



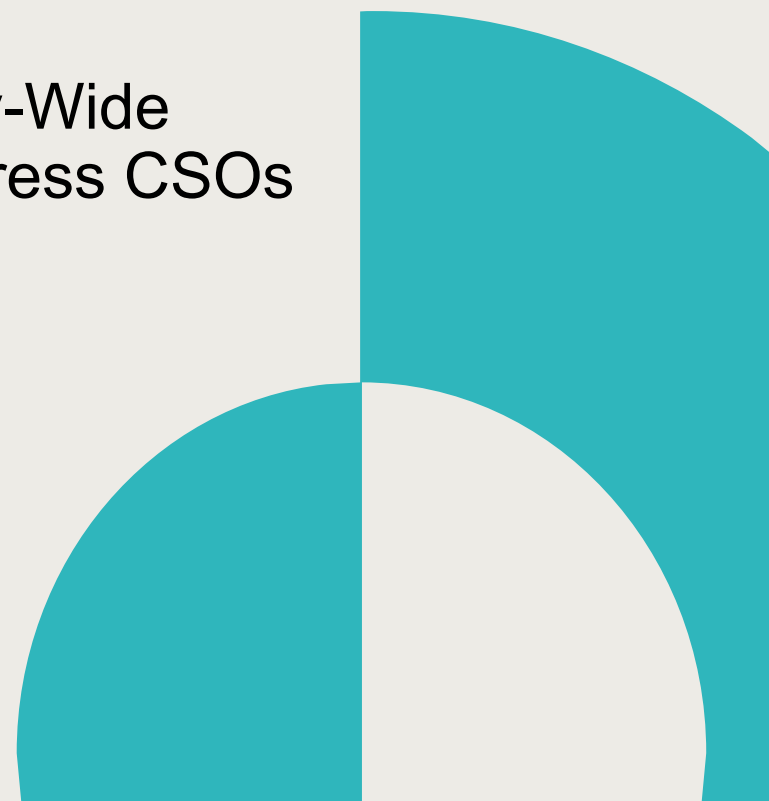
# Analysis of the Implementation of City-Wide Green Infrastructure Solutions to Address CSOs

Case Studies:  
New York City, Philadelphia, Cleveland

NEWEA Annual Conference & Exhibit

Boston, Massachusetts

January 30, 2019





# Presentation Outline

- Background on Regulations
- Overview of GI Programs and Long Term Control Plans (LTCPs)
  - New York City
  - Philadelphia
  - Cleveland (NEORS)
- Examples of Common GI Technologies
- Status Updates on LTCPs
- Lessons Learned
- Questions



# Regulations

Background on city regulations



# Consent Decree Requirements by City

## Regulations by City

City		Time Frame	Goal	Methods Utilized
New York City	New York	20 Years	Reduce CSO discharge through green and grey infrastructure	Green and grey infrastructure
Philadelphia	Pennsylvania	25 Years	Reduce stormwater pollution entering the waterways by 85%	Mostly green infrastructure
Northeast Ohio Regional Sewer District	Ohio	25 Years	Limit overflows from 80 per year to 4 per year resulting in 98% capture	Mostly grey infrastructure



# GI Programs and Long Term Control Plans

New York City, Philadelphia and Cleveland





## New York City

---

**Regulated Agency:** NYC  
Department of  
Environmental Protection

**Population:** > 8 million  
citizens

**Infrastructure:** 14  
wastewater treatment plants

**Collection System:** 60%  
Combined, 40% Separated

**GI Program and LTCPs:**  
City-wide GI Program and 11  
LTCPs utilizing green and  
grey infrastructure

# NYC Green Infrastructure Program

## 2010

NYC Green Infrastructure Plan was published. Consent Order began in 2012 and extends through 2030

## \$410 Million

Total investment of GI between 2010 and March 2017

## 1.67

### BG/yr

Target CSO volume reduction per based on Performance Metric Report

## 78,749

### Acres

Total Impervious Area Citywide

## \$1

### Billion

Budgeted between 2017-2027

## 4,320

### Constructed

Total number of assets that have ben constructed since the start of the program



# NYC's Long Term Control Plans – Grey Infrastructure Improvements

## Tunnels

1

### Bronx River

\$185M grey – sewer modifications

*Hydraulic Relief*

2

### Hutchinson River

\$167M grey – disinfection, floatables and outfall

## Disinfection

3

### Alley Creek

\$12M grey - disinfection

4

### Flushing Creek

\$18M grey – disinfection

5

### Flushing Bay

\$1,616M 25 MG CSO storage tunnel

6

### Newtown Creek

\$1,422M 39 MG CSO storage tunnel and PS expansion

7

### Gowanus Canal

\$932M 2 CSO storage tanks

## Tanks

8

### Coney Island

\$197M already implemented in grey infrastructure

9

### Westchester Creek

\$124M already implemented in grey infrastructure

10

### Jamaica Bay

LTCP not yet approved

11

### East River/ Open Waters

LTCP not yet approved





# Philadelphia

---

**Regulated Agency:** Philadelphia Water Department

**Population:** > 1.5 million citizens

**Infrastructure:** 3 wastewater treatment plants

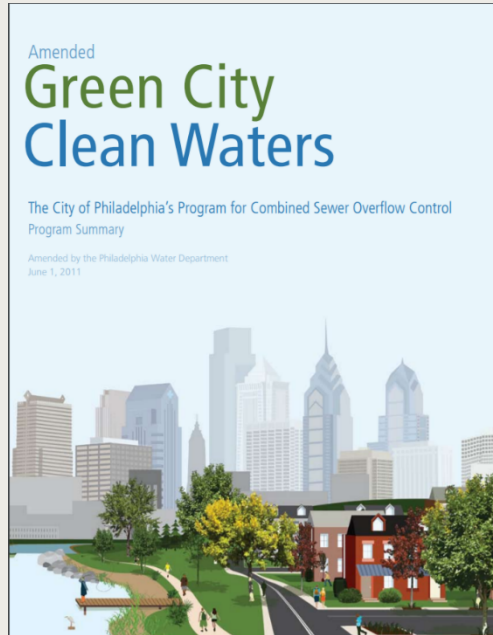
**Collection System:** 60% Combined , 40% Separated

**Long Term Control Plan:**

- Green stormwater infrastructure
- Stream corridor restoration and preservation
- Wet weather treatment plant upgrades

# PHILADELPHIA, PENNSYLVANIA

## GREEN INFRASTRUCTURE PLAN



2011

*“eliminate the pollutants that otherwise would be removed by the capture of 85% by volume of the combined sewage collected in the Combined Sewer System during precipitation events”*

# Philadelphia Green City Clean Waters Program

25

Year plan

85%

Of CSS

Eliminate the pollutants that otherwise would be removed by the capture of 85% by volume of the combined sewage collected in the Combined Sewer System during precipitation events

\$2.4

Billion

Total investment after 25-year period

\$1.67

Billion

Dedicated to Green Stormwater Infrastructure

\$345

Million

Wet weather treatment plant upgrades

\$420

Million

Adaptive management which can be directed towards either green or gray infrastructure



# Stream Corridor Restoration and Preservation

Restoring Living Resources and...

## Tookany/Tacony-Frankford Watershed

\$3.12M Commitment

Public Education and Volunteer Programs

Municipal Measures

Sewer Evaluation, cleaning, relining and rehab

Monitor and Reporting

## Cobbs Creek Watershed

\$2.92M Commitment

Public Education and Volunteer Programs

Municipal Measures

Sewer Evaluation, cleaning, relining and rehab

Monitor and Reporting

## Delaware Direct Watershed

\$33.65M Commitment

Public Education and Volunteer Programs

Municipal Measures

Sewer Evaluation, cleaning, relining and rehab

Monitor and Reporting

## Schuykill River

\$33.65M Commitment

Public Education and Volunteer Programs

Municipal Measures

Sewer Evaluation, cleaning, relining and rehab

Monitor and Reporting



# Wet Weather Upgrades to WWTPs

## Northeast, Southeast and Southwest WWPTs

### Northeast



- Vortex Swirl Concentrator
- Conventional Clarifiers
- Chemically Enhanced Primary Treatment with Conventional Clarifiers
- Ballasted Flocculation

### Southeast



- Vortex Swirl Concentrator
- Conventional Clarifiers
- Chemically Enhanced Primary Treatment with Conventional Clarifiers
- CEPT with Plate Settlers
- Ballasted Flocculation

### Southwest



- Vortex Swirl Concentrator
- Conventional Clarifiers
- Chemically Enhanced Primary Treatment with Conventional Clarifiers
- Ballasted Flocculation



## Cleveland

---

**Regulated Agency:**  
Northeast Ohio Regional  
Sewer District

**Population:** > 1.4 million  
citizens in Cleveland and 61  
suburban communities

**Infrastructure:** 3  
wastewater treatment plants

**Collection System:** 23%  
Combined , 77% Separated

**Long Term Control Plan:**  
Grey infrastructure utilized  
and only minimum required  
green infrastructure  
implemented

# NEORSD – Project Clean Lake

## 25

Year plan

Reduce total volume of raw sewage discharges from 4.5 billion gallons to 494 million gallons annually

## 98%

Capture of CSO

Wet weather flows will be captured and treated

## 3

WWTPs

Increasing capacity at all three wastewater treatment plants

## 7

Storage Tunnels

Construction of 7 tunnels ranging from 2-5 miles in length up to 300 feet underground

## \$42

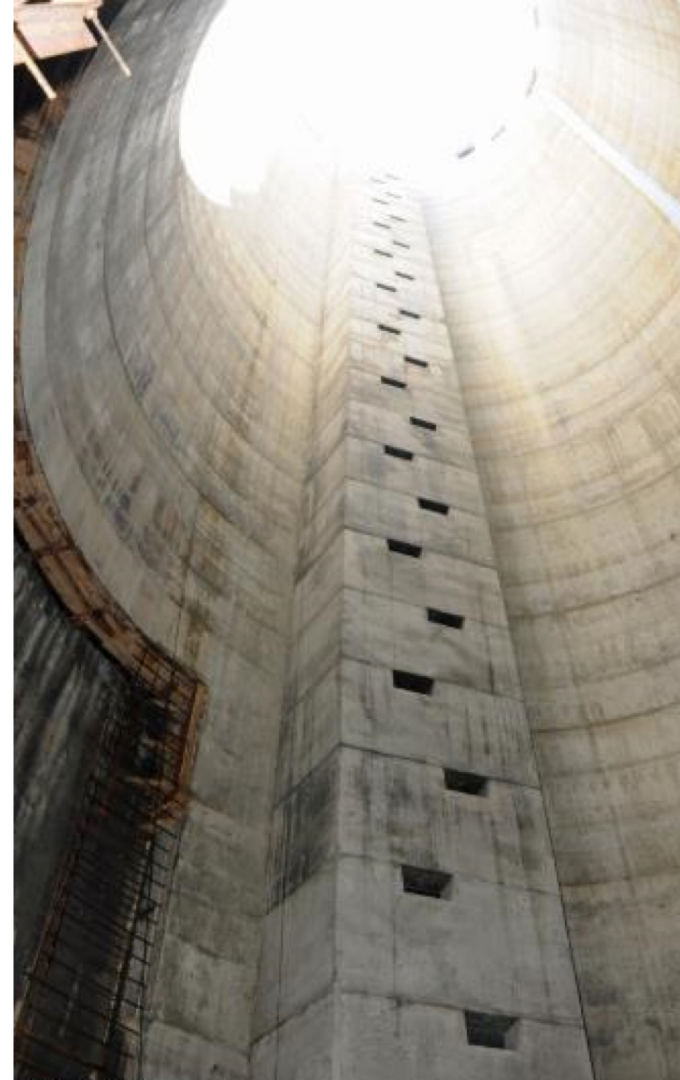
Million

Six program areas to implement green infrastructure technologies

## \$3

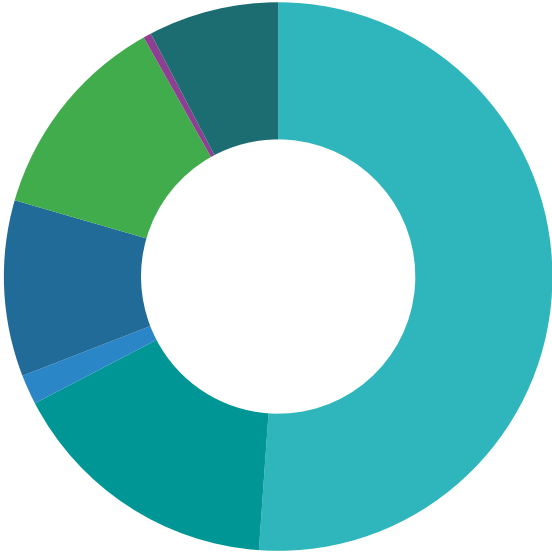
Billion

Total 25-year investment for green and gray improvements

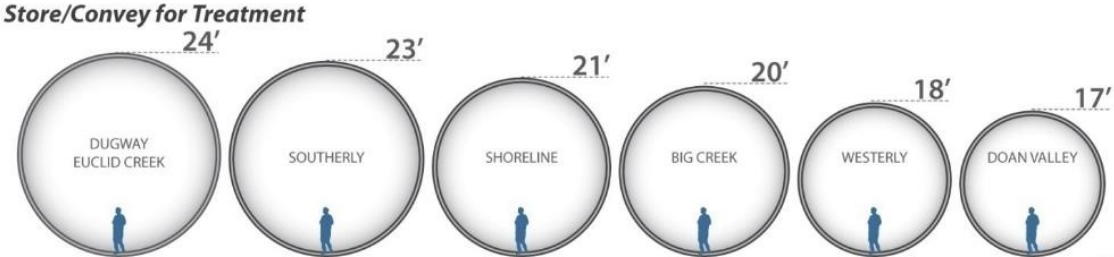


# Cleveland Consent Decree: \$3B

## CSO – 25 Year Capital Improvement Plan

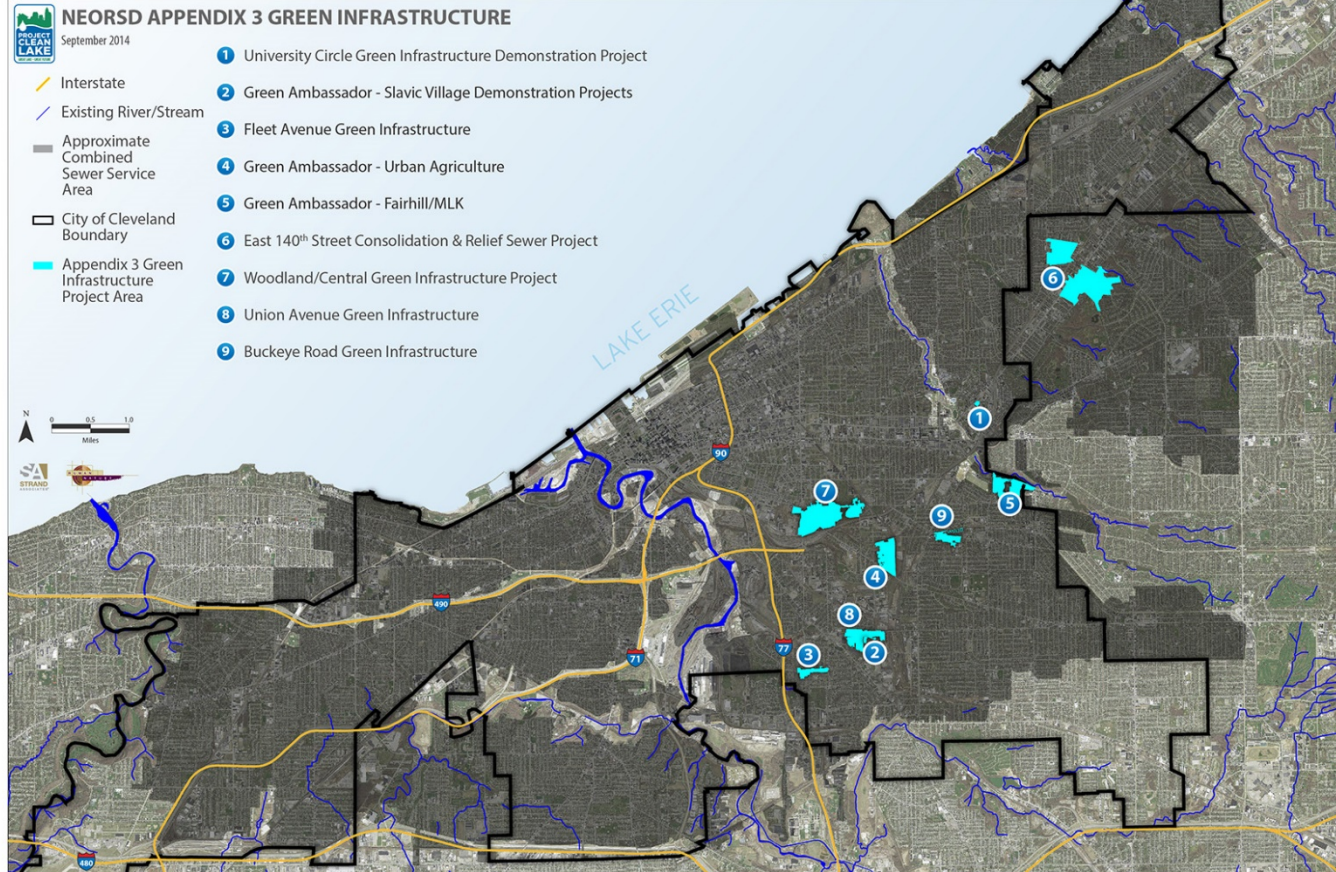


- Tunnels
- Sewer Improvements
- Green Infrastructure
- WWTP Improvements
- Pump Stations
- Storage Tanks
- Other





# Green Infrastructure Programs



# GI Technologies Used

The background is a solid teal color. On the right side, there are two large, white, geometric shapes that resemble stylized mountain peaks or abstract triangles. The top one is a right-angled triangle pointing towards the right, and the bottom one is a larger triangle pointing towards the left, partially overlapping the teal background.

# Common Types

## GI Technologies Philadelphia



**STORMWATER WETLAND**



**GREEN ROOFS**



# Common Types

## GI Technologies Philadelphia/ NYC



**RIGHT-OF-WAY  
BIOSWALES / RAIN  
GARDENS**

**POROUS /  
PERMEABLE  
PAVEMENT**



**STORMWATER GREEN  
STREETS / BUMPOUTS**



**RAIN BARRELS / CISTERNS (Philadelphia Only)**





# Common Types

## GI Technologies Cleveland



**INFILTRATION BASINS**



**PERMEABLE PAVERS**

**DETENTION BASINS**

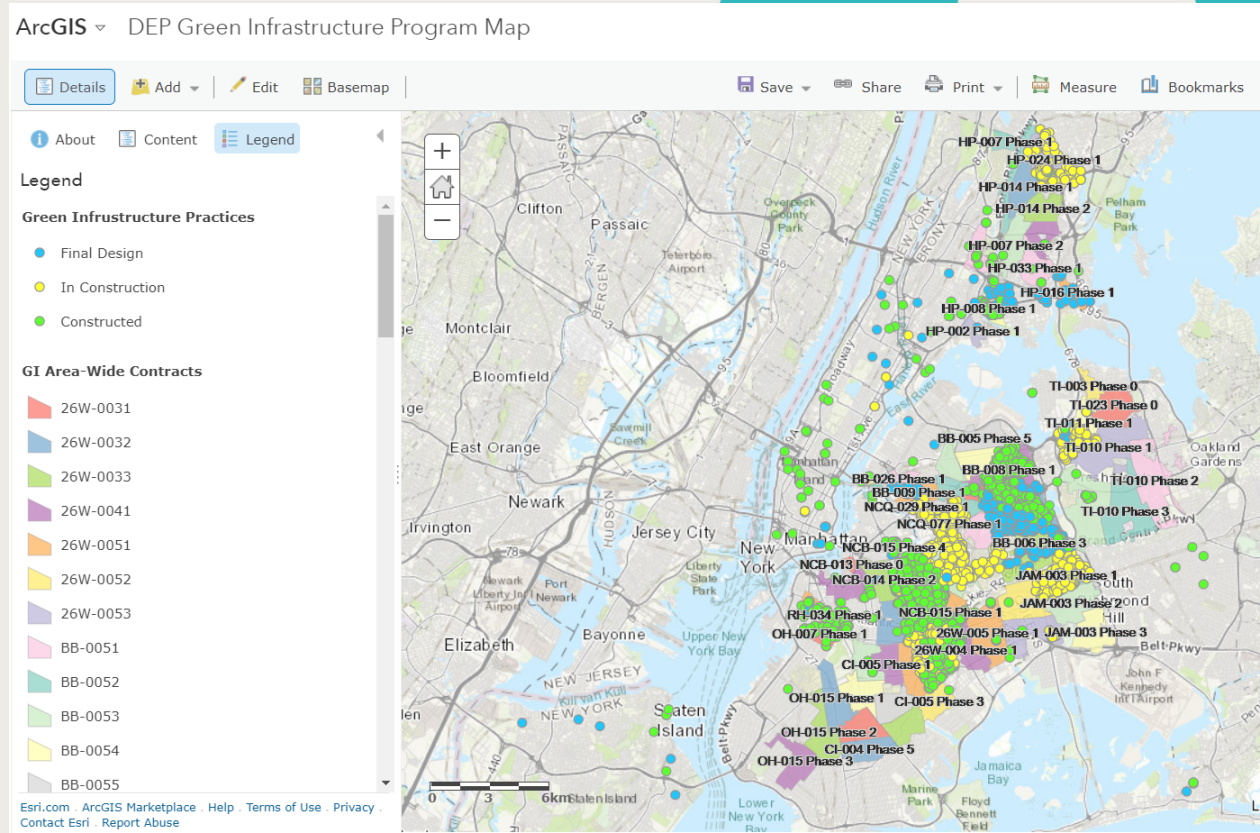


# Status Update

The background is a solid teal color. On the right side, there are two white geometric shapes: a large right-angled triangle pointing towards the top-right corner, and a smaller right-angled triangle pointing towards the bottom-left corner, positioned below the first one.

## Status Update

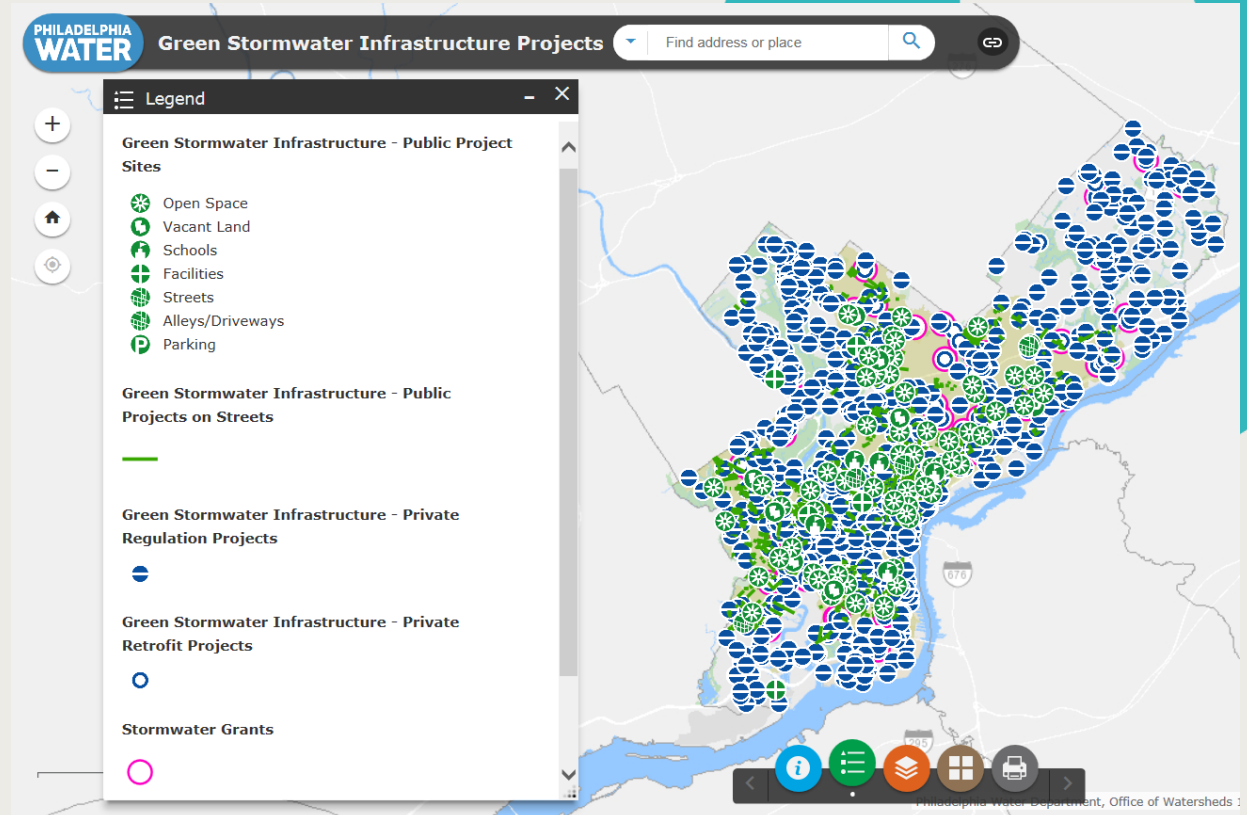
- 467 “Greened acres”
- 4,320 GI systems constructed or in construction between 2010 and 2017, thousands more in planning and design
- Based on 1.5% GI implementation rate, 507 MG/yr of CSO volume reduction
- Planned \$1 billion investment over the next 10 years

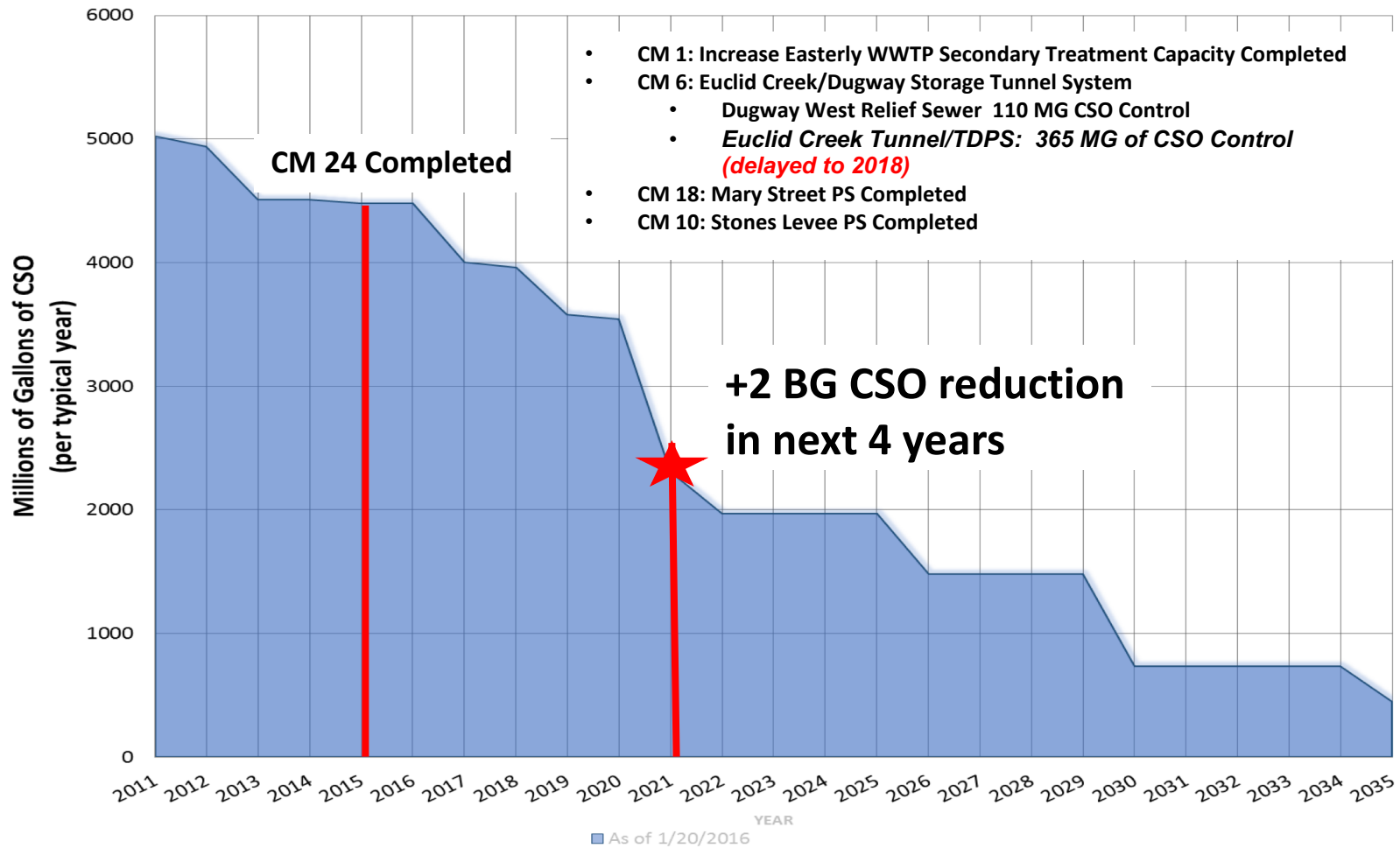


# Philadelphia, Pennsylvania

## Status Update 2016

- Installed over 1,000 “greened acres”
- Reduction of over 1.5 billion gallons of CSOs
- 467 green infrastructure sites





# Lessons Learned

The image features a solid teal background. On the right side, there is a large, white, geometric shape that resembles a stylized arrow or a bracket pointing towards the left. The shape has a diagonal top edge, a horizontal top edge, a vertical right edge, a horizontal bottom edge, and a diagonal bottom edge. The text "Lessons Learned" is positioned on the left side of the teal area.

# Lessons Learned

1

There is a need for BOTH green and grey technologies

---

2

Some cities find green infrastructure to be more cost effective while others find grey to be more cost effective

---

3

Grey infrastructure allows for the management more stormwater during **larger** wet-weather events; green infrastructure good for **small** and **long duration** storms

---

4

Green infrastructure allows for increased public awareness between agencies and rate payers and other environmental benefits

---



# Green Infrastructure is trending



Chicago



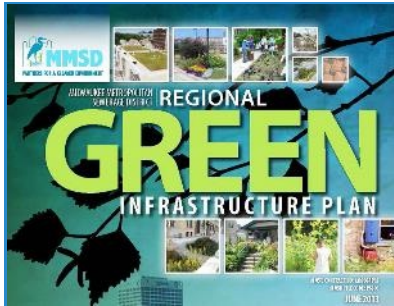
St. Louis



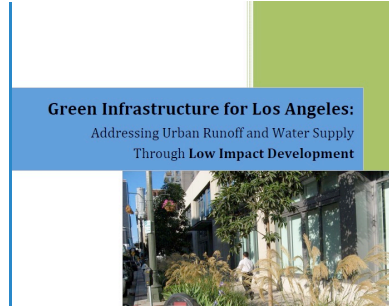
Seattle



Atlanta



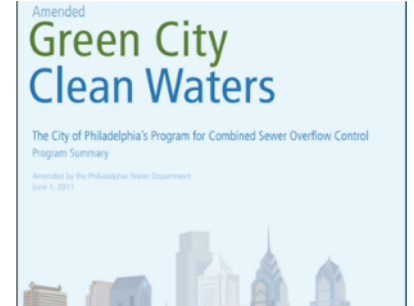
Milwaukee



Los Angeles



New York City

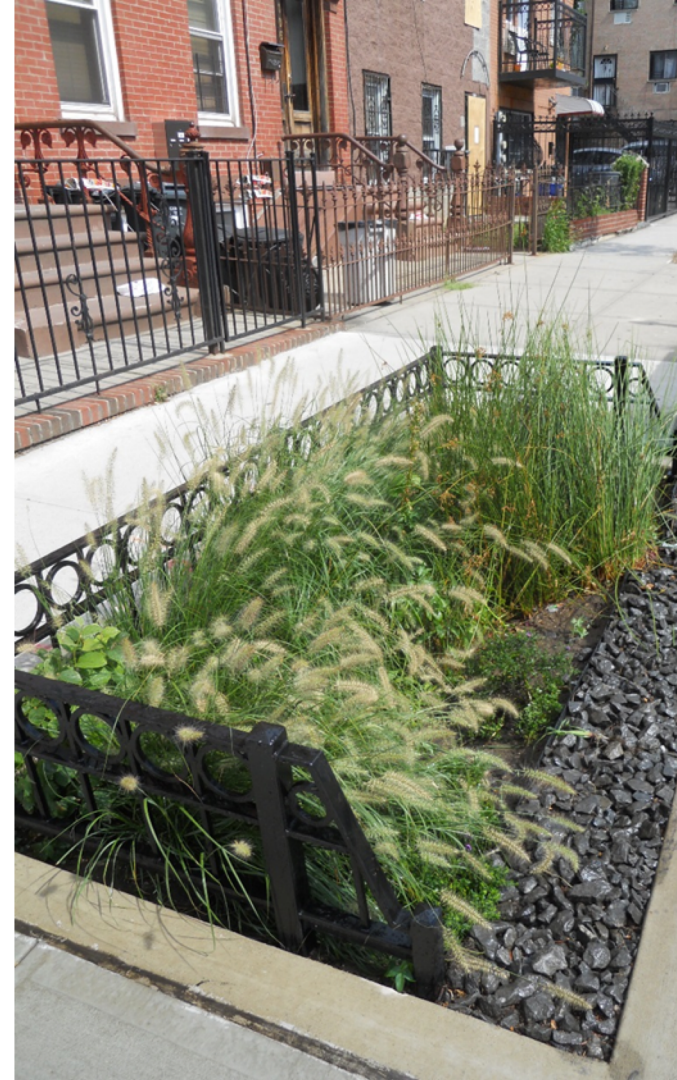


Philadelphia



# Green Infrastructure Lessons Learned

- Use of vegetation & natural features to assure water supplies and manage stormwater
- 85% of storms <1-inch in rainfall volume
- 80% of pollutant mass is transported in the first quarter inch of runoff
- GI is less effective during flash flood events compared to long duration storms
- Dispersed management approach
- Most effective higher in watershed
- Community benefits & visibility
- Long term maintenance plan required
- Public Relations



# Success: Combination of Green and gray

- GI technologies are good for smaller rain events <1 inch in depth
- GI technologies will have minimal effects on large scale flood events
- Gray infrastructure will be more cost effective in storing large volumes of stormwater





# Thank you!

---

Kathryn DePippo, PE, ENV SP  
Project Engineer

E [Kathryn.depippo@mottmac.com](mailto:Kathryn.depippo@mottmac.com)

T 212.532.3078