, p. 25.
[54] *Ibid.* pp. 26-27.

potential future approaches through green and green-gray hybrid stormwater management solutions. In 2021, the Mayor's Office of Resiliency released the City's first "Stormwater Resiliency Plan," along with maps developed by DEP based on models of flood-prone areas under different storm scenarios and with current and future climate projections. Following Tropical Storm Ida, the City accelerated and expanded upon the commitments in the Stormwater Resiliency Plan in "The New Normal" report, and subsequently in DEP's "Increasing Stormwater Resilience in the Face of Climate Change: Our Long Term Vision." As part of the commitments identified in these plans, DEP has been developing cloudburst projects to mitigate extreme rain events, utilizing the flood maps and building upon the City's existing efforts and projects incorporating operational and structural approaches. [55]

- Modeling—Water Demand and Wastewater Flow Projections

The Integrated Water Management group in BEPA is developing updated short- and long-term water demand projections in consultation with BWS to statistically characterize trends in water use patterns by user class, sectors, and geographic regions. The Integrated Water Management group will also consider the influence of climatic and socio-demographic factors that shape short- and long-term demand trends when updating the projections. Additionally, BEPA is developing updated dry weather wastewater flow projections by sewershed to empirically connect water demand and wastewater flow projections and translate water demand forecasts to projected wastewater flows. BEPA developed a forecasting framework, which will be used for the development of the water demand forecast model. The forecasting framework centers around the disaggregation of water-use data, as well as the socioeconomic and other variables that can be used to explain variability in water use. Initial projections are available through 2055. Global Climate Models (GCMs) tend to underestimate the multi-year variability of precipitation over some regions, including NYC's watershed, resulting in an underestimation of the magnitudes and/or intensities of prolonged droughts as well as prolonged wet periods. Two methods – an analog method and a change-factor-method are being proposed to correct for this bias. BWS is testing these methods for Ashokan Reservoir basin.[56]

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[55] *Ibid.,* pp. 51-52; this research was procured via the Master Contract.
[56] *Ibid*., p. 52.

- Environment—Climate—Climate Change Scenarios

BWS relies on a variety of models to inform daily operations and long-term planning. New and ongoing research is primarily two-fold: developing predictive models and forecasts and incorporating climate change scenarios. To refine the bureau's responsiveness to weather conditions and support climate resiliency, several studies are planned to create and validate models used to forecast streamflow, extreme weather events, greenhouse gas emissions, and changes in the City's demand projections over time. Collectively, these studies will provide the modeling infrastructure needed to span daily water supply operations in tandem with the long-term forecasting to maintain the water supply for 8.5 million people in New York City and one million people in upstate counties. The bureau is working on downscaling, bias correcting, and disaggregating most recent Global Climate Models projections known as CMIP6 datasets. Additionally, BWS is developing methods to address under-representation of decadal scale variability in these projections. The bureau uses two hydrologic models – the Soil and Water Assessment Tool (SWAT) and the Generalized Watershed Loading Function (GWLF). These tools are valuable modeling assets to predict changes in reservoir water quality and quantity based on projected weather conditions. The weather conditions driving SWAT and GWLF are climate change projections that consider various levels of greenhouse gas emissions. BWS is also collaborating with the Bureau of Sustainability on an innovative approach to predicting long-term demand under various climate change scenarios. This work dovetails with the SWAT streamflow modeling to understand how droughts in an era of climate change will affect reliable water supply in the future. Beginning in late 2023, the Watershed Agricultural Council, DEP, and Columbia University began research focusing on how future climate change scenarios are predicted to impact future agricultural production in the City's watersheds. These predictions will inform adaptation strategies to ensure that agricultural practices within the City's watersheds do not contribute to water quality degradation. This research will also tie in with BWS's existing models. The nexus among each of these climate change considerations is the City's Operational Support Tool. The Operational Support Tool emulates the operation of the city's water supply using observed or modeled demand for water, streamflow and stream water quality. The Operational Support Tool will be driven by scenarios of streamflow and water demand under drought which will allow the bureau to assess and then adapt to risks imposed by climate change on the City's water supply. This effort will ensure the city has a safe and reliable source of water for decades to come.[57]

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[57] bws-research-summary-2024-2025.pdf (nyc.gov). p. 11.

See also bws-research-summary-2024-2025.pdf (nyc.gov), pp. 18-21, for a description of DEP's academic partnerships including with Town+Gown:NYC and its Master Contracts.