



Environmental  
Protection

**NYC** Mayor's Office of Climate &  
Environmental Justice

# Cloudburst Management in NYC

for Long-Term Resilience

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## Part 1: Understanding

- What is Cloudburst Management?
- How the City Manages Stormwater Every Day
- Pilot Projects
- Long Term Planning

## Part 2: Process

- What is a Cloudburst Hub?
- Factors the City Considers
- Planning Process
- Case Study

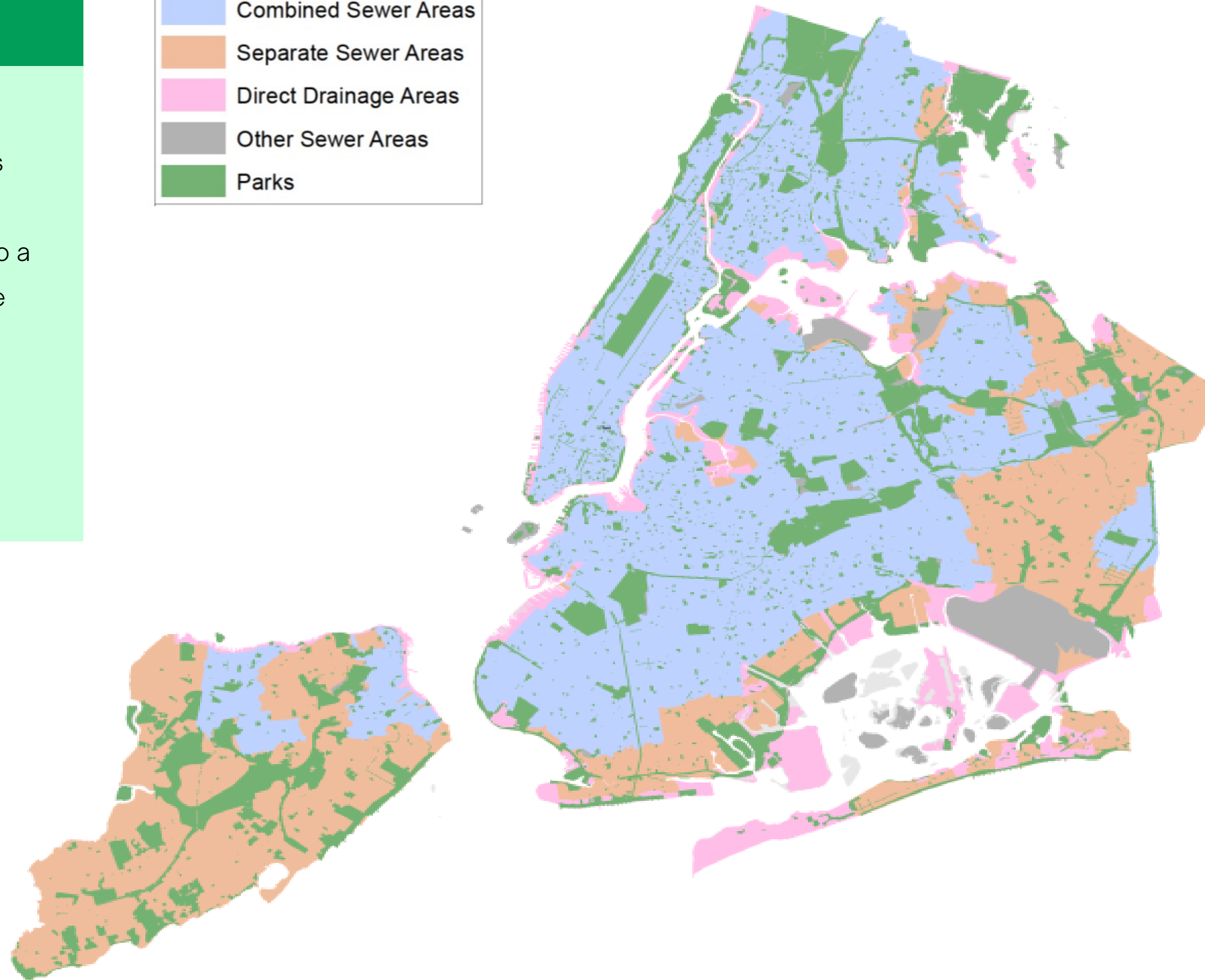
## Part 3: Next Steps

- Progress Update

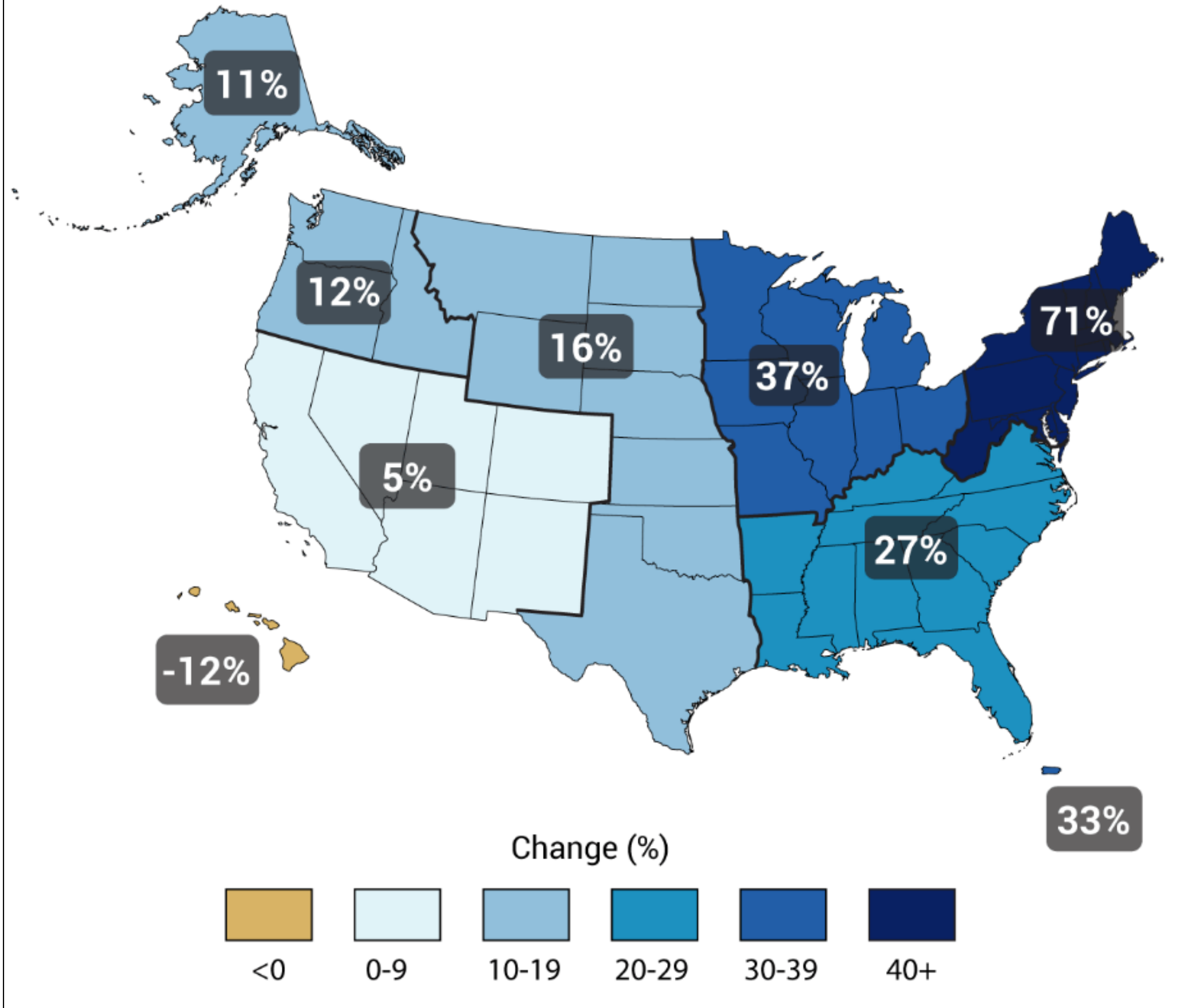
# Agenda

# Sewer System

Much of our city's stormwater eventually flows into storm drains and from there into the sewer system. The City has two sewer systems. The Combined Sewer System has pipes that carry the flow of wastewater and stormwater to a local wastewater treatment plant. The Municipal Separate Storm Sewer System (MS4) has pipes for connecting wastewater directly to the wastewater treatment plant for further processing, and pipes for connecting stormwater directly to local waterways.



## Observed Change in Very Heavy Precipitation



## Heavy Precipitation Trends (1958-2012)

The National Climate Assessment calculates a 71% increase in the annual amount of precipitation from heavy rain events\* from 1958 to 2012 in the Northeast.

\*The National Climate Assessment defines “heavy precipitation” as the top 1% of daily precipitation values

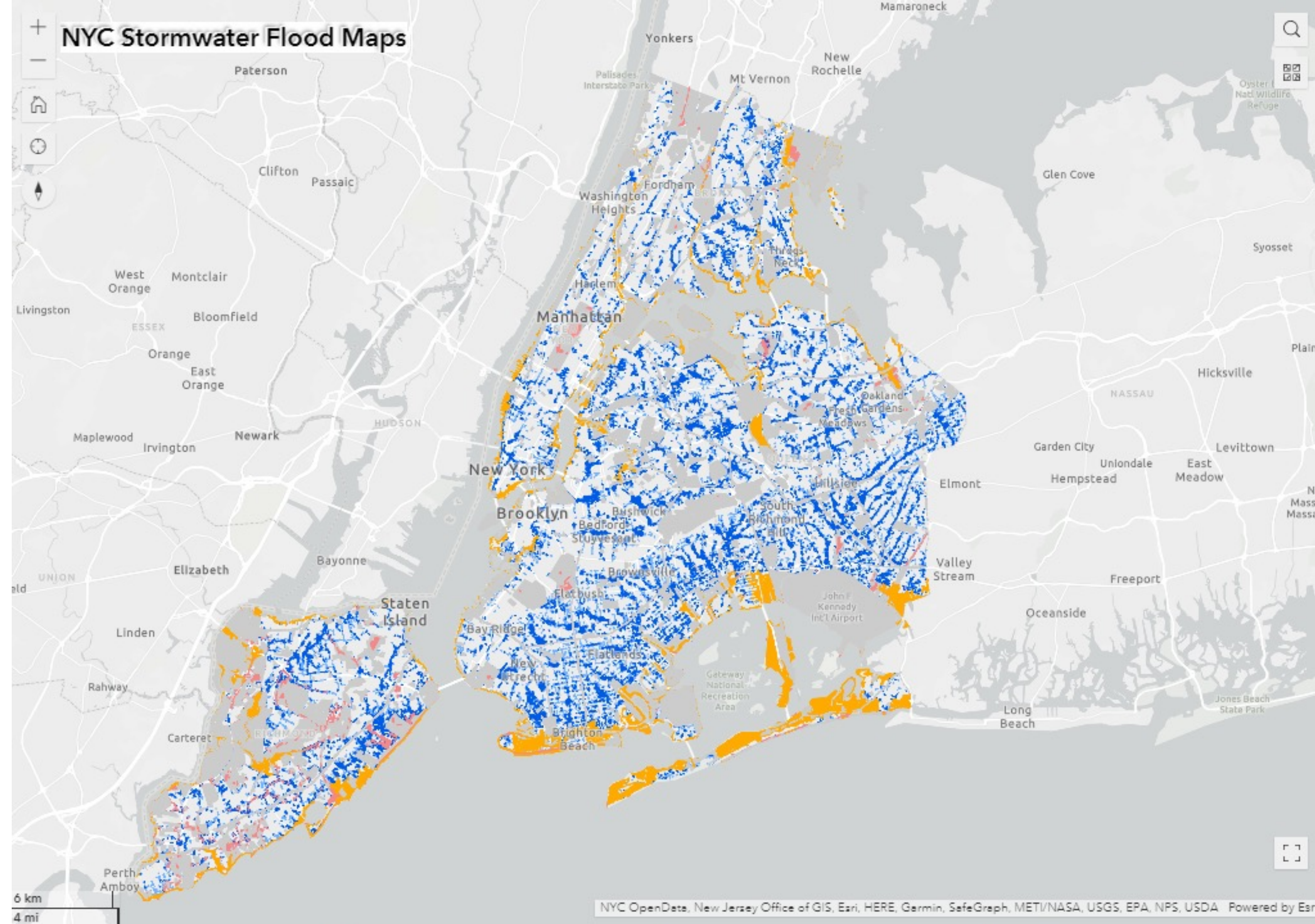
# NYC Stormwater Flood Maps

Three scenarios:

Moderate Stormwater Flood with Current Sea Levels

Moderate Stormwater Flood with 2050s Sea Levels

Extreme Stormwater Flood with 2080s Sea Levels



Moderate Stormwater Flood with Current Sea Levels

Moderate Stormwater Flood with 2050 Sea Level Rise

Extreme Stormwater Flood with 2080 Sea Level Rise

Area not included in analysis  
Future High Tides 2080  
National Wetlands Inventory  
Deep and Contiguous Flooding (1ft and greater)  
Nuisance Flooding (greater or equal to 4 in and less than 1ft)



# How the City Manages Stormwater Every Day

Cloudburst Management is one of many ways the City is working to make neighborhoods more resilient to stormwater flooding and improve water quality. There is a broad citywide effort to better manage stormwater to improve the health of our local waterways and prevent flooding.

The City manages stormwater on public land, like parks and roads, through the sewer system, green infrastructure, and Bluebelts. The City also develops stormwater management requirements for private property owners throughout the city.

# Sewer Upgrades

The City is building out sewers in underserved areas, accelerating catch basin cleanings to improve functionality, and will upgrade 70 miles of sewers per year (1% of the system).

When planning for future drainage infrastructure, DEP will consider projected sea level rise and rainfall intensity as well as environmental justice.





## Sewer Maintenance

Our crews are enhancing catch basin inspections to make sure they are working properly. Our vacuum trucks remove garbage, debris, and grease build-ups.

DEP will continue data driven approaches to system maintenance and monitoring to optimize current performance.





2030 Goal: 1.67 BGY CSO Reduction

2021 Accomplishments:

- 507 MGY CSO reduction
- 11,050 Assets
- 1,504 Greened Acres

## Green Infrastructure Program

Green infrastructure collects stormwater from streets, sidewalks, and other hard surfaces before it can enter the sewer system or cause local flooding. By reducing the amount of stormwater that flows into the Sewer System, green infrastructure helps prevent Sewer Overflows and improves the health of local waterways.

# Resilient NYC Partners



## Environmental

- Demonstrate commitment to sustainability and community
- Improve water quality and health of local waterways
- Enhance stormwater management on site
- Increase biodiversity with green projects



## Social

- Create customer interest and increase public safety
- Partner with the City in stormwater and resiliency initiatives
- Reduce ponding on paved surfaces used by customers and staff



## Economic

- Lower flood risk and liability
- Receive funding for parking lot resurfacing, tree plantings, or other site improvements
- Guard against future costs such as more restrictive stormwater regulations

Investments that work for you and the community!

- \$53M contract to target highly impervious lots >50,000 SF
- Awarded to 3<sup>rd</sup> party administrator to incentivize cost-effective aggregation of projects
- Pay-for-performance framework
  - \$250,000 per greened acre + bonus payments

**Goal: 200 Greened Acres in 5 years.**



## RESILIENT NYC PARTNERS

NYC provides the funding and the expertise, you provide the property.

Resilient NYC Partners is an NYC-funded program that helps you improve your property and NYC meet its resiliency goals. Property owners can use these funds for projects like:

- Building green roofs and rain gardens
- Fixing drainage issues and reducing ponding
- Resurfacing or replacing pavement
- Building subsurface stormwater storage

These projects can help to improve your community and promote your commitment to a resilient and sustainable NYC.

Partnering with us is easy!

We know construction can be a big undertaking. Our expert team has worked with property owners on similar projects. We know how to streamline the process and make it work for you, your residents, tenants, employees, and other property users.

- 1 Assessment**  
We will schedule a site visit with you to better understand your property to tailor a project that fits your needs.
- 2 Planning & Review**  
We will develop detailed plans for your review. Together, we will refine and finalize your project.
- 3 Scheduling & Approvals**  
Once a project is agreed upon, we will work with you to make a construction plan and obtain permits.
- 4 Construction**  
Build it! Construction typically lasts 4-6 weeks. We will work with you to make sure everyone is safe and minimally disrupted.

**Don't miss out on this opportunity—funds are limited!**

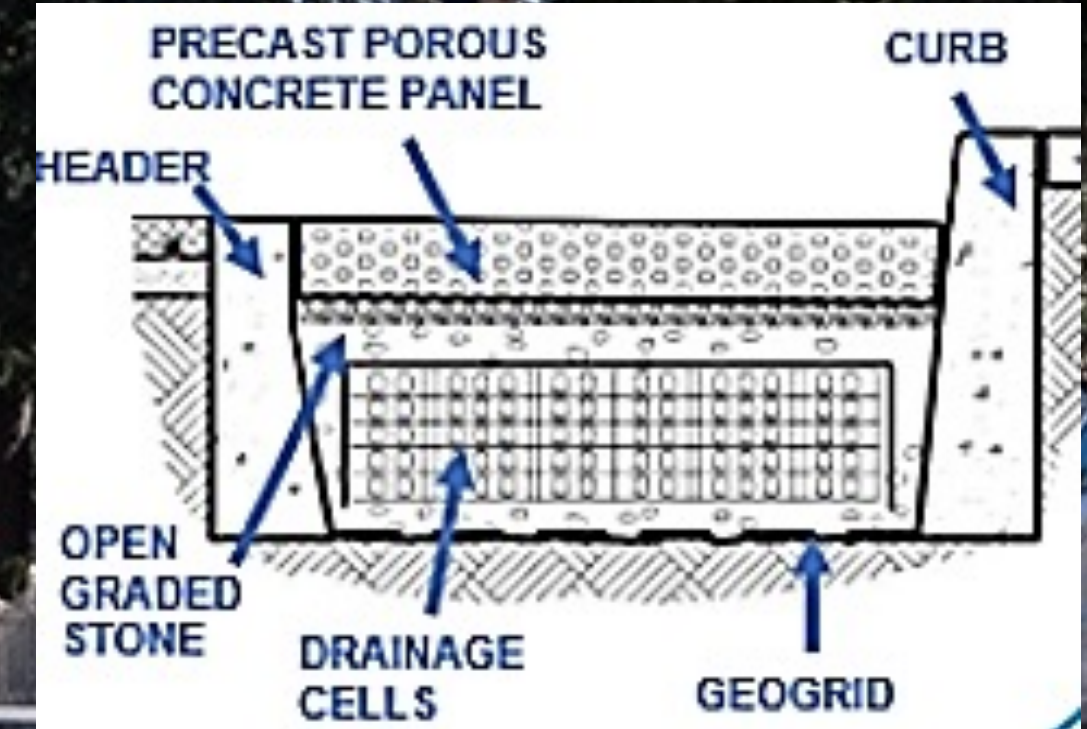
Contact our team at [info@resilientpartners.nyc](mailto:info@resilientpartners.nyc) to schedule a meeting or visit [resilientpartners.nyc](http://resilientpartners.nyc) for more information.



## Porous Pavement

Porous pavement is being implemented only in residential areas throughout the city, per GI siting criteria.

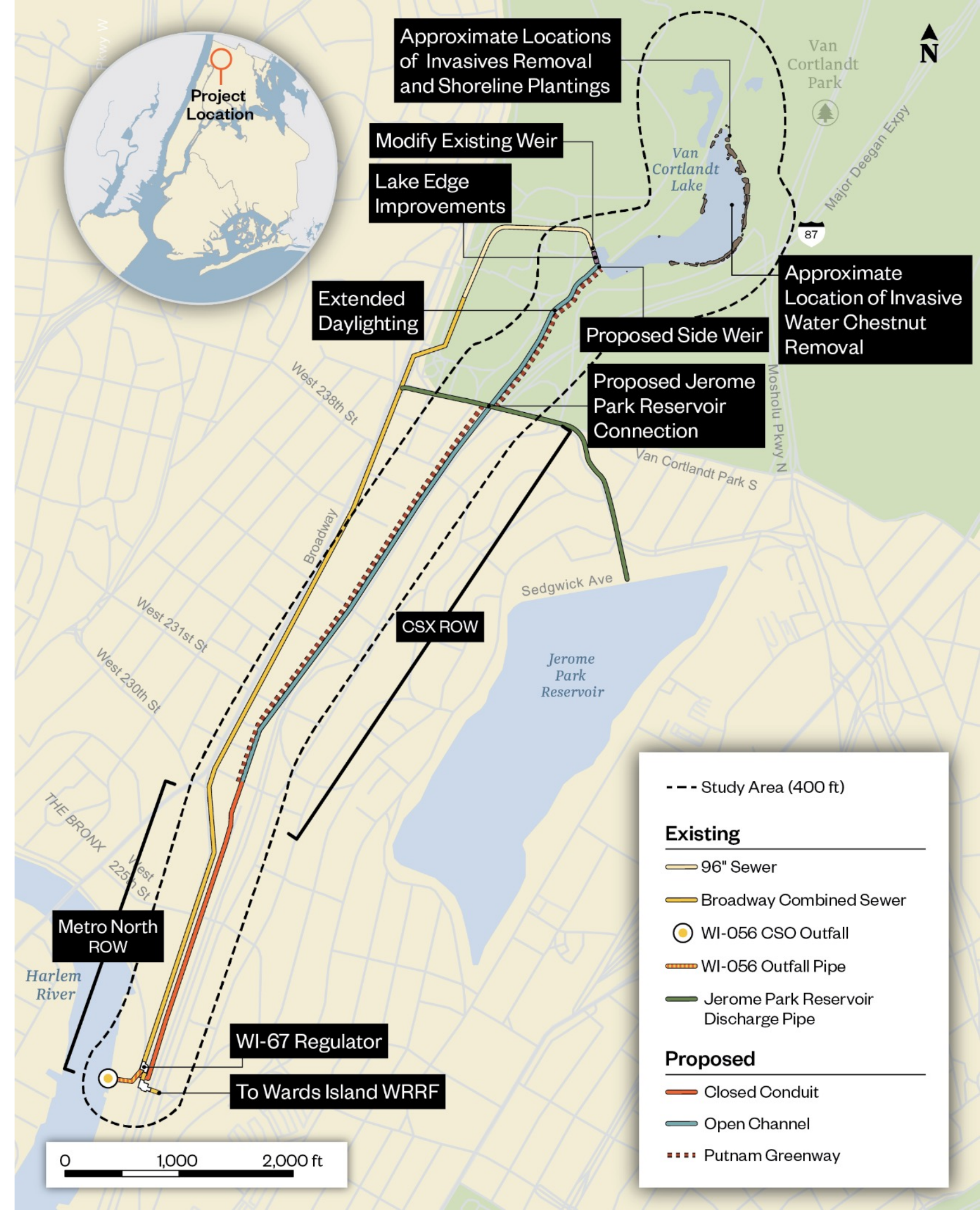
17,000 linear feet has been constructed in pilot areas in the Queens and Bronx, and an additional 300,000 linear feet is entering design in Brooklyn and the Bronx.



# Daylighting

Stream daylighting is the process of restoring a stream to a more natural state by removing any obstructions covering it, such as concrete or pavement.

Design is underway for Tibbets Brook in the Bronx that will have an anticipated 214-220 MGY reduction of CSO to the Harlem River.



A lush green landscape featuring a bluebelt system. In the foreground, there are tall, vibrant green grasses. A paved path winds through the middle ground, crossing a small stream. The background is filled with dense, green trees under a bright sky. A concrete structure is visible on the left side of the stream.

## Bluebelt Program

Bluebelts are ecologically rich and cost-effective drainage systems that naturally handle stormwater on our streets and sidewalks. As New York City prepares for rising sea levels and heavier rains due to climate change, Bluebelts offer a natural and effective solution for stormwater management. 84 Bluebelts have been constructed, and a new city-wide plan is underway.

Part 1

# Understanding Cloudburst Management

NYC Cloudburst Management | 9/20/2022





# What is a cloudburst?

A cloudburst is a sudden, heavy downpour where a lot of rain falls in a short amount of time. Cloudbursts can cause flooding, damage property, disrupt critical infrastructure, and pollute New York's rivers and Harbor.

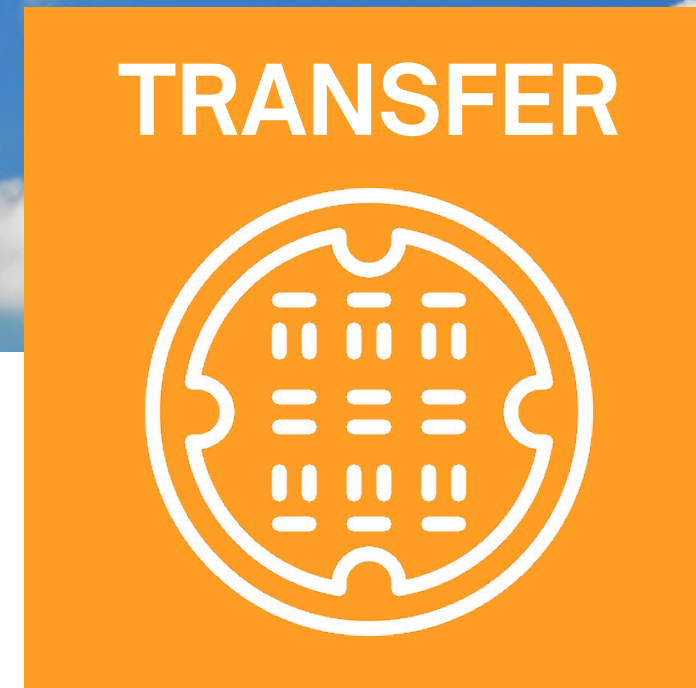
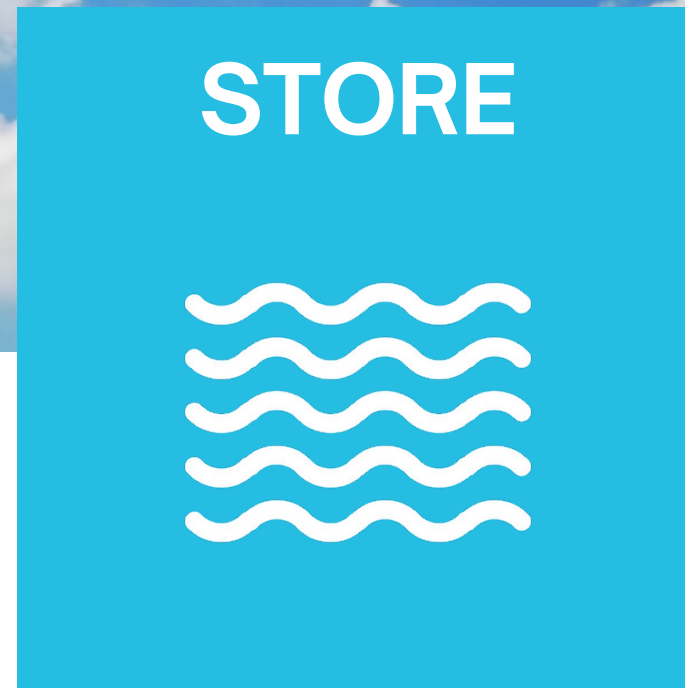
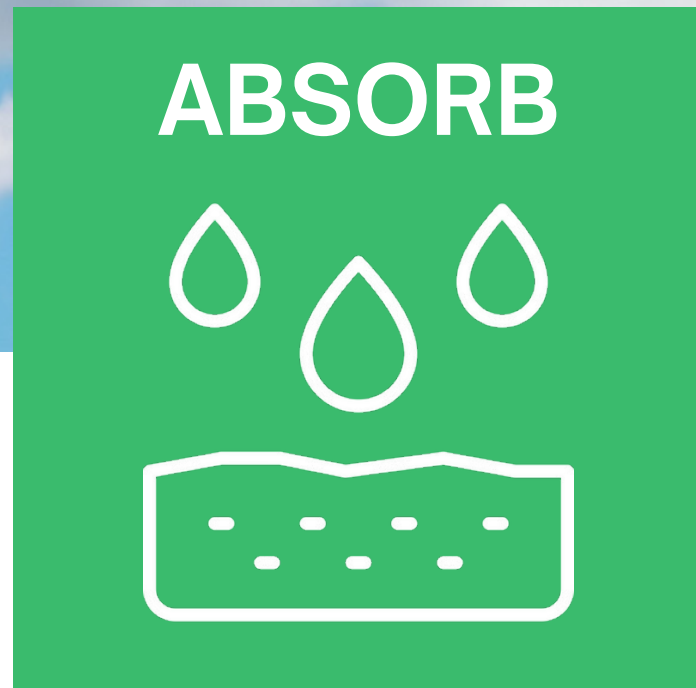


# What is Cloudburst Management?

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, typically building for up to 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

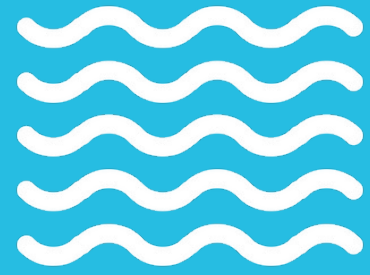
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**ABSORB**



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

STORE

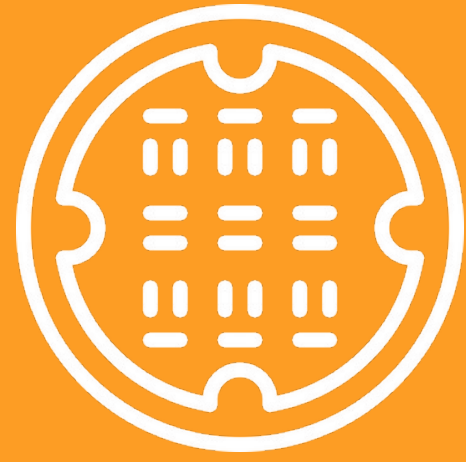


# Projects that hold rainwater

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

TRANSFER



Projects that move water from one place to another

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

# Benefits of Cloudburst Management

Cloudburst Management benefits local communities economically, socially, and environmentally.



## ECONOMIC

Reduces costly negative impacts of extreme stormwater events, such as physical damages to infrastructure.



## SOCIAL

May provide public amenities and open space that can be used when it's not raining. They can also minimize flooding from heavy rain events



## ENVIRONMENTAL

Improves water quality and vegetated elements reduce the amount of carbon dioxide in the atmosphere.

# Cloudburst Management Pilot Projects

To complement storm sewer and green infrastructure work, DEP initiated a cloudburst study to assess risks, prioritize response, develop location-specific solutions, and assign costs and benefits for managing cloudbursts.

As a result of the study, DEP is testing the implementation of Cloudburst Management at the NYC Housing Authority's (NYCHA) South Jamaica Houses, and has also begun to implement several other cloudburst pilot projects throughout the city.

# 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.



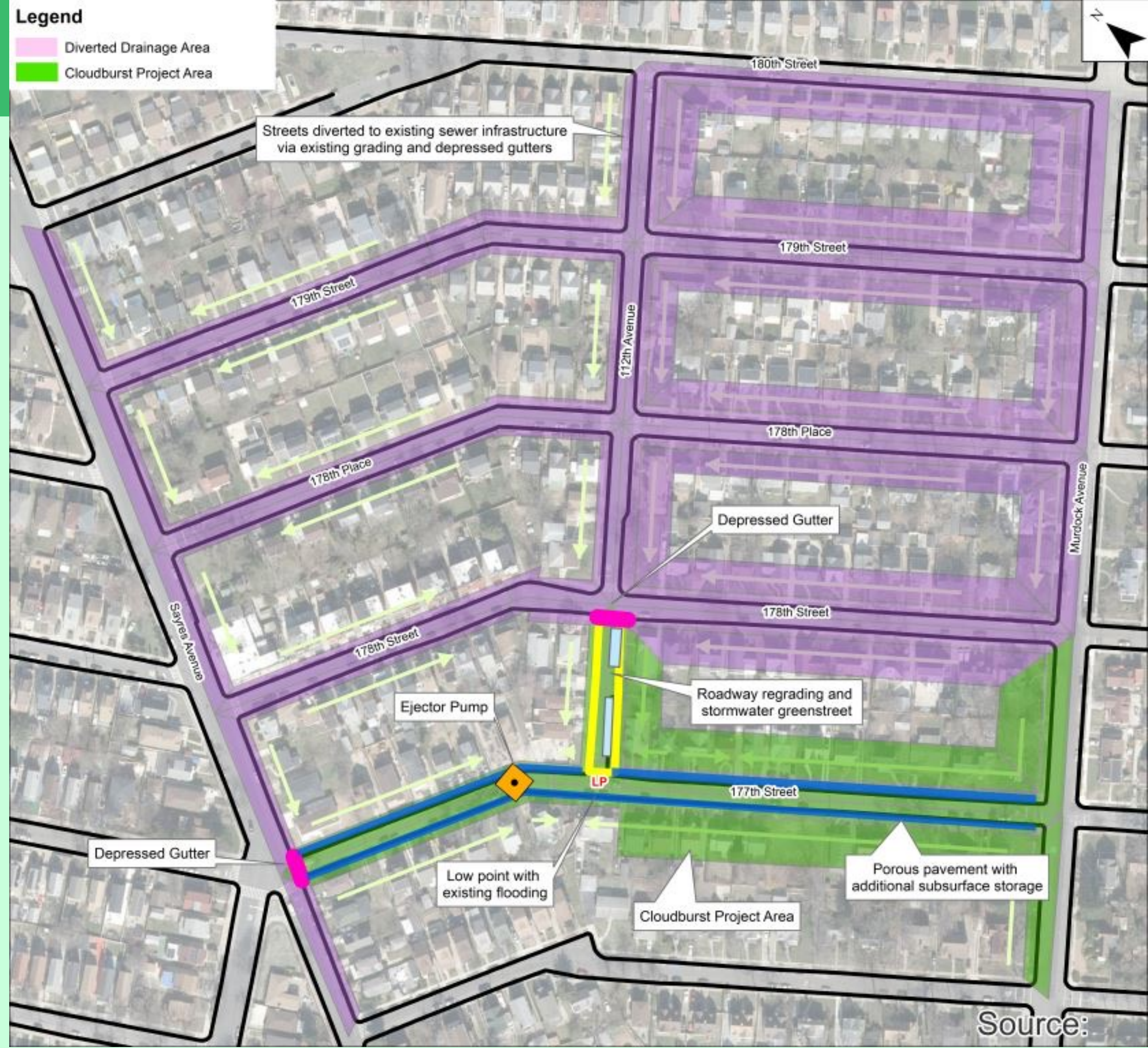
# St. Albans, Queens

The neighborhood of St. Albans, Queens is prone to frequent flooding, particularly at the low-point near the intersection of 177th Street and 112th Avenue. During heavy rain events, the pumping station cannot manage street runoff outside of the Direct Tributary Drainage Area, so runoff would bypass existing catch basins (street drains), leading to additional runoff at the intersection.

The cloudburst demonstration project proposed involved a combination of green infrastructure and roadway changes, including depressed gutters.

In addition to helping prevent flooding, this project would also help roadway safety, making conditions safer for pedestrians and vehicles.

As of September 2022, design is underway with construction anticipated to start in 2024.





# Clinton Houses

The NYCHA Clinton Houses in East Harlem was built on fill and at low elevations, putting it and nearby streets at high flood risk during heavy rain events. DEP collaborated with NYCHA on a project to reduce damages from flooding. The goal of the project was to move excess rainfall into a series of underground storm water storage systems located in existing spaces, such as basketball courts, parking lots and others, while improving these spaces with nature-based planting and amenities, such as depressed enclosed seating that can store water during extreme rainfall events.

As of September 2022, the city was awarded \$8.3M from FEMA to construct this Cloudburst project.



Part 2

# Cloudburst Planning Process

NYC Cloudburst Management |  
9/20/2022



# CLOUDBURST RESILIENCY PLANNING STUDY

## EXECUTIVE SUMMARY



# Cloudburst Study

In 2017 DEP published the Cloudburst Resiliency Planning Study based on Copenhagen's Cloudburst Management. The conceptual plan focused on Southeast Queens and featured potential solutions to manage stormwater for both everyday and extreme rain events, leveraging stormwater features to enhance outdoor spaces and neighborhood connectivity .



An aerial photograph of a flooded street in New York City. The water is deep and reflects the sky. A dark-colored car is parked on the street in the foreground. The street has yellow markings and a white dashed line. Trees and buildings are visible in the background. The text 'THE NEW NORMAL: COMBATING STORM-RELATED EXTREME WEATHER IN NEW YORK CITY' is overlaid in white, bold, sans-serif font. The 'NYC' logo is in the bottom right corner of the image.

# THE NEW NORMAL: COMBATING STORM-RELATED EXTREME WEATHER IN NEW YORK CITY

## Ida's Impact

After the devastation caused by Hurricane Ida, the City issued a report called, [The New Normal Report: Combating Storm-Related Extreme Weather In New York City.](#)

The report prioritized stormwater resilience initiatives, including bringing Cloudburst Management projects into areas vulnerable to flooding from heavy rain.



**Increasing Stormwater Resilience  
in the Face of Climate Change:  
Our Long Term Vision**

# Long Term Vision

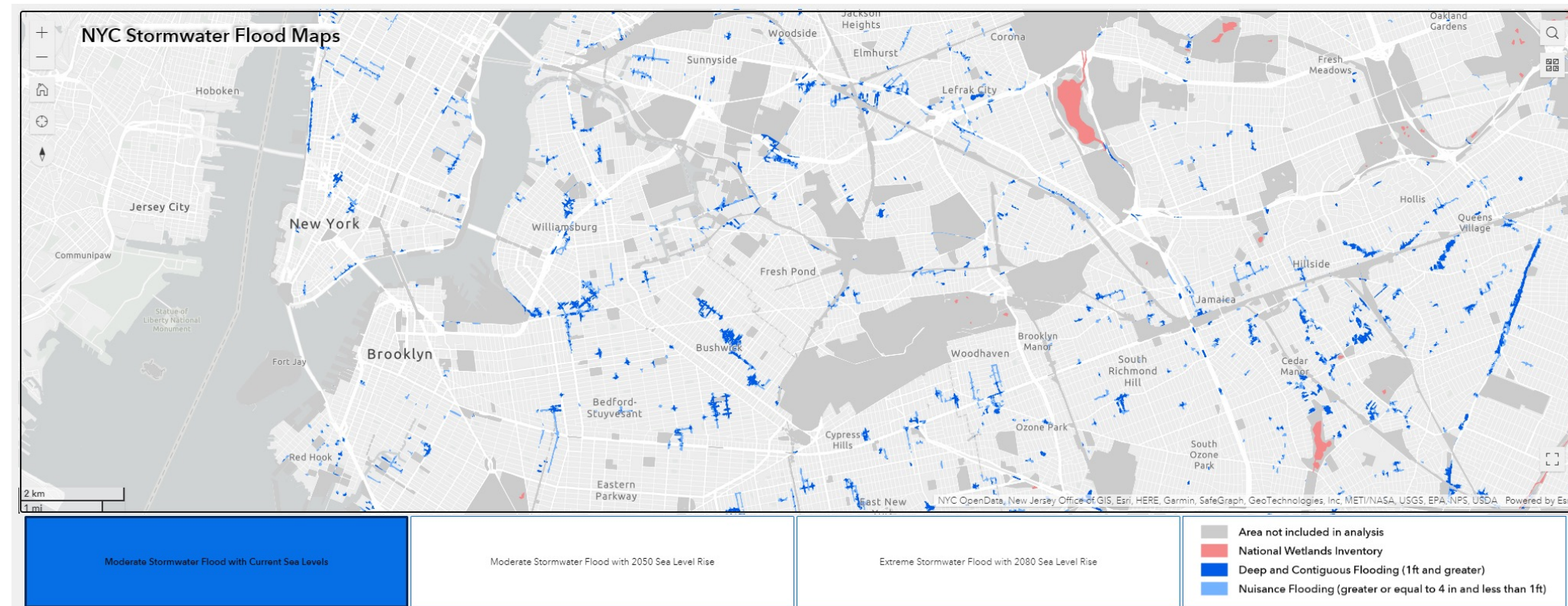
On September 1, 2022, one year after Ida, DEP released a long term stormwater vision for NYC.

The report includes a vision for expanding cloudburst design principles wherever feasible and introduces the concept of Cloudburst Hubs.



# What is a cloudburst hub?

Individual or clustered cloudburst management projects that are concentrated around a local flooding hotspot



# Cloudburst Considerations

The City looks at many factors when investing in Cloudburst infrastructure, such as:

<p><b>Physical Features</b></p> <p>Including the mix of both natural and constructed physical features</p>	<p><b>Storm Drains and Sewer Pipes</b></p> <p>Including the number and size of storm drains and sewer pipes</p>	<p><b>Available Space</b></p> <p>The City will assess the space available for new projects within the area</p>
<p><b>Below Ground Conditions</b></p> <p>Including soil quality and existing utility infrastructure</p>	<p><b>Green-Grey Infrastructure</b></p> <p>The City will assess the possibility of connecting green and grey infrastructure</p>	<p><b>Social and Economic Factors</b></p> <p>The City will consider the local conditions of people and businesses</p>

# Planning Process



## Desktop Analysis

Complete desktop review to assess physical and socioeconomic vulnerability and identify planning areas.

## Feasibility Studies

Quantify opportunities to reduce and transfer stormwater from flooded areas, conduct field assessments, and analyze below ground conditions.

## Conceptual Designs for 10 Cloudburst Hubs

Initiate site-specific analysis and conceptual designs in 10 initial Cloudburst Hubs, identifying costs and benefits of potential solutions. Federal funding support needed

## Design and Construction of 4 Cloudburst Hubs

Begin implementation of 4 initial Cloudburst Hubs, with potential to add more as funding is secured.





# Desktop Analysis Review

The Desktop Analysis involved assessing the physical, social, and operational factors that contribute to planning areas being vulnerable to flooding from heavy rain. The assessment included local conditions and opportunities, as well as current and planned City projects.

This analysis helped identify priority planning areas to be considered for Cloudburst Hubs.

# Cloudburst Framework

## 1. Physical Vulnerability

- Flooding hotspots, historically and in recent rainfall events
- Predicted modeled conditions using stormwater flood maps

## 2. Operational Feasibility

- Understanding local conditions and opportunities by including locations prone to flooding, major investments in priority areas, current or planned projects in priority areas, existing partnerships, or other areas of interest

## 3. Social Vulnerability

- Considering social factors that may increase vulnerability to stormwater flooding

# Physical Vulnerabilities

## Objective

Identify flooding hot spots, balancing historic complaint data, modeled current and future precipitation scenarios and complaint/impact data from 2021 events.

## Results

**The majority of flooding hotspots are in Queens, Staten Island, and Brooklyn, but impacts are seen across all 5 boroughs.**

**Identification of physically vulnerable areas across the five boroughs.**

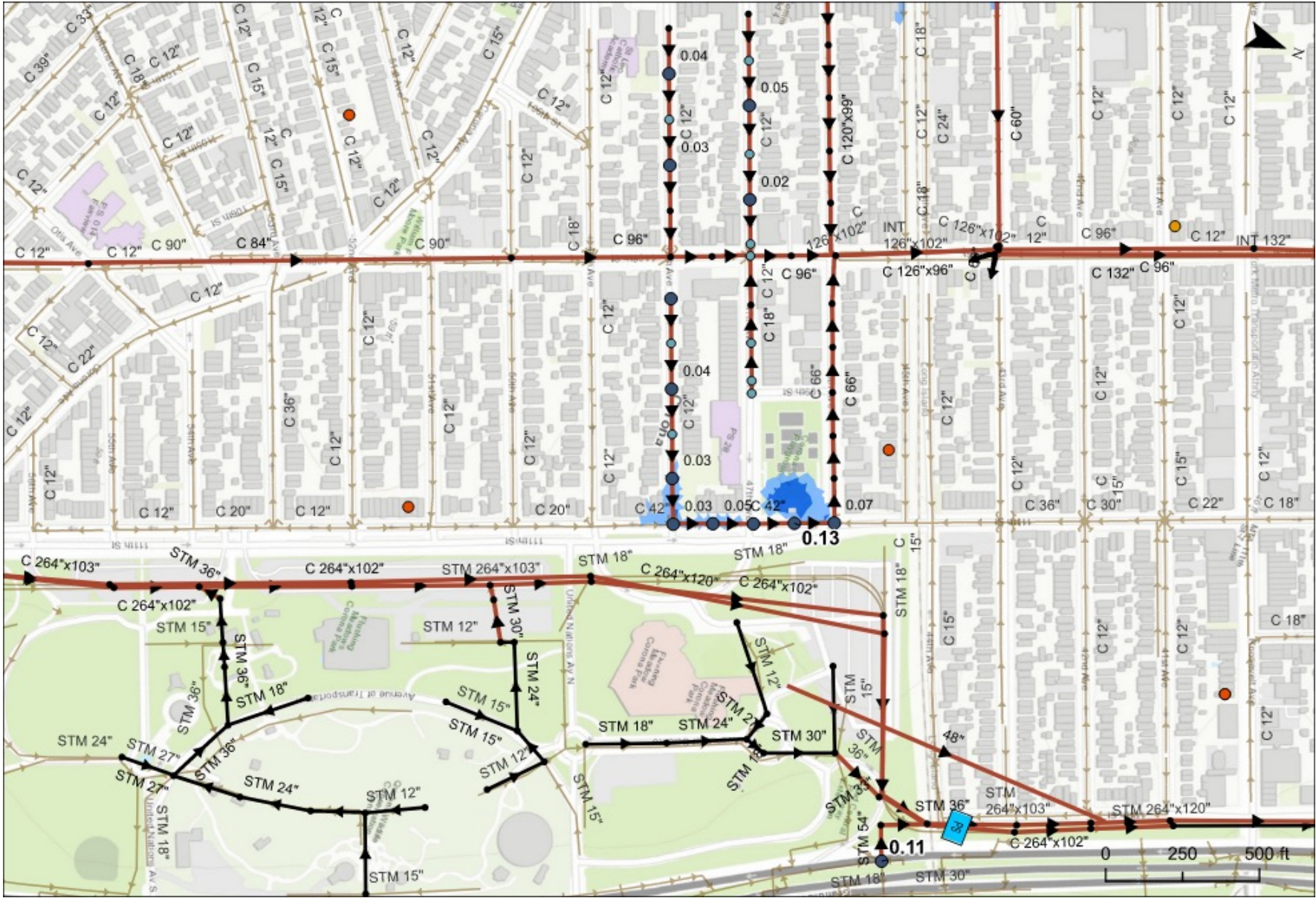
# Operational Feasibility

## Objective

Understanding immediate opportunities and agency feasibility for implementation

## Results

Submissions for agency synergistic opportunities across the 5 boroughs, particularly from NYCHA, Parks, and DOT



# Social Vulnerabilities

## Objective

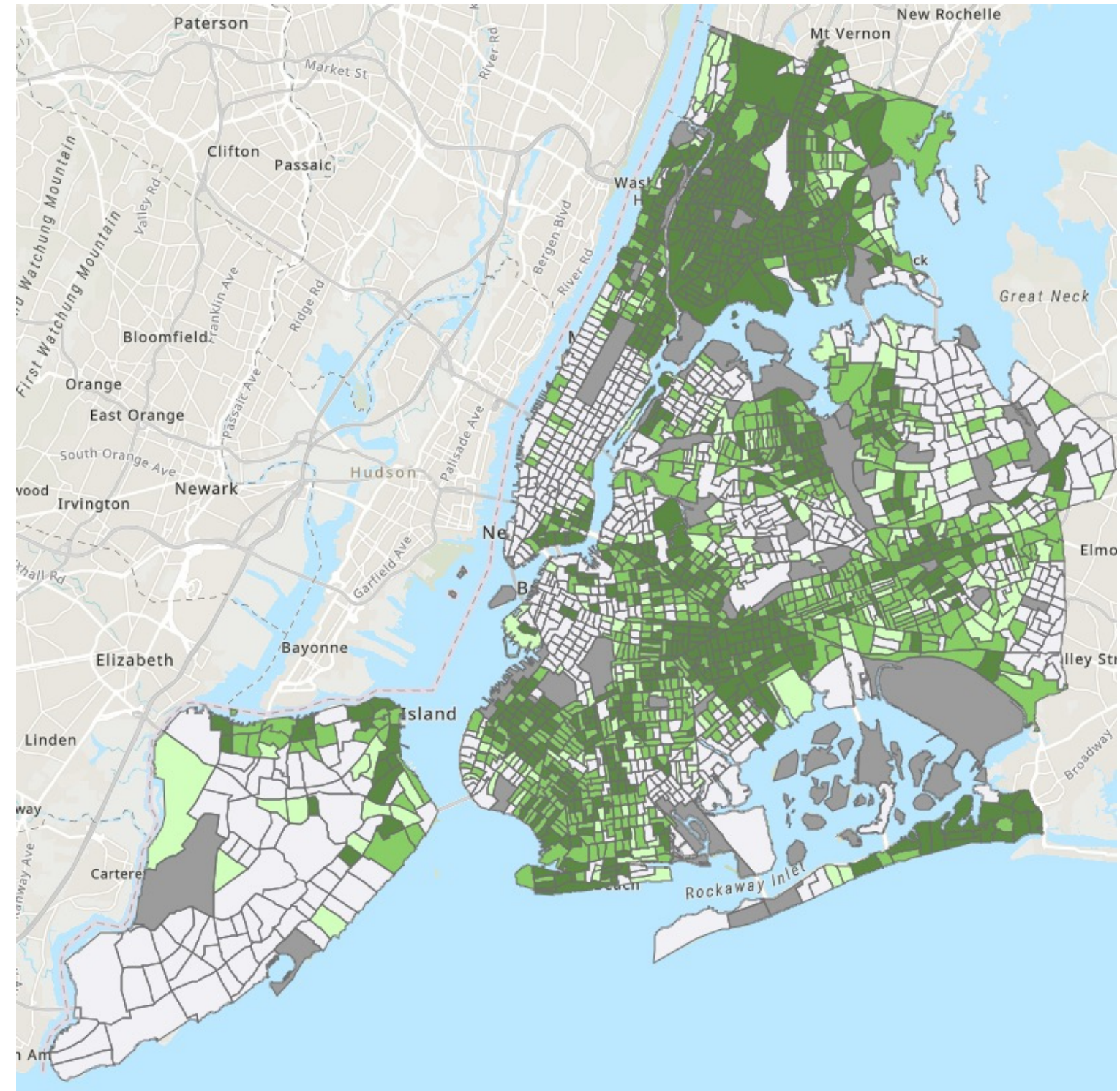
Consider social factors that may increase vulnerability to stormwater flooding that will impact ability to prepare for floods.

## Results

Using the CDC's Social Vulnerability Index to identify vulnerable areas and prioritize for federal and state funding opportunities.

Learn more:

<https://www.atsdr.cdc.gov/placeandhealth/svi/index.html>



CDC Social Vulnerability Index



# Feasibility Studies

The Feasibility Studies are currently underway and will include field assessments and the analysis of below ground conditions in the priority planning areas.

This process will contribute to the identification of Cloudburst opportunities for which the City will conduct conceptual designs.

# Cloudburst Adaptation Toolbox

## Aggregated Asset Types

### ✓ **Flow Diversion/ Conveyance**

- Raised crosswalk
- Raised intersection
- Depressed gutters
- Supplemental street drainage

### ✓ **ROW Storage**

- Non-vegetated sidewalk storage
- Vegetated sidewalk storage
- Vegetated median lane
- Enhanced tree pits

### ✓ **Offline Storage**

- Surface storage
- Subsurface storage

### ✓ **Porous Pavement Storage**

- Porous parking lane
- Porous pedestrian ramps
- Porous median
- Porous bike lane/greenway

# Process for Assigning Specific Adaptations

## Determine Cause of Flooding at Hotspots

1. Review existing drainage infrastructure
2. Assess how water flows through the sewers and over land

## Identify Cloudburst Management Opportunities

3. Review future planned infrastructure
4. Identify and assess feasibility of interventions

## Estimate Benefits of Interventions

5. Stormwater volume managed
6. Community benefits



# Potential Metrics for Prioritization/Design

All Cloudburst Hubs will be screened for the potential of highest stormwater volume capture in order to reduce flooding as much as possible, and as well as screened for social vulnerability using the CDC's Social Vulnerability Index. Additional metrics (draft table below) will then be used to identify Hubs with added benefits. The initial Hub locations will be announced by the end of 2022.

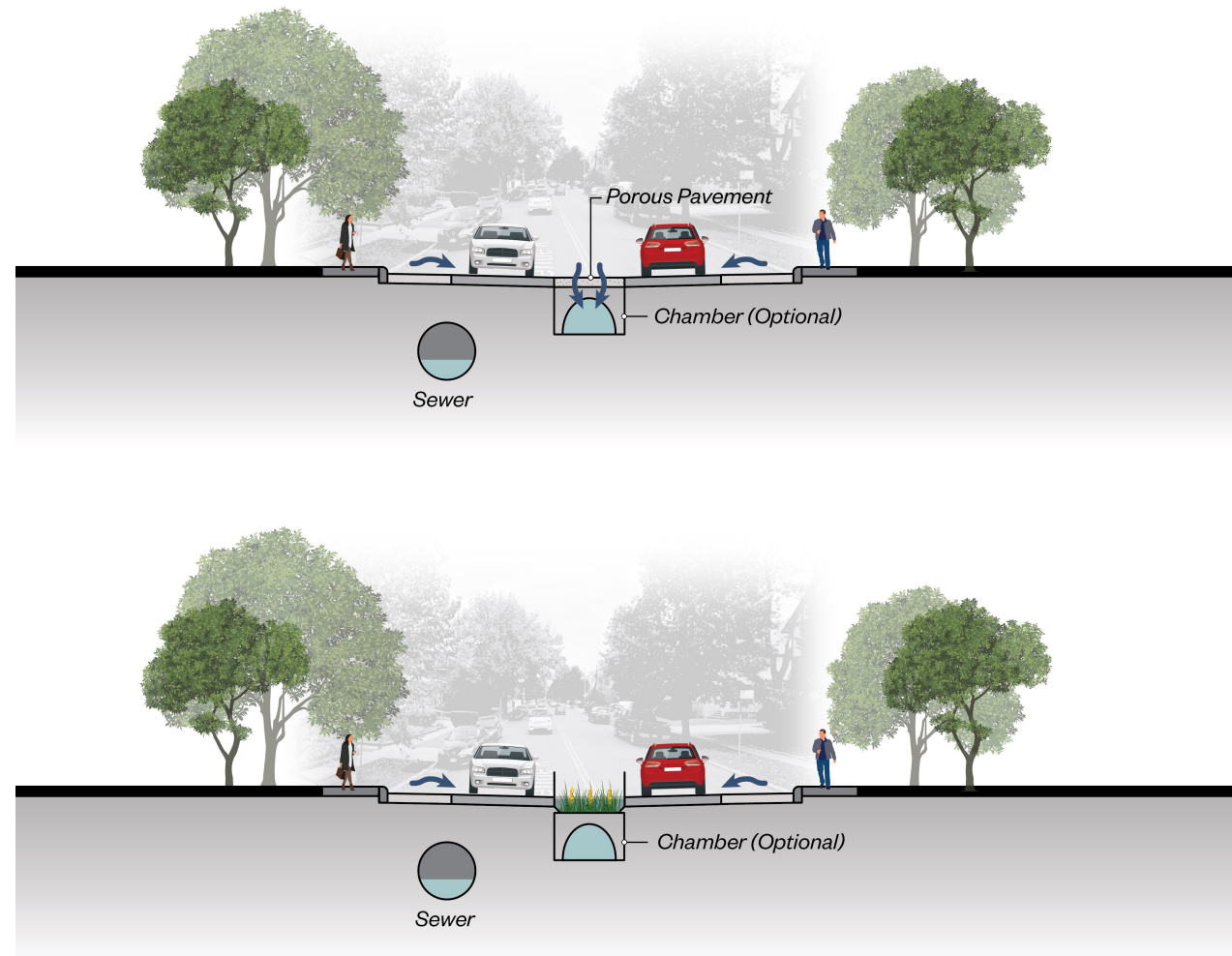
Category	Metric	Description
Physical	Critical facilities (number)	Number of critical facilities that potentially experience reduced flood risk due to cloudburst projects.
Social	Population density	Population density served nearby to cloudburst hub.
Environmental	Additional potential GI projects (sf)	Additional potential green infrastructure (GI) square footage (sf) that could be included in cloudburst hub design
Cost	$(\text{Cost})/(\text{Stormwater volume managed})$	The cost per gallon of stormwater managed, as a ratio
Operational	Alignment with near-term capital projects	This analysis of existing resiliency projects or programs near flooding hot spots allows the city to maximize funding and accelerate implementation.
	Alignment with other resiliency programs	This analysis of existing agency projects near flooding hot spots allows the city to maximize funding and accelerate implementation.

Let us know what you think! Please respond to our survey on which metrics are most important to you by **10/26/22** here:

<https://outreached.wufoo.com/forms/cloudburst-metrics-survey/>

# Median Storage

Provides temporary storage of stormwater during cloudburst events

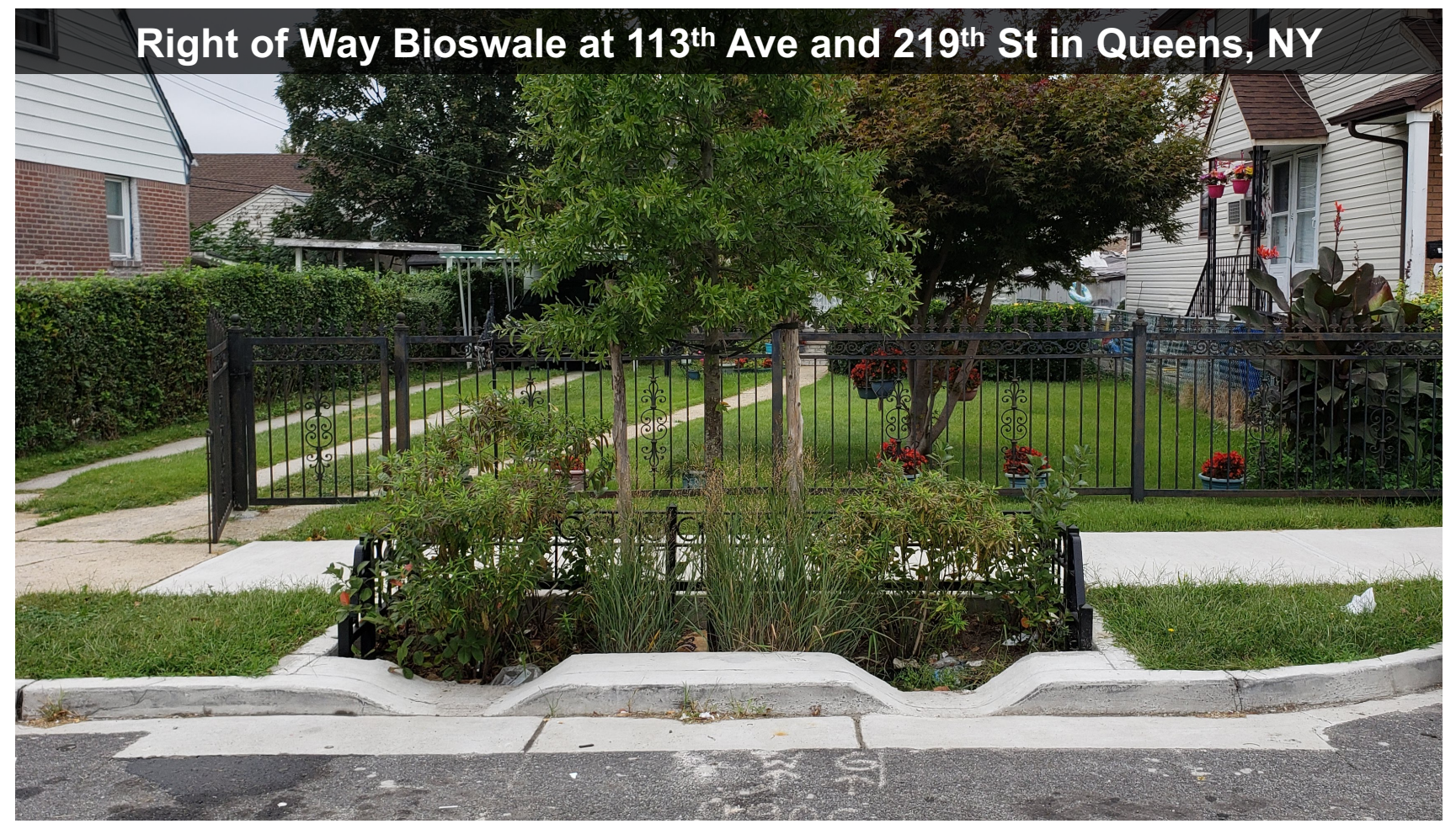
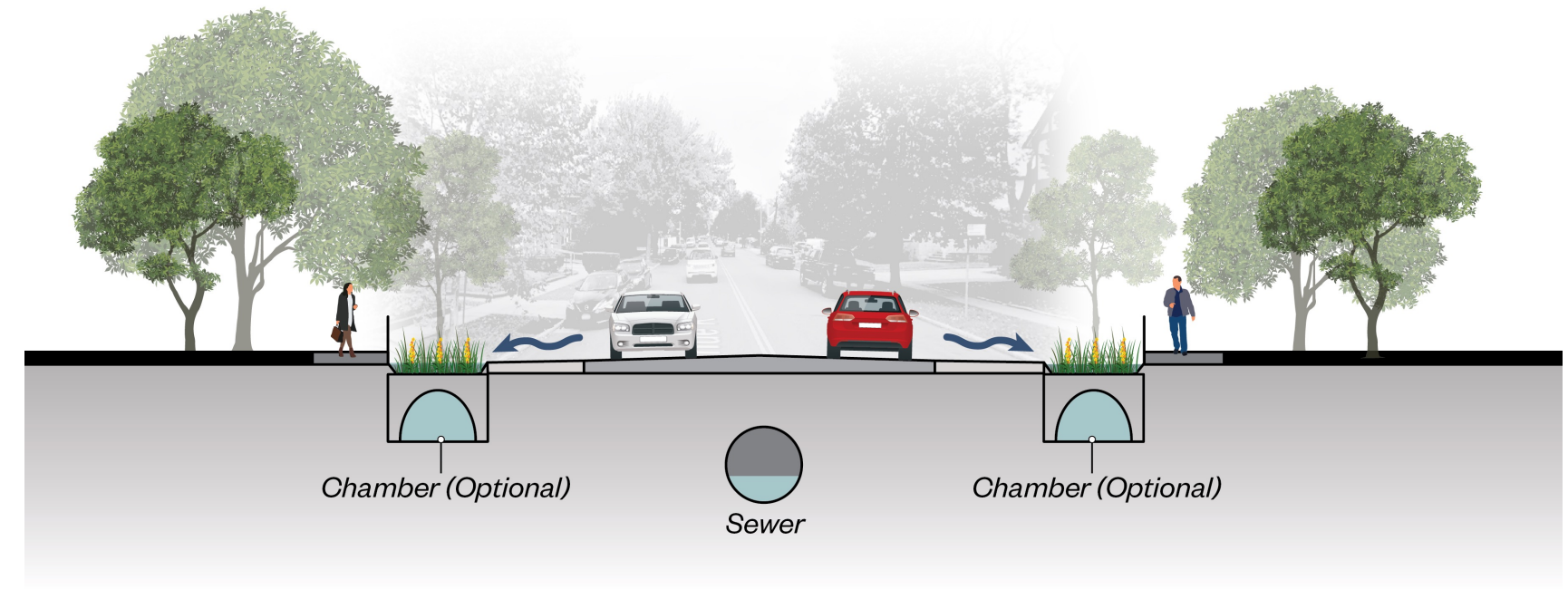


Beach 67<sup>th</sup> Street, Median GI – Post-Construction Renderings



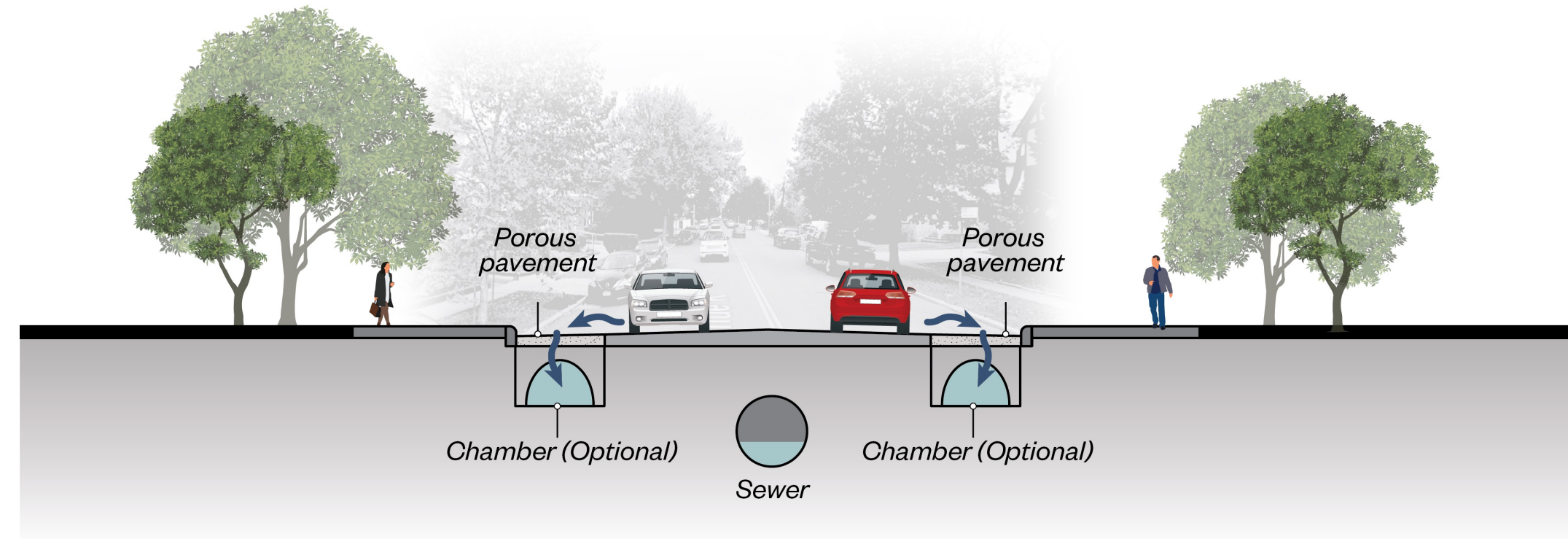
# Infiltration and Rain Gardens

Provides temporary storage of stormwater during cloudburst events



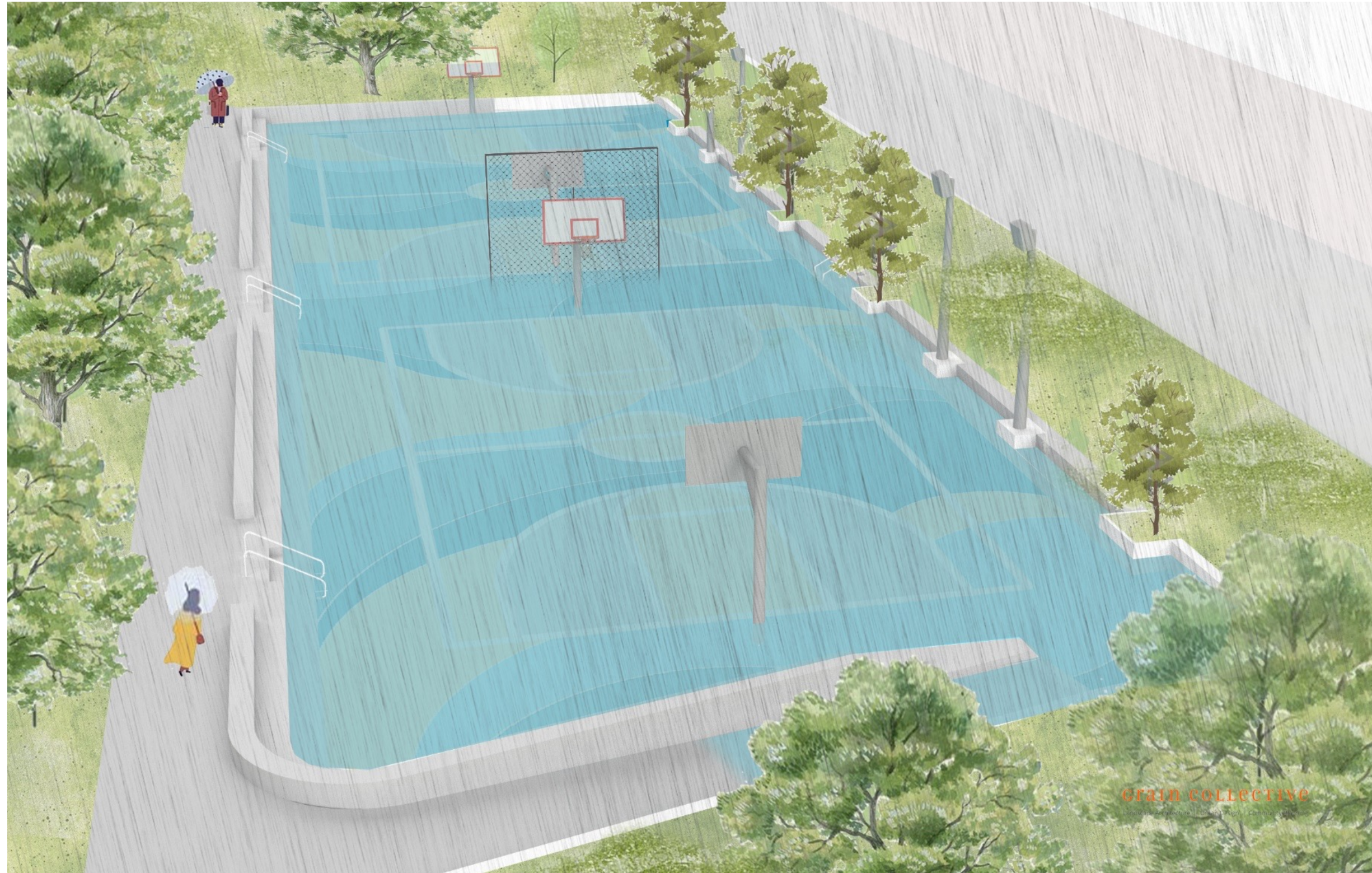
# Porous Pavement / Asphalt

Provides temporary storage of stormwater during cloudburst events



# Surface/ Subsurface Storage

Provides temporary storage of stormwater during cloudburst events



Rendering of Sunken Basketball Court at South Jamaica Houses

# Innovative Opportunities

High volume capture, non-traditional opportunities from lessons learned around the world

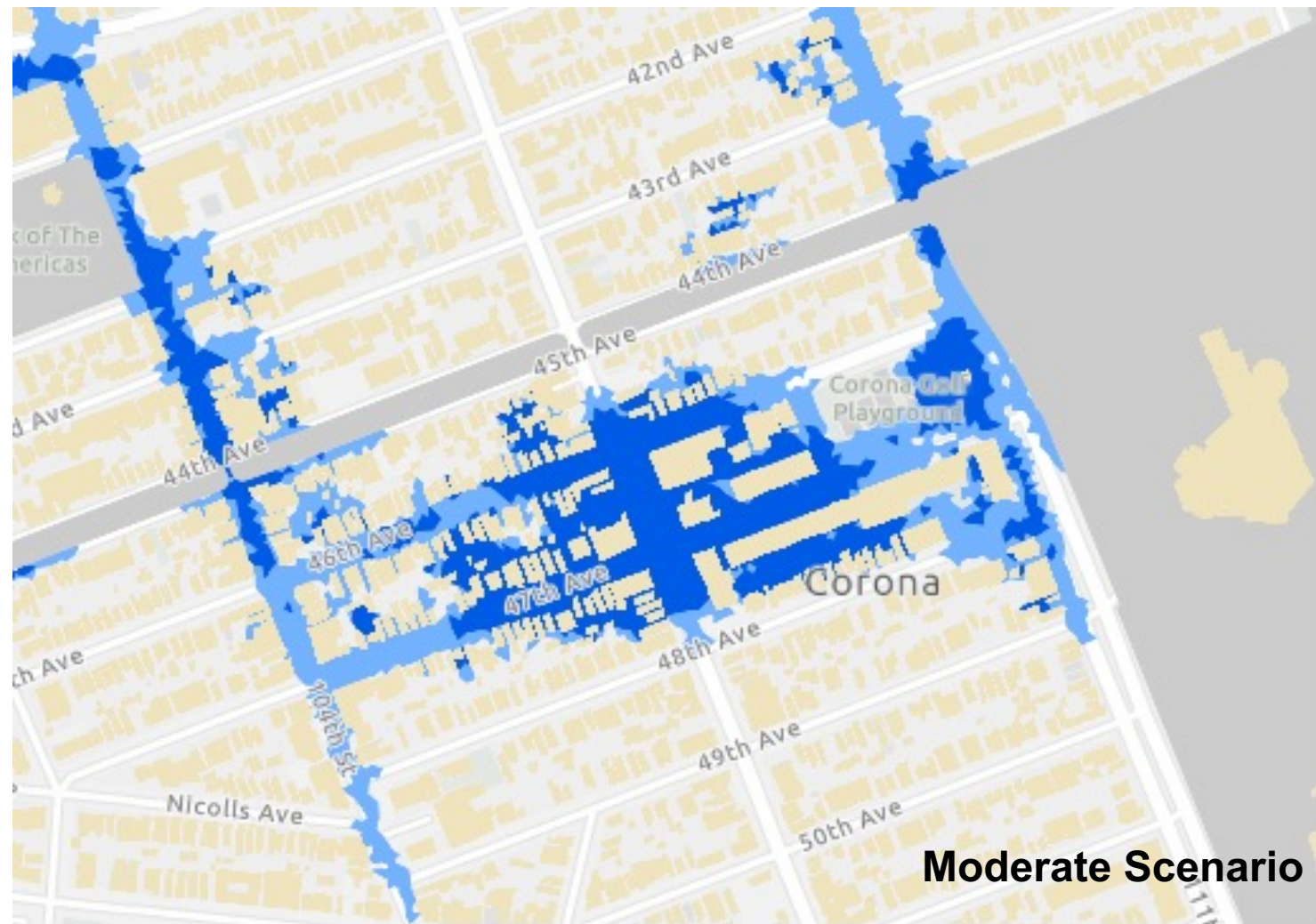
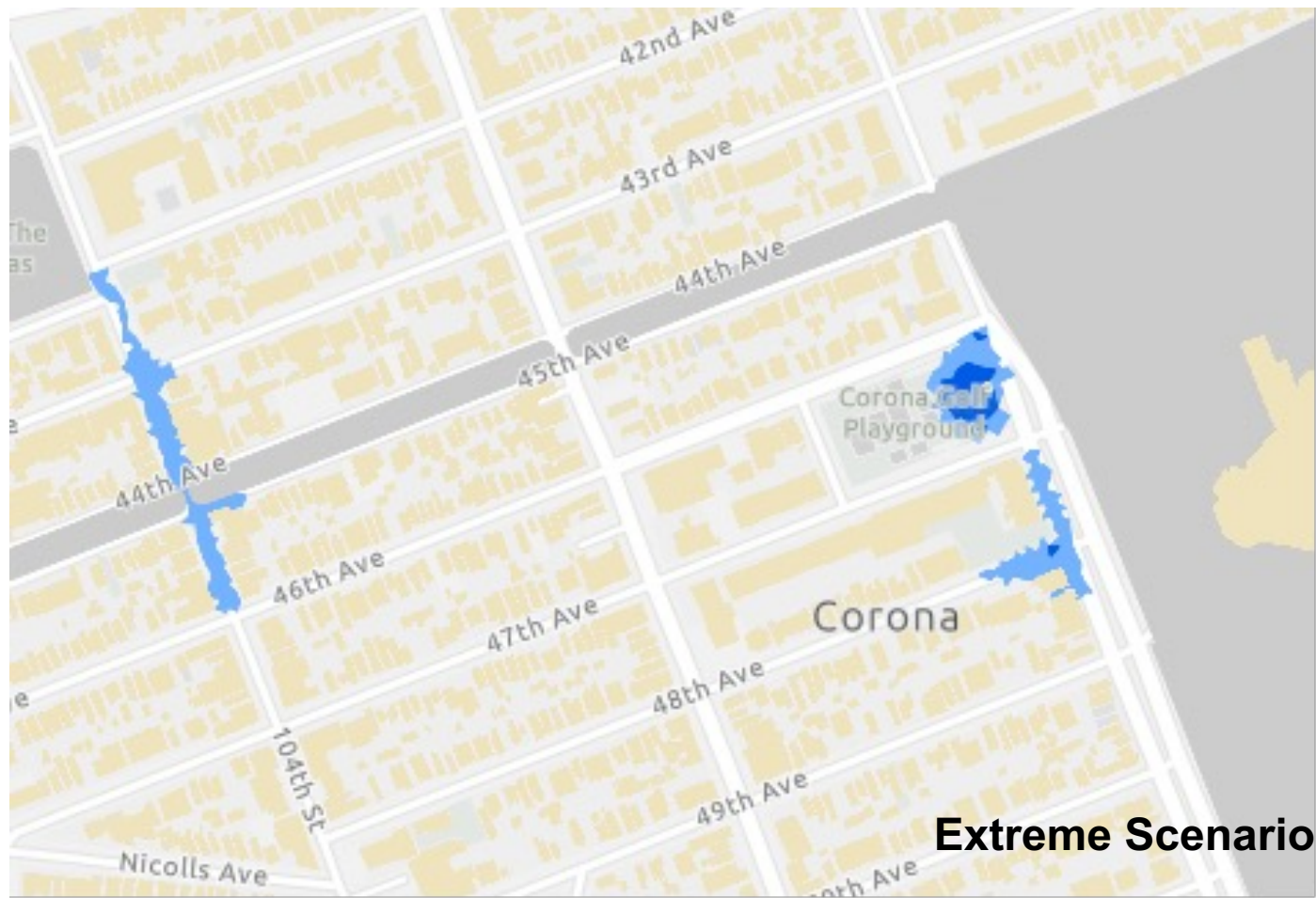
Pictured: Miami cloudburst open street



# Case Study: Corona Cloudburst Hub

NYC Cloudburst Management | 9/20/2022

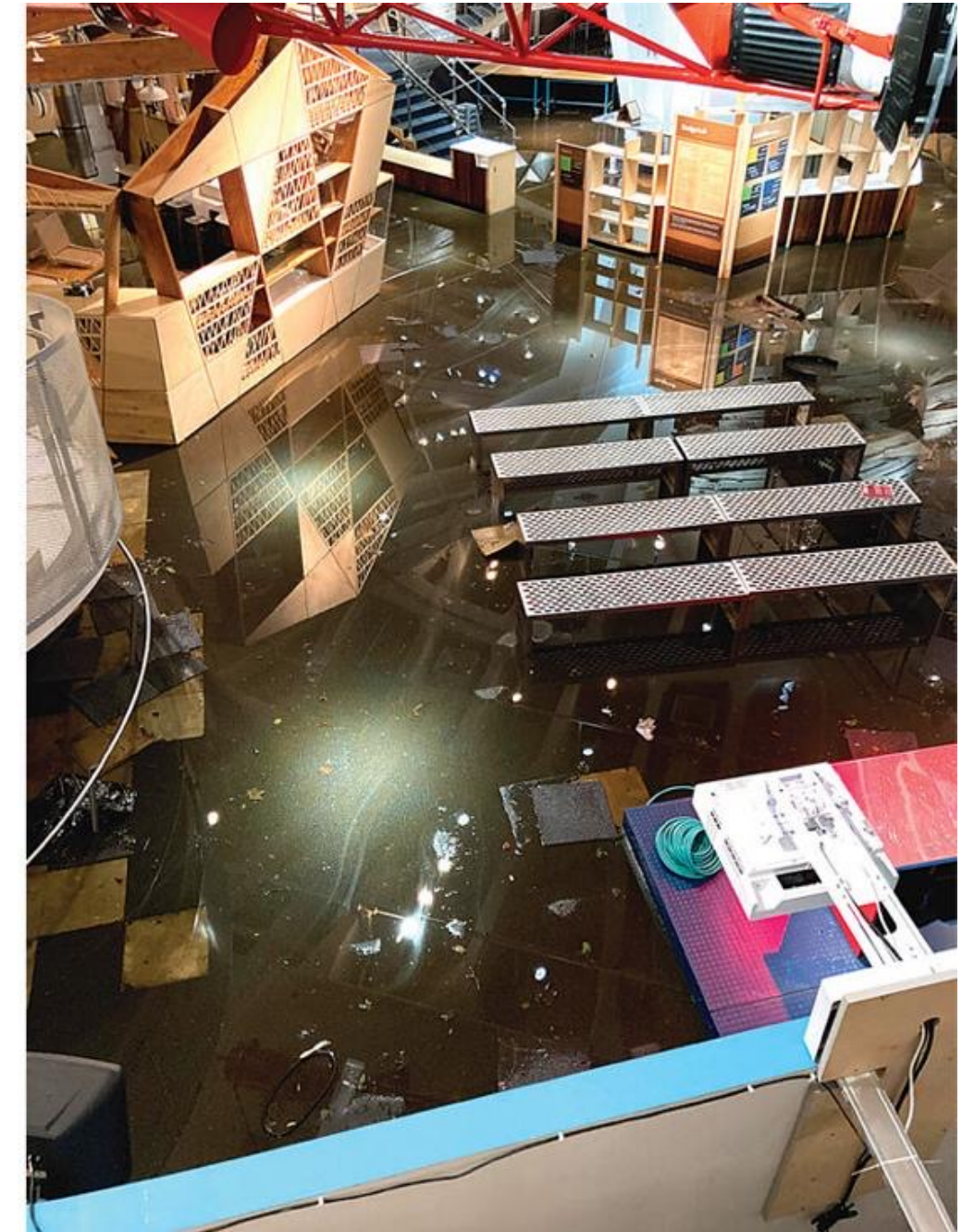




**BB-15**  
 Planning Area  
**Corona**  
 Demonstration Hub



# Hurricane Ida destroyed about 50% of the museum's exhibits



# Coordination with Ongoing Infrastructure Improvements

Subject to site investigations – for discussion only

45<sup>th</sup> Ave

46<sup>th</sup> Ave

47<sup>th</sup> Ave

48<sup>th</sup> Ave

49<sup>th</sup> Ave

50<sup>th</sup> Ave

111<sup>th</sup> St Safety Improvements

NY Hall of Science Parking  
Access Improvements

Q369 Pre-K  
Construction

New York  
Hall of Science



# Potential Cloudburst Management Opportunities

Subject to site investigations – for discussion only



**LEGEND**

	Surface/Subsurface Storage		Supplemental Street Drainage
	Subsurface Storage Only		Raised Crossing
	Porous Concrete Parking Lane		Constructed GI
	Porous Asphalt Bike Lane		

Image © 2022 Maxar Technologies

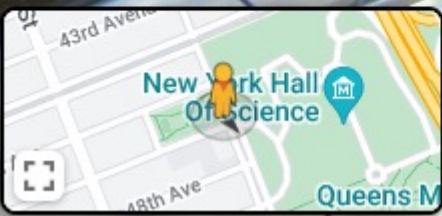
# 111<sup>th</sup> St and 47<sup>th</sup> Ave

Subject to site investigations – for discussion only

40-42 111th St  
New York  
Google  
Street View - Oct 2019



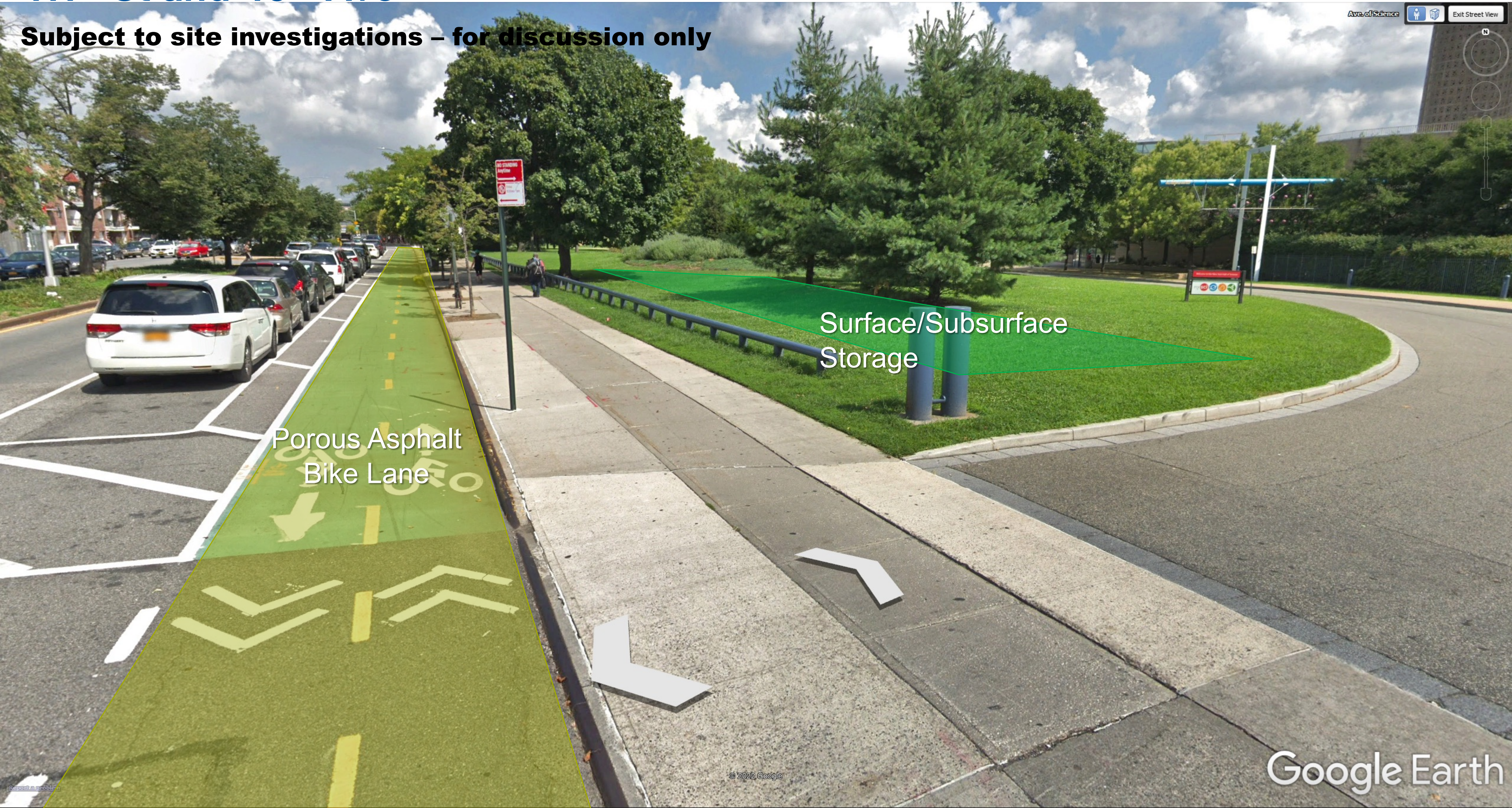
Porous Concrete  
Parking Lane (111<sup>th</sup> St)



Google

# 111<sup>th</sup> St and 49<sup>th</sup> Ave

**Subject to site investigations – for discussion only**



Surface/Subsurface  
Storage

Porous Asphalt  
Bike Lane

# Parking Lot of New York Hall of Science

Subject to site investigations – for discussion only



Subsurface Storage  
(Future Addition)





# Next Steps



# Next Steps

Fall 2022: Results of initial feasibility studies

End of 2022: Announcement of initial cloudburst hubs

Q1-Q2 2023: Stakeholder engagement and site visits

April 2023: Strategic Plan Released

2025: Construction of initial cloudburst hubs





Contact us if there are any questions.

Thank you  
for your time!

Website

[nyc.gov/dep/cloudburst](https://nyc.gov/dep/cloudburst)

Phone Number

Report flooding issues by calling 311.

Email Address

[onewater@dep.nyc.gov](mailto:onewater@dep.nyc.gov)