



## Executive Summary

The Earth is warming. Atmospheric and oceanic temperatures are rising, and extensive scientific modeling predicts more dramatic increases into the future. As these trends accelerate, sea level will rise, and a more volatile climate with unpredictable precipitation patterns and more intense storms will be likely. In order to effectively anticipate and confront these climatic shifts, policymakers must begin to act now.

**Climate change must be considered in all short-term and long-term infrastructure and policy planning initiatives.**

Greenhouse gas (GHG) emissions must be rigorously identified and cataloged. Comprehensive plans for emissions reductions must be developed and implemented. And potential risks must be identified and addressed so that essential services can continue to be provided as the climate changes.

In recognition of this charge, the New York City Department of Environmental Protection (DEP or the Department), which is responsible for providing water supply, drainage, and wastewater management services to millions of New Yorkers, has developed a comprehensive Climate Change Program. Through this program, DEP works closely with leading scientists and engineers to project regional climate changes; assesses the impacts of a warming Earth on New York City's water systems; and identifies opportunities for meaningful change.

Based on this work, and in accordance with PlaNYC, Mayor Michael Bloomberg's plan for a sustainable City, DEP has begun to implement many programs that address global climate change and its projected impacts on New York City's drinking water delivery, stormwater management and wastewater treatment systems. The following Report summarizes this substantial process of analysis and action and outlines a comprehensive adaptation strategy for DEP as it prepares for a warmer and more volatile future.



“The impacts of climate change will be pervasive and profound. Most natural and man-made systems will be affected, and the City of New York’s water supply, drainage, and wastewater management systems are no exception...the time to take action is now.”

Emily Lloyd  
*Commissioner, NYCDEP*

## ES1 | A Context for Action: Climate Change Science

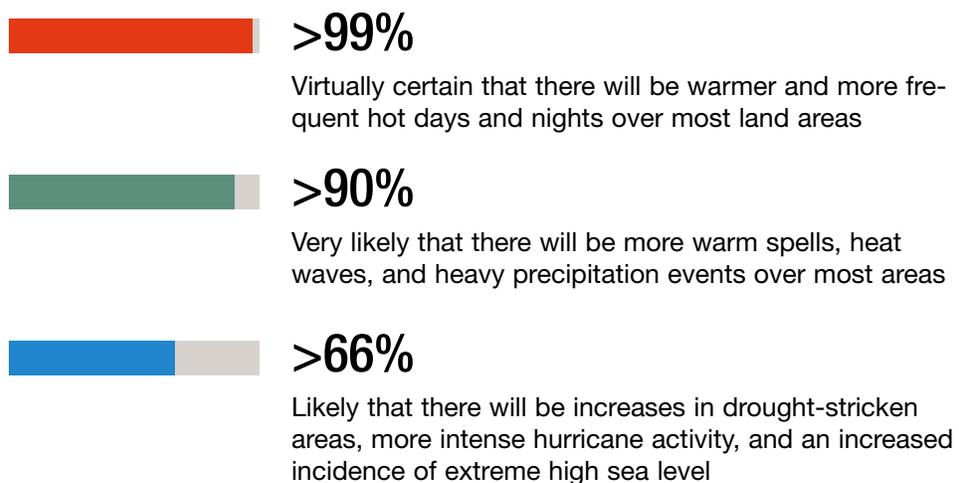
Scientific evidence indicates that human activities such as the burning of fossil fuels and land use change are producing unprecedented quantities of heat-trapping GHGs, including carbon dioxide, methane, and nitrous oxide. GHG concentrations in the atmosphere are now greater than at any time in the last 650,000 years. Scientists agree that the pronounced increase in atmospheric GHGs since the mid-19th century is very likely to have fueled the simultaneous increase in global average atmospheric temperature.

Extensive data indicate that changes in New York City's regional climate have been consistent with changes in global GHG concentrations and atmospheric temperature. In the New York City region from 1900 to 2005, the annual average temperature rose by approximately 1.9°F, the annual

average precipitation increased by approximately 4.2 inches (an increase of nearly 10%), and the sea level rose by approximately one foot.

Modeling projections performed for DEP by the Columbia University Center for Climate Systems Research and the NASA Goddard Institute for Space Studies at Columbia University (Columbia University) indicate that by the 2080s the most probable amounts of change in New York City and its Watershed Region will be 7.5°F to 8.0°F increase in temperature, a 7.5% to 10% increase in precipitation, and a 15.7 to 17.7 inch rise in sea level. Scientists anticipate that extreme weather events will also be more frequent.

The Intergovernmental Panel on Climate Change (IPCC) states that on a global scale during the 21st century, it is:



## ES2 | DEP's Climate Change Action Plan

As the potential impacts of climate change became clearer, and as scientific consensus grew, DEP realized the critical need for an internal program devoted to climate change and its relevance to Department infrastructure and operations. In 2003, DEP established partnerships with a range of scientists and engineers and created a formal Climate Change Task Force to oversee the Department's investigation of and preparation for the potential risks associated with climate change.

In 2004, the Climate Change Task Force which includes members from multiple internal Bureaus and participants from Columbia University, HydroQual, Mayor Bloomberg's Offices of Environmental Coordination and Long-Term Planning and Sustainability, and the New York City Law Department was formed to provide additional guidance to DEP in recognition of the increasing importance of developing a comprehensive climate change assessment

and action plan.

Led by the Task Force, the mission of DEP's Climate Change Program is to ensure that all aspects of Departmental planning: 1) take into account the potential risks of climate change on the City's water supply, drainage, and wastewater management systems, and 2) integrate GHG emissions management to the greatest extent possible.

In generating this Report, the Task Force conducted extensive internal interviews to identify potential impacts to DEP, frequently met with key science advisors, initiated a preliminary inventory of DEP's own GHG emissions, and participated in several major national and international conferences to share ideas and establish active partnerships with other municipalities and utilities around the world.



### DEP's Action Plan

DEP has developed a comprehensive Climate Change Action Plan to address the effects of atmospheric warming and global climate change on its water supply, drainage, wastewater and water quality protection operations, and strategies for greenhouse gas mitigation.



Using this information as a foundation, the Task Force has established a Climate Change Action Plan in order to properly address the potential repercussions of global climate change on DEP's operations. The Action Plan includes the following tasks:

**TASK 1:** Work with climate scientists to improve regional climate change projections.

**TASK 2:** Enhance DEP's understanding of the potential impacts of climate change on the Department's operations.

**TASK 3:** Determine and implement appropriate adaptations to DEP's water systems.

**TASK 4:** Inventory and manage greenhouse gas emissions.

**TASK 5:** Improve communication and tracking mechanisms.

The following sections summarize the climate change-related issues identified by the Task Force, and the Department's progress and priorities in addressing these concerns. A more detailed presentation of DEP's Climate Change Action Plan is summarized in tabular form in Chapter 6.

## **TASK 1** Work with Climate Scientists to Improve Regional Climate Change Projections

### **The Challenge**

Until now, much of DEP's water supply, drainage, and wastewater management planning has been guided by historical data for climate-related variables, such as temperature, precipitation, sea level, drought, and flooding. For its systems to continue to effectively function over the coming decades, DEP's planning and investments must instead be informed by the range of future climate conditions projected by global climate models. Because the Department will adopt different strategies for adjusting its systems to climate change, uncertainty in the projections must be minimized. Working with the scientific community, DEP must continually improve its regional climate modeling.

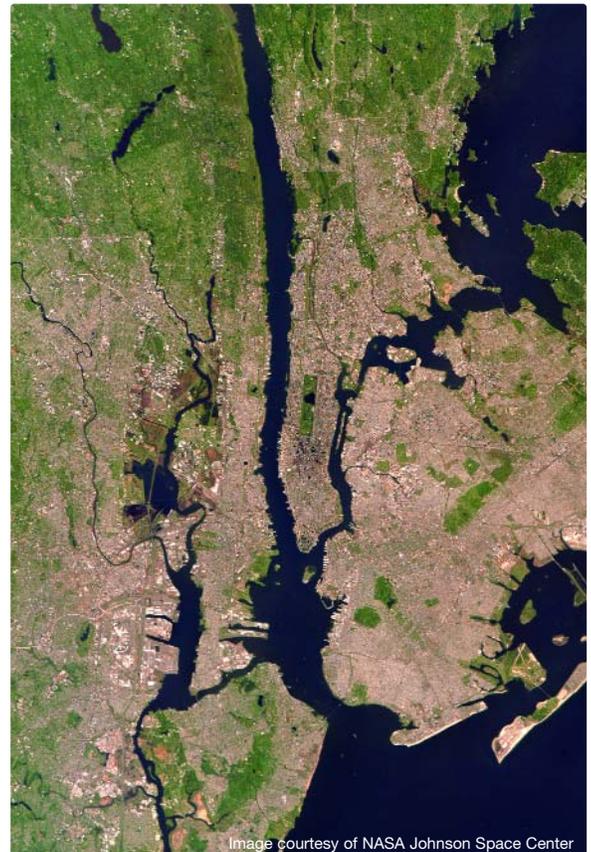
### **DEP's Progress**

DEP has funded the development of a set of regional climate change projections that are based on data from the best available global climate models. DEP now has the most comprehensive set of climate data that has been produced for New York City and its Watershed Region: Columbia University and NASA have provided annual projections for temperature, precipitation and sea level for the 2020s, 2050s, and 2080s. Additional projections have also been provided for shorter time periods and other climate variables.

### **DEP's Priorities**

To further advance this task, DEP will:

- Work with regulatory and other agencies on the PlaNYC initiative to update the existing 100-year flood elevations using current sea level data and develop agreed-upon estimates of future 100-year flood elevations, sea level rise, storm intensity, and maximum probable flood using climate change projections.
- Test a Regional Climate Model to New York City and its watersheds to create projections on smaller spatial scales and timescales that take into account local topography.
- Identify additional data and monitoring stations needed to track global and regional climate changes.



► See Chapter 1 for a full discussion of the climate change science and projections that DEP is now using for its climate change planning and the actions that DEP is taking to reduce uncertainty in climate change trends and projections. The actions are also summarized in Chapters 5 and 6 of the Report.

## TASK 2 Enhance DEP's Understanding of the Potential Impacts of Climate Change on the Department

### The Challenge

At the magnitudes currently anticipated, climate change could compromise the existing water supply and treatment systems in the following ways:

#### WATER SUPPLY SYSTEM

- Changing precipitation patterns could increase the frequency and severity of droughts and flooding.
- Heavier precipitation and more frequent storms could threaten DEP's unfiltered water systems by washing additional nutrients and particles into the reservoirs and increasing pathogen levels.
- Both droughts and sea level rise could cause salt fronts to encroach upon the Hudson and Delaware Rivers and threaten the water supply of neighboring jurisdictions and New York City's emergency supply.
- More frequent heat waves could increase water demand.
- Warmer weather could both reduce snowpack, which would decrease the amount of water stored in the watershed, and extend the growing season, which would increase the uptake of water by vegetation and thus reduce flows into reservoirs.
- Impacts to stream ecology from warmer weather may lead to more pressure for New York City to make additional reservoir releases for ecological management purposes.

#### DRAINAGE AND WASTEWATER MANAGEMENT SYSTEMS

- More frequent intense rainfalls could cause more flooding of streets and basements and overwhelm the capacities of sewers and treatment facilities.
- More frequent coastal storms could cause more damage to critical infrastructure.
- Rising seas could cause backups in the sewers and wastewater treatment facilities.
- Increased temperature of harbor waters could affect aquatic life.

Because modifying its infrastructure is both time-consuming and expensive, DEP must identify potential risks to, and anticipate potential needs of, its infrastructure well into the future. To identify the adjustments that are most cost-effective and likely to minimize climate change impacts, the potential range of risks and the probability of their occurrence must be quantified.

### DEP's Progress

DEP has performed a preliminary study of climate change and its potential impacts on New York City's systems for water supply, stormwater management, and wastewater treatment. Task Force members have conducted extensive interviews with system operators to catalog known and projected system vulnerabilities. In addition, a detailed plan for further study and quantification of impacts has been outlined.

### DEP's Priorities

To further advance this task, DEP will:

- Conduct a phased, integrated modeling project to quantify and provide a more comprehensive understanding of the potential impacts of climate change on drinking water quality, supply and demand.
- Conduct an integrated modeling, inundation and flood mapping, and cost/benefit analysis project to quantify and provide a more comprehensive understanding of the potential impacts of climate change on drainage, wastewater treatment processes and infrastructure, and harbor water quality.
- Establish a uniform Department-wide system for documenting and reporting the occurrence, levels, and impacts of flooding and other extreme weather events on DEP's systems in the watershed and in the City.
- Identify additional data and monitoring stations needed to track global and regional climate changes.

► See Chapter 2 for a full discussion of the potential impacts of climate change on New York City's drinking water, drainage, and wastewater systems and the actions that DEP is taking to further study and quantify the impacts. The potential impacts and the actions are also summarized in Chapters 5 and 6 of the Report.

## **TASK 3 Determine and Implement Appropriate Adaptations to DEP's Water Systems**

### **The Challenge**

DEP is continually making substantial investments in its infrastructure, which is designed and built to last for decades. Indeed, the Department's current 10-year capital program is approximately \$20 billion. DEP's infrastructure, as well as its operations, programs, and policies, has been designed on the assumption that future climate and sea level changes will follow historical patterns. But as global warming alters the regional climate, these critical assumptions will become less dependable predictors of risk. Therefore, in order to minimize the impacts of climate change on its water systems, DEP must modify the assumptions on which its current planning and investments are based.

Adjusting DEP's systems will be challenging because the extent of climate change is uncertain, yet the requirements of engineering are very precise. In addition, with millions of customers, thousands of miles of tunnels and pipes, and hundreds of facilities, DEP's systems are not only vital, but also vast. DEP will thus need to work to balance the need to swiftly adjust its infrastructure with the need to make prudent decisions and capital investments.

### **DEP's Progress**

DEP is committed to taking climate change into account in all strategic and capital planning. To achieve this goal, the Department has pushed to ensure that its planners, engineers, operators, and managers are cognizant of and considering the potential risks that climate change may pose to the City's infrastructure. DEP has begun to plan for climate change and implement strategies for adapting its systems at the earliest possible time with the goal of minimizing future service disruptions and financial demands on water and sewer ratepayers.

Most of DEP's ongoing programs and system upgrades can and will be built to improve system resiliency to future climate conditions. However, a more comprehensive effort is needed to build and maintain flexible systems capable of withstanding global climate change. DEP has made a formidable start in identifying many possible strategies for adapting its infrastructure to changes in climate conditions. The Department has identified priority actions that can be initiated immediately, as well as alternative adaptation strategies that, concurrently with DEP's work to refine climate projections and quantify cli-

mate change impacts, need to be further evaluated including their cost effectiveness.

In addition, as part of PlaNYC, DEP has worked with Mayor Bloomberg's office over the past year to identify system improvements that will help guarantee through at least 2030 continued delivery of an adequate supply of high-quality drinking water to upstate and in-City customers, reduce street flooding in the City, and improve harbor water quality. The City has committed to these actions primarily to meet regulatory requirements, address the aging of the City's infrastructure, anticipate a growing population, and achieve PlaNYC's goal of opening 90% of the City's waterways for recreation. However, these actions, which include measures to maintain and deliver an adequate amount of high-quality drinking water, reduce water demand, and implement stormwater Best Management Practices, will also considerably improve DEP's ability to provide water services under climate change scenarios that may compromise the water systems.

### **DEP's Priorities**

To further advance this task, DEP will:

- Add climate change as a factor in DEP's Risk Prioritization, which is used to prioritize projects and allocate funding by assessing the probability and severity of infrastructure failure and the associated costs, in order to ensure that additional risks due to climate change are reflected in the Department's capital planning.

- Identify and evaluate potential adaptation strategies based on the findings of each phase of DEP's integrated modeling project to study the impacts of climate change on the water supply system.

- Identify and evaluate a range of adaptation strategies based on the findings of DEP's project to identify the magnitude and location of climate change impacts on drainage, wastewater management facilities,

and harbor water quality, and develop a long-term, phased strategy for implementing the adaptation measures. Most immediately, DEP will evaluate flood protection measures for the three Water Pollution Control Plants (WPCPs) that will soon undergo rehabilitation, Rockaway, Hunts Point, and Tallman Island.

▶▶ See Chapter 3 for a full discussion of potential adaptation strategies for New York City's water systems, the ongoing DEP programs and PlaNYC initiatives on which the Department will build to address climate change, and the actions that DEP is taking to determine and implement appropriate adjustments to the water systems. The potential adaptations and actions are also summarized in Chapters 5 and 6 of the Report.

## TASK 4 Inventory and Manage Greenhouse Gas Emissions

### The Challenge

In order for New York City to assist in the global effort to slow the pace of climate change, PlaNYC set an ambitious target of reducing the City government's GHG emissions by 30% below 2006 levels by 2017. A City-wide emissions inventory conducted by Mayor Bloomberg's Office calculated that, in 2006, DEP's water supply, stormwater, and wastewater management facilities accounted for 17% of total City of New York government emissions. Thus, reductions at DEP facilities should appreciably assist the City in achieving its GHG reduction goal.

DEP owns and operates a large number of very diverse GHG emissions sources, including hundreds of stationary combustion sources at major facilities and a fleet of over 2,000 mobile sources. Thus, systematic integration of GHG emissions management strategies into all aspects of Departmental planning, engineering, and construction will be necessary to effectively reduce DEP's GHG emissions. In order to reduce its carbon footprint DEP will need to maximize, to the extent practical, implementation of energy efficiency practices and use of renewable

energy and alternative fuels. Further, through the forests and plantings that DEP manages both in the City's watershed and in its landfill and wetland restoration projects, DEP will be able to reduce its CO<sub>2</sub> emissions through carbon sequestering and absorption.

### DEP's Progress

New York City, recognizing the consequences of climate change, has taken early action toward reducing its GHG emissions. In 2001 the City joined ICLEI – Local Governments for Sustainability – Cities for Climate Protection™ (CCP) Campaign and, as discussed above, PlaNYC has set an ambitious GHG emissions reduction target. The PlaNYC 30% reduction target will help guide and structure DEP's own efforts to build more efficient infrastructure and reduce emissions. New York City is also active in four major litigation initiatives aimed at limiting uncontrolled emissions of GHGs nationally; a recent ruling by the U.S. Supreme Court in one of these initiatives, hailed as one of the Court's most significant environmental decisions, could lead to regulation by the U.S. Environmental Protection Agency in this area.

Because a GHG emissions baseline must be established in order to measure emissions reductions, DEP has already completed initial baseline emissions inventories for DEP's energy use during the years 1995, 2004, and 2005. These inventories indicate that approximately 80% to 85%, excluding vehicles, of the Department's GHG emissions from energy consumption stem from WPCPs and sludge dewatering operations; thus DEP's initial focus for emissions management is on its WPCPs. Since 2003, at each of four DEP plants, the New York Power Authority has installed eight fuel cells powered by anaerobic digester gas (ADG) that otherwise would have been flared into the atmosphere. ADG is a by-product of the wastewater treatment process with very high methane content and global warming potential. Over the last four years, the fuel cells have consumed a total of 253 million cubic feet of ADG and generated 18.7 million kilowatt hours of clean power.

### DEP's Priorities

To further advance this task, DEP will:

- Complete a comprehensive emissions inventory and a process for yearly updates. The first priority will be the 14 WPCPs (DEP's largest emitters), and the second-level priority will be DEP's vehicle fleet.
- Develop a Department-wide GHG management plan with facility-specific management plans that are integrated with the capital improvement program. DEP will first increase equipment efficiency during the planned upgrade of the Rockaway WPCP and use the improvements as a pilot for the development of GHG management plans for other facilities.
- Examine all current and pending construction contracts to see where energy can be used more efficiently. Most immediately, DEP will install more energy-efficient equipment during the planned replacement of boilers at the Port Richmond WPCP and generators at the 26th Ward WPCP.
- Reduce methane leaks from sewage processing equipment and expand the use of ADG for on-site energy production at the WPCPs.

► See Chapter 4 for a broader discussion of GHG emissions and management in the City of New York and at DEP, New York City's ongoing legal efforts to ensure emissions reductions nationally, and the actions that DEP is taking to inventory and manage its GHG emissions. The actions are also summarized in Chapter 6 of the Report.

## TASK 5 Improve Communication and Tracking Mechanisms

### The Challenge

The success of Tasks 1 through 4 will depend on effective program management, and this in turn will require effective communication and measurement of performance. Extensive internal coordination as well as collaboration with other agencies and stakeholders will be necessary. Furthermore, performance benchmarks and key indicators for tracking and quantifying progress must be developed to enable project managers and other DEP staff to quickly identify and address obstacles or problems as they arise and provide DEP with a strong sense of tangible improvement and progress. A well-orchestrated approach to climate change will increase the efficiency of DEP's operations, guarantee a swift response to potential climate shifts, and enhance the oversight and management of key projects.

### DEP's Progress to Date

Over the past four years, DEP's Climate Change Program and agency-wide Climate Change Task Force have built a strong foundation of knowledge about climate change science and projections, impacts, adaptations, and GHG mitigation in relation to the mission of the Department. This knowledge has allowed DEP to develop this Action Plan for holistic incorporation of climate change projections within the Department's long-term strategic and capital planning processes.

Through partnerships with scientists at Columbia University and other institutions, external collaboration with colleagues both within the United States and abroad, participation in conferences and workshops, membership with the Climate and Lake Impacts

Program in Europe (CLIME) project, and presentations of the work of the Task Force to other agencies, DEP has begun a long-term endeavor to share knowledge and spur innovation.

### DEP's Priorities

- Develop a plan for the continued success of DEP's Climate Change Program. The first two steps will be to:
  - Establish a senior-level steering committee to focus climate change efforts and permanently institutionalize the mission of DEP's Climate Change Program.
  - Establish a Climate Change Office within DEP's Bureau of Environmental Planning and Analysis. This Office will support the engineering and operating Bureaus by coordinating internal climate change activities and external outreach with other agencies and stakeholders, working to make climate change science more relevant and useful to DEP's policy-makers and engineers, and serving as the central repository at DEP for climate change data.
- Develop a climate change intranet site to promote uniform data usage throughout all Bureaus, improve intra-Department information sharing, and enhance DEP's decision-making capabilities.
- Develop a reporting mechanism that sets performance benchmarks and establishes key indicators for tracking and quantifying progress.
- Participate in the new intergovernmental New York City Climate Change Task Force and the new Inter-agency Best Management Practices Task Force, both announced by Mayor Bloomberg as part of PlaNYC, in order to share and gain ideas, guidance, and logistical support from other Departments and stakeholders.
- Foster relationships with other water organizations, including the Water Utilities Climate Change Steering Committee sponsored by the San Francisco Public Utilities Commission, in order to exchange ideas, challenges, policies, and science; pool resources; and formulate research agendas that engage scientists and practitioners for shared problem-solving.

►► The actions that DEP is taking to improve communications and tracking mechanisms are summarized in Chapter 6 of the Report.

## ES3 | Conclusion

This Report signifies a critical transition from analysis to action. By discussing in depth DEP's work to date and its Action Plan for addressing the challenge of climate change, the Report provides the Department and its operational and regulatory Bureaus with a point of reference for advancing its long-term strategic and capital planning with the added perspective of climate change. DEP is committed to this ongoing and evolving process because it will assist the Department in achieving its ultimate goal of providing high-quality water services to the people of New York City for decades to come.



The New York City Department of Environmental Protection  
**CLIMATE CHANGE PROGRAM**

