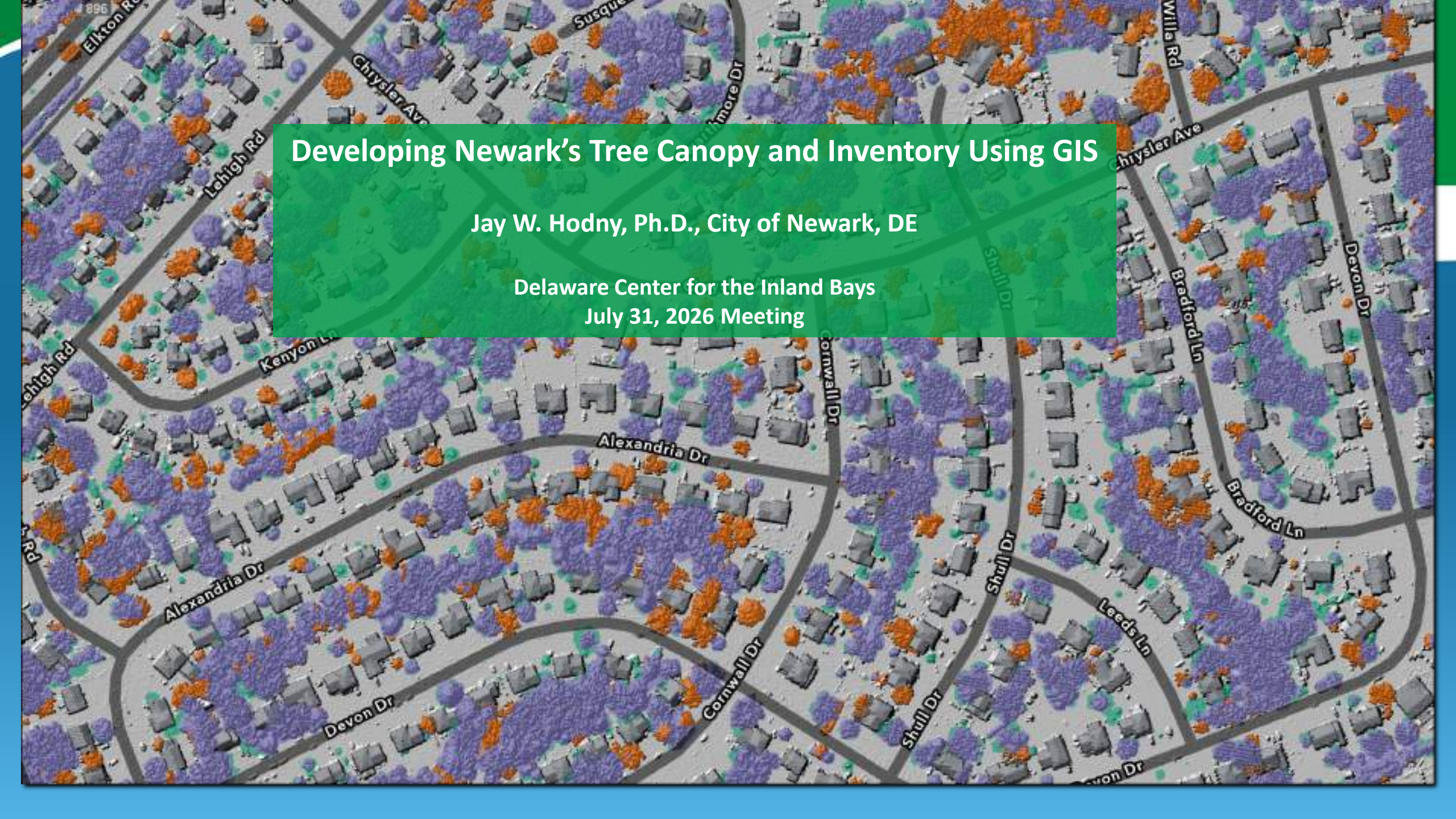




Developing Newark's Tree Canopy and Inventory Using GIS

Jay W. Hodny, Ph.D., City of Newark, DE

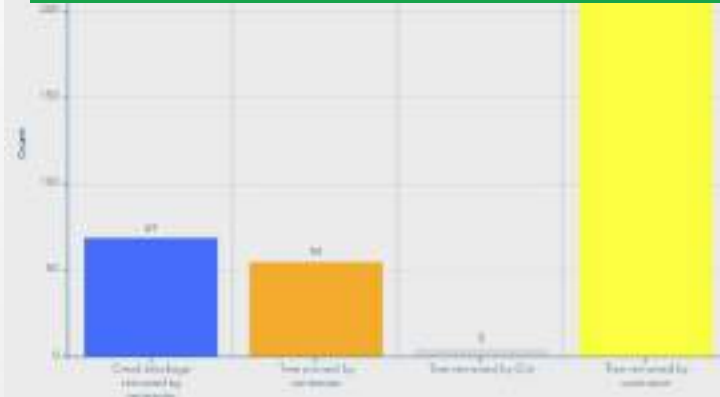
Delaware Center for the Inland Bays
July 31, 2026 Meeting

City of Newark, DE

- ▶ Tree City USA member for 22+ years
- ▶ November 2015 – Tree inventory on city-owned property
 - ▶ 4,087 trees, genus/species, tree condition, maintenance recommendations
- ▶ ArcGIS Dashboard – track tree maintenance and creek blockage costs
- ▶ Newark's Sustainability Plan – 2019
 - ▶ Goal 4.3: growing canopy to 36% by 2030
 - ▶ Maintain/replace existing trees
- ▶ From above – tree canopy – U of Vermont Spatial Analysis Laboratory
 - ▶ Canopy change over time, where to plant
- ▶ From below – tree inventory – “boots-on-the-ground” application
 - ▶ Tree location, identify, condition, other
- ▶ Together – more impactful forestry decisions

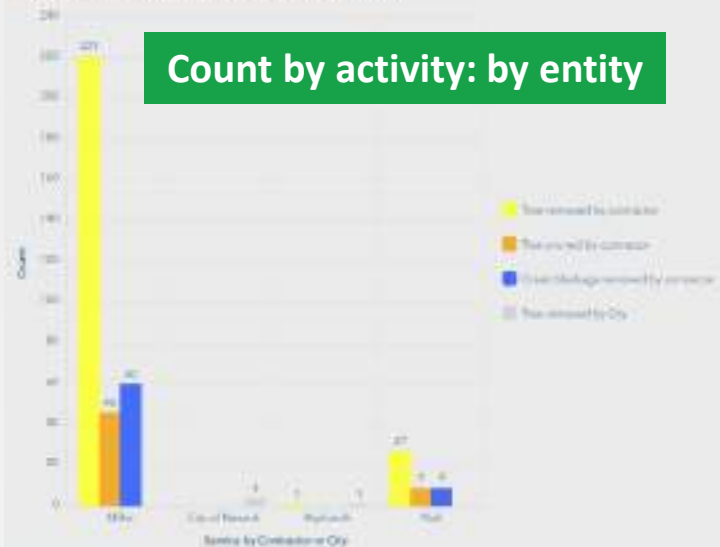


Count by activity: city or contractor



Removal and pruning of trees and removal of fallen trees in stream (creek blockages) by the City and its contractors. (As of May 12, 2022, includes 2019 data since the start of tracking the tree maintenance is GIS)

Services Provided by Contractor or City Employees (by count)

144 *Journal of Management Education* 34(1)

Activity location
Symbology by activity: city or contractor

[Map Larger](#)

True and Crink Mustardseed Seed FS

FREE MOVIE

Trade - ThailandPositive

- DCF
- Japan HB
- New Castle
- Network

Marek_Arciuch_ParkRec_Server_PS

- [illegible]

Hope to resurrect and expand Dashboard

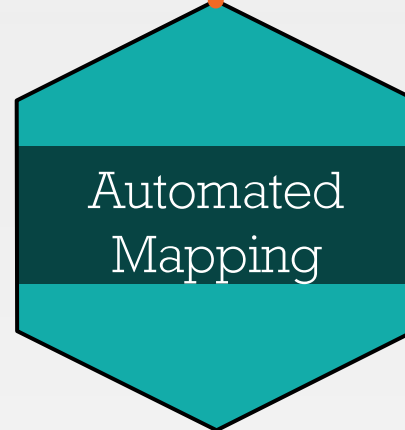
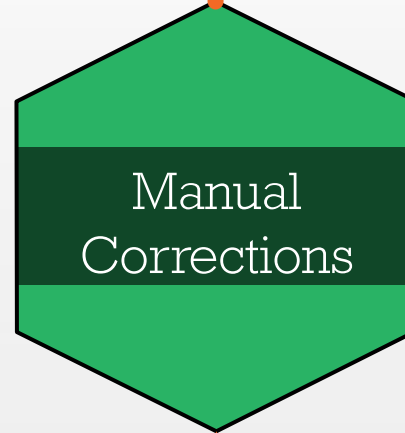
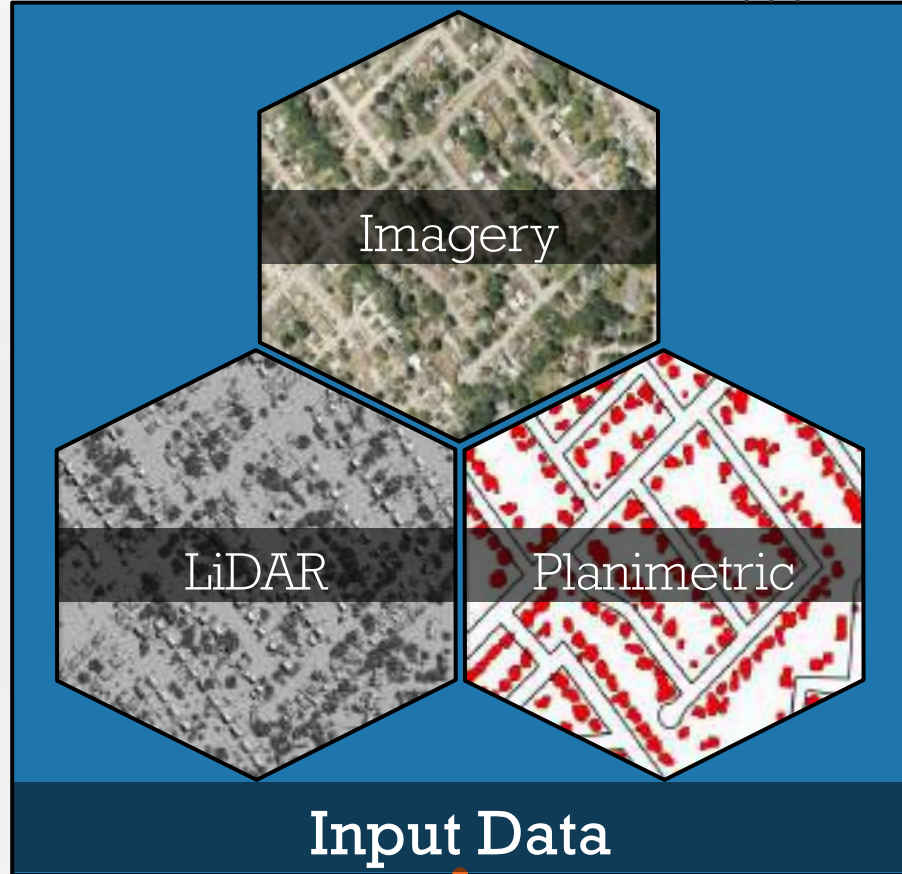
Maintenance Costs

\$358,579

As of late spring 2020...

The Tree Canopy - from above

- ▶ Land Cover Mapping – imagery and lidar (8 ft height)
- ▶ Tree Canopy & Change Mapping (2014 and 2023)
- ▶ USDA Forest Service's Urban Tree Canopy protocols



Lidar – find relative high point of tree, then trace down until sharp change in elevation = crown edge

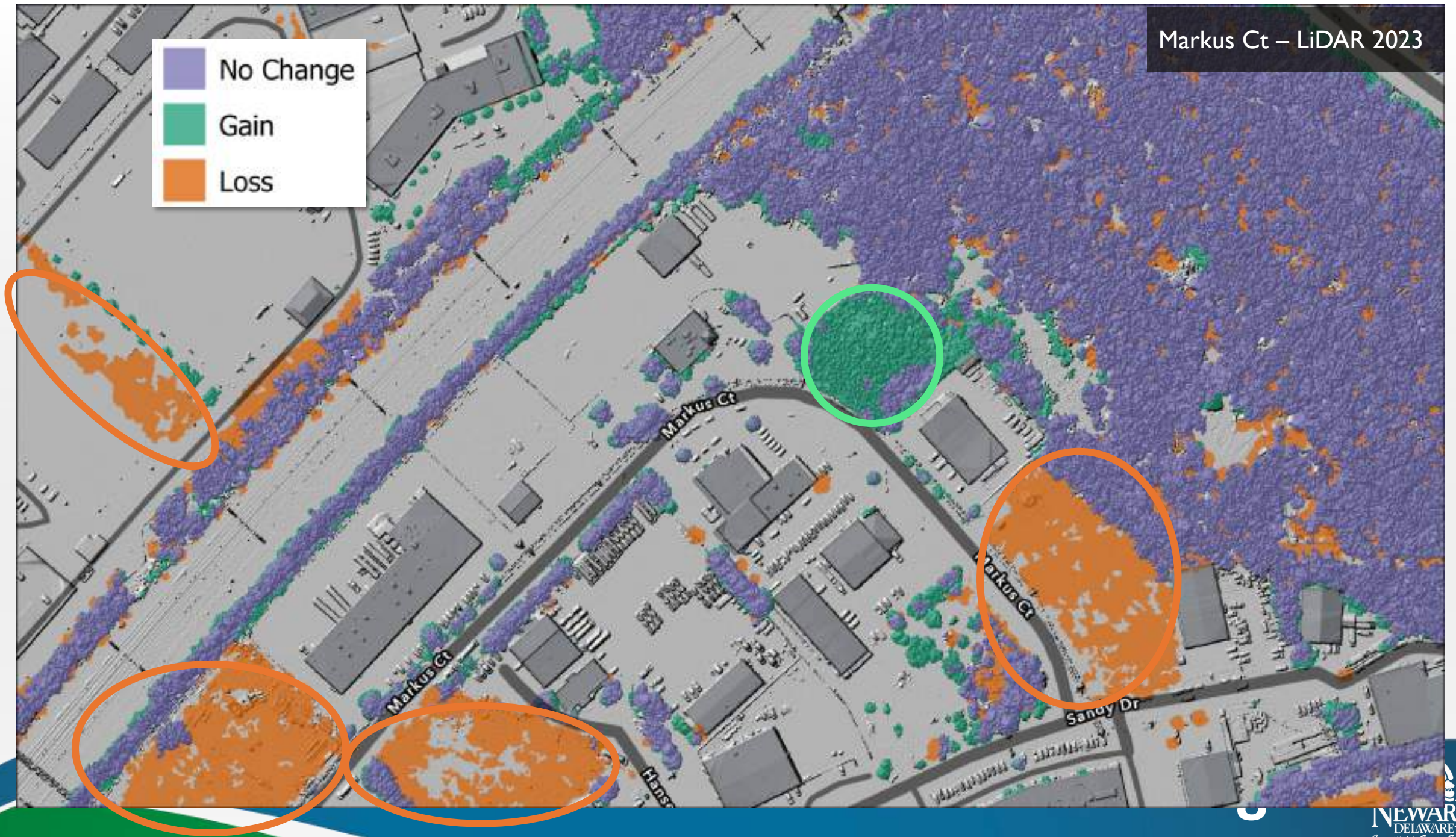


80,000

Estimated Individual Trees in 2023







The Tree Canopy - from above

Goal 4.3: Grow canopy to 36% by 2030

NET GAIN: +5 acres, canopy growth



Tree Canopy is Stable

34.7% in 2014

34.8% in 2023



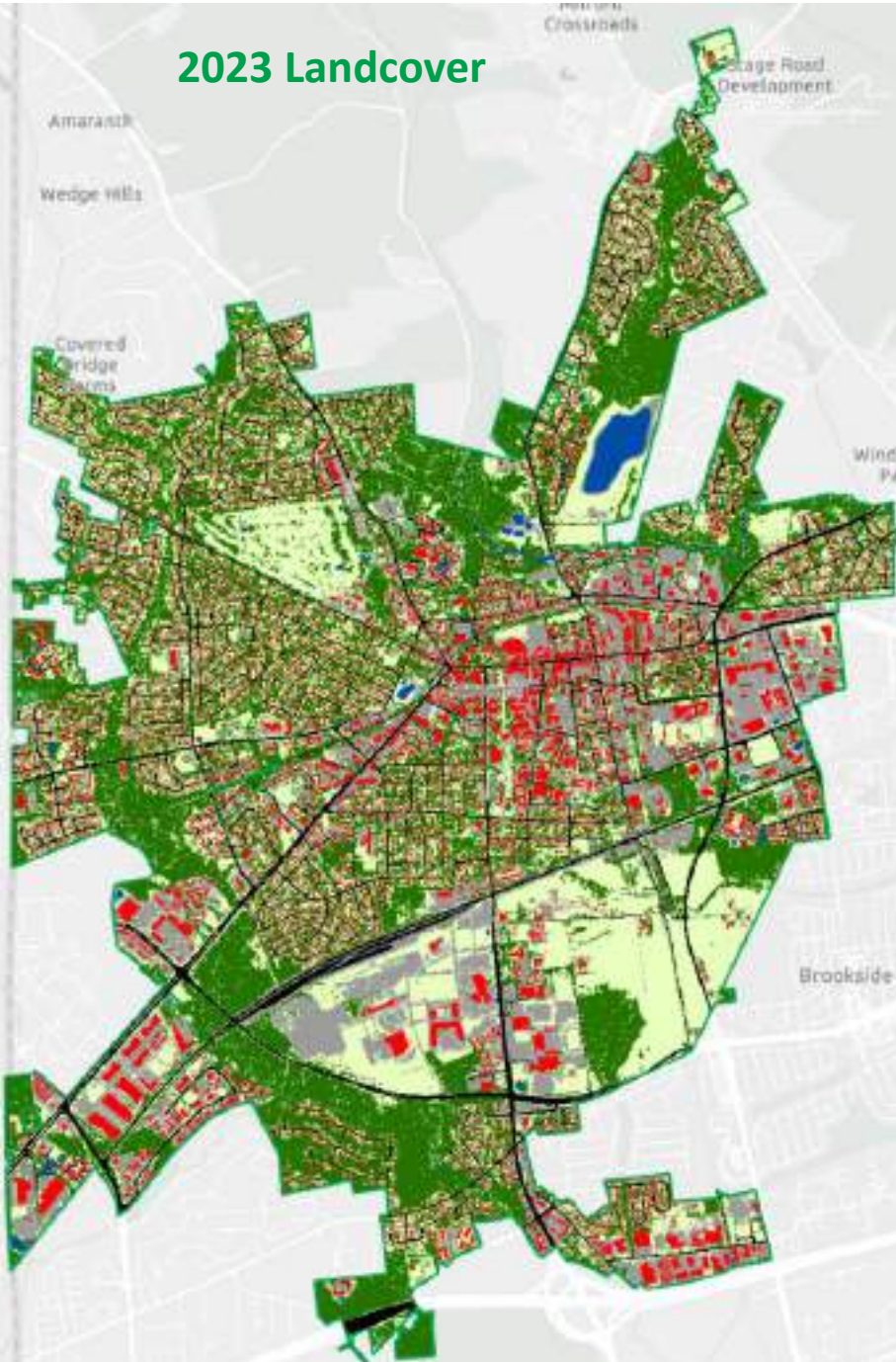
Both Gains and Losses

239 acres of Gain

234 acres of Loss

1,851 acres No Change

2023 Landcover





Existing Tree Canopy: The amount of urban tree canopy present when viewed from above using aerial or satellite imagery (8 ft).



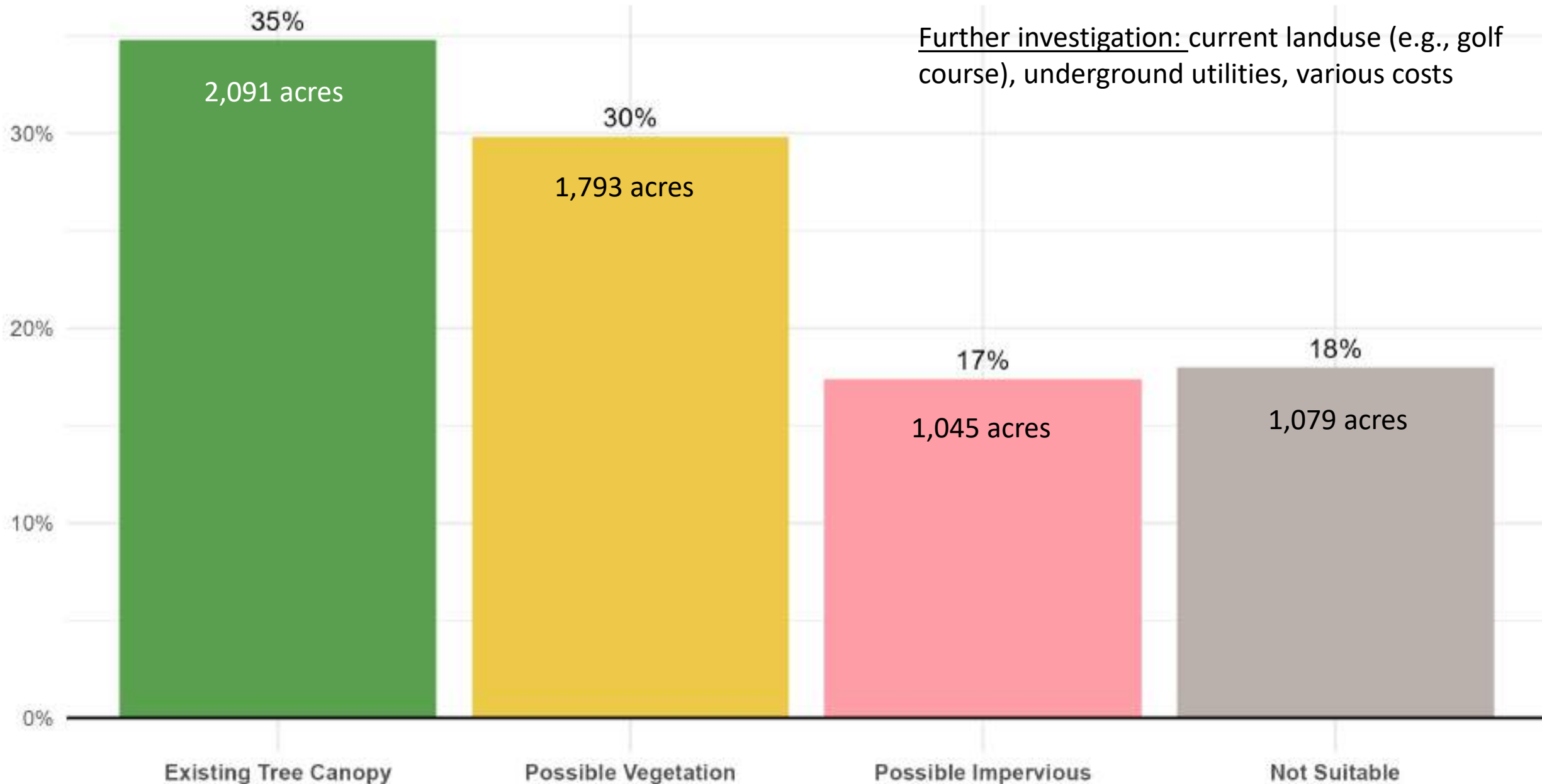
Possible Vegetated Tree Canopy: Grass or shrub area that is theoretically available for the establishment of tree canopy.



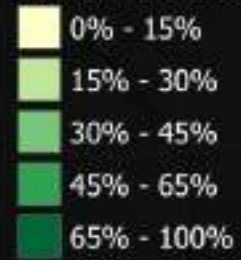
Possible Impervious Tree Canopy: Asphalt or concrete surfaces, excluding roads and buildings, that are theoretically available for the establishment of tree canopy.



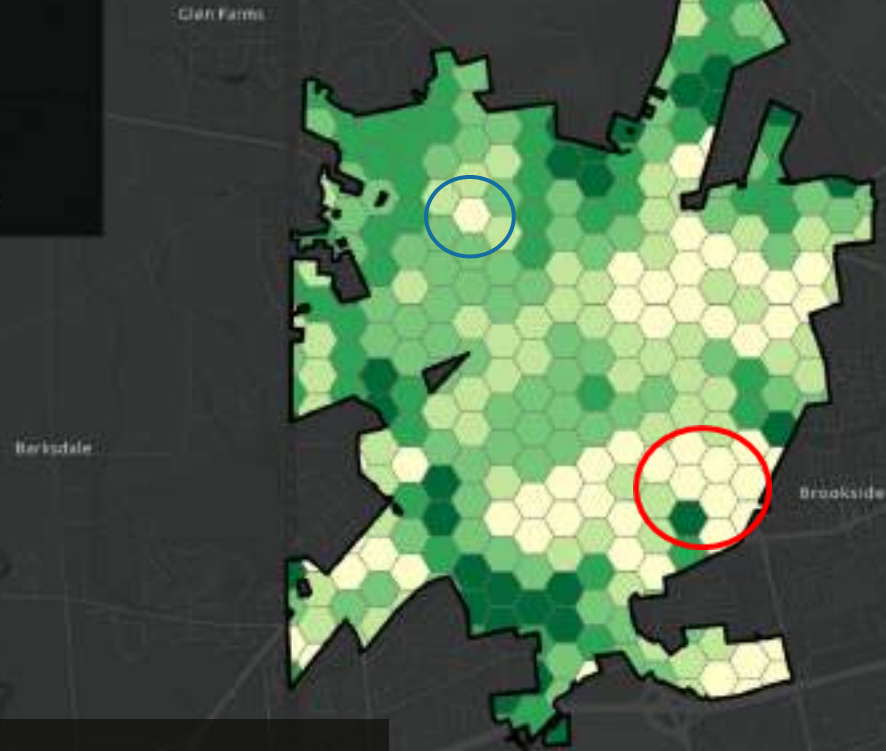
Not Suitable: Areas where it is highly unlikely that new tree canopy could be established (primarily buildings and roads).



Existing Tree Canopy %



- 25-acre hexagons



Hexagons – Existing Tree Canopy %

Possible Tree Canopy - Vegetation %



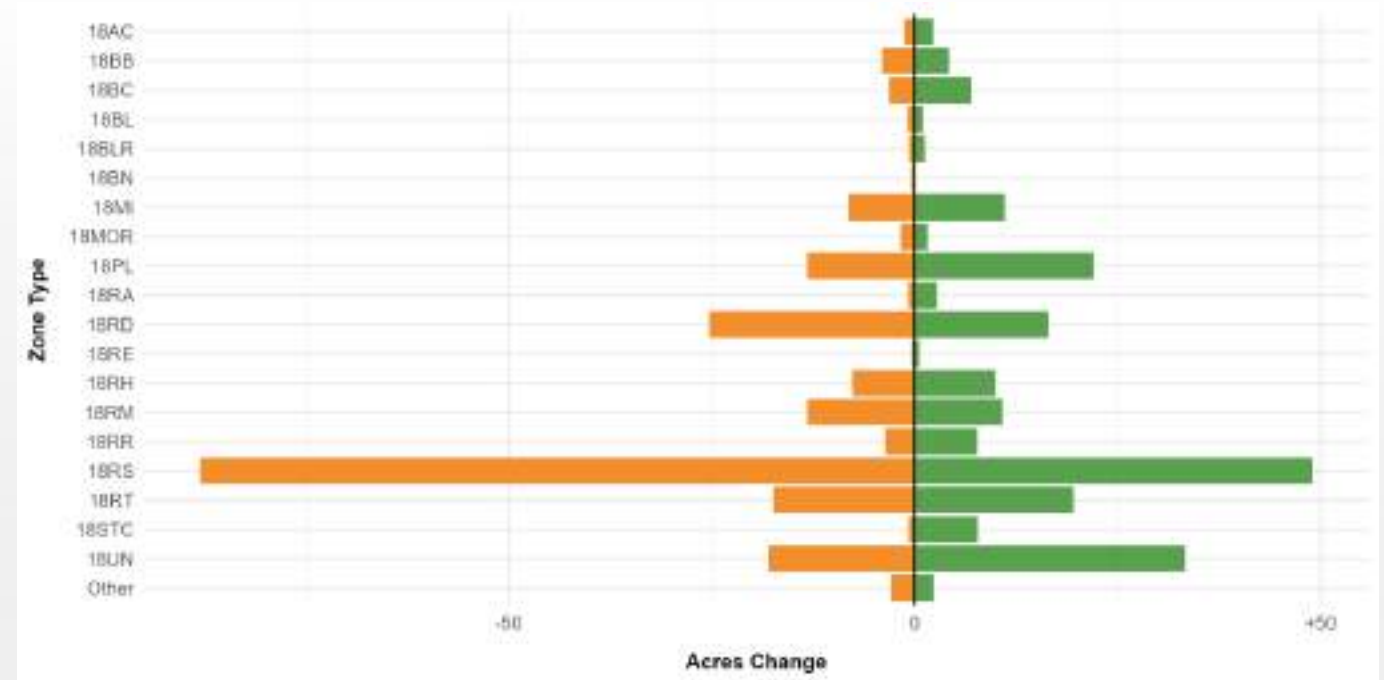
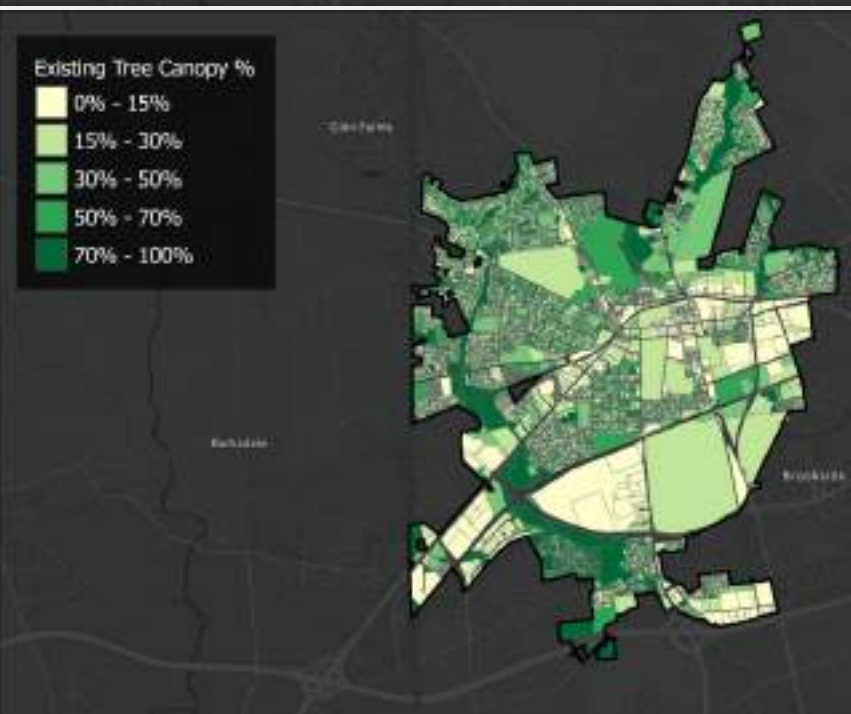
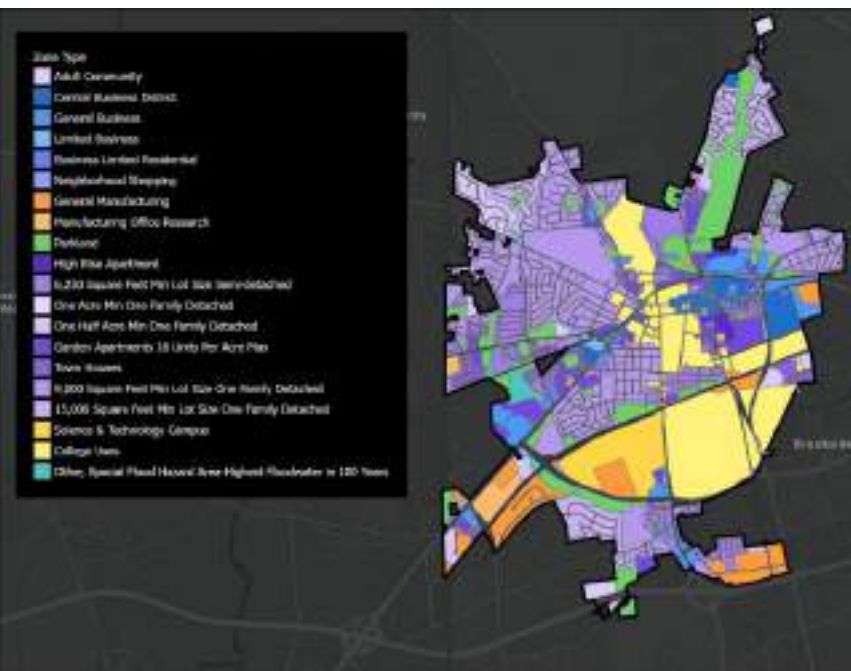
Hexagons – Possible Tree Canopy - Vegetation %

- Golf course

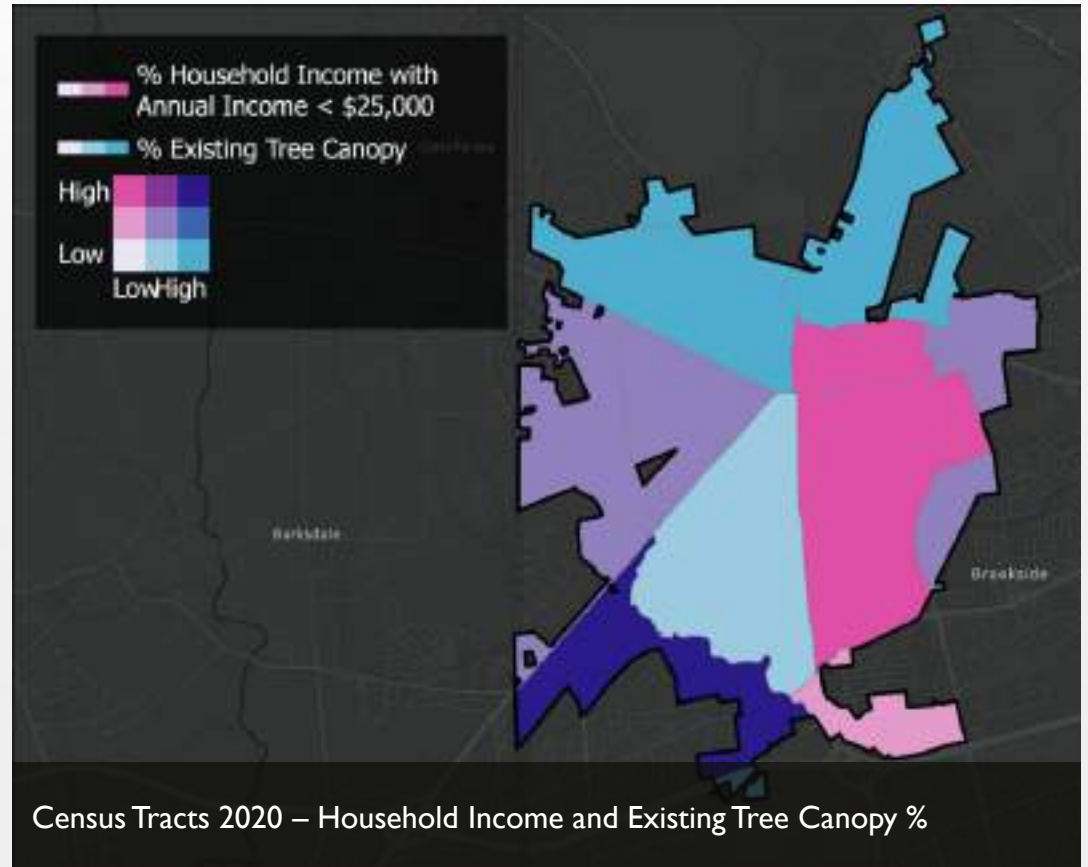
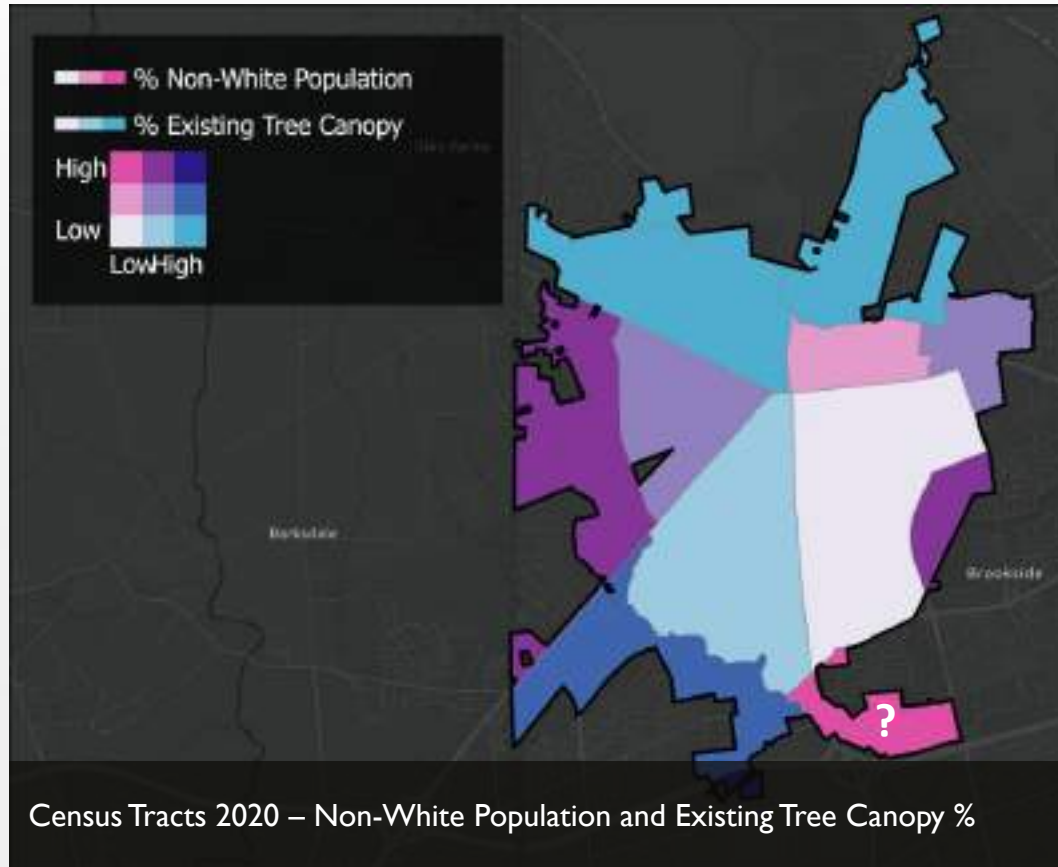


- UD farm fields
- Wooded area



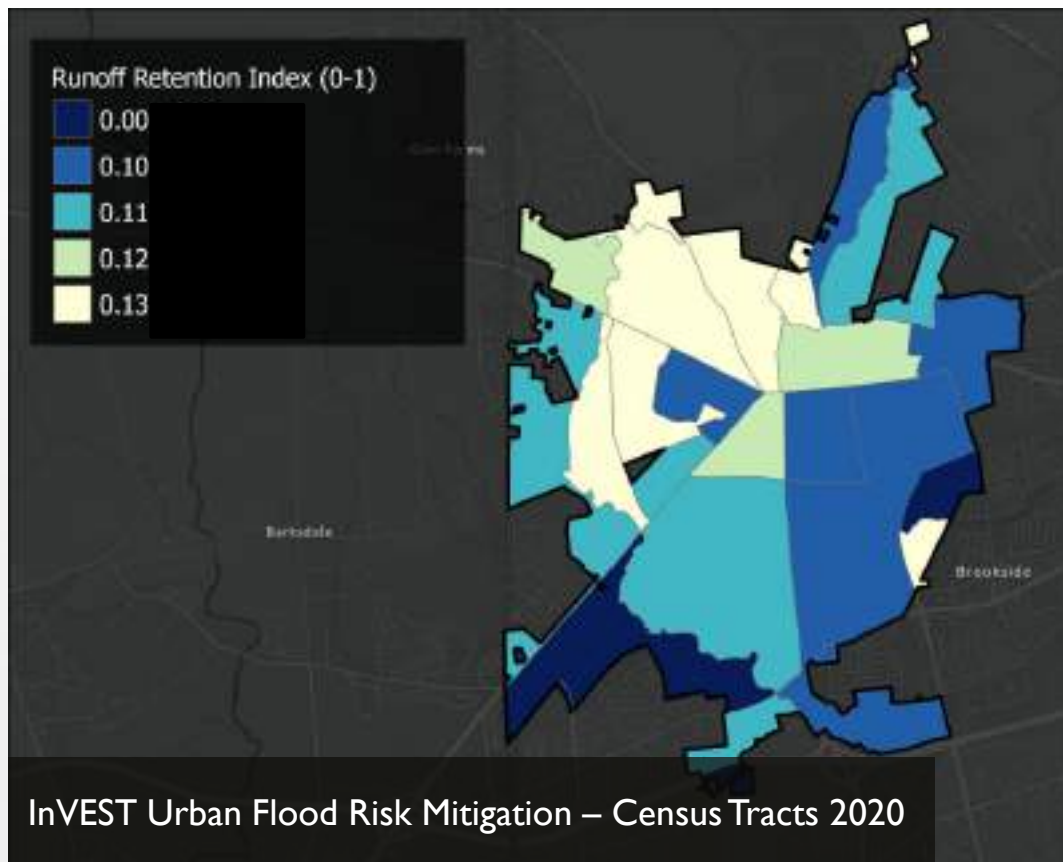


- 18RS – single family residential; rezoned to garden apartments (18RM)?
- Replaced with apartments - removal of trees from original yards

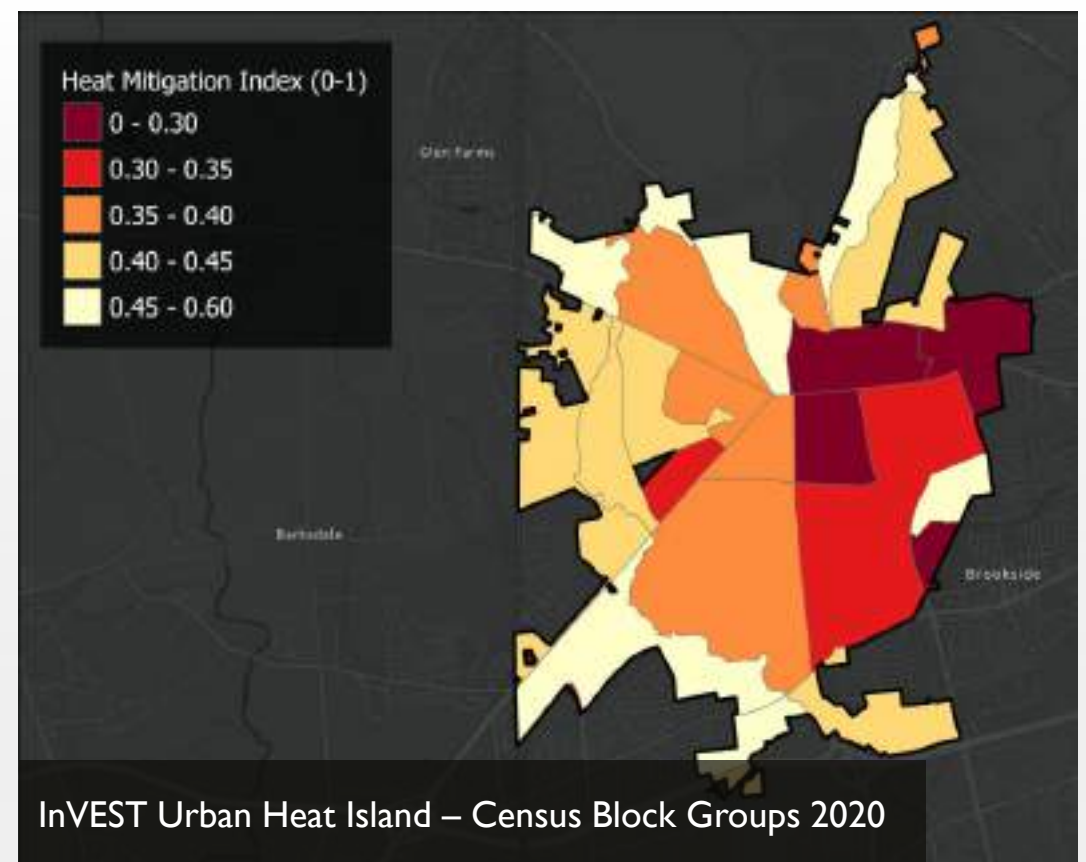


Demographics

- ? – commercial area



Dark blue – high surface runoff, plant here!

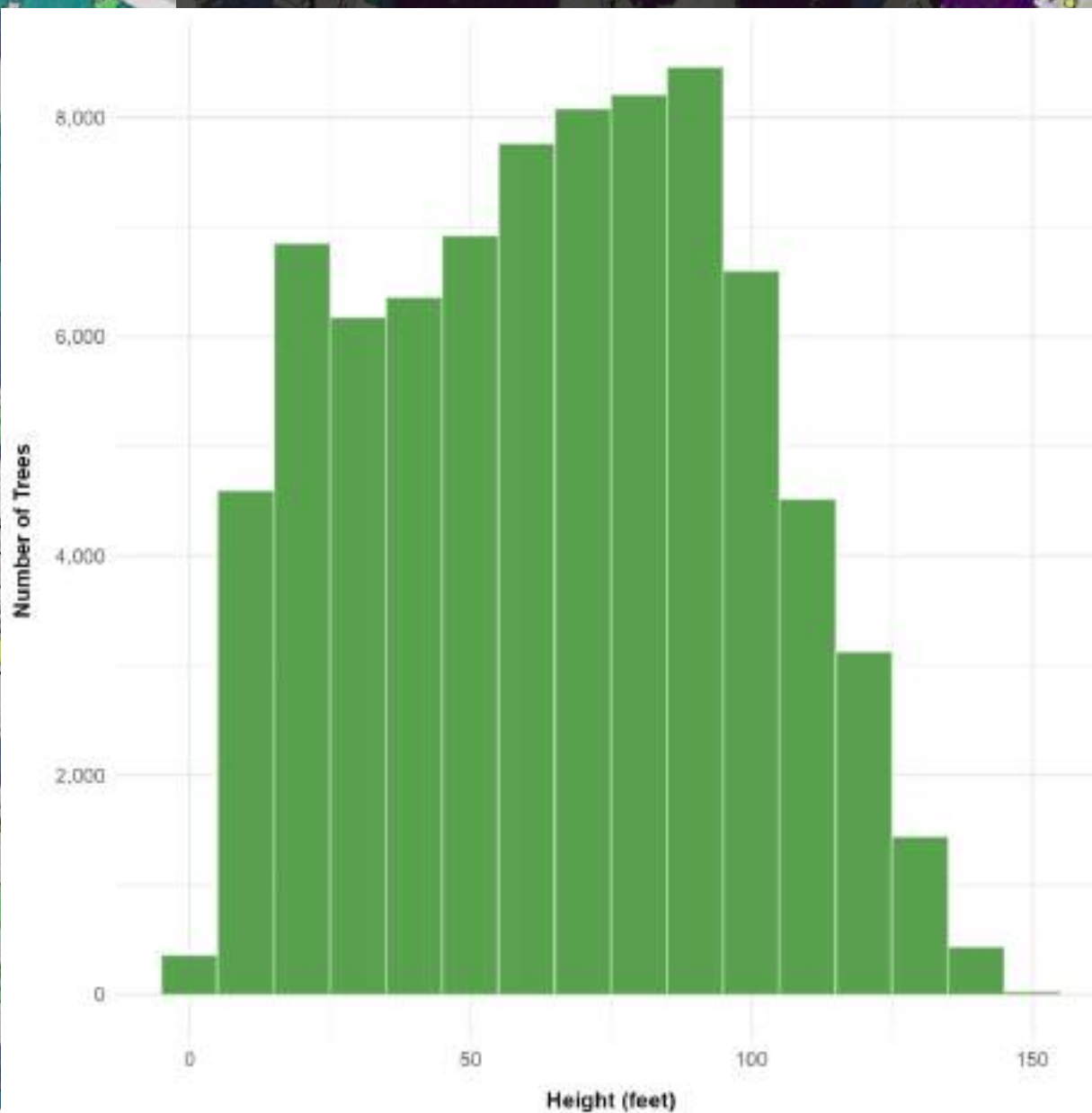


Dark red – least capacity to mitigate heat, if possible plant here!

Individual Tree Height Distribution Histogram

Height

- < 30 ft
- 30 ft - 50 ft
- 50 ft - 80 ft
- 80 ft - 100 ft
- >100 ft



The Tree Inventory - from below

- ▶ “Boots-on-the-ground” inventory program – new
 - ▶ Assisted by the canopy results
 - ▶ Identify trees and areas for planting to reach 36% canopy goal by 2030
- ▶ ArcGIS Tree Management Solution
 - ▶ Borrowed taxonomy list – common name, family, genus, species, cultivar
- ▶ ArcGIS Pro – feature class development, publishing web items
- ▶ ArcGIS Field Maps – data collection

The Tree Inventory - from below – How did we do this?

▶ **ArcGIS Pro**

- ▶ Tree inventory FGDB FC – point, attributes, domains, attachments
- ▶ Horticulture area FGDB FC – polygon, attributes, domains, attachments
 - ▶ Areas planted, mulched, and maintained to a high standard; traffic islands, sign gardens, etc.
- ▶ Attribute Rules - field calculations
- ▶ Contingency value development
- ▶ Published two layer service to AGOL

▶ **ArcGIS Field Maps**

- ▶ Designer – collection forms, logic
- ▶ Inventory collection

The Tree Inventory - from below – How did we do this?

- ▶ Attribute Rules
 - ▶ Arcade script
 - ▶ Tree pit area
 - ▶ Average spread

Calculation Constraint Validation

Add Rule Columns Filter

Disabled	Order	Rule Name	Subtype	Field	Min Pro Release	Min Enterprise Release	Min Arcade Release
☐	1	TreePitArea	<All>	TREE_PIT_AREA	2.3	10.7	1.0.0
☒	2	AveSpread	<All>	AVG_SPREAD	2.3	10.7	1.0.0

AveSpread

Calculation

2.3

Rule Name: AveSpread

Description: Calculates the average spread using the EW_Spread and NS_Spread fields.

Subtype: <All>

Field: AVG_SPREAD

☒ Editable

Expression: `var avspread = Average($feature.EW_SPREAD, $feature.NS_SPREAD); return avspread;`

Triggers: Insert ☒ Update ☒ Delete ☐

Triggering Fields:

2 of 2 Calculation rules listed at 5/5/2026 2:22:37 PM.

Tree pit/planting area – critical root zones of significant trees

The Tree Inventory - from below – How did we do this?

Contingency value development

- ▶ ArcGIS Tree Management Solution – snatched tree taxonomy CSV table
 - ▶ Select common name, subsequent genus, species, family, cultivar values contingent on selection; autopopulate
- ▶ Start - manually creating a contingent value CSV file – stopped, time-consuming
 - ▶ Instead, Export- and Import- Contingent Values GP tools (Community Forum)
 - ▶ Exported my initial start, creates Field Groups and Contingent Values CSV tables – “templates!”
 - ▶ “My” Field_Groups.csv was correct, “My” Contingent_Values.csv needed help
 - ▶ Corrected issues, populated remaining values, Import Contingent Values GP tool, imported successfully!
 - ▶ Additional settings to work through, asked for help

The Tree Inventory - from below – How did we do this?

Import Contingent Values GP Tool

Common Name

Species

Genus

Family

Cultivar

Contingency Values CSV

CAV_ID	IS_RETIRED	FIELD_GROUP	SUBTYPE	SUBTYPE_NAME	CV_TYPE1	CV_VALUE1	DESCRIPTION1	CV_TYPE2	CV_VALUE2	DESCRIPTION2	CV_TYPE3	CV_VALUE3	DESCRIPTION3	CV_TYPE4	CV_VALUE4	DESCRIPTION4	CV_TYPE5	CV_VALUES	DESCRIPTION5
1	FALSE	TreeTaxonomy	0		3	Alaska-Cedar	Alaska-Cedar	3	Nootkatensis	Nootkatensis	3	Callitropsis	Callitropsis	3	Cupressaceae	Cupressaceae		2	
2	FALSE	TreeTaxonomy	0		3	Alaska Willow	Alaska Willow	3	Alaxensis	Alaxensis	3	Pumilia	Pumilia	3	Cupressaceae	Cupressaceae			
3	FALSE	TreeTaxonomy	0		3	Allegany Chinkapin	Allegany Chinkapin	3	Deppeana	Deppeana	3	Juniperus	Juniperus	3	Cupressaceae	Cupressaceae			
4	FALSE	TreeTaxonomy	0		3	Alligator Juniper	Alligator Juniper	3	Deppeana	Deppeana	3	Juniperus	Juniperus	3	Cupressaceae	Cupressaceae			
5	FALSE	TreeTaxonomy	0		3	Alpine Larch	Alpine Larch	3	Lyallii	Lyallii	3	Larix	Larix	3	Pinaceae	Pinaceae			
6	FALSE	TreeTaxonomy	0		3	Alternate-Leaf Dogwood	Alternate-Leaf Dogwood	3	Alternifolia	Alternifolia	3	Cornus	Cornus	3	Cornaceae	Cornaceae			
7	FALSE	TreeTaxonomy	0		3	American Basswood	American Basswood	3	Americana	Americana	3	Tilia	Tilia	3	Malvaceae	Malvaceae			
8	FALSE	TreeTaxonomy	0		3	American Beech	American Beech	3	Grandifolia	Grandifolia	3	Fagus	Fagus	3	Fagaceae	Fagaceae			
9	FALSE	TreeTaxonomy	0		3	American Elm	American Elm	3	Americana	Americana	3	Ulmus	Ulmus	3	Ulmaceae	Ulmaceae			
10	FALSE	TreeTaxonomy	0		3	American Elm	American Elm	3	Americana	Americana	3	Ulmus	Ulmus	3	Ulmaceae	Ulmaceae			
11	FALSE	TreeTaxonomy	0		3	American Elm	American Elm	3	Americana	Americana	3	Ulmus	Ulmus	3	Ulmaceae	Ulmaceae			
12	FALSE	TreeTaxonomy	0		3	American Elm	American Elm	3	Americana	Americana	3	Ulmus	Ulmus	3	Ulmaceae	Ulmaceae			
13	FALSE	TreeTaxonomy	0		3	American Holly	American Holly	3	Opaca	Opaca	3	Ilex	Ilex	3	Aquifoliaceae	Aquifoliaceae			
14	FALSE	TreeTaxonomy	0		3	American Hornbeam	American Hornbeam	3	Caroliniana	Caroliniana	3	Carpinus	Carpinus	3	Betulaceae	Betulaceae			
15	FALSE	TreeTaxonomy	0		3	American Mountain-Ash	American Mountain-Ash	3	Americana	Americana	3	Cornus	Cornus	3	Cornaceae	Cornaceae			
16	FALSE	TreeTaxonomy	0		3	American Plum	American Plum	3	Americana	Americana	3	Tilia	Tilia	3	Malvaceae	Malvaceae			
17	FALSE	TreeTaxonomy	0		3	Apache Pine	Apache Pine	3	Engelmannii	Engelmannii	3	Pinus	Pinus	3	Pinaceae	Pinaceae			
18	FALSE	TreeTaxonomy	0		3	Arizona Cypress	Arizona Cypress	3	Arizonica	Arizonica	3	Cupressus	Cupressus	3	Cupressaceae	Cupressaceae			
19	FALSE	TreeTaxonomy	0		3	Arizona Madrone	Arizona Madrone	3	Arizonica	Arizonica	3	Cornus	Cornus	3	Cornaceae	Cornaceae			
20	FALSE	TreeTaxonomy	0		3	Arizona Pine	Arizona Pine	3	Arizonica	Arizonica	3	Pinus	Pinus	3	Pinaceae	Pinaceae			
21	FALSE	TreeTaxonomy	0		3	Arizona Walnut	Arizona Walnut	3	Major	Major	3	Juglans	Juglans	3	Juglandaceae	Juglandaceae			
22	FALSE	TreeTaxonomy	0		3	Arizona White Oak	Arizona White Oak	3	Arizonica	Arizonica	3	Quercus	Quercus	3	Fagaceae	Fagaceae			
23	FALSE	TreeTaxonomy	0		3	Ash Juniper	Ash Juniper	3	Ashii	Ashii	3	Juniperus	Juniperus	3	Cupressaceae	Cupressaceae			
24	FALSE	TreeTaxonomy	0		3	Athel Tamarisk	Athel Tamarisk	3	Aphylla	Aphylla	3	Tamarix	Tamarix	3	Tamaricaceae	Tamaricaceae			
25	FALSE	TreeTaxonomy	0		3	Atlantic White-Cedar	Atlantic White-Cedar	3	Thyoides	Thyoides	3	Libocedrus	Libocedrus	3	Cupressaceae	Cupressaceae			
26	FALSE	TreeTaxonomy	0		3	Australian-Pine	Australian-Pine	3	Equisetifolia	Equisetifolia	3	Pinus	Pinus	3	Pinaceae	Pinaceae			
27	FALSE	TreeTaxonomy	0		3	Autumn-Olive	Autumn-Olive	3	Umbellata	Umbellata	3	Elaeagnus	Elaeagnus	3	Elaeagnaceae	Elaeagnaceae			
28	FALSE	TreeTaxonomy	0		3	Baker Cypress	Baker Cypress	3	Bakeri	Bakeri	3	Cupressus	Cupressus	3	Cupressaceae	Cupressaceae			
29	FALSE	TreeTaxonomy	0		3	Baldcypress	Baldcypress	3	Distichum	Distichum	3	Taxodium	Taxodium	3	Taxodiaceae	Taxodiaceae			

Field Group TreeTaxonomy

Search

Filter

COMMONNAME	SPECIES	GENUS	FAMILY	CULTIVAR
Alligator Juniper	Deppeana	Juniperus	Cupressaceae	<NULL>
Alpine Larch	Lyallii	Larix	Pinaceae	<NULL>
Alternate-Leaf Dogwood	Alternifolia	Cornus	Cornaceae	<NULL>
American Basswood	Americana	Tilia	Malvaceae	<NULL>
American Beech	Grandifolia	Fagus	Fagaceae	<NULL>
American Elm	Americana	Ulmus	Ulmaceae	<NULL>
American Elm	Americana	Ulmus	Ulmaceae	Princeton
American Elm	Americana	Ulmus	Ulmaceae	Valley Forge
American Holly	Opaca	Ilex	Aquifoliaceae	<NULL>
American Hornbeam	Caroliniana	Carpinus	Betulaceae	<NULL>

A	B	C	D	E	F	G
NAME	IS_RESTRICTIVE	FIELD1	FIELD2	FIELD3	FIELD4	FIELD5
TreeTaxonomy	TRUE	COMMONNAME	SPECIES	GENUS	FAMILY	CULTIVAR

Fields Group CSV

22

The Tree Inventory - from below – How did we do this?

ArcGIS Field Maps

- ▶ Web map with tree inventory and horticulture service
- ▶ Designer – set up field forms for tree collection (and horticulture areas)
 - ▶ Early testing - contingency value working!
- ▶ What about trees not in the taxonomy table (e.g., non-native trees)? (Community Forum)
 - ▶ Created “escape hatch” for Other and Unknown ‘common name’ choices
 - ▶ Select “Other” or “Unknown”
 - ▶ Form logic hides other taxonomy fields
 - ▶ Opens “Other Tree” text field, enter ‘common name’
 - ▶ Add ‘common name’ and taxonomy to table – ‘Add Contingent Value’ GP Tool
- ▶ Added field calculations – tree pit area and average spread, with default values
- ▶ Simplify the user experience

The Tree Inventory - from below – How did we do this?

5:01 99 GPS accuracy 45.2 ft - 30 ft required

Collect Submit

Common Tree Name: Alpine Larch

Take photo Attach

TreeTaxonomy

COMMON NAME: Alpine Larch

SPECIES: Larch

GENUS: Larch

FAMILY: Pinaceae

LOCATION: No value

HSC Tree: No

Specific Tree Information *

INSPECTOR TYPE: City Arborist

PARK or PARCEL NAME: No value

LOCATION TYPE: Park

DIAMETER: 3

HEIGHT: 25

EAST WEST SPREAD: 20

NORTH SOUTH SPREAD: 10

AVERAGE SPREAD: 15

CONDITION: Good

PLANTING AREA: Lawn

TREE PIT LENGTH: 12

TREE PIT WIDTH: 10

TREE PIT AREA: 120

OVERHEAD WIRES: No value

MAINTENANCE NEEDED: Mulch/Woodchip

MAINTENANCE RECOMMENDATION: Dead Wood Removal

OWNED BY: City of Newark

MAINTAINED BY: City of Newark

NOTE:

Collect Submit

Common Tree Name: Other

TreeTaxonomy

COMMON NAME: Other

Other Tree: Banana tree

HSC Tree: No

Specific Tree Information *

INSPECTOR TYPE: City Arborist

PARK or PARCEL NAME: No value

LOCATION TYPE: Park

DIAMETER: 2.5

HEIGHT:

- Collecting trees planted in the last two years or over 20" in DBH
- HSC – Historically Significant and Champion Trees - DBH >20"

The Tree Inventory - from below – How did we do this?

Pro

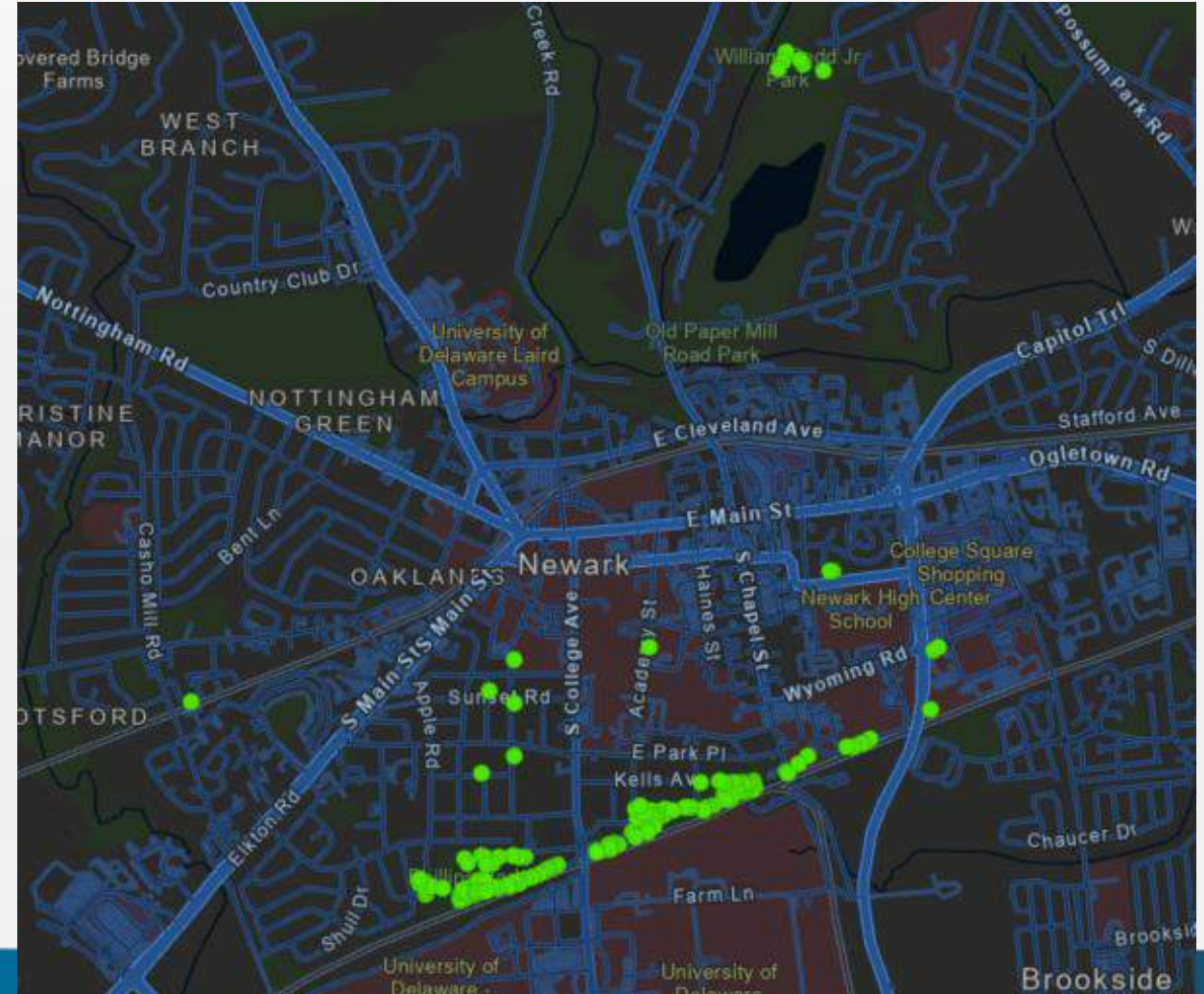
- ▶ Created tree inventory feature class
 - ▶ Contingent value taxonomy, attribute rules
 - ▶ Publish service

Field Maps

- ▶ Web map - collection form
 - ▶ Attach photo

Considering

- ▶ Seed tree inventory FC with 80,161 tree points



Thank you! Questions?

City of Newark, DE

- ▶ Jay W. Hodny, Ph.D., GIS Technician – jhodny@newark.de.us, (302) 366-7000

University of Vermont

- ▶ Maeve Naumann, Geospatial Research Specialist - Maeve.Naumann@uvm.edu
- ▶ Paige Brochu, Ph.D., Director – Paige.Brochu@uvm.edu

LiDAR

- ▶ 2014 USGS Hurricane Sandy Supplemental for Maryland And Delaware – Normalized, Classified Point Clouds and Surface Models
Source: USGS [Link](#)
- ▶ 2023 USGS Delaware Statewide Lidar - Normalized, Classified Point Clouds and Surface Models
Source: USGS [Link](#)

Imagery

NAIP:

Source: USGS [Link](#)

- ▶ 2013 1 Meter, 4-Band, Leaf-On
- ▶ 2023 1 Foot, 4-Band, Leaf-On

Orthos:

- ▶ 2012 1 Foot, 4-Band, Leaf-Off, Source: Delaware.gov [Link](#)
- ▶ 2022 6 Inch, 5-Band, Leaf-Off, Source: Delaware.gov [Link](#)
- ▶ 2023 3 Inch, 3-Band, Leaf-Off, Source: NCCDE [Link](#)