Innovative Initiatives for Source Water Protection -

NYC Green Infrastructure

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Project Engineer, ROW Green Infrastructure –
Design and Construction

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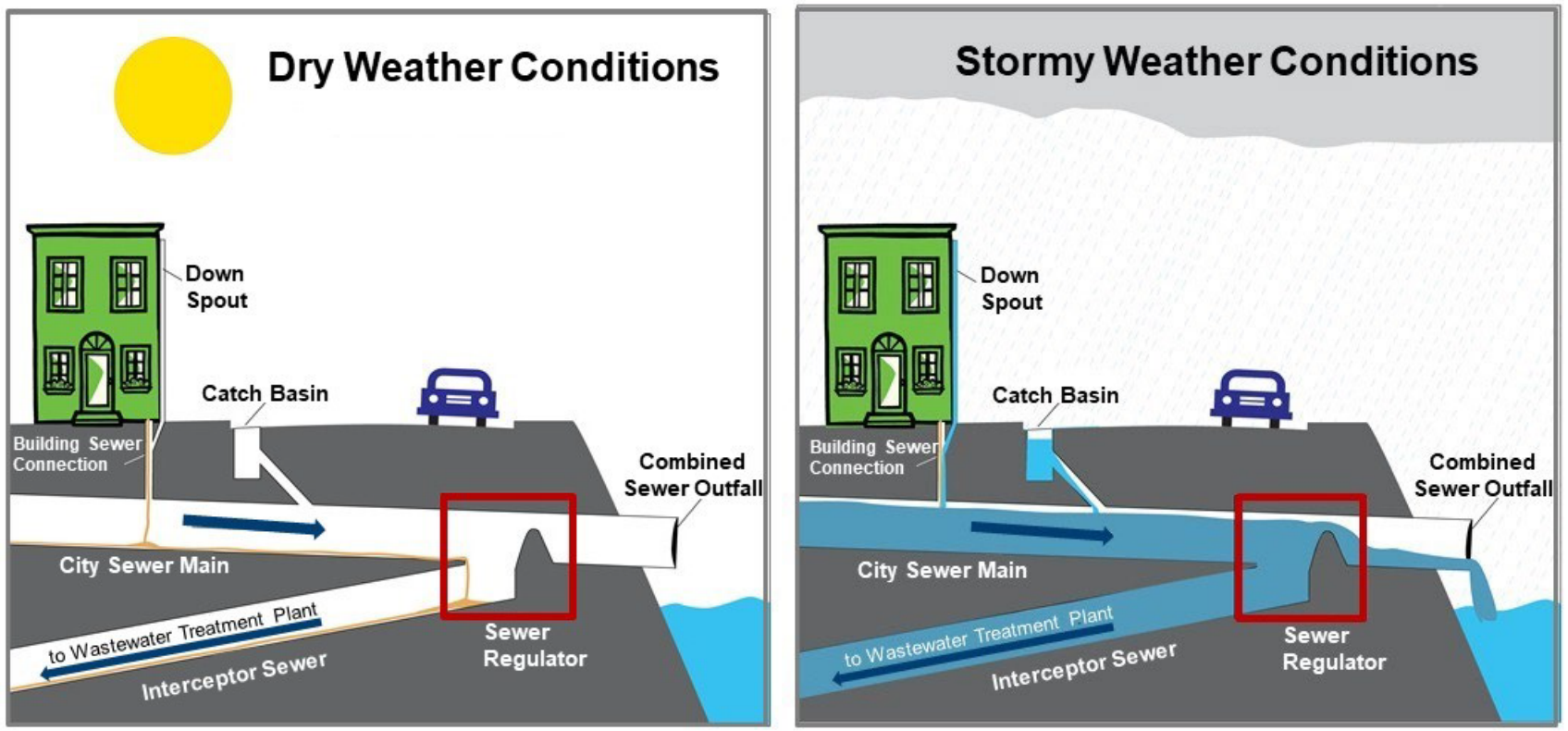
What is Green Infrastructure?

Green infrastructure (GI) practices are designed, constructed and maintained to collect stormwater runoff when it rains to reduce CSOs.

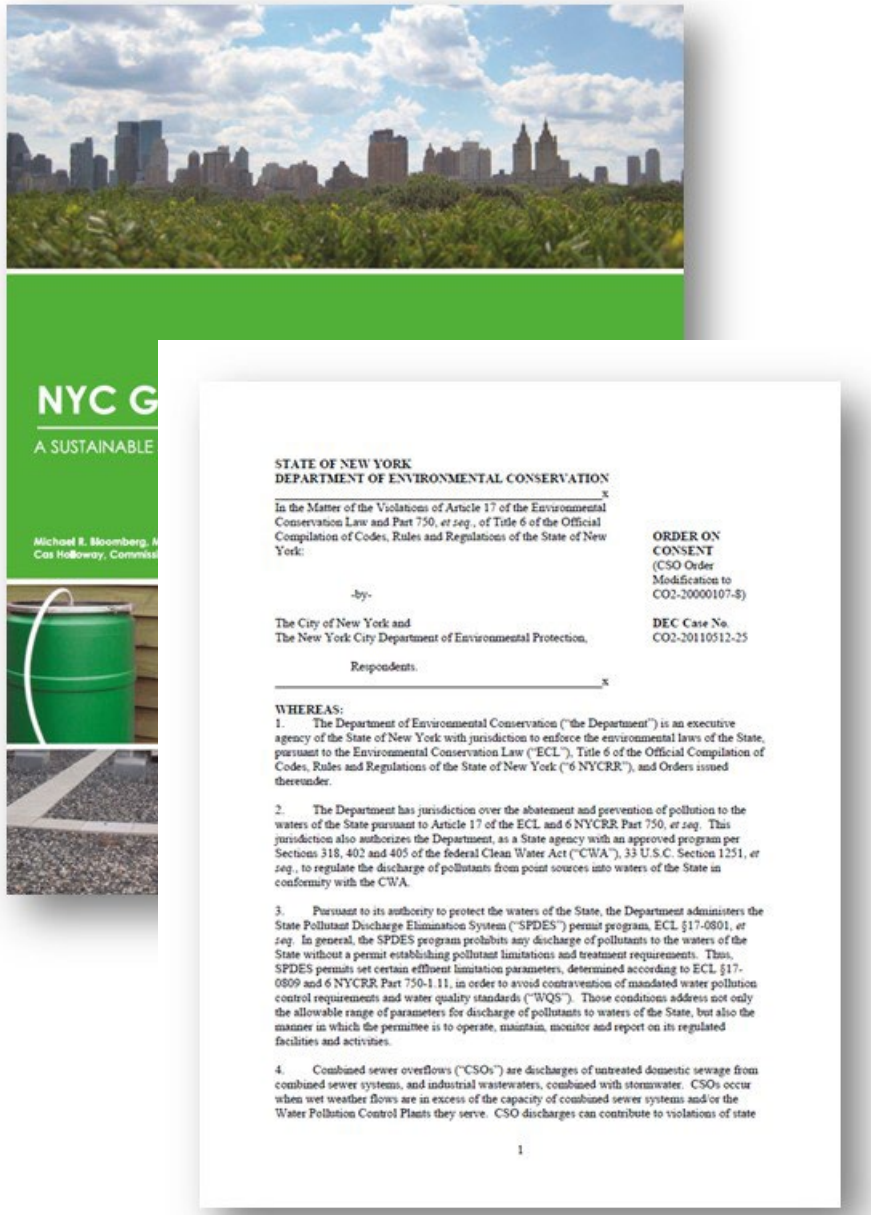
What is a Combined Sewer Overflow?

- Approximately 60% of NYC's sewer system is **combined**, which means it combines **sewage and stormwater flows during wet weather**.



- When the sewer system is at full capacity, a diluted mixture of rain water and sewage is released into local waterways. This is called a combined sewer overflow (CSO).

NYC Green Infrastructure Plan

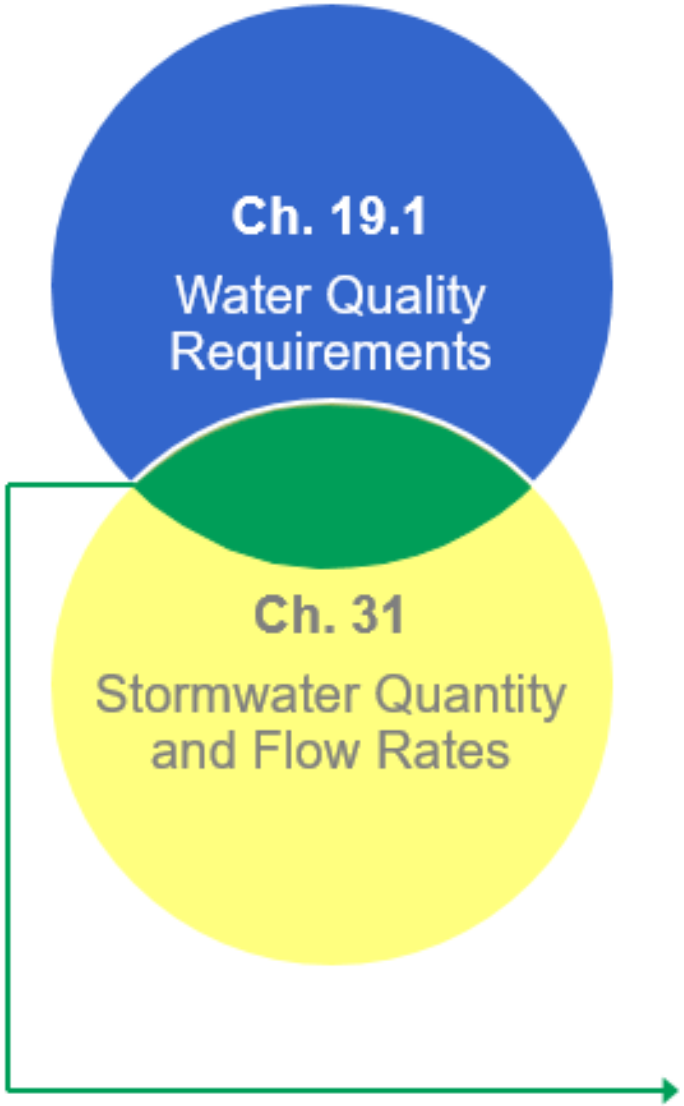


2010 – NYC Green Infrastructure Plan
Laid framework to use green infrastructure to manage 1" of stormwater runoff from 10% of impervious surfaces in **combined sewer areas** by 2030.

2012 – Amended Consent Order DEP and NYS Department of Environmental Conservation (DEC) signed an historic agreement to incorporate a green and grey adaptive management approach into the CSO reduction program.

2023 – Amended Consent Order to report on Green Infrastructure implementation by CSO reduction. Must manage 1.67BGY of CSO by 2040.

Unified Stormwater Rule:



Stormwater Construction Permit

- Applies to **CSS/MS4 projects** that disturb 20,000 sf or more of soil, OR add 5,000 sf or more of new impervious surface
- Must comply with Unified Stormwater Rule
- Manage volume of 1.5-inch rainfall event

Site/House Connection Proposal

- Applies to **CSS/MS4 projects** that require a site/house connection proposal
- Must comply with Unified Stormwater Rule
- Provide specified detention volume and maximum-release rate based on project type:
  - CSS-site: 1.85” volume, greater of 0.1 cfs/acre or 0.046 cfs
  - CSS-house: 1.50” volume, greater of 0.1 cfs/acre or 0.046 cfs
  - MS4-site: 1.50” volume, greater of 1.0 cfs/acre or 0.046 cfs
  - MS4-house: 1.10” volume, greater of 1.0 cfs/acre or 0.046 cfs

Green infrastructure framework that supports application of practices to meet both objectives

NYC Green Infrastructure Program

City Sidewalks

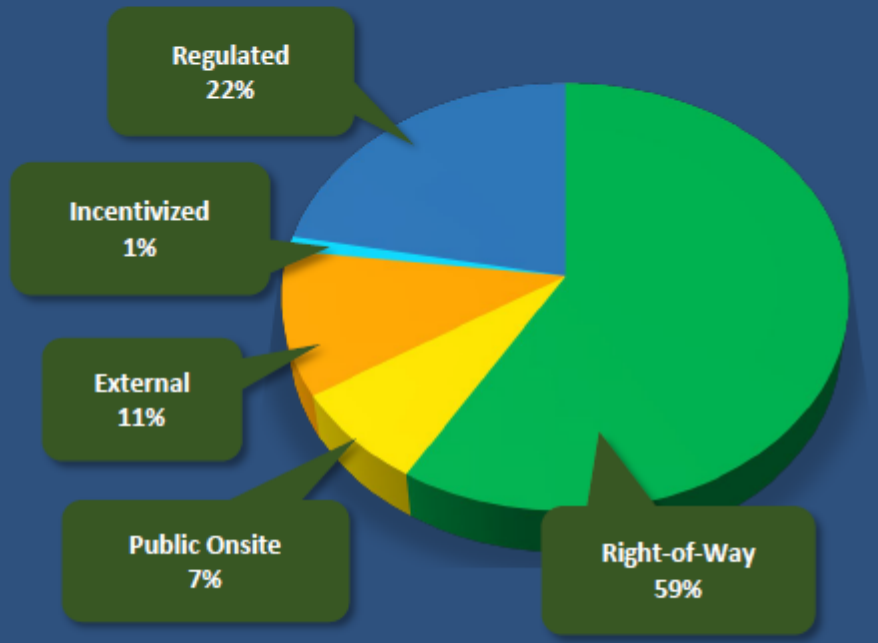
City Streets

City Properties

Private Properties

Green Infrastructure Program Overview

Breakdown of Greened Acres by Program Area



Right-of-Way: primarily funded by DEP and implemented within city streets and sidewalks

Public Onsite: primarily funded by DEP and implemented within publicly owned property, such as schools, parks, and public housing

Incentivized: implemented on private property (private onsite) through incentives provided by DEP

External: not funded by DEP, may be implemented in the right-of-way (ROW), or public or private onsite

Regulated: implemented through DEP stormwater regulations (2012 Stormwater Rule or 2022 Unified Stormwater Rule)

Program Highlights

2,299 Greened Acres

12,781 Assets

80%+ of Assets Constructed in Environmental Justice Areas[1]

[1]Based on the Environmental Justice Area Census Tract Designation data published by the Mayor's Office of Climate & Environmental Justice, last updated March 2021.

Additional Reading & Resources

Access more information about the NYC DEP Green Infrastructure Program, including previous Annual Reports and the Green Infrastructure Plan, at:

https://www.nyc.gov/site/dep/water/green-infrastructure.page

"Greened Acre" is an area equivalent to one acre of impervious surface covered by one inch of stormwater.

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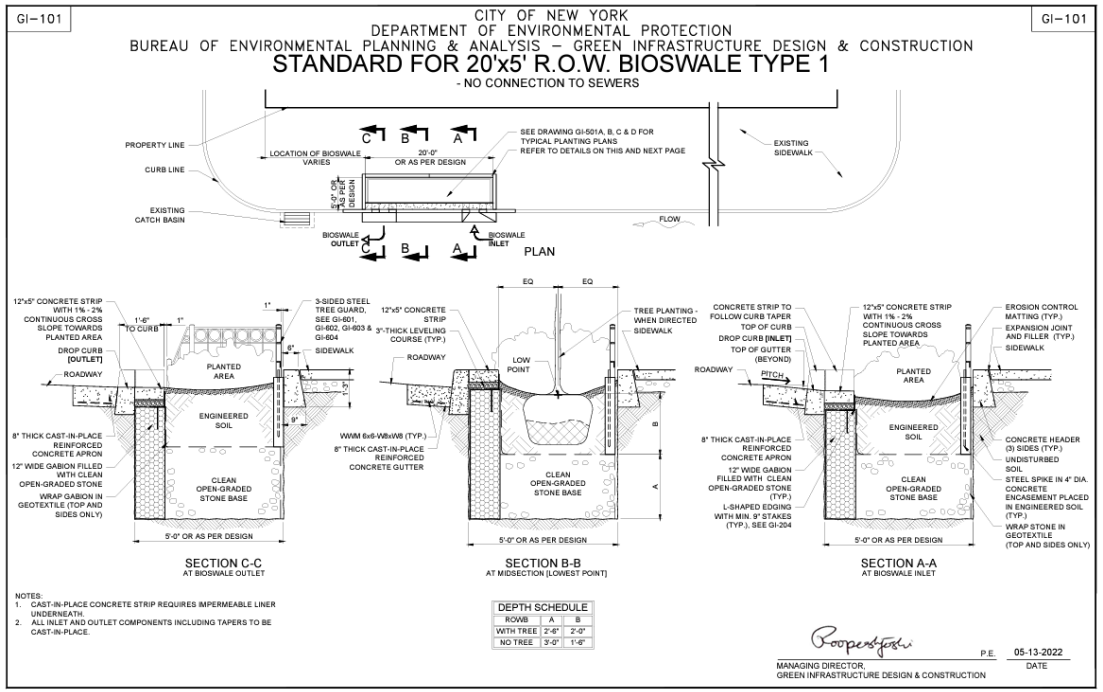
Overview of ROW GI Practices

ROWB and ROWRG

- Installed in the sidewalk adjacent to the curb line
- Stormwater gutter runoff is directed into a vegetated basin consisting of a sandy engineered soil mixture, underlain by an open graded stone storage layer
- Numerous planting palettes are available to optimize plant selection depending on surrounding conditions and practice width
- Precast concrete strip adjacent to the curb provides access for pedestrians exiting parked vehicles
- The ROW Rain Gardens may be recommended at locations where ROWBs are unsuitable due to high bedrock and/or groundwater

Sidewalk Rain Garden (Bioswale)

ROW GI Standards & Features


GI-101

CITY OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF ENVIRONMENTAL PLANNING & ANALYSIS – GREEN INFRASTRUCTURE DESIGN & CONSTRUCTION

STANDARD FOR 20'x5' R.O.W. BIOSWALE TYPE 1

- NO CONNECTION TO SEWERS

GI-101

PLAN

SECTION C-C
AT BIOSWALE OUTLET

SECTION B-B
AT MIDSECTION (LOWEST POINT)

SECTION A-A
AT BIOSWALE INLET

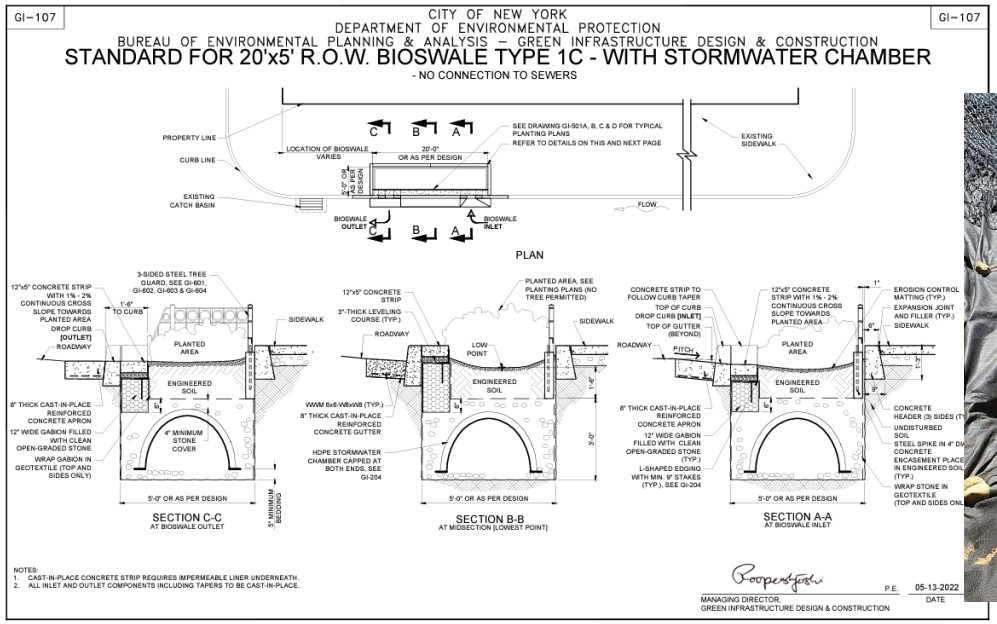
NOTES:
1. CAST-IN-PLACE CONCRETE STRIP REQUIRES IMPERMEABLE LINER UNDERNEATH.
2. ALL INLET AND OUTLET COMPONENTS INCLUDING TAPERS TO BE CAST-IN-PLACE.

DEPTH SCHEDULE

ROW@	A	B
WITH TREE	2'-6"	2'-0"
NO TREE	3'-0"	1'-6"

MANAGING DIRECTOR,
GREEN INFRASTRUCTURE DESIGN & CONSTRUCTION

P.E. 05-13-2022
DATE


GI-107

CITY OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF ENVIRONMENTAL PLANNING & ANALYSIS – GREEN INFRASTRUCTURE DESIGN & CONSTRUCTION

STANDARD FOR 20'x5' R.O.W. BIOSWALE TYPE 1C - WITH STORMWATER CHAMBER

- NO CONNECTION TO SEWERS

GI-107

PLAN

SECTION C-C
AT BIOSWALE OUTLET

SECTION B-B
AT MIDSECTION (LOWEST POINT)

SECTION A-A
AT BIOSWALE INLET

NOTES:
1. CAST-IN-PLACE CONCRETE STRIP REQUIRES IMPERMEABLE LINER UNDERNEATH.
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MANAGING DIRECTOR,
GREEN INFRASTRUCTURE DESIGN & CONSTRUCTION

P.E. 05-13-2022
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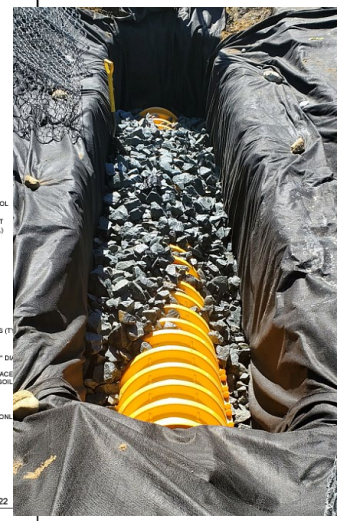
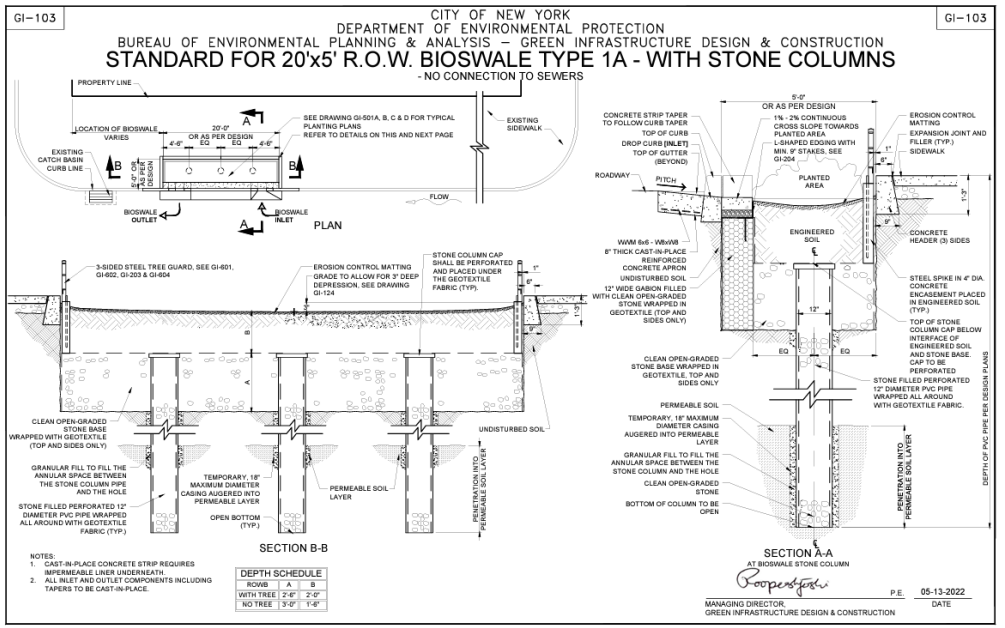



GI-103

CITY OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF ENVIRONMENTAL PLANNING & ANALYSIS – GREEN INFRASTRUCTURE DESIGN & CONSTRUCTION

STANDARD FOR 20'x5' R.O.W. BIOSWALE TYPE 1A - WITH STONE COLUMNS

- NO CONNECTION TO SEWERS

GI-103

PLAN

SECTION B-B

SECTION A-A
AT BIOSWALE STONE COLUMN

NOTES:
1. CAST-IN-PLACE CONCRETE STRIP REQUIRES IMPERMEABLE LINER UNDERNEATH.
2. ALL INLET AND OUTLET COMPONENTS INCLUDING TAPERS TO BE CAST-IN-PLACE.

DEPTH SCHEDULE

ROW@	A	B
WITH TREE	2'-6"	2'-0"
NO TREE	3'-0"	1'-6"

MANAGING DIRECTOR,
GREEN INFRASTRUCTURE DESIGN & CONSTRUCTION

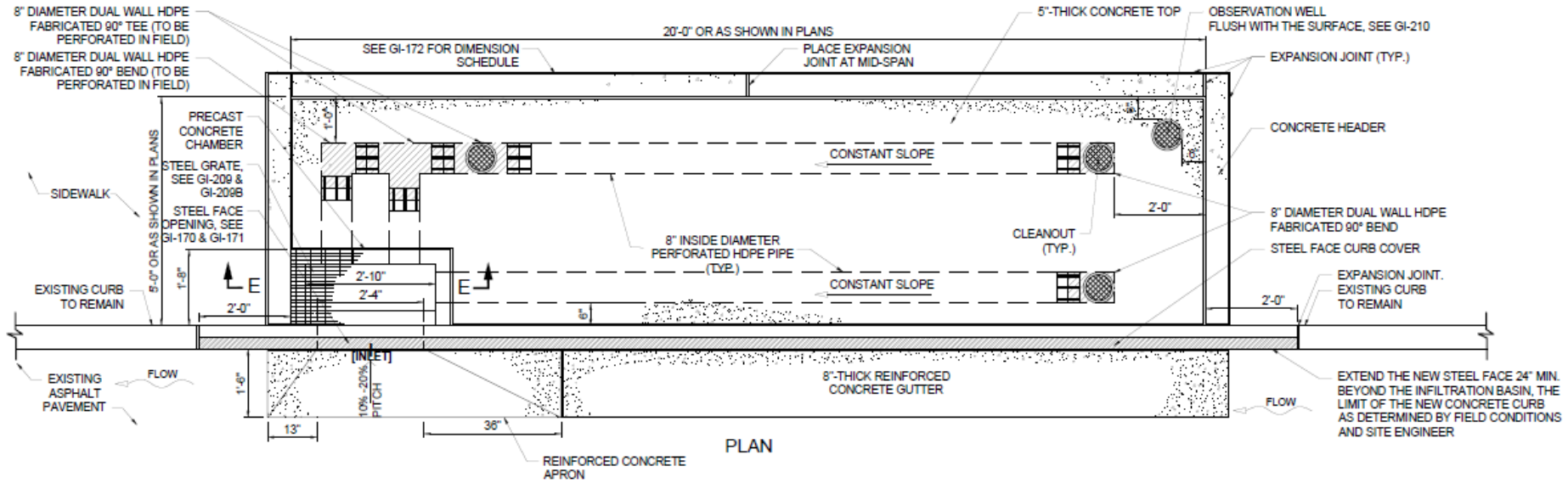
P.E. 05-13-2022
DATE

ROW Green Infrastructure Types

11

ROW Infiltration Basin

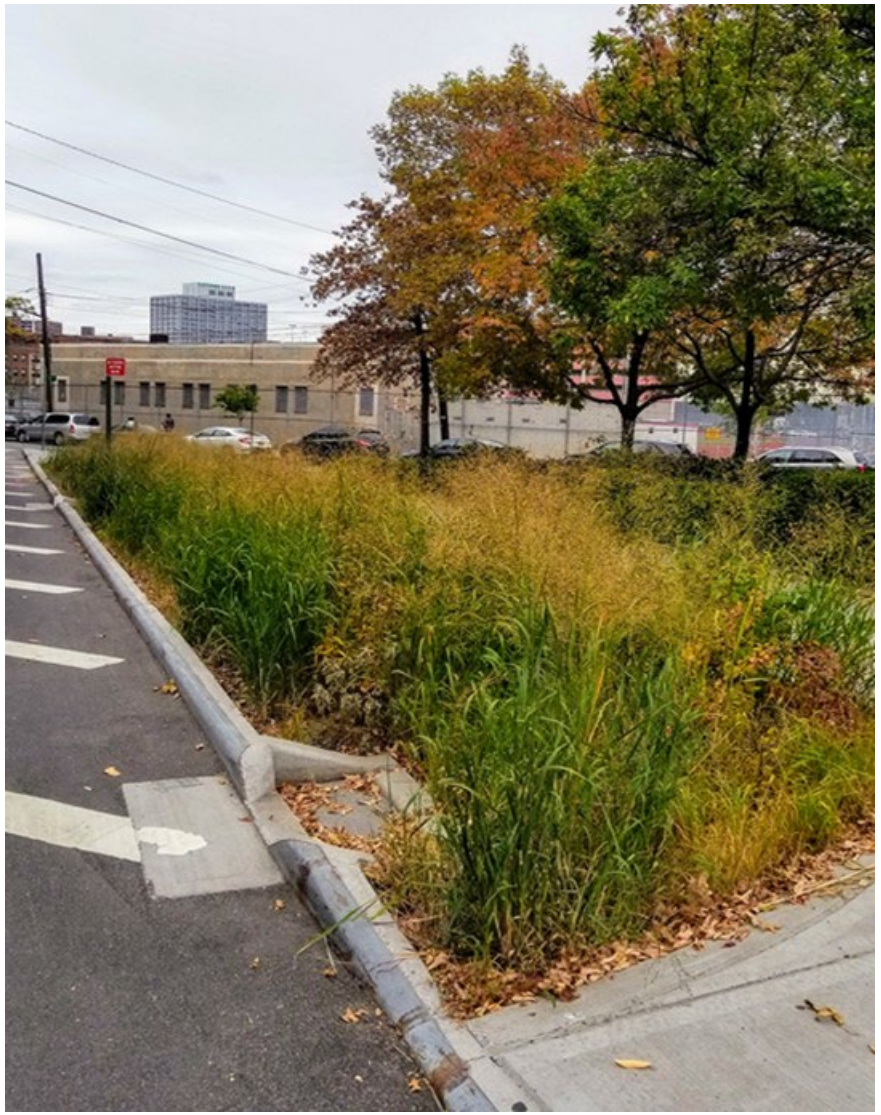
- Similar to ROW Bioswales and ROW Rain Gardens, ROW Infiltration Basins are also installed adjacent to the curb within the sidewalk.
- The option of the surface being concrete, grass, or a combination of both, allows these to be sited where ROWB and ROWRG cannot meet DOT sidewalk clearance requirements.



Overview of ROW GI Practices

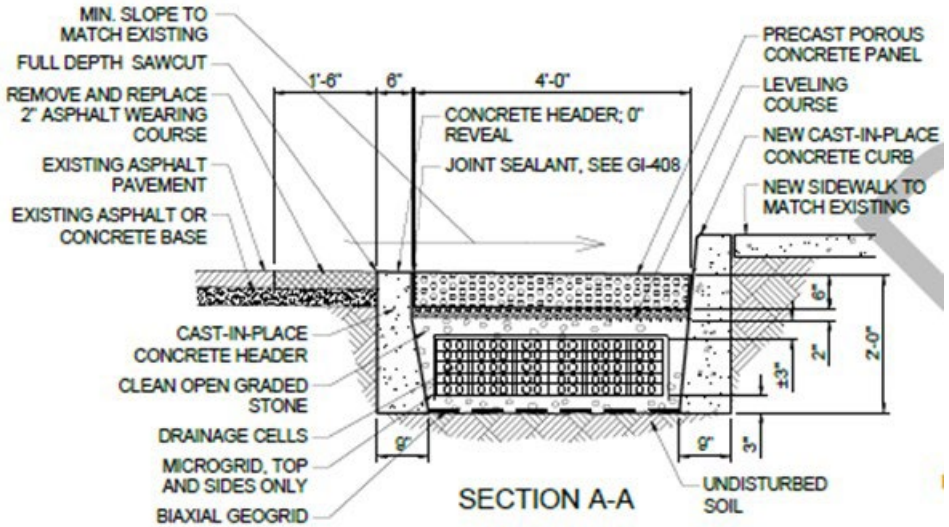
ROW Infiltration Basin

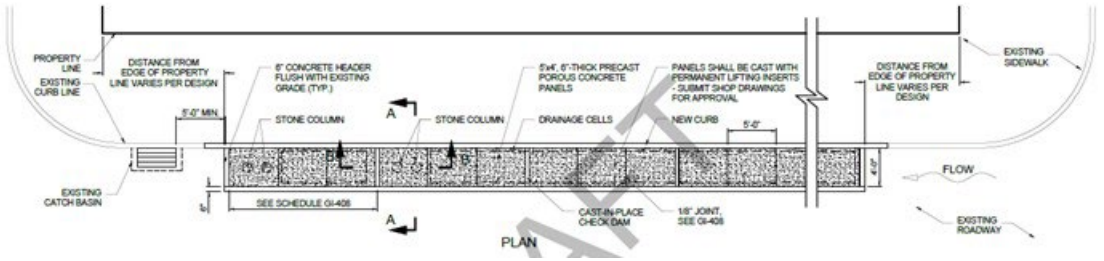
ROW Cloudburst Swales & SW Greenstreets



ROW Precast Porous Concrete Panels

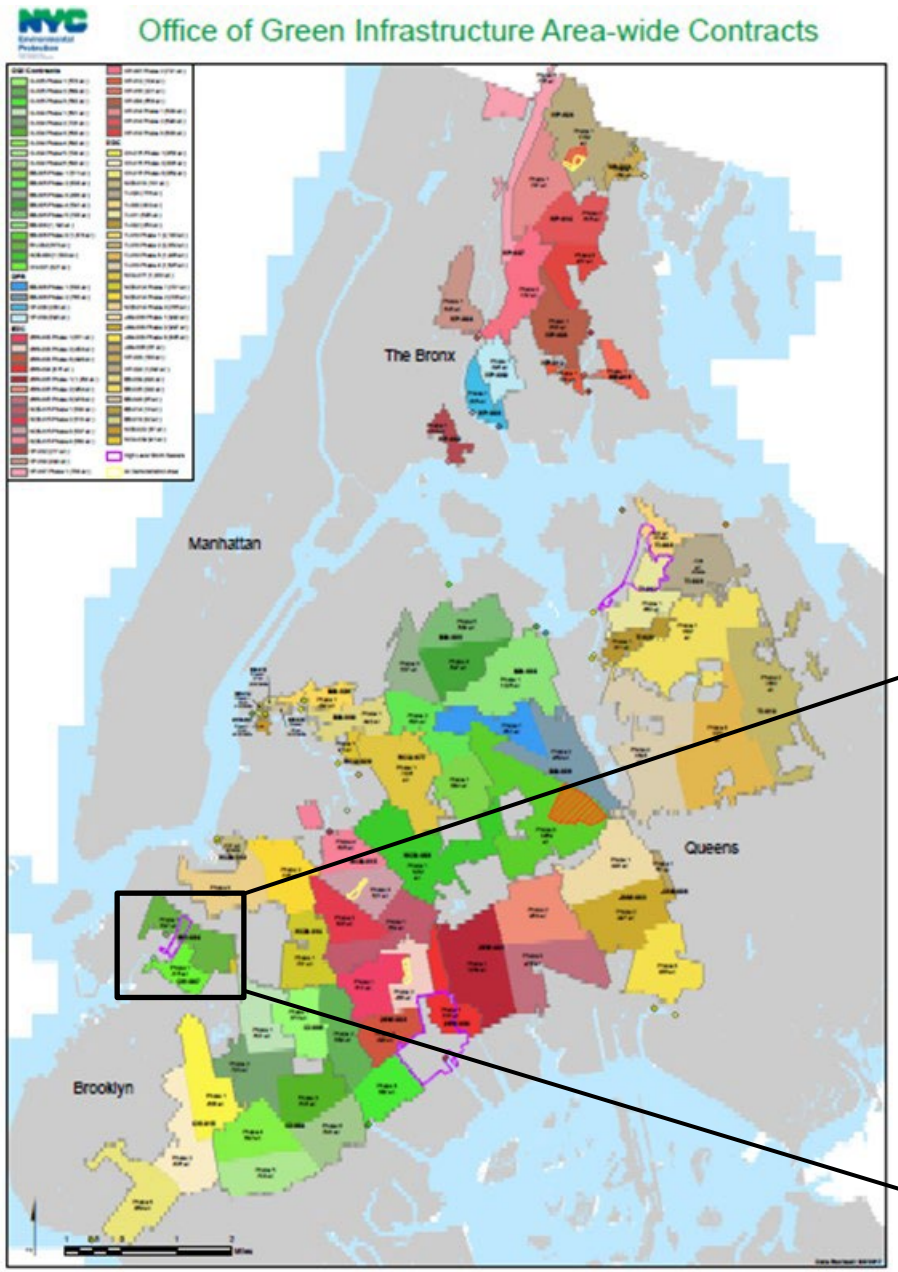
- Typically installed in the parking lane of the roadway
- Need to consider existing conditions such as slope, traffic load, existing utilities and mature street trees
- Ideal for long stretches of road where there are no other ROW GI practices.
- Should be designed to look continuous across the entire length of the block.





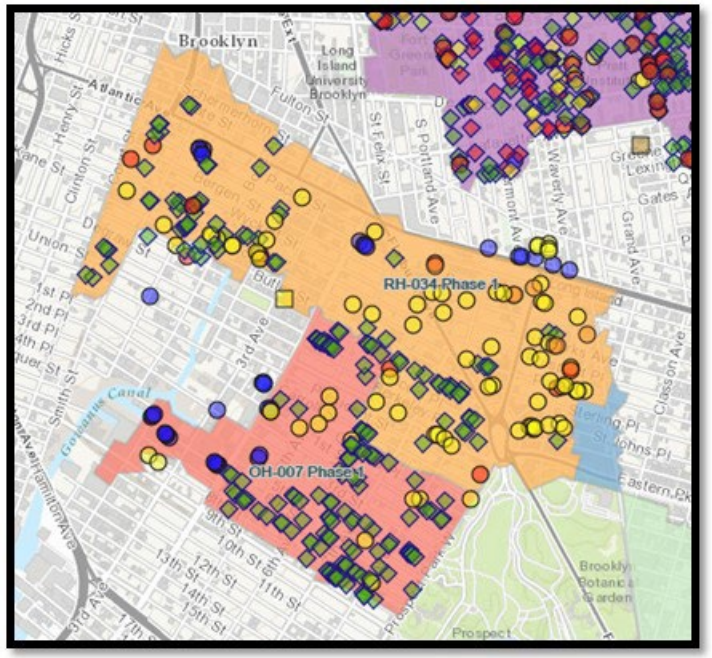
ROW Porous Concrete

Priority Areas and Area-wide **Approach**

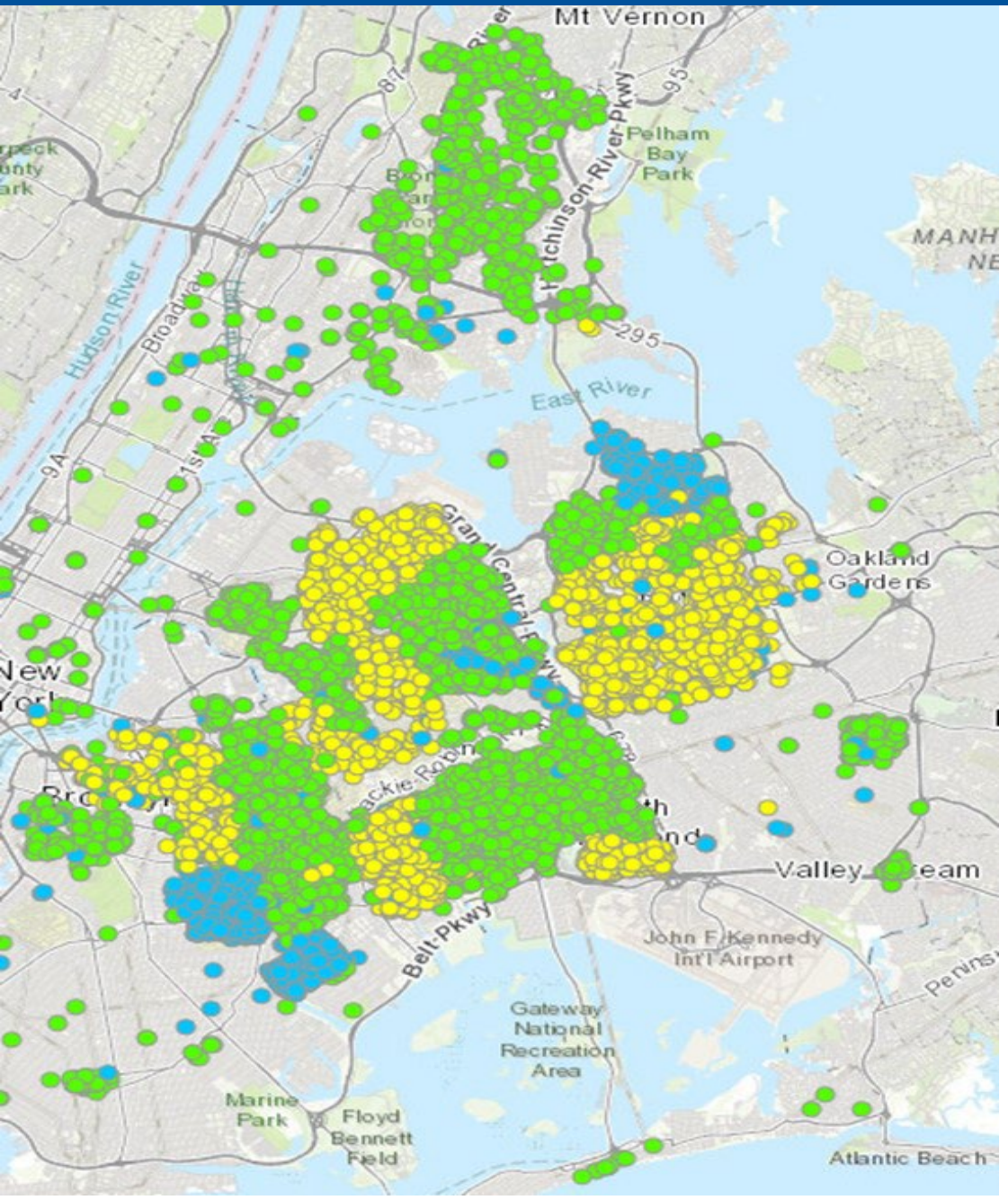


The Area-wide Approach allows DEP to:

- Focus resources on selected CSO tributary areas (Priority Areas)
- Saturate these CSO tributary areas with as much GI as practical
- Achieve efficiencies through standard designs, specifications and procedures
- And allows the public to track progress online, nyc.gov/dep/gimap



Green Infrastructure Program Snapshot



- Over 12,000 GI assets constructed or in construction.

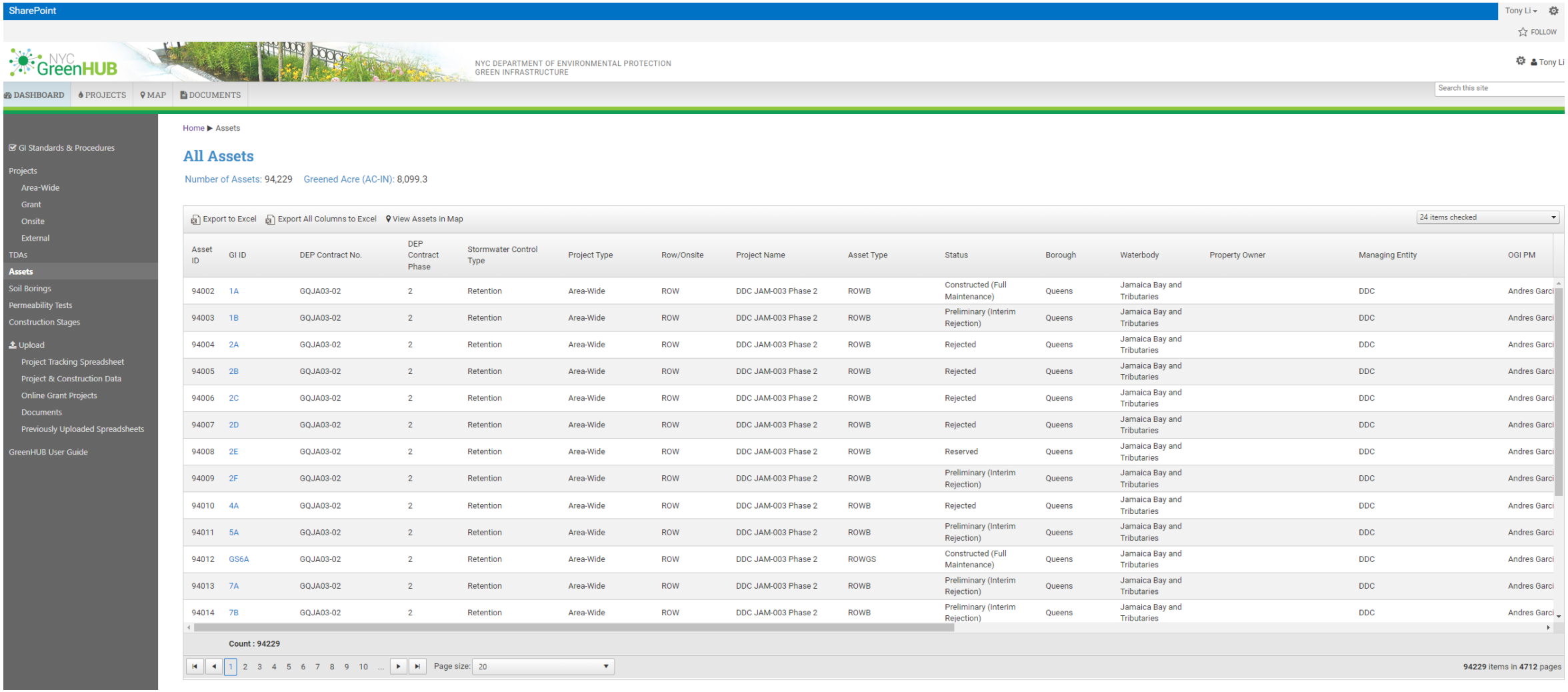
www.nyc.gov/dep/gimap

LEGEND

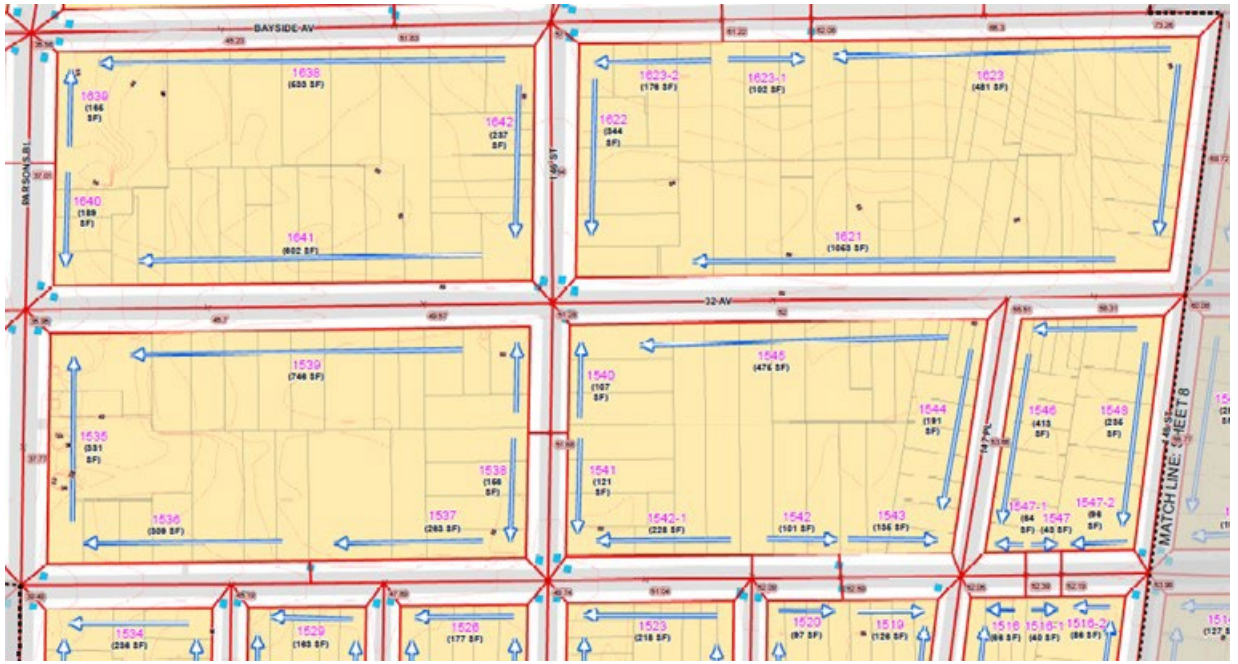
- Final Design
- In Construction
- Constructed

Source: DEP Green Infrastructure Program Map (publicly accessible)

Asset tracking – GreenHub



Tributary Drainage Area Analysis



- The **TDA Spreadsheet** estimates the total area of **Potential** ROW GI required per tributary, and tracks other tributary-specific information

TDA Analysis					Walkthrough Data								
Tributary Area Number	ROW Tributary Area (SF)	Impervious Tributary Area (SF)	Volume of 1" Rainfall on Impervious Tributary Area (CF)	Area of GI Required in Tributary (SF)	Field Observations*	Number of GI Assets in Tributary	Surface Area of GI Assets (SF)	Calculated Volume Managed (CF)	Percent of 1" Rainfall Managed	Limiting Factor 1 (if necessary)	Limiting Factor 2 (if necessary)	Limiting Factor 3 (if necessary)	Sidewalk Width (decimal ft)
1063-1	13715	15087	1257	419	High Point identified, TDA split into 1063 and 1063-1.	3	216	648	52%	Outside of Contract Area			0.0
1064	18668	20535	1711	570		0	0	0	0%	Narrow Sidewalk			7.8
1065	14412	15854	1321	440		0	0	0	0%	Narrow Sidewalk	Mature Trees	Entrances/Acces	7.8
1066	21637	23801	1983	661		3	200	600	30%	Entrances/Access	Mature Trees		9.8
1067	7963	8759	730	243		0	0	0	0%	Narrow Sidewalk	Entrances/Access		7.4

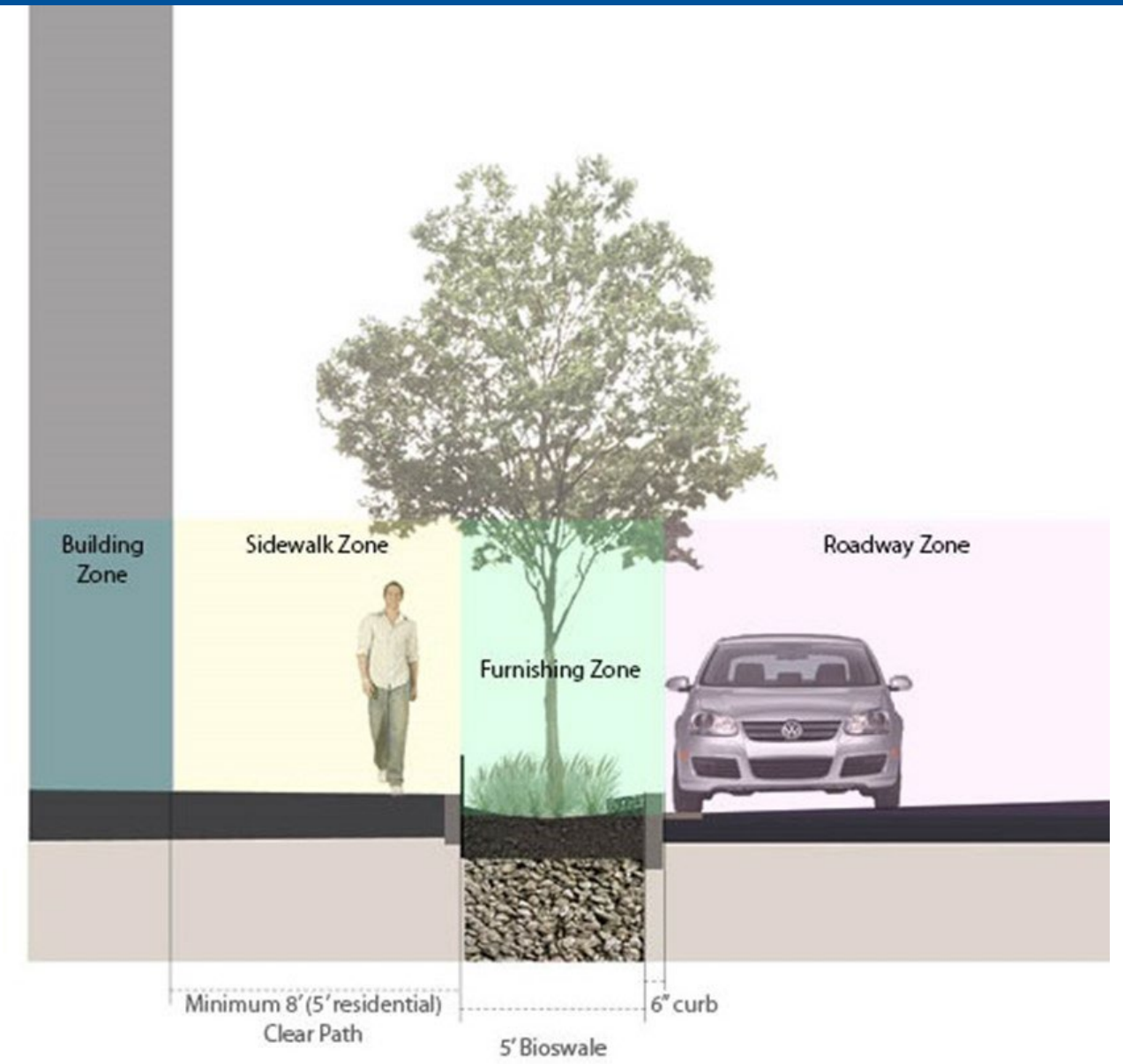
Right of Way Siting Criteria

Above Ground

- Sidewalk widths
- Driveways
- Fire Hydrants
- Mature Trees
- Pedestrian Ramps
- Building Entrances/Exits
- Parking meters, bike racks, Link NYC kiosks
- Bus Stops

Below Ground

- Groundwater, bedrock, soil conditions
- Utility conflicts

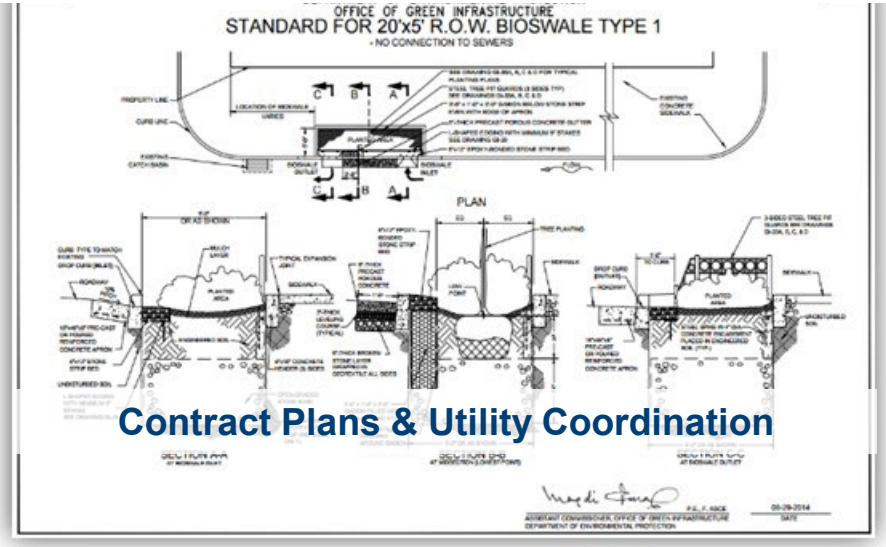


https://www1.nyc.gov/assets/dep/downloads/pdf/water/stormwater/green-infrastructure/green-infrastructure-siting-criteria.pdf

Selection Process

Soil Investigations

Surveys



Contract Plans & Utility Coordination

Construction

Outreach and Engagement

- Brochures are carried by all field teams
- DEP presents rain garden information to community boards, elected officials, environmental organizations, and civic groups
- Maps and lists of locations are distributed before construction begins
- Community Construction Liaisons are available during construction process
- Green infrastructure hotline
  718-595-7599
- Rain Gardens website and email
  nyc.gov/raingardens
  raingardens@dep.nyc.gov
- All rain gardens will have decals and identified as DEP infrastructure

Maintenance

Rain Gardens in NYC

The New York City Department of Environmental Protection (DEP) is building rain gardens and other types of green infrastructure to manage stormwater and improve water quality in local waterways.

Rain gardens are planted areas designed to collect and manage stormwater that runs off the streets and sidewalks when it rains.

Green infrastructure is a cost-effective way to help create a sustainable New York City.

- ✓ Beautifies neighborhoods
- ✓ Purifies air
- ✓ Reduces temperature during hot weather
- ✓ Improves street drainage
- ✓ Reduces puddles and ponds

- All GI in the public right-of-way is maintained by the City
- City crews visit locations regularly:
  - Remove litter
  - Replace plants
  - Prune trees
  - Clear inlets/outlets
  - Perform corrective maintenance as needed
- The frequency of visits depends on the needs. For example in heavily trafficked/commercial districts DEP may visit at least twice a week

Green Infrastructure Transformations

BEFORE

BEFORE

AFTER

AFTER

26

July 31, 2020 Morning: Localized flooding due to heavy rain (216th St and 110th Ave)

July 31, 2020 Afternoon (2 PM) : Resident pleased to see how much and how quickly the asset was able to drain the water.


BEFORE
AFTER


BEFORE
AFTER

ROW Large-Scale Projects

ROW Large-Scale Projects

Existing Conditions - Beach 67th Street

ROW Large-Scale Projects

NYC Environmental Protection

Beach 67th Street - Design

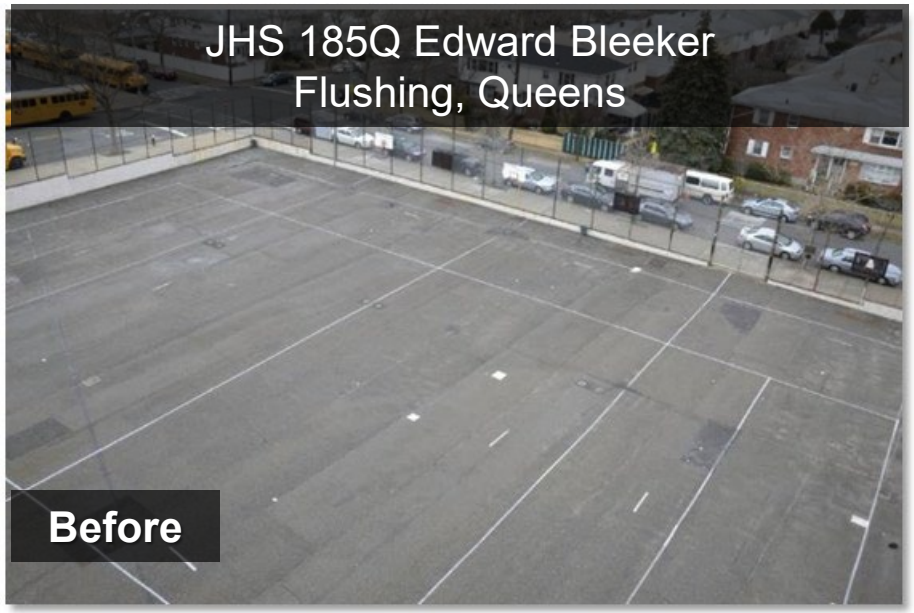
Beach 67th Street - Constructed

Beach 67th street before & after

On-site Green Infrastructure

- On-site assets are located within a park, school, public housing, or other city-owned property
- Assets types vary in size and configuration
- There are 4 main asset types:
  - Subsurface systems
  - Rain gardens
  - Permeable pavements
  - Turf fields

Public Property Retrofits



Partners

NYC DDC Department of Design and Construction
NYC Parks
NEW YORK CITY HOUSING AUTHORITY
NYC Department of Education
SCA NYC School Construction Authority
THE TRUST FOR PUBLIC LAND

Example Sites (Constructed)

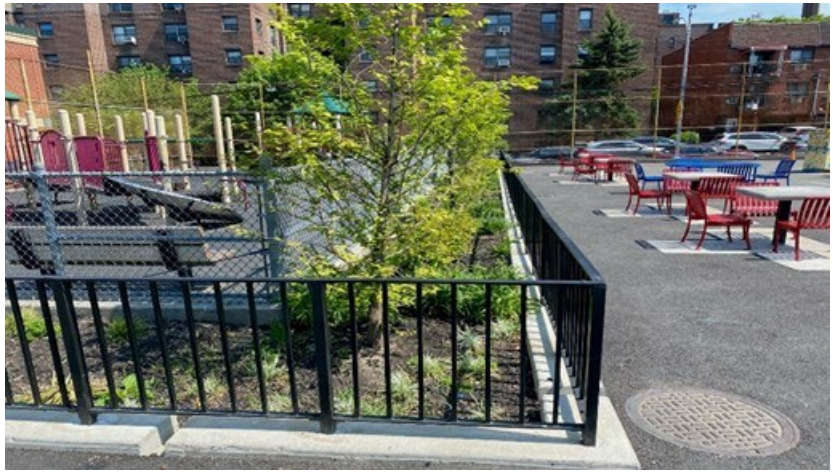
- Van Alst Playground (Astoria)
- North/South Conduit (Ozone Park)
- Flushing Town Hall
- Forest Park Overlook (Kew Gardens)

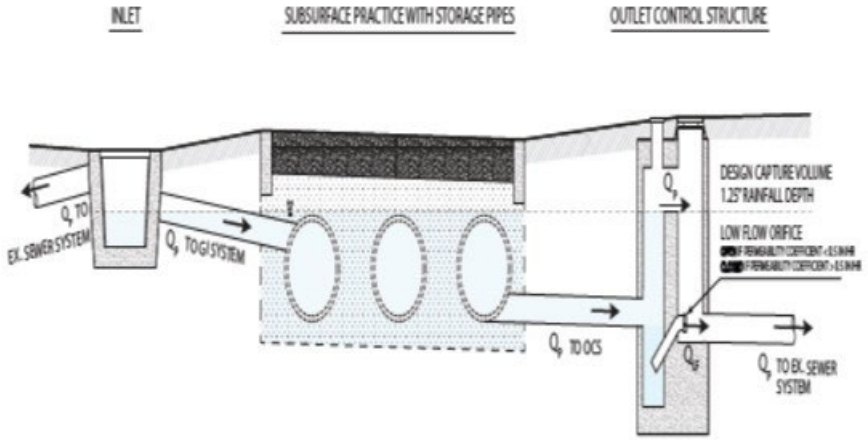
Types of Onsite Green Infrastructure

Subsurface Detention Systems

- Provide temporary storage of stormwater runoff underground.
- Have an open-bottom and can incorporate perforated pipe and stormwater chambers for added detention volume.
- Primarily designed with a gravel bed that stores water until it can infiltrate into the ground.

Rain Gardens





Types of Onsite Green Infrastructure

Permeable Pavements

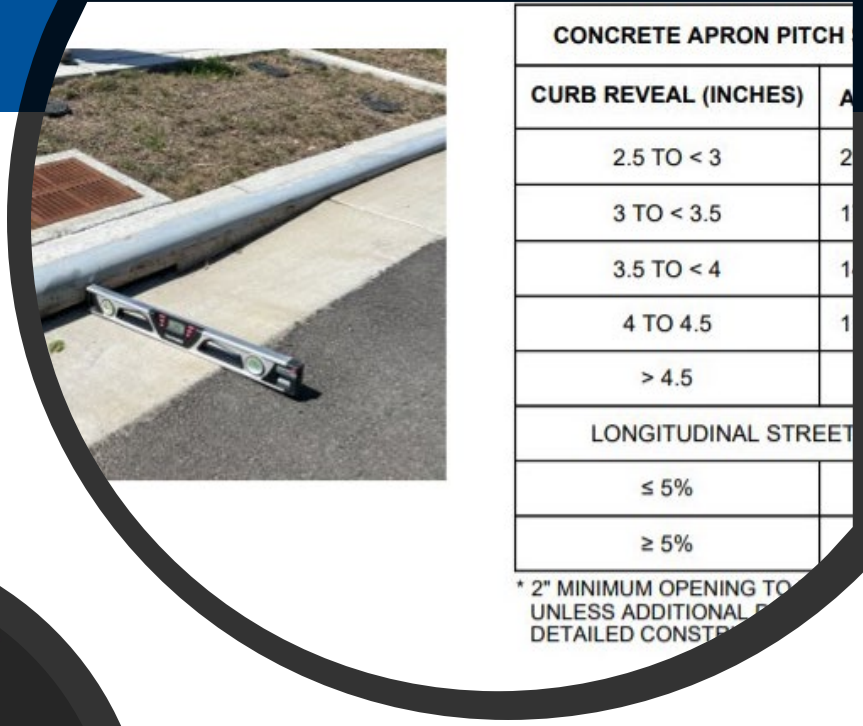
- Allow stormwater runoff to filter through surface voids into an underlying stone reservoir for temporary storage and/or infiltration.
- Consisting of a surface pavement layer, an underlying stone aggregate reservoir layer, optional underdrains and geotextile over uncompacted soil subgrade.
- Most common are pervious concrete, porous asphalt, and permeable interlocking concrete pavers (PICP)

Turf Fields

- The synthetic fabric conveys the storm runoff in the storage system beneath to promote infiltration in the ground.
- The storage system includes a stone bed and perforated pipes

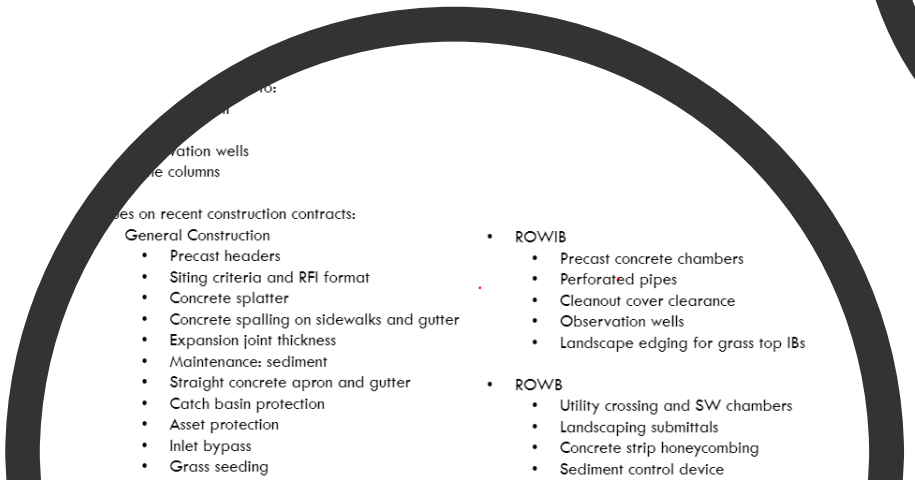
Construction

- New Contractor Training Program
- Lessons Learned review
- Inspections at key stages of construction
- Inspection Checklists
- Daily Work Notices
- Monthly Meetings and Field visits
- RFIs
- GI Submittal Reviews
- Asset Testing



CONCRETE APRON PITCH	
CURB REVEAL (INCHES)	A
2.5 TO < 3	2
3 TO < 3.5	1
3.5 TO < 4	1
4 TO 4.5	1
> 4.5	
LONGITUDINAL STREET	
≤ 5%	
≥ 5%	

* 2" MINIMUM OPENING TO
UNLESS ADDITIONAL
DETAILED CONSTR

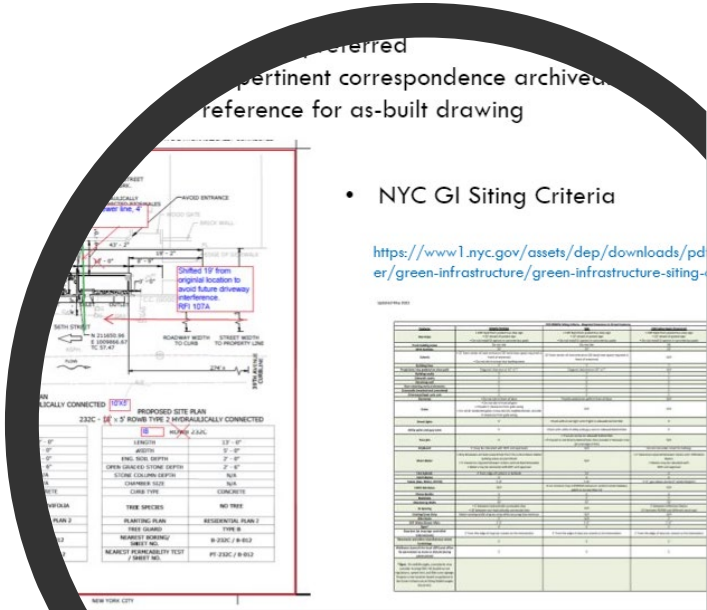


ation wells
e columns

es on recent construction contracts:

General Construction
- Precast headers
- Siting criteria and RFI format
- Concrete splatter
- Concrete spalling on sidewalks and gutter
- Expansion joint thickness
- Maintenance: sediment
- Straight concrete apron and gutter
- Catch basin protection
- Asset protection
- Inlet bypass
- Grass seeding

- ROWIB
  - Precast concrete chambers
  - Perforated pipes
  - Cleanout cover clearance
  - Observation wells
  - Landscape edging for grass top IBs
- ROWB
  - Utility crossing and SW chambers
  - Landscaping submittals
  - Concrete strip honeycombing
  - Sediment control device



referred
pertinent correspondence archived
reference for as-built drawing

- NYC GI Siting Criteria

https://www1.nyc.gov/assets/dep/downloads/pd
er/green-infrastructure/green-infrastructure-siting-

Questions?

Visit https://www.nyc.gov/site/dep/water/green-infrastructure.page to learn more and view a map of green infrastructure locations.