Environmental Protection

Webinar: DEP's Citywide Parcel-Based Impervious Area Study

June 23, 2020

Housekeeping

- This webinar is being recorded. All participants are muted.

- Please type your questions throughout the webinar in the **Questions Box.**

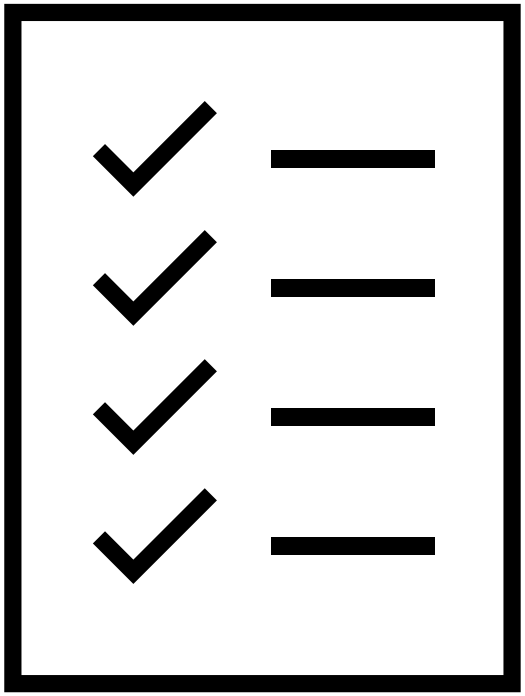
- Questions will be answered at the end of the webinar, following the presentation.

Webinar Agenda

1. Study Objective and Goals
2. Study Overview
3. Study Findings
4. Summary and Next Steps
5. Questions

Study Objective and Goals

Objective: Generate a Geographic Information System (GIS) land cover layer that displays citywide pervious and impervious area at the parcel level.



Goal: Expand and improve upon the analysis that informed the 2010 NYC Green Infrastructure Plan.

- Use an enhanced methodology and data inputs to improve resolution

Goal: Inform and support citywide planning efforts, projects, and programs.

- Apply the parcel-based impervious area GIS layer to ongoing stormwater planning and resiliency planning initiatives

Study Overview

DEP's Citywide Parcel-Based Impervious Area Study is an 18-month analysis that concludes in July 2020.

Data Compilation

- Compiled existing data and data inputs; reviewed and analyzed data to determine suitability for the study

Citywide Impervious Area GIS Layer

- Developed a citywide parcel-based impervious area GIS layer
- Documented the methodology and business rules used to create the layer, plus the QA/QC methods implemented during development

Maintenance Plan

- Developed a maintenance plan with step-by-step instructions for updating the GIS layer in the future, when source datasets (vector only) are updated

Example: Applying the Impervious Area GIS Layer

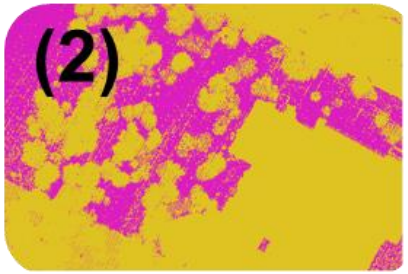
- Analyzed change in imperviousness between 2010 and 2019, and identified the reasons for those changes (e.g., data quality, development)

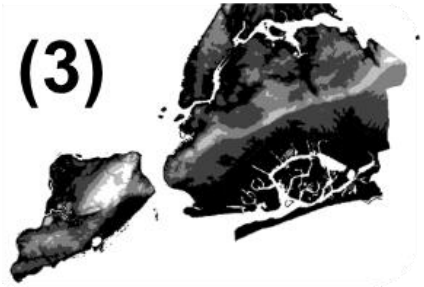
Data Compilation

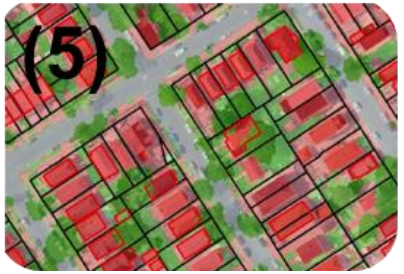
Source Datasets

- All source datasets were analyzed and determined to be suitable for the study
- Four core datasets – **Ortho Imagery, LiDAR, Planimetrics,** and **MapPLUTO** – were identified as a robust set for developing a rational impervious area GIS layer

Source Datasets Used for Impervious Area Layer
(1) 2018 Ortho Imagery
(2) 2017 LiDAR Intensity
(3) 2017 LiDAR Digital Elevation Model
(4) 2016 Planimetrics
(5) Parcels – 2018 MapPLUTO
2018 Building Footprints





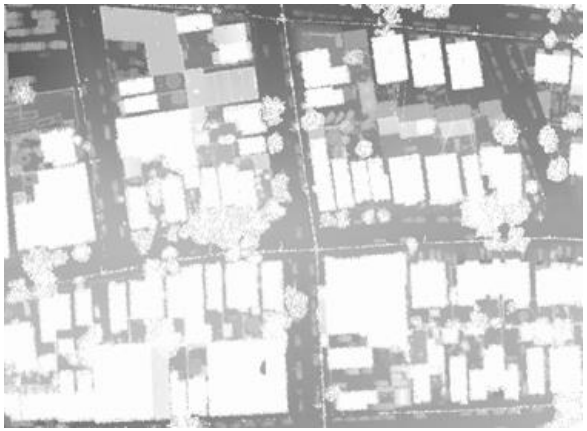


Landcover Classification Process – Remote Sensing

- Remote Sensing is the science of obtaining information about objects or areas from a distance from aircraft, satellites, and handheld devices
- In addition to capturing the visible spectrum (red, green, and blue light), Remote Sensing often provides other bands of data, such as Near Infrared
- Remote Sensing enabled the team to identify a broader range of land classifications at the parcel level, like the difference between grass and artificial turf

Traditional Red, Green, and Blue Light

Near-Infrared



Digital Elevation Model (DEM)

Citywide Impervious Area GIS Layer

Landcover Classification Process

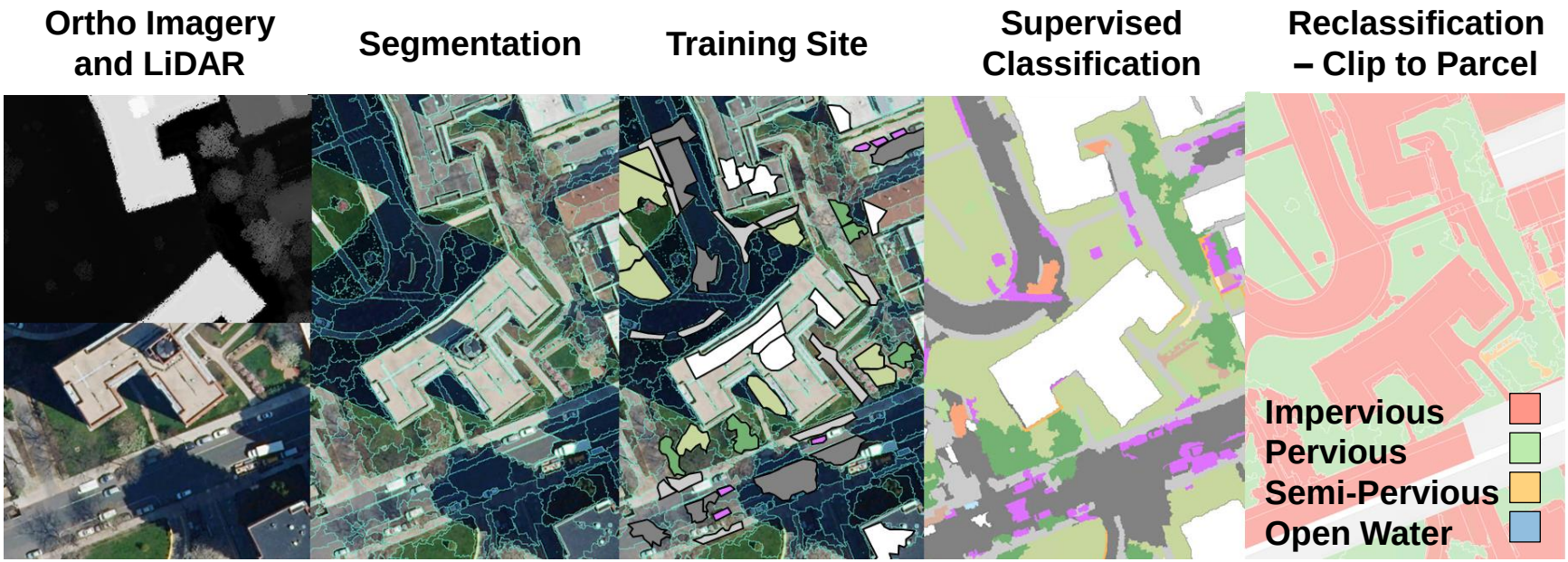
- Nineteen land cover classes were identified and assigned a level of imperviousness and C-Value; C-Value is a weighted runoff coefficient
- C-Values are consistent with DEP's 2012 Guidelines for the Design and Construction of Stormwater Management Systems and best practices in other cities

Land Cover Class	C-Value Range	Level of Imperviousness
1. Metal 2. Rubber 3. Wood	> 0.98	**Impervious**
4. Concrete	0.85-0.98	
5. Roof	0.85-0.95	
6. Asphalt 7. Brick Paver 8. Rock	0.8-0.98	
9. Solar Panel 10. Pool 11. Water	N/A	
12. Gravel	0.25-0.85	**Semi-Pervious**
13. Synthetic Turf	0.25-0.7	
14. Bare Soil	0.15-0.5	
15. Sand	0.3-0.5	**Pervious**
16. Grass 17. Bush	0-0.35	
18. Tree	N/A	
19. Open Water	N/A	**N/A**

Citywide Impervious Area GIS Layer

Layer Development Methodology

- **First:** using the source ortho imagery and LiDAR datasets, each borough was segmented into small areas with similar spatial characteristics, or segments ("Segmentation")
- **Second:** the project team manually trained a computer model to automatically classify 99% of segments as different land surface types, which was then manually checked and cleaned ("Training Site" and "Supervised Classification")
- **Third:** the data was reclassified into three levels of imperviousness, or as Open Water ("Reclassification – Clip to Parcel"), and clipped to MapPLUTO



Citywide Impervious Area GIS Layer

Overall Classification Accuracy and Measure of Confidence

- **Classification Accuracy** is a standard method for defining how accurately a computer model is performing, based on a manually defined accuracy set
  - 85% is a widely accepted value for Classification Accuracy in Remote Sensing
- **Measure of Confidence** was developed for this study to help define the quality of the completed GIS layer against another land cover layer, manually digitized by a hydrologist
  - An independent hydrologist manually assigned surfaces within a subsample of parcels in each borough; this represents the percent of surface area where the computer model and the independent hydrologist were in agreement

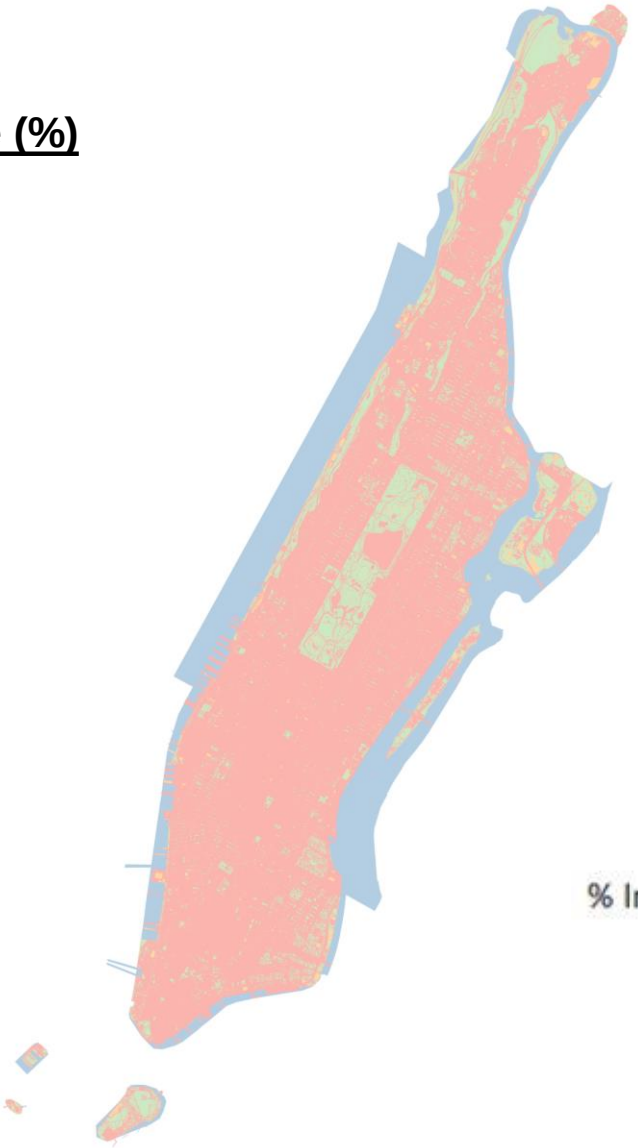
Percent	Classification Accuracy	Measure of Confidence
0%	The computer model never matched the surface type that the project team manually assigned	The completed GIS layer never matched the surface type that the independent hydrologist manually assigned
100%	The computer model always matched the surface type that the project team manually assigned	The completed GIS layer always matched the surface type that the independent hydrologist manually assigned

Impervious Area GIS Layer – Manhattan

Overall Classification Accuracy: 85.86% | Measure of Confidence: 92.35%

Land Cover Percentage (%)

- 29.27 roof
- 23.38 asphalt
- 20.85 open water
- 9.64 tree
- 7.24 concrete
- 4.31 grass
- 1.88 metal
- 0.81 water
- 0.78 bare soil
- 0.44 bush
- 0.43 gravel
- 0.22 brick paver
- 0.22 synthetic turf
- 0.18 wood
- 0.07 rock
- 0.03 solar panel
- 0.01 pool
- 0.01 sand
- 0.00 rubber



63.09% Impervious

14.39% Pervious

1.67% Semi-Pervious

20.85% Open Water

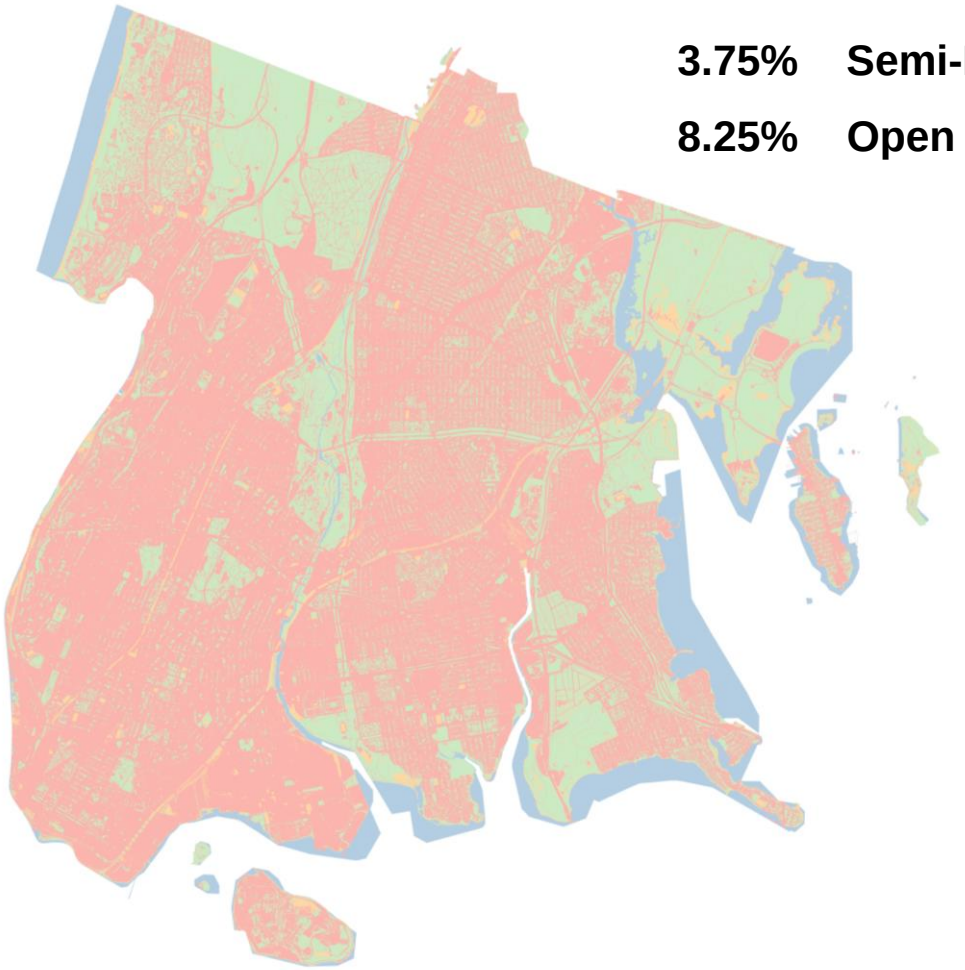
$$\% \text{ Impv} = \frac{\text{Total Impv Cover}}{\text{Total Parcel Area Excluding Open Water}} \times 100\%$$

Impervious Area GIS Layer – Bronx

Overall Classification Accuracy: 89.22% | Measure of Confidence: 88.82%

Land Cover Percentage (%)

- 22.04 asphalt
- 20.91 roof
- 16.10 tree
- 10.47 grass
- 9.77 concrete
- 8.25 open water
- 3.44 bush
- 3.15 metal
- 1.82 bare soil
- 1.66 gravel
- 0.69 water
- 0.39 sand
- 0.35 wood
- 0.27 synthetic turf
- 0.24 brick paver
- 0.20 rock
- 0.13 solar panel
- 0.11 pool
- 0.00 rubber

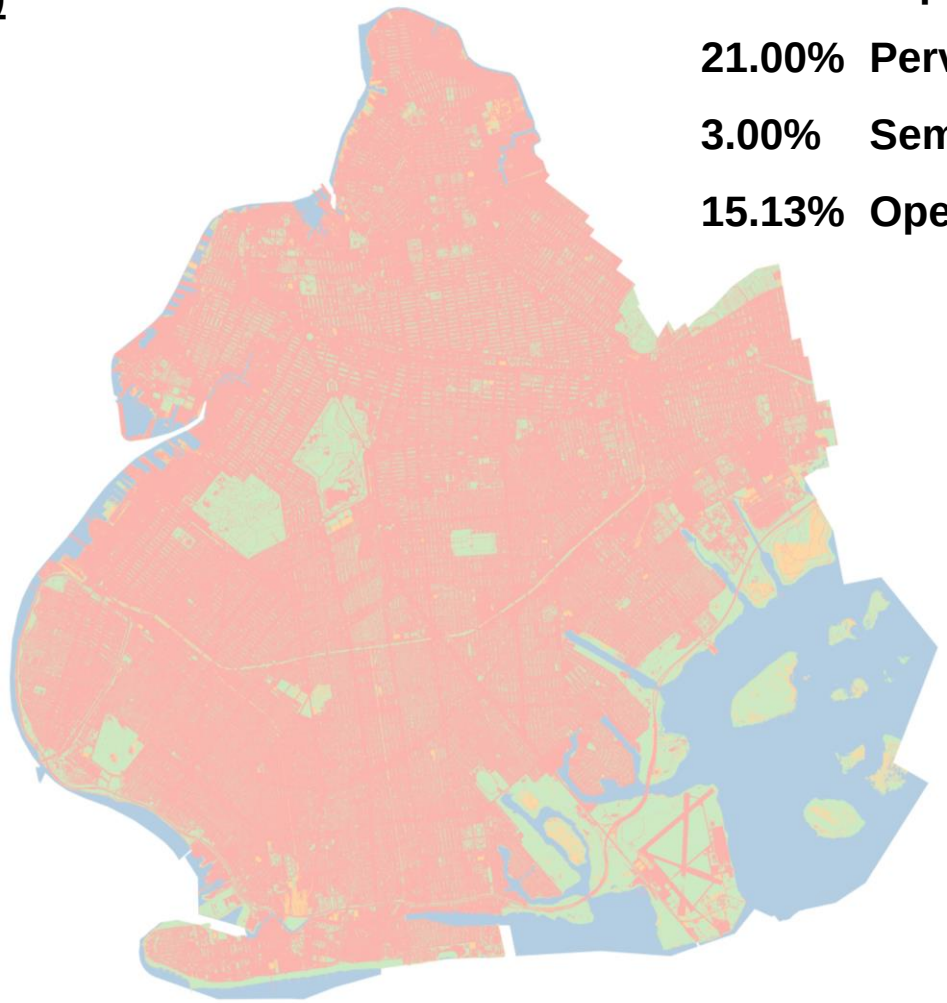


Impervious Area GIS Layer – Brooklyn

Overall Classification Accuracy: 86.90% | Measure of Confidence: 92.01%

Land Cover Percentage (%)

- 25.07 roof
- 16.74 asphalt
- 15.13 open water
- 14.76 concrete
- 10.13 tree
- 7.90 grass
- 2.97 metal
- 1.86 bush
- 1.54 bare soil
- 1.25 gravel
- 1.11 sand
- 0.54 brick paver
- 0.22 pool
- 0.22 synthetic turf
- 0.19 water
- 0.17 solar panel
- 0.17 wood
- 0.03 rock
- 0.00 rubber

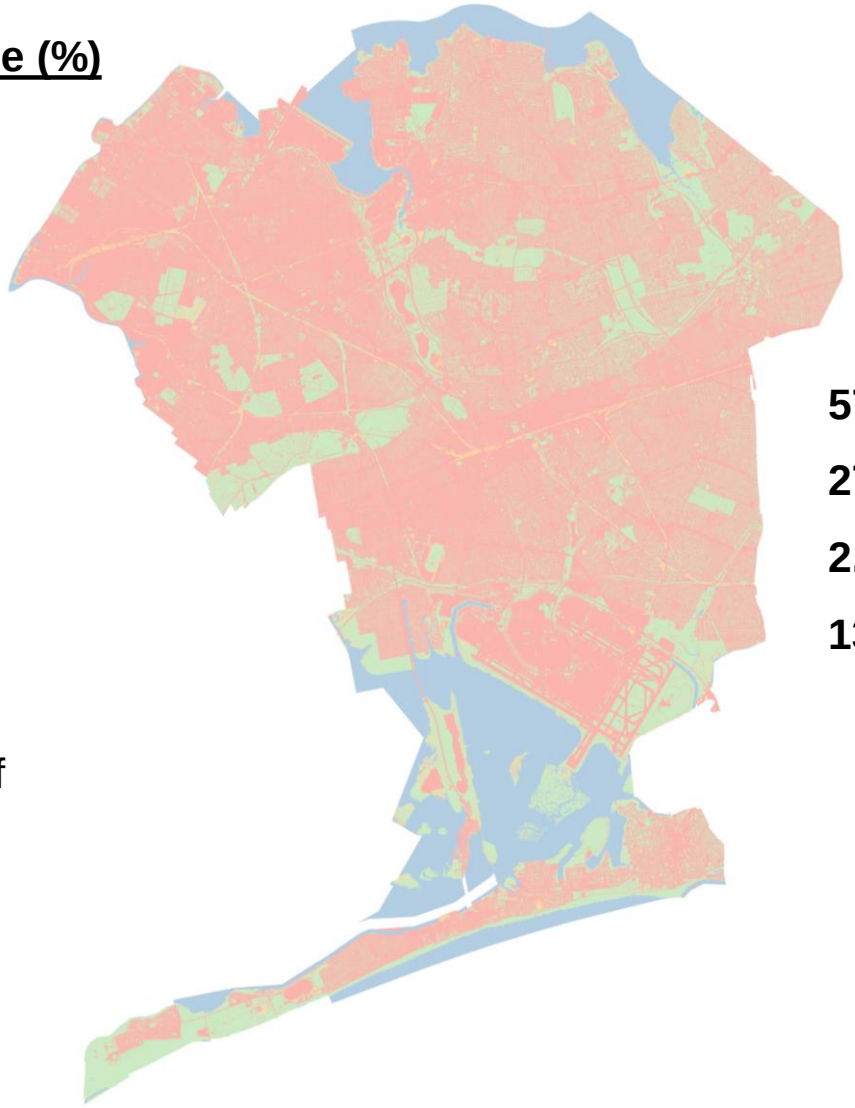


Impervious Area GIS Layer – Queens

Overall Classification Accuracy: 88.05% | Measure of Confidence: 96.36%

Land Cover Percentage (%)

- 19.44 asphalt
- 19.09 roof
- 15.18 grass
- 14.67 concrete
- 13.22 open water
- 8.83 tree
- 2.82 metal
- 1.72 bush
- 1.50 sand
- 1.25 gravel
- 0.71 bare soil
- 0.59 water
- 0.32 brick paver
- 0.20 synthetic turf
- 0.20 wood
- 0.13 pool
- 0.11 solar panel
- 0.03 rock
- 0.00 rubber



57.39% Impervious

27.24% Pervious

2.15% Semi-Pervious

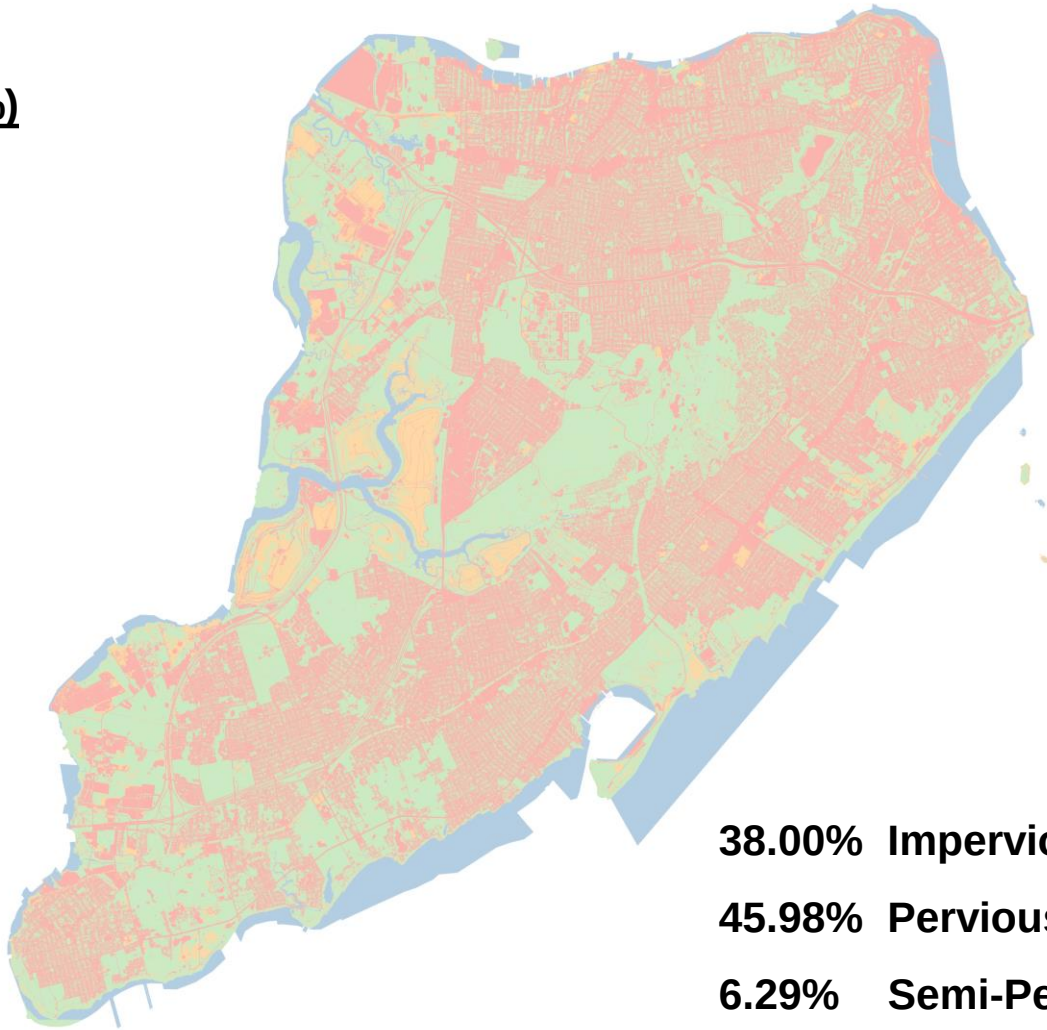
13.22% Open Water

Impervious Area GIS Layer – Staten Island

Overall Classification Accuracy: 86.65% | Measure of Confidence: 87.30%

Land Cover Percentage (%)

- 26.40 tree
- 15.17 grass
- 13.92 asphalt
- 13.67 roof
- 9.73 open water
- 6.16 concrete
- 4.84 bare soil
- 3.55 bush
- 1.50 metal
- 1.30 gravel
- 0.92 water
- 0.86 sand
- 0.82 brick paver
- 0.48 pool
- 0.44 solar panel
- 0.15 synthetic turf
- 0.08 wood
- 0.00 rock
- 0.00 rubber



Example: Applying the Impervious Area GIS Layer

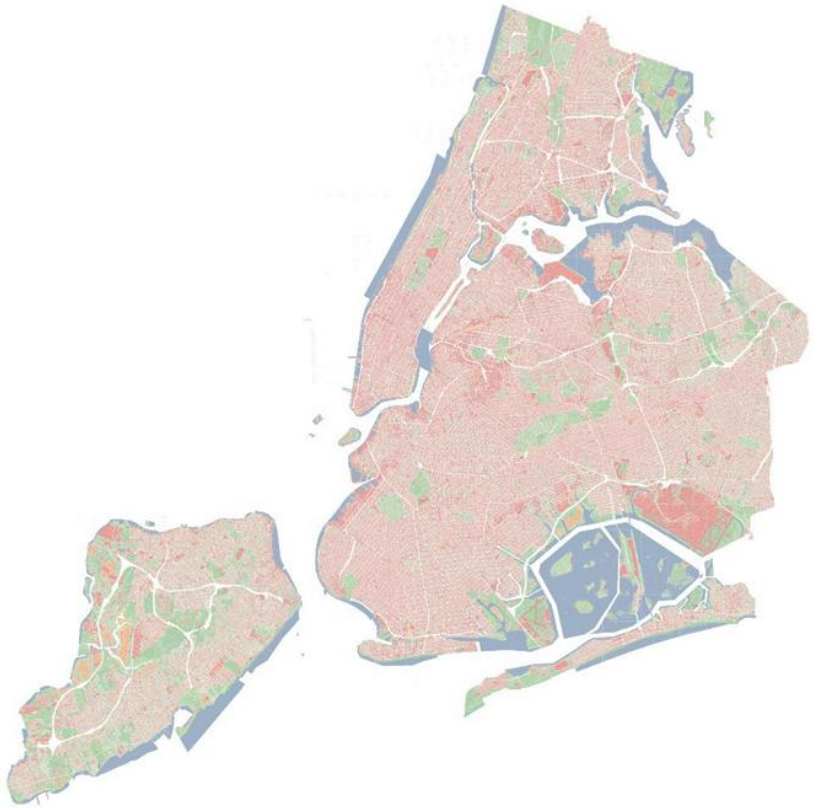
- Applied the impervious area GIS layer to broadly identify pervious and impervious changes between 2010 and 2019; identified reasons for those changes
- Eight reasons for change in imperviousness and perviousness between 2010 and 2019 were identified

Reason for Change	Description
1. Improved Data and Methodology	Includes increased resolution between 2010 and 2019, methodology improvements, correction of incorrectly identified surfaces in 2010 due to dense shadows, and other errors in 2010
2. Land Cover Changes	Includes new developments and other significant changes in land cover between the 2010 dataset and this 2019 impervious area GIS layer
3. Tree Canopies	Tree canopy was “on” in 2010, while it was removed (“off”) in 2019
4. Bare Soil, Gravel, and Synthetic Turf	Bare Soil, Gravel, and Synthetic Turf were classified as “impervious” in 2010, while classified as “semi-pervious” in 2019
5. Natural Features	Includes coastal areas, wetlands, and other areas that were subject to change due to natural reasons between 2010 and 2019
6. Green Roofs	Accounts for green roofs installed or removed after 2010
7. Playgrounds	Accounts for playgrounds installed or removed after 2010
8. Unknown	Any data not classified

Example: Applying the Impervious Area GIS Layer

Net Pervious Area Change Since 2010: -0.12 square miles (-0.1%)

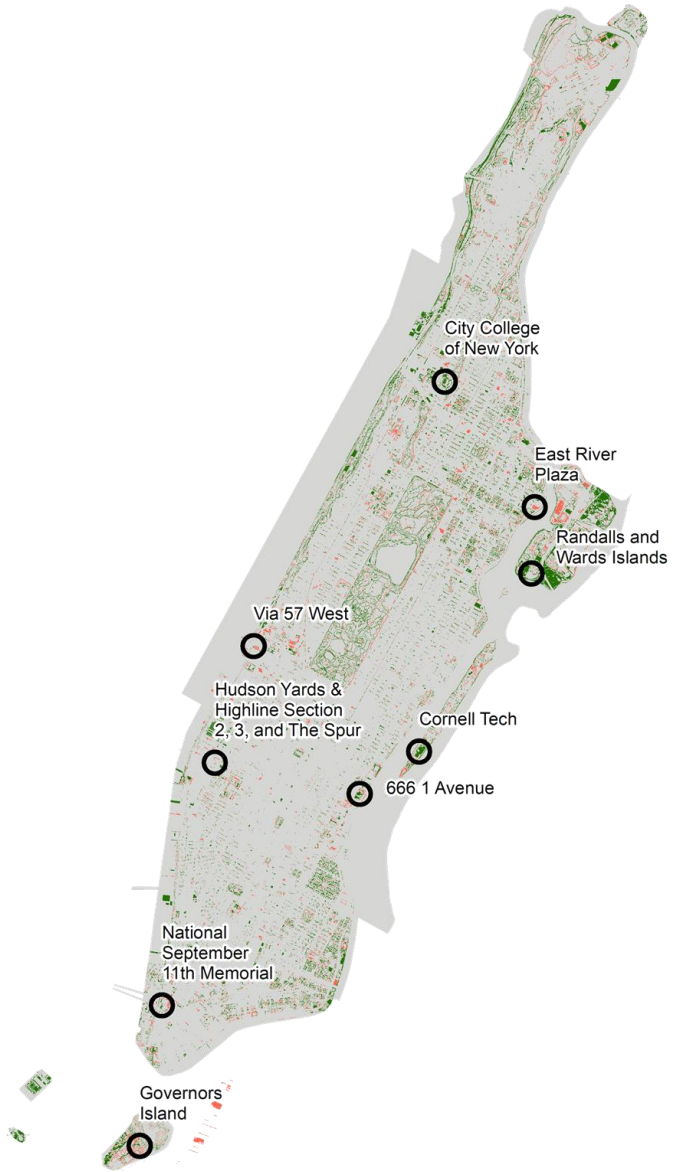
Citywide		
Reason for Change	**Pervious to Impervious Change in Sq. Miles (%)**	**Impervious to Pervious Change in Sq. Miles (%)**
Improved Data and Methodology	21.59 (91%)	14.42 (61%)
Land Cover Changes	1.11 (5%)	0.70 (3%)
Tree Canopies	0.22 (1%)	0.38 (2%)
Bare Soil, Gravel, and Synthetic Turf	0.00 (0%)	4.13 (18%)
Natural Features	0.00 (0%)	2.37 (10%)
Green Roofs	0.00 (0%)	0.09 (0%)
Playgrounds	0.31 (1%)	0.25 (1%)
Unknown	0.42 (2%)	1.19 (5%)
Total	**23.65 Square Miles**	**23.53 Square Miles**



Example: Applying the Impervious Area GIS Layer

Net Pervious Area Change Since 2010: +0.95 square miles (+31.0%)

Manhattan		
Reason for Change	**Pervious to Impervious Change in Sq. Miles (%)**	**Impervious to Pervious Change in Sq. Miles (%)**
Improved Data and Methodology	0.53 (78%)	0.86 (53%)
Land Cover Changes	0.07 (9%)	0.19 (12%)
Tree Canopies	0.06 (8%)	0.29 (18%)
Bare Soil, Gravel, and Synthetic Turf	0.00 (0%)	0.15 (9%)
Natural Features	0.00 (0%)	0.04 (2%)
Green Roofs	0.00 (0%)	0.06 (4%)
Playgrounds	0.03 (5%)	0.01 (0%)
Unknown	0.00 (0%)	0.04 (2%)
Total	**0.69 Square Miles**	**1.63 Square Miles**



Example: Applying the Impervious Area GIS Layer

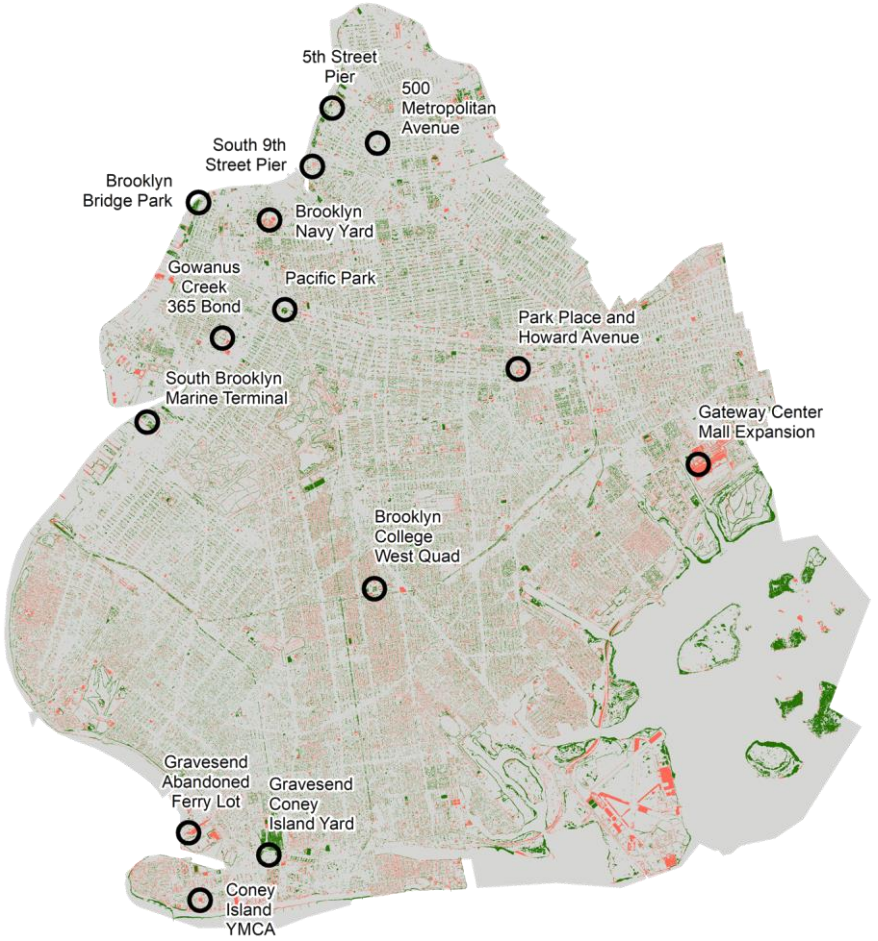
Net Pervious Area Change Since 2010: +1.90 square miles (+15.1%)

Bronx		
Reason for Change	**Pervious to Impervious Change in Sq. Miles (%)**	**Impervious to Pervious Change in Sq. Miles (%)**
Improved Data and Methodology	2.03 (88%)	2.99 (71%)
Land Cover Changes	0.10 (4%)	0.07 (2%)
Tree Canopies	0.08 (4%)	0.00 (0%)
Bare Soil, Gravel, and Synthetic Turf	0.00 (0%)	0.47 (11%)
Natural Features	0.00 (0%)	0.21 (5%)
Green Roofs	0.00 (0%)	0.00 (0%)
Playgrounds	0.04 (2%)	0.02 (0%)
Unknown	0.04 (2%)	0.44 (11%)
Total	**2.30 Square Miles**	**4.21 Square Miles**

Example: Applying the Impervious Area GIS Layer

Net Pervious Area Change Since 2010: +2.60 square miles (+18.0%)

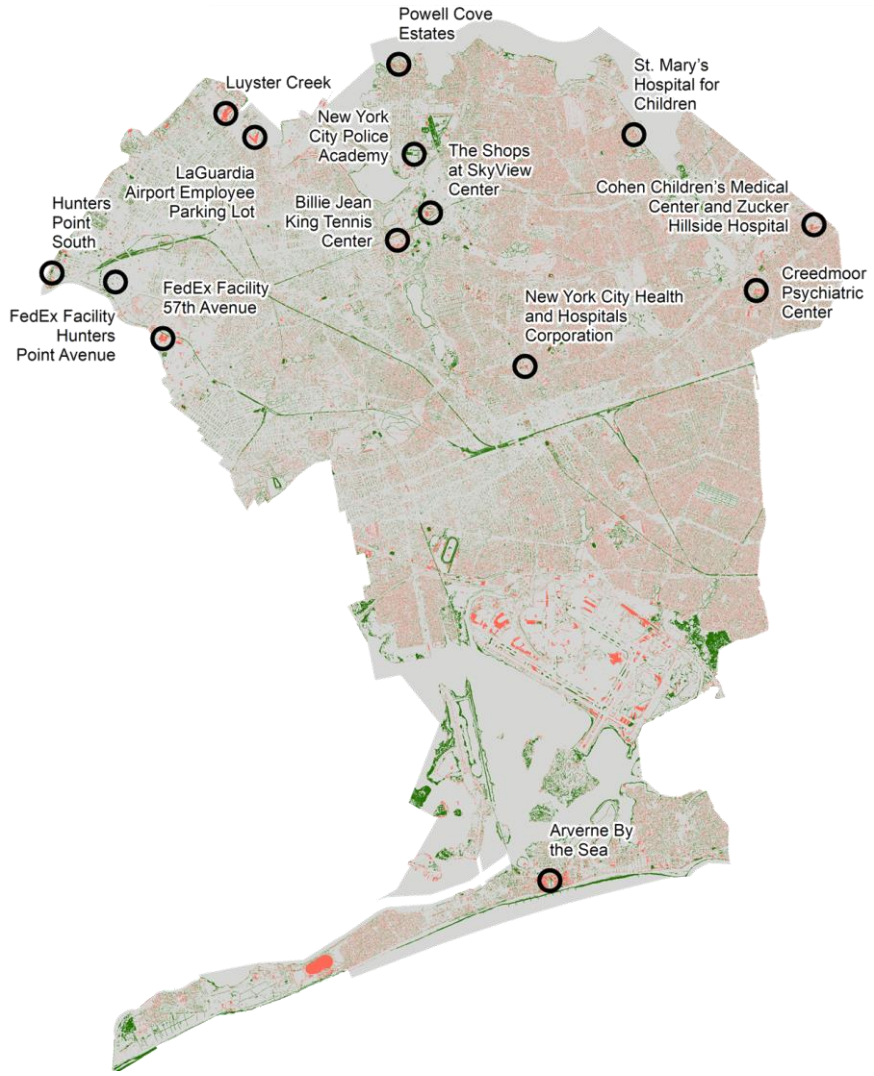
Brooklyn		
Reason for Change	**Pervious to Impervious Change in Sq. Miles (%)**	**Impervious to Pervious Change in Sq. Miles (%)**
Improved Data and Methodology	3.10 (87%)	4.32 (70%)
Land Cover Changes	0.23 (7%)	0.11 (2%)
Tree Canopies	0.08 (2%)	0.09 (2%)
Bare Soil, Gravel, and Synthetic Turf	0.00 (0%)	0.50 (8%)
Natural Features	0.00 (0%)	0.70 (11%)
Green Roofs	0.00 (0%)	0.02 (0%)
Playgrounds	0.07 (2%)	0.13 (2%)
Unknown	0.08 (2%)	0.27 (5%)
Total	**3.56 Square Miles**	**6.15 Square Miles**



Example: Applying the Impervious Area GIS Layer

Net Pervious Area Change Since 2010: +0.24 square miles (+0.7%)

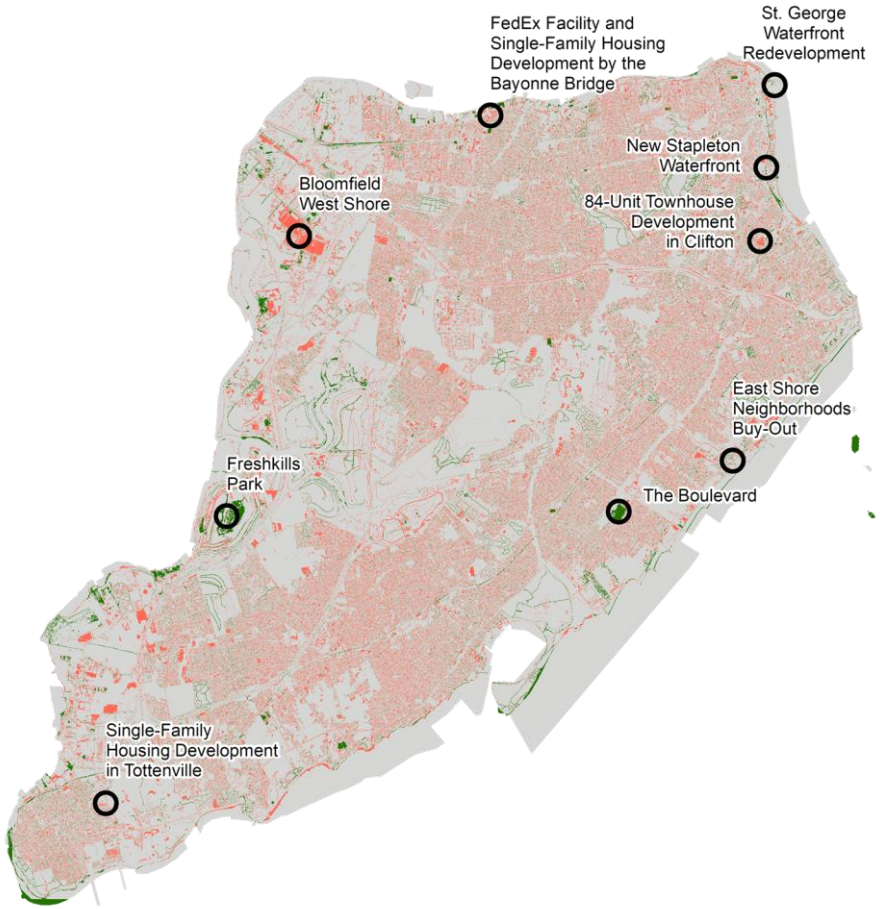
Queens		
Reason for Change	**Pervious to Impervious Change in Sq. Miles (%)**	**Impervious to Pervious Change in Sq. Miles (%)**
Improved Data and Methodology	8.19 (94%)	5.08 (57%)
Land Cover Changes	0.22 (2%)	0.03 (0%)
Tree Canopies	0.00 (0%)	0.00 (0%)
Bare Soil, Gravel, and Synthetic Turf	0.00 (0%)	2.18 (24%)
Natural Features	0.00 (0%)	1.19 (13%)
Green Roofs	0.00 (0%)	0.01 (0%)
Playgrounds	0.09 (1%)	0.08 (1%)
Unknown	0.23 (3%)	0.39 (5%)
Total	**8.72 Square Miles**	**8.95 Square Miles**



Example: Applying the Impervious Area GIS Layer

Net Pervious Area Change Since 2010: -5.80 square miles (-15.7%)

Staten Island		
Reason for Change	**Pervious to Impervious Change in Sq. Miles (%)**	**Impervious to Pervious Change in Sq. Miles (%)**
Improved Data and Methodology	7.75 (92%)	1.17 (45%)
Land Cover Changes	0.49 (6%)	0.30 (11%)
Tree Canopies	0.00 (0%)	0.00 (0%)
Bare Soil, Gravel, and Synthetic Turf	0.00 (0%)	0.83 (32%)
Natural Features	0.00 (0%)	0.23 (9%)
Green Roofs	0.00 (0%)	0.00 (0%)
Playgrounds	0.07 (1%)	0.01 (1%)
Unknown	0.08 (1%)	0.04 (2%)
Total	**8.39 Square Miles**	**2.59 Square Miles**



Summary and Next Steps

The parcel-level land cover GIS layer generated by this study is the first of its kind for New York City. The layer is based on a robust methodology, updated data, and enhanced technology, making it an important policy and planning tool.

Borough-Level Imperviousness Summary				
Borough	**Impervious**	**Semi-Pervious**	**Pervious**	**Open Water**
Manhattan	63.09%	1.67%	14.39%	20.85%
Bronx	57.58%	3.75%	30.41%	8.25%
Brooklyn	60.86%	3.00%	21.00%	15.13%
Queens	57.39%	2.15%	27.24%	13.22%
Staten Island	38.00%	6.29%	45.98%	9.73%

The parcel-level land cover GIS layer can be broadly applied. Applications include but are not limited to:

- Supporting models for estimating flooding and other climate change impacts
- Correlating imperviousness with other metrics, including heat and surface temperature, erosion, socioeconomics, and population/density trends
- Illustrating the effectiveness of green infrastructure at managing stormwater and imperviousness
- Supporting a One Water or integrated approach to managing the city's water resources

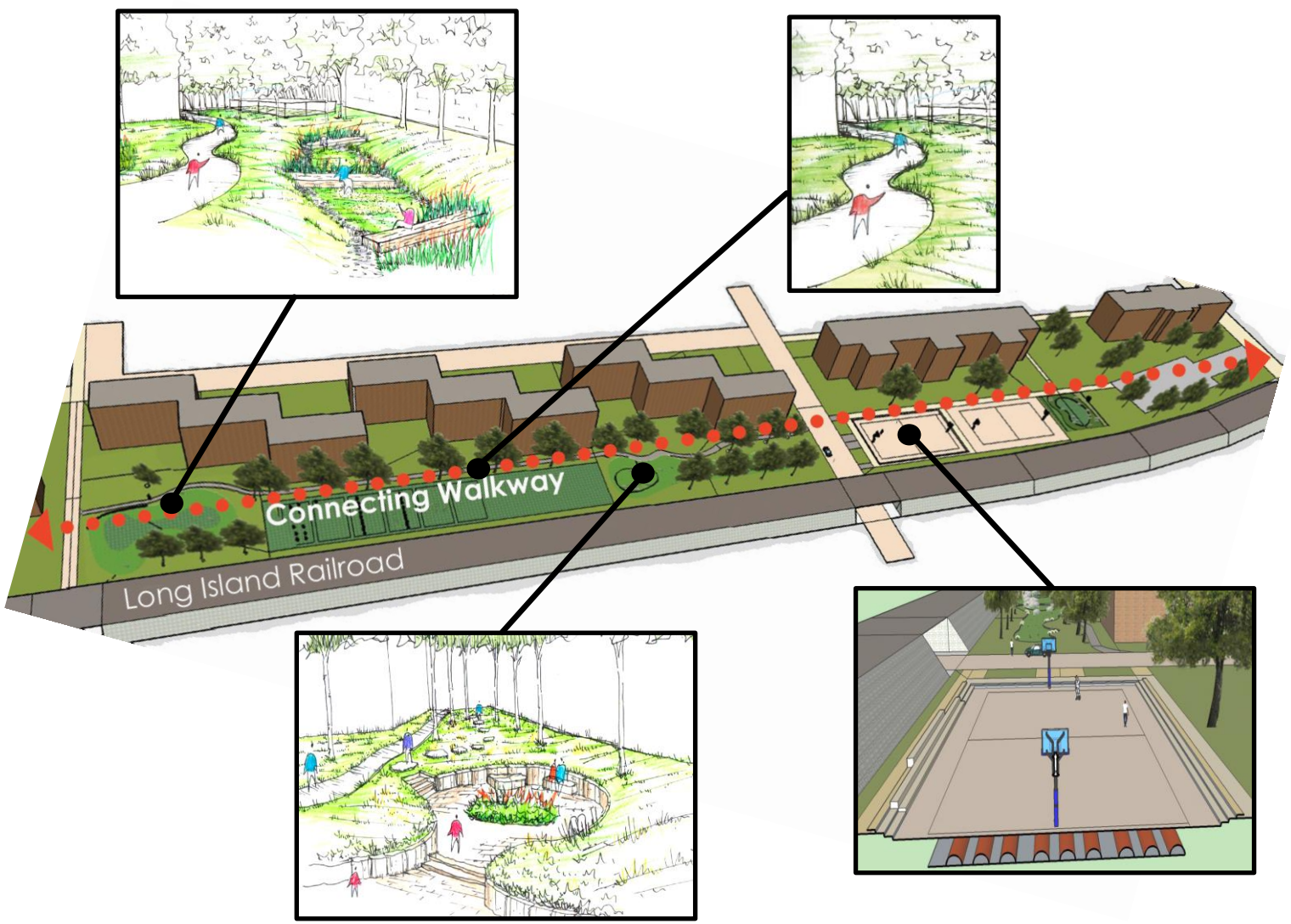
Developing an Integrated Approach

"One Water is an integrated planning and implementation approach to managing finite water resources for long-term resiliency and reliability, meeting both community and ecosystem needs."

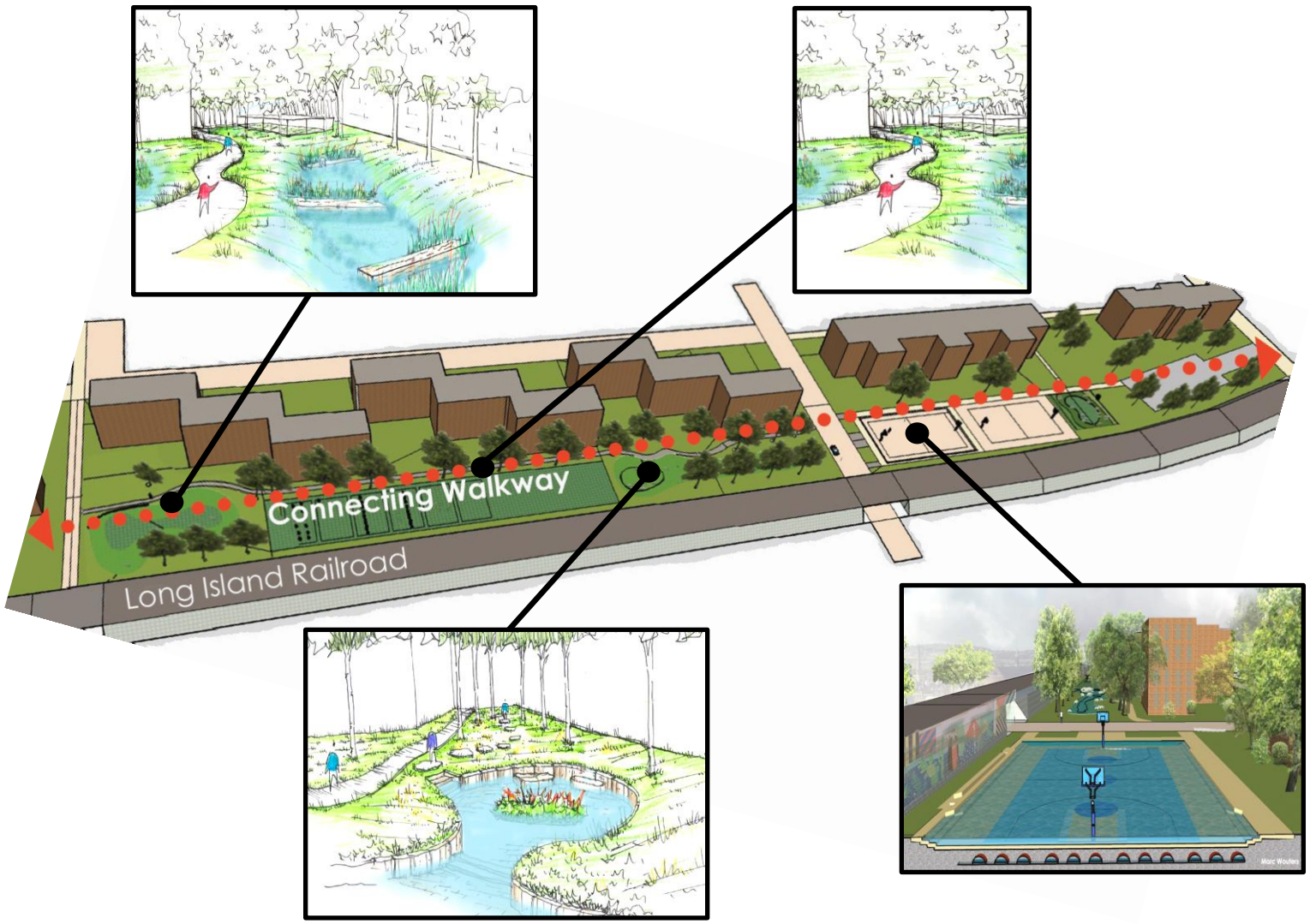
-Water Research Foundation

Green Infrastructure Program

Cloudburst Management Pilot Program



Cloudburst Management Pilot Program



Integrated Water/Stormwater Benefits

Central Park Jackie Onassis Reservoir Recirculation Project

- 830,000 gallons per day of potable water savings
- **About 4 Million Gallons per year** of Combined Sewer Overflow reduction to the East River

Prospect Park Valve Replacement Project

- 800,000 gallons per day of potable water savings
- **About 12 Million Gallons per year** of Combined Sewer Overflow reduction to New York Bay

Water Conservation and Reuse Pilot Program

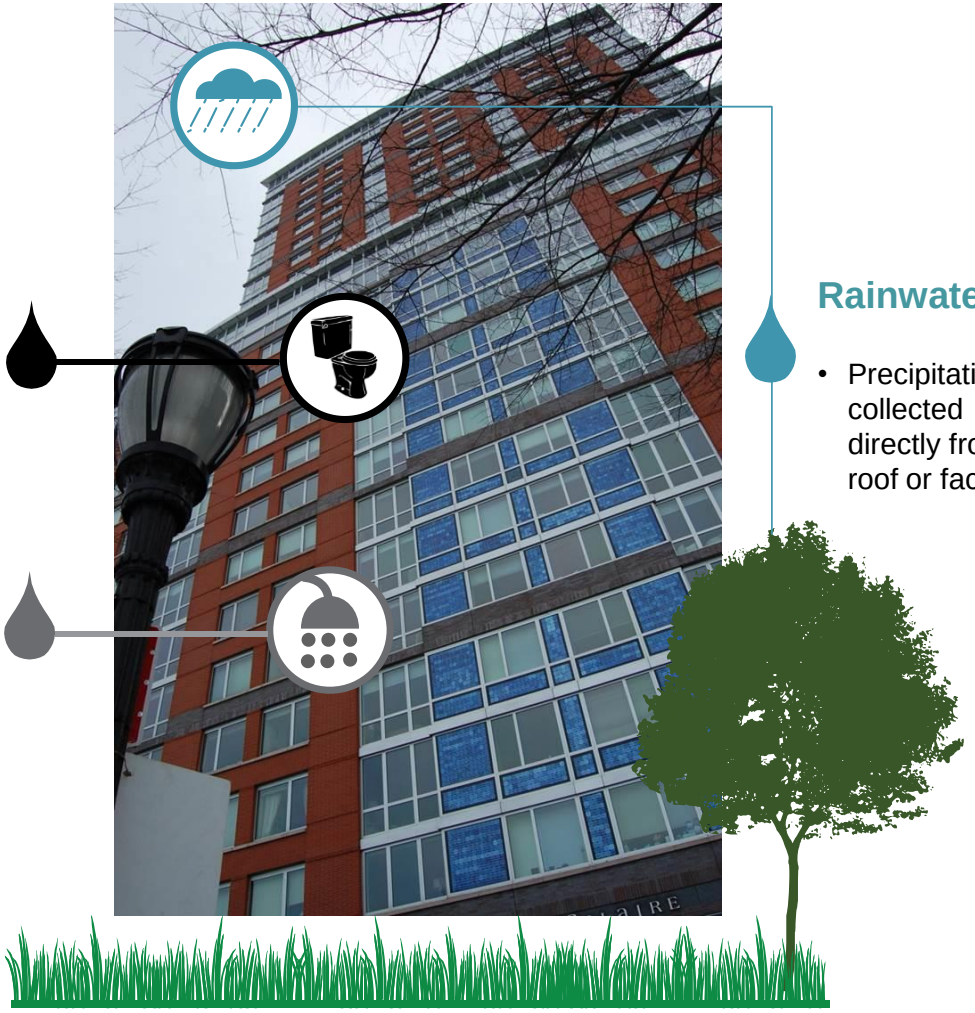
Treated water can be used for non-potable reuse including flushing, laundry, and cooling.

Black Water

- Toilets
- Showers
- Washers
- Cooling tower washdown/ blowdown
- Any other fixtures discharging animal or vegetable matter

Gray Water

- Discharge from lavatories and condensate water



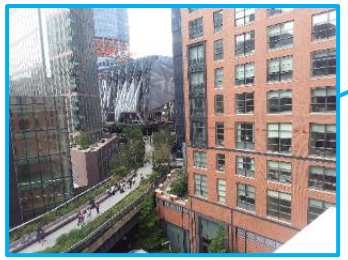
Rainwater

- Precipitation collected directly from roof or facade

Examples of Water Reuse and Recirculation

Forest House

Related Companies



Brooklyn Botanic Garden

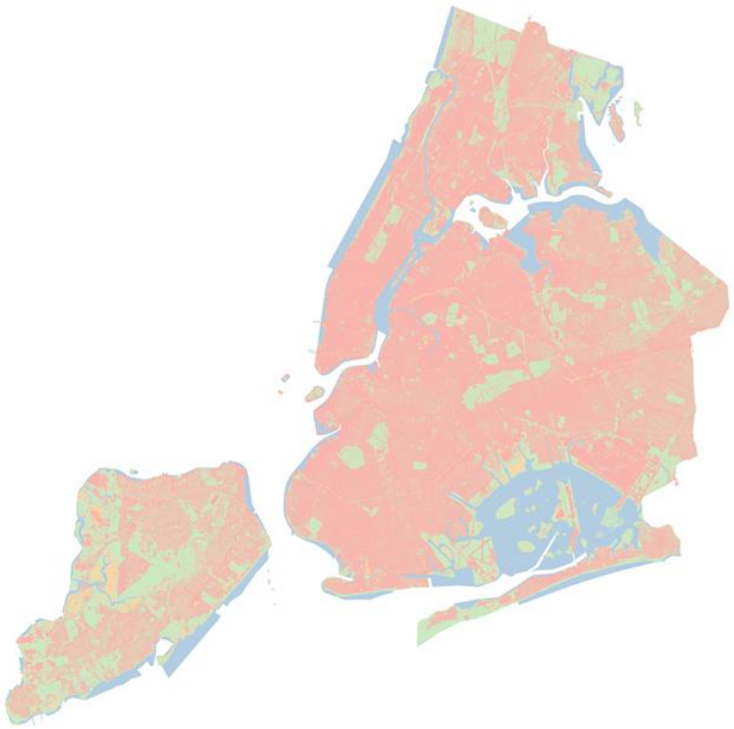
FDNY Fire Academy

Local 1 Plumbers Union

Summary and Next Steps

The parcel-level land cover GIS layer will be available on OpenData in July and will include the following feature classes for each borough:

Feature Class	Summary/Description
Impervious Area per Parcel	Three levels of imperviousness were derived: Pervious, Semi-Pervious, and Impervious. Open Water areas are kept separate.
Percent Impervious Area per Parcel	Percent imperviousness per parcel.
Land Cover Classification per Parcel	Land cover classification per parcel. 19 classes total.



Thank you! Questions?

Contact Information:

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