HERO 2021
Sustainable Worcester

HERO Team

Apple Gould-Schultz, David Henriques, Sarah Hughes, Caleigh McLaren, Madeline Regenye

Meet the Research Team

Graduate Mentors: Marc Healy and Nicholas Geron

Directors: John Rogan, Ph.D. and Deborah Martin, Ph.D

Undergraduate Research Team: (left to right) Apple Gould-Schultz, Caleigh McLaren, Madeline Regenye (Regs), David Henriques, Sarah Hughes

Overview

Background and Introduction

Historical Wetland Mapping

Flood Mitigation Solutions

Spatial Dynamics of the Urban Heat Island

Modeling Green Infrastructure

HERO Over the Years

2014

HERO fellows research the Asian Longhorned Beetle infestation in Worcester

2017

HERO fellows focus on DCR Greening the Gateway Cities and the impact of planting programs

2019

HERO fellows research tree survivorship in the Gateway Cities of Pittsfield and Leominster

2021-2022

This year we are conducting research to understand the impact of tree canopy on the Urban Heat Island Effect, and the locations of historic wetlands.

Research Question

How can the human and biophysical legacies of land use and land cover in Worcester inform future green infrastructure to create a more resilient and sustainable city?

Broad Meadow Brook

Tree Planting Strip on Harding Street

Research Objectives

Historical Wetlands and Flooding Solutions

01 Delineate historical wetlands in Worcester and compare them with modern day floodplain characteristics.

02 Identify potential green infrastructure solutions for flood mitigation in Green Island.

Urban Heat Island Mitigation

03 Compare surface/air temperature and ozone variability of Green Island and Columbus Park at a high resolution with in situ measurements.

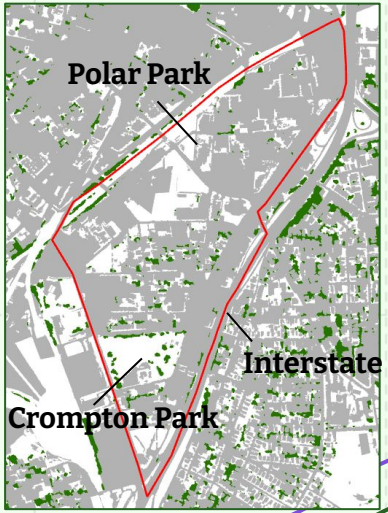
04 Model the role of street trees and treated roofs/solar panels on surface temperature in Worcester.

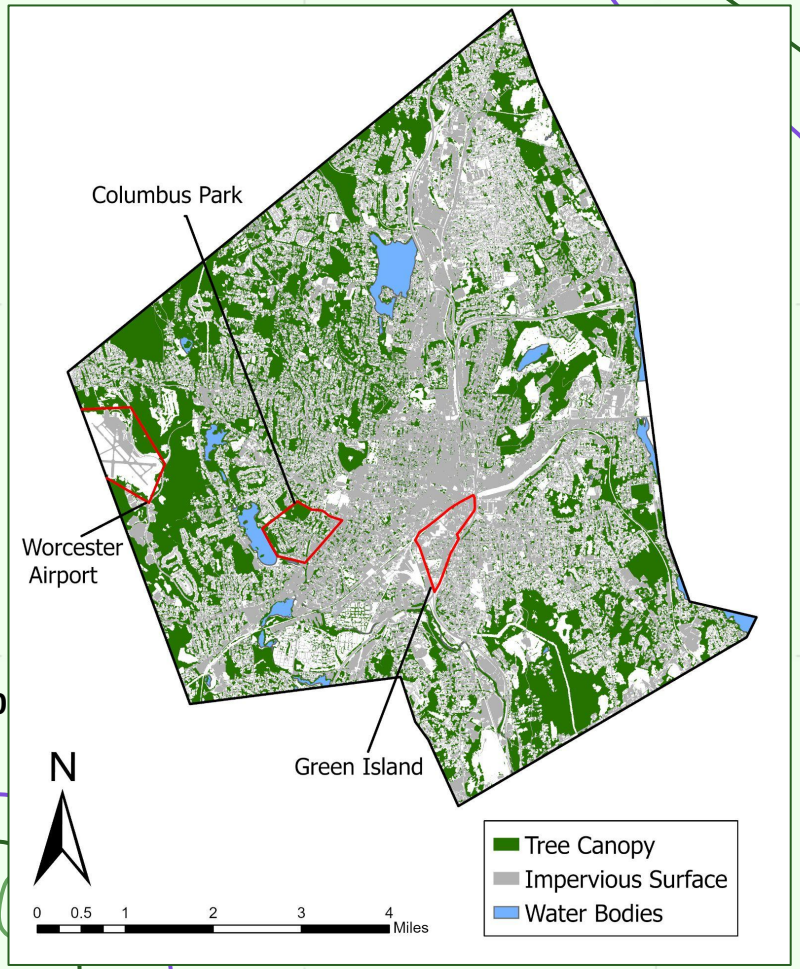

Landsat Satellite Thermal Imagery
Juvenile canopy mitigation
Unmitigated: Higher ozone concentration
Canopy mitigation: lower ozone concentration
Urban Heat Island Temperature and Air Quality
ENTERING INC. 1722 WORCESTER
EXIT 13
122A
Vernon St
Kelley Sq
AIRPORT
Worcester Airport
Fieldwork
Historical Wetlands and Streams
Modern Flooding

Study Area

Columbus Park

Green Island





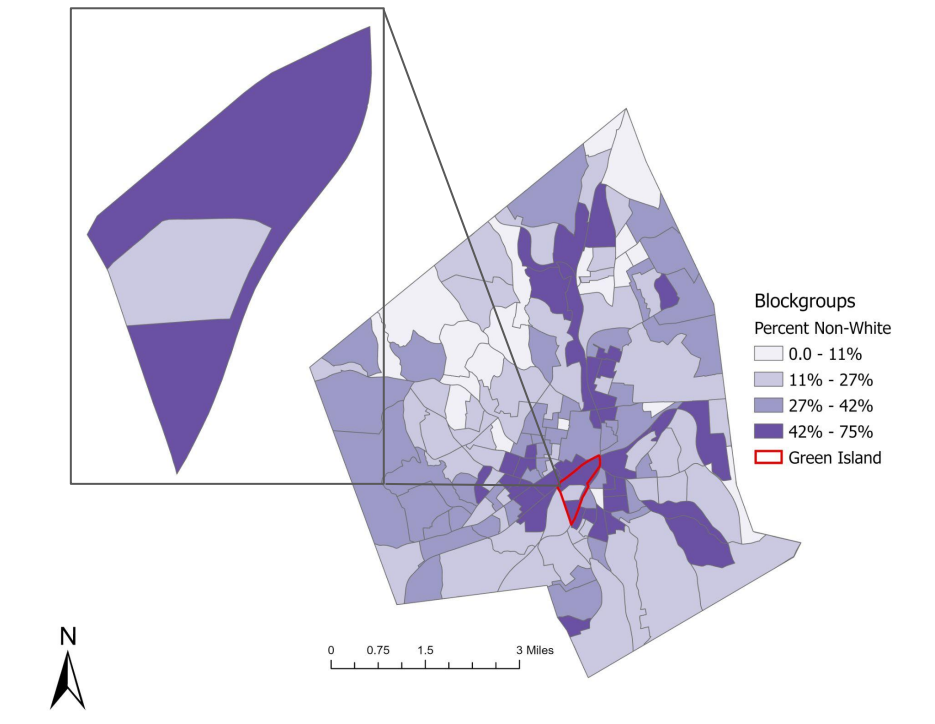
Characteristics of Green Island

Population: 1,583

Economic
Median Household Income: $30,396*
Percent Renter: 88.5%*

Demographic
Population Demographic Distribution: 48% White; 15% Black; 10% Asian; 27% Other
Percent Population with Limited English: 12.25%*
Environmental Justice Group: Minority and Income

Education
>25 with Bachelor's Degree: 10%*
>25 with HS Degree: 25%*



*Average of Block Groups

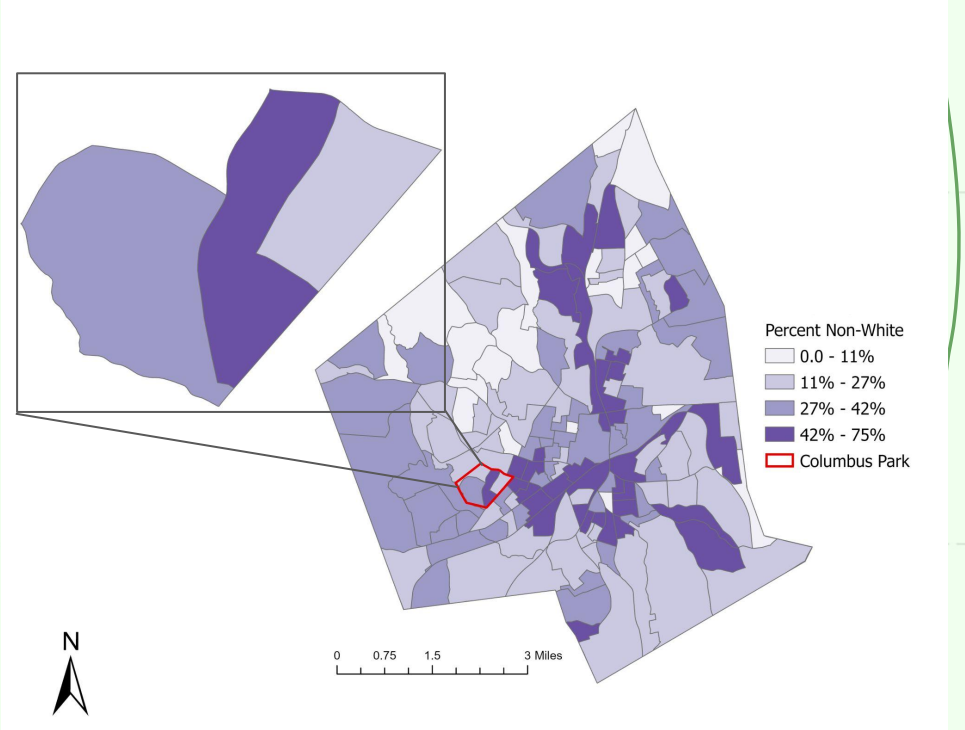
Characteristics of Columbus Park

Population: 3,037

Economic
Median Household Income: $37,135*
Percent Renter: 66%*

Demographics
Population Demographic Distribution: 49% White, 17% Black, 15% Asian, 0.5% American Indian, 17% Other
Percent Population with Limited English: 9.42%*
Environmental Justice Group: Minority and Income

Education
>25 with Bachelor's Degree: 13.4%*
>25 with HS Degree: 15.5%*

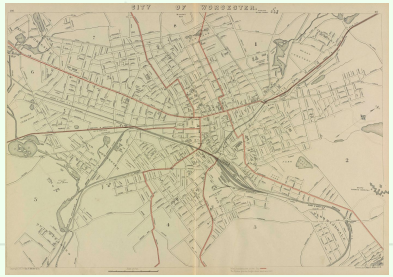


*Average of Block Groups

01

Delineate historical wetlands in Worcester and compare them with modern day floodplain characteristics

Historical Wetland Mapping



1833

1870

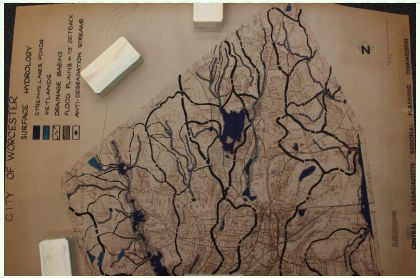
1891

1908

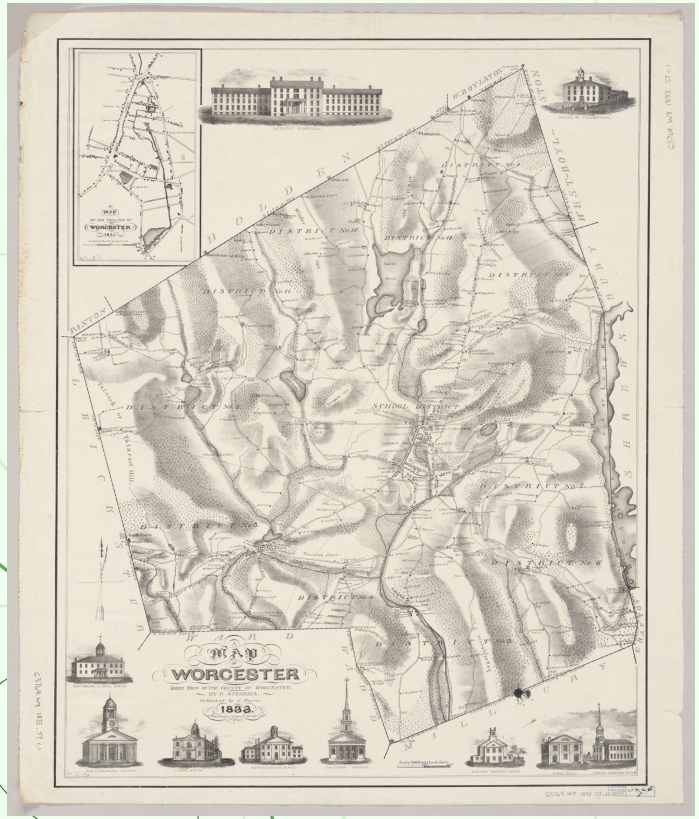
1946-56

1960s

1980

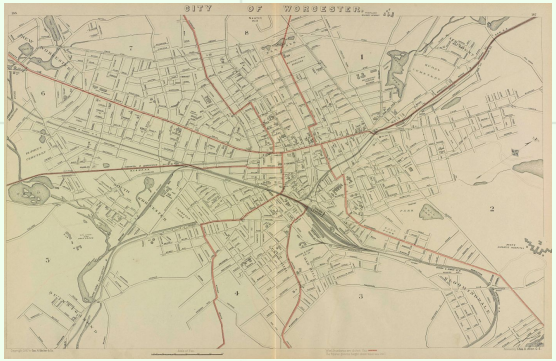


Historical Wetland Mapping

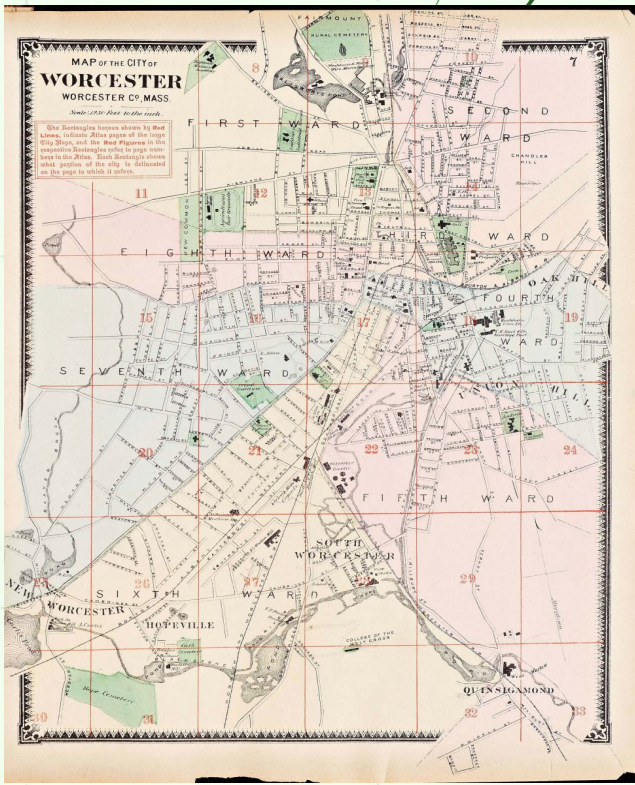


1833 Worcester Map

1908 Worcester Map



1891 Worcester Map



1870 Worcester Map

Historical Wetland Mapping

1940s-1950s Topography Map

1960s Wetlands Map

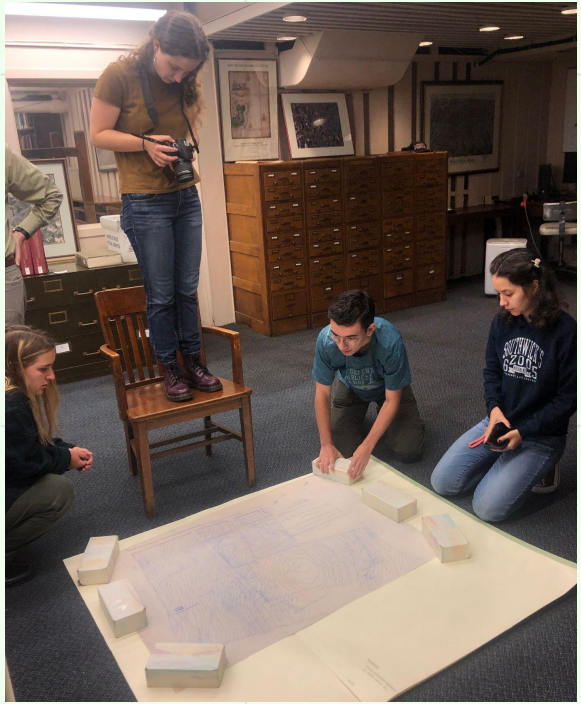
1980 FEMA Flood Insurance Maps

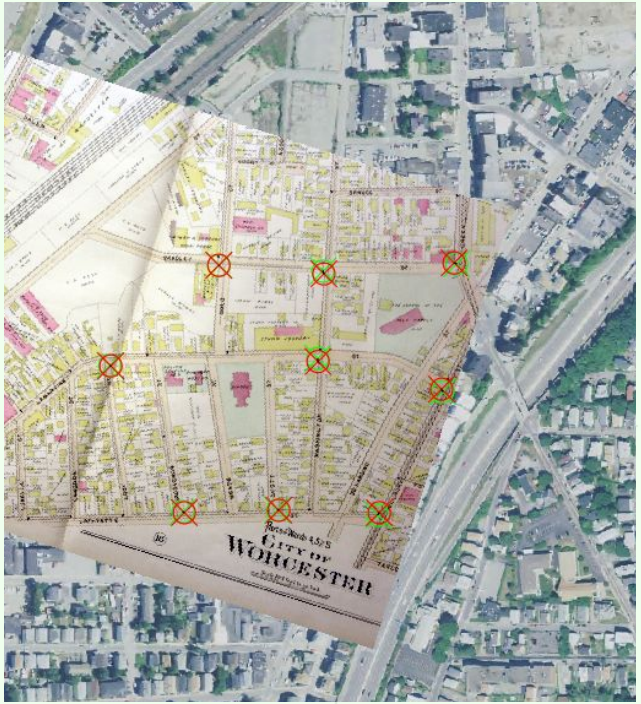
Wetland Mapping Methods

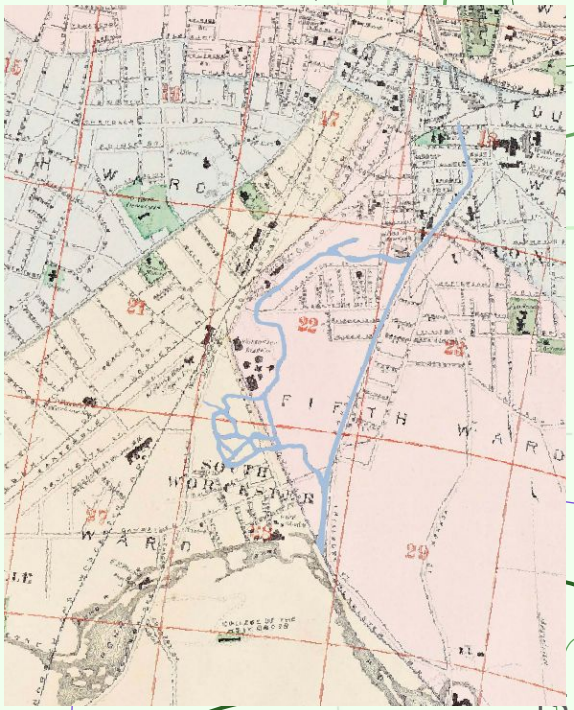
Historical Map Collection

Georeferencing: ArcGIS

Digitizing of Features QGIS

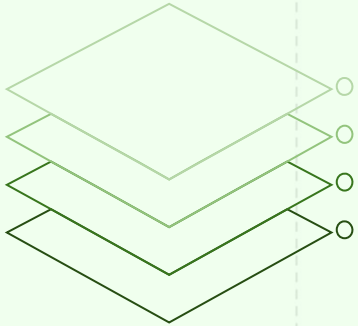






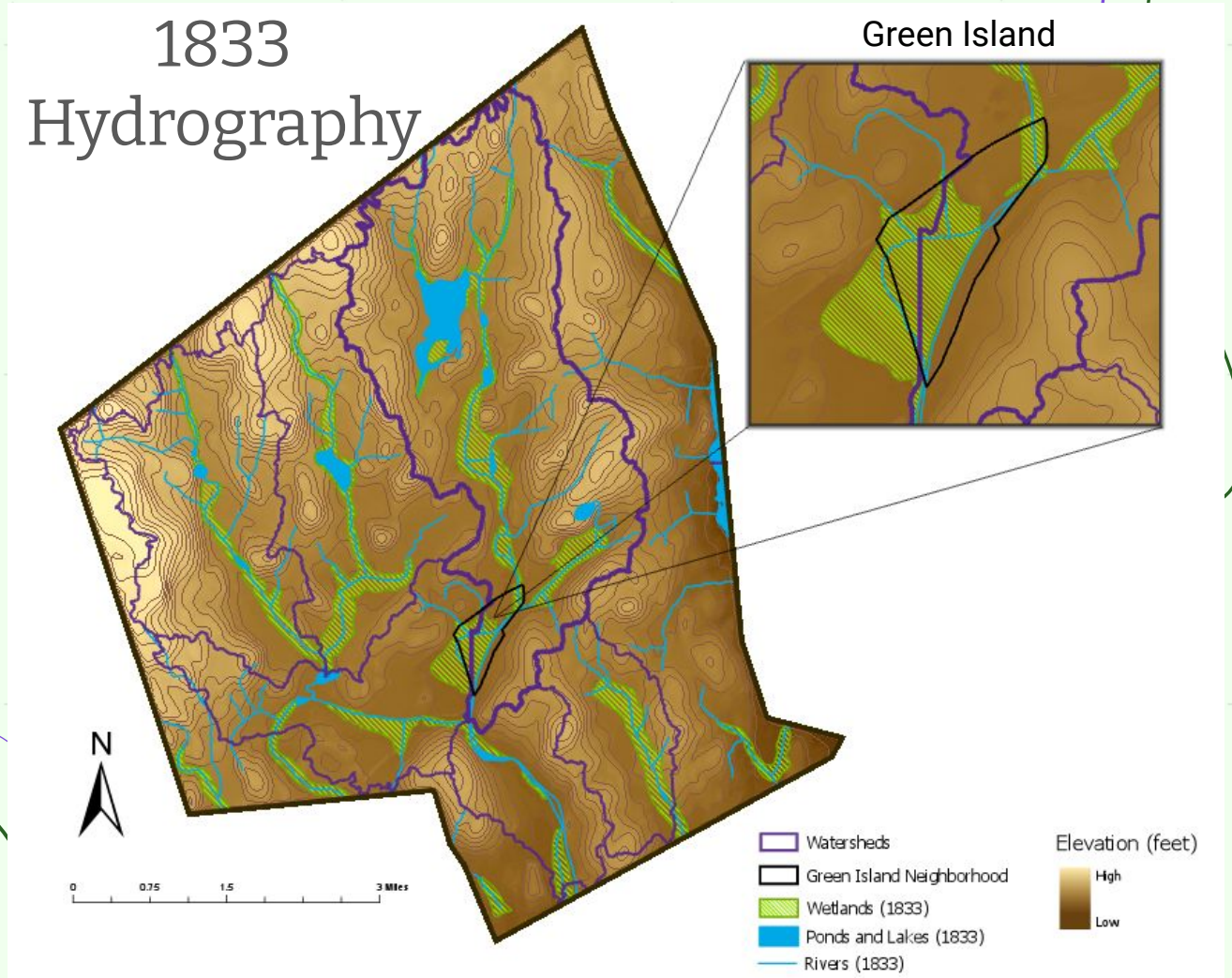
Wetland Mapping Methods Continued

Historical Features Overlaid Over Current Layers



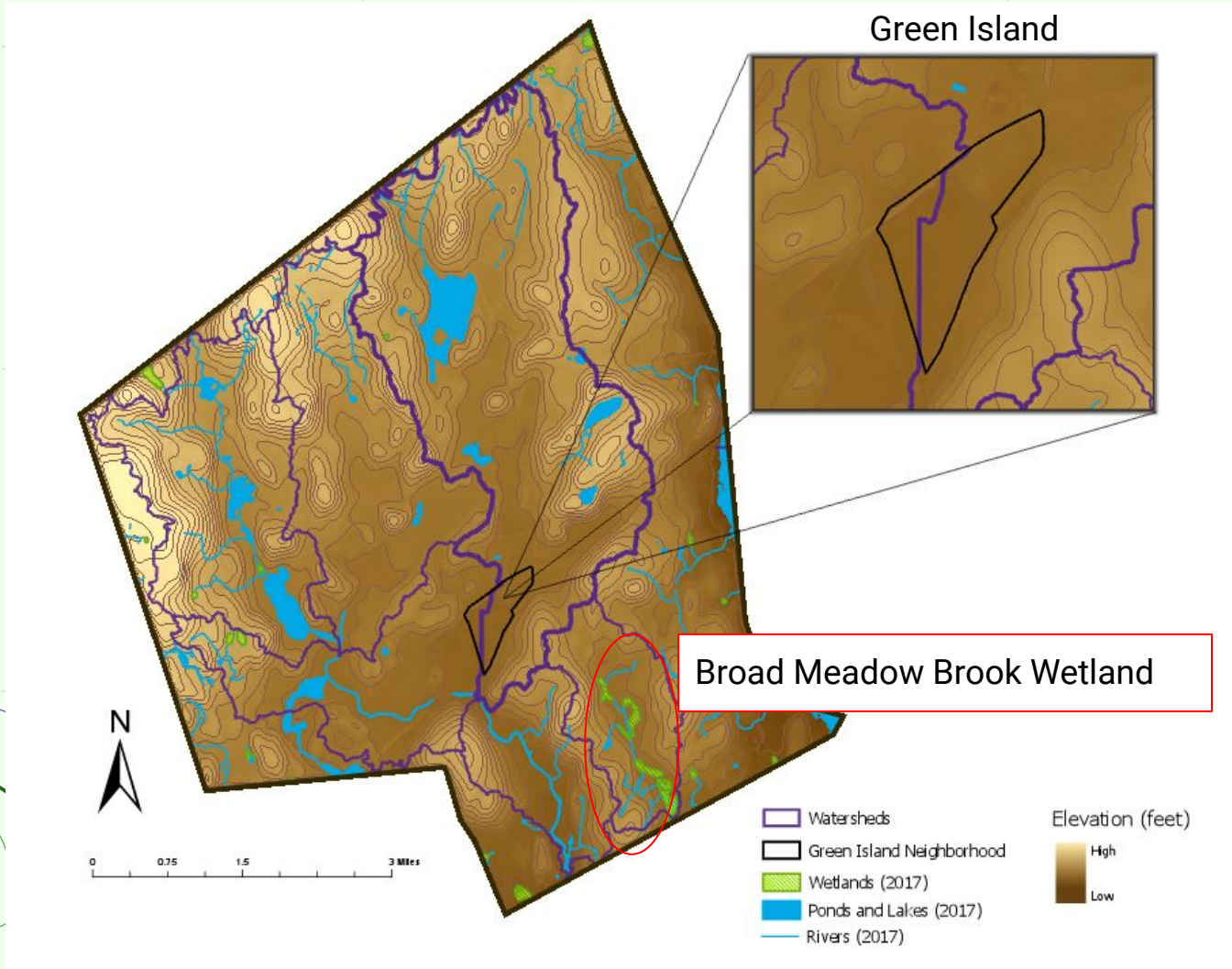
- Digital Elevation Model (DEM)
- Water Bodies
- Reported Floods and Flood Zones
- Buildings and Streets

1833 Hydrography



2017 Hydrography

1,853.3 acres of wetland lost from 1833 to 2017



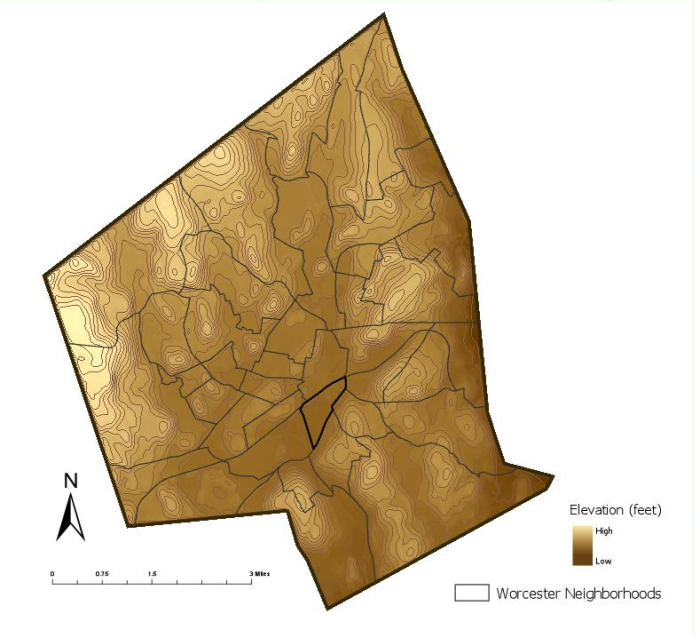
147.4 Polar Parks

worth of wetlands were drained in Worcester between 1833 to present.

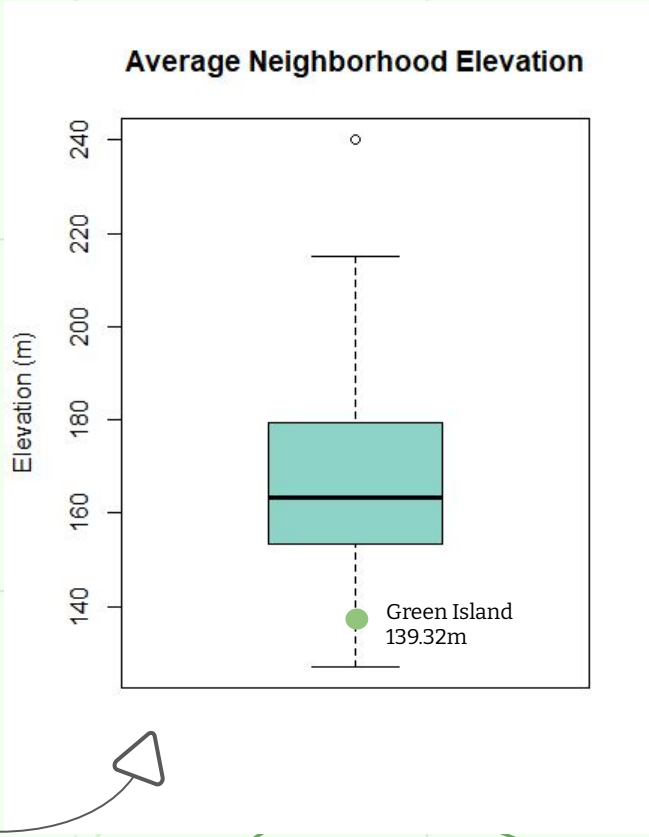
96.6 Polar Parks

worth of reservoirs, lakes, and ponds were created in Worcester between 1833 to present.

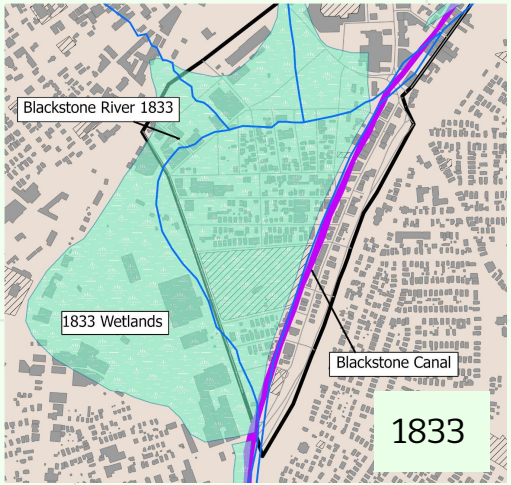
Elevation of Worcester Neighborhoods

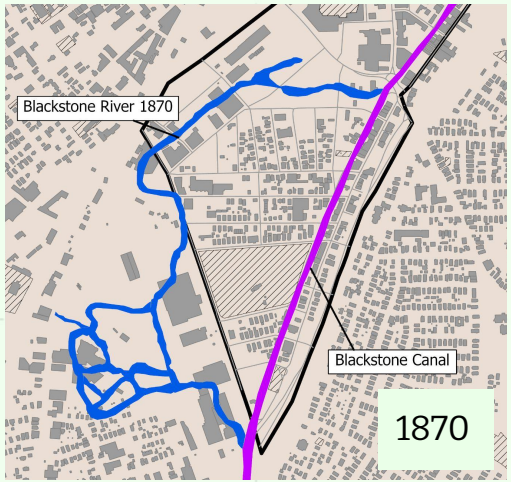


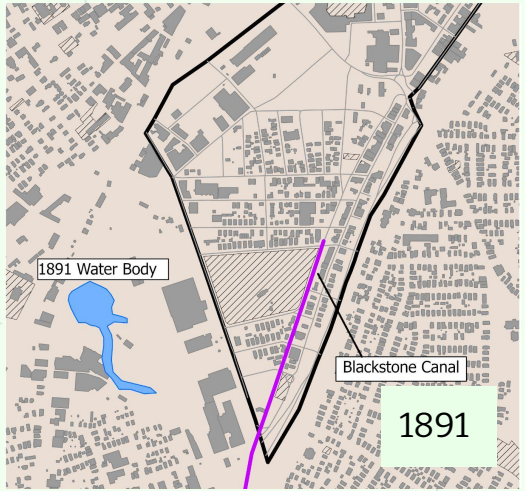
Green Island has the second lowest neighborhood elevation in Worcester.

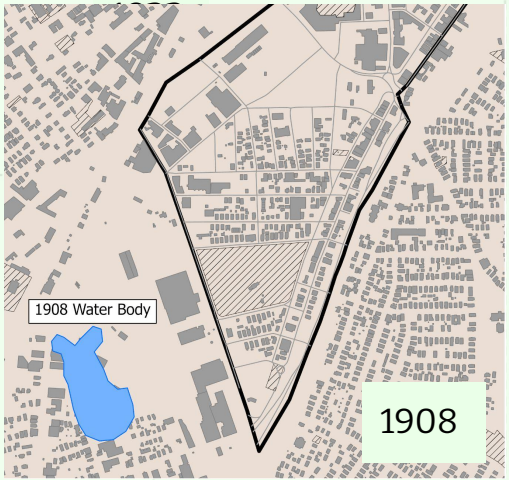


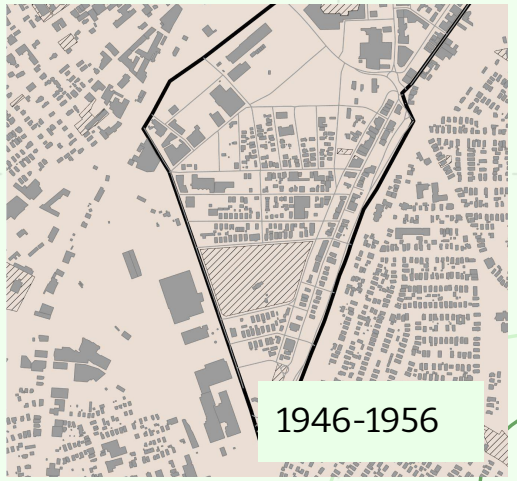
Disappearing Hydrology in Green Island

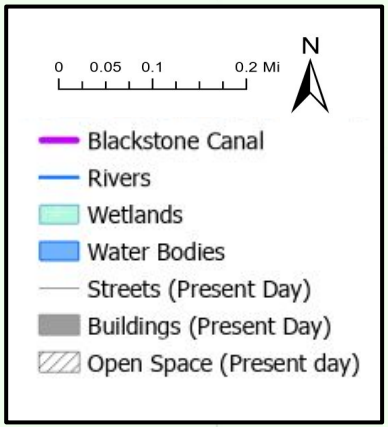




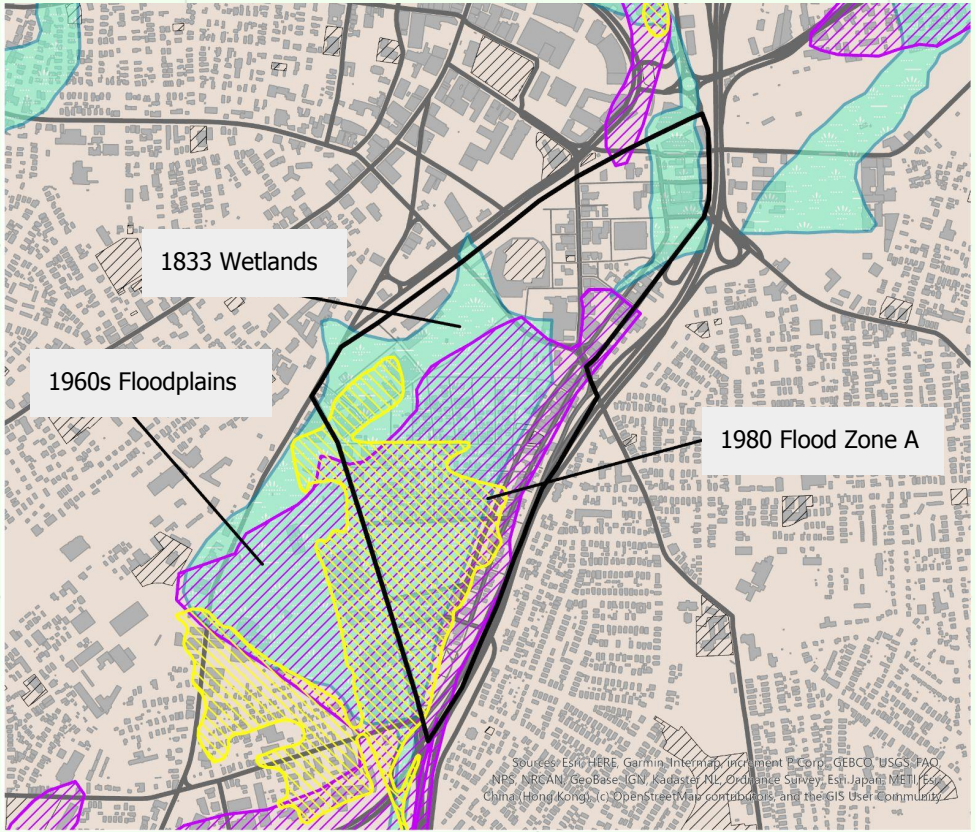


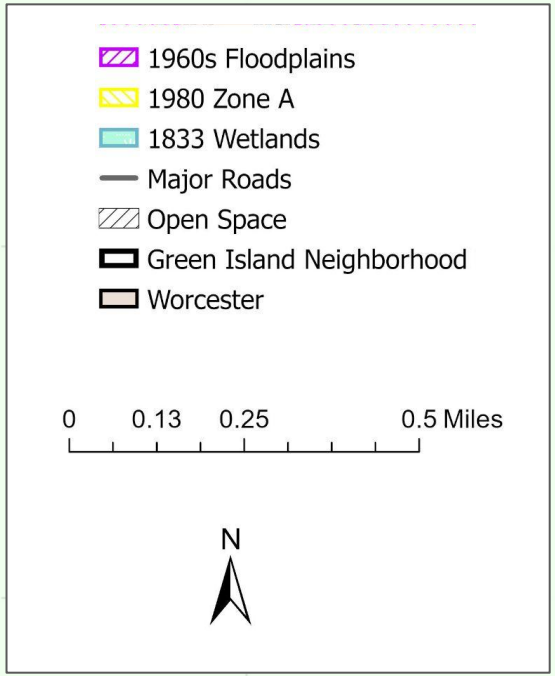




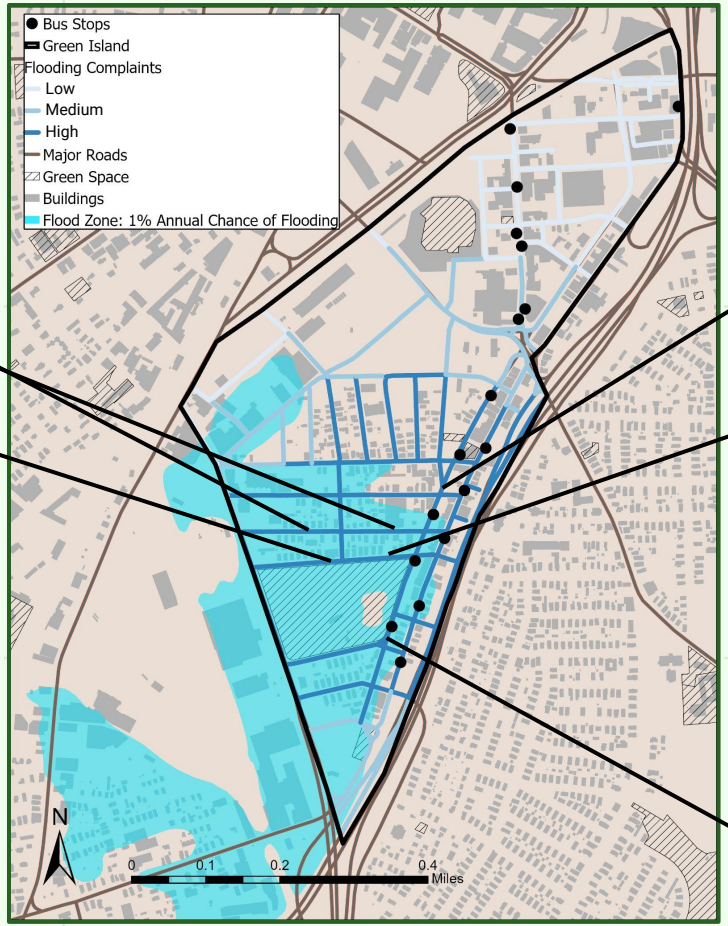


Evidence of Consistent Flooding in Green Island





FEMA 2017 Flood Zones and Top 5 Reported Flooded Streets



1) Upper Harding St

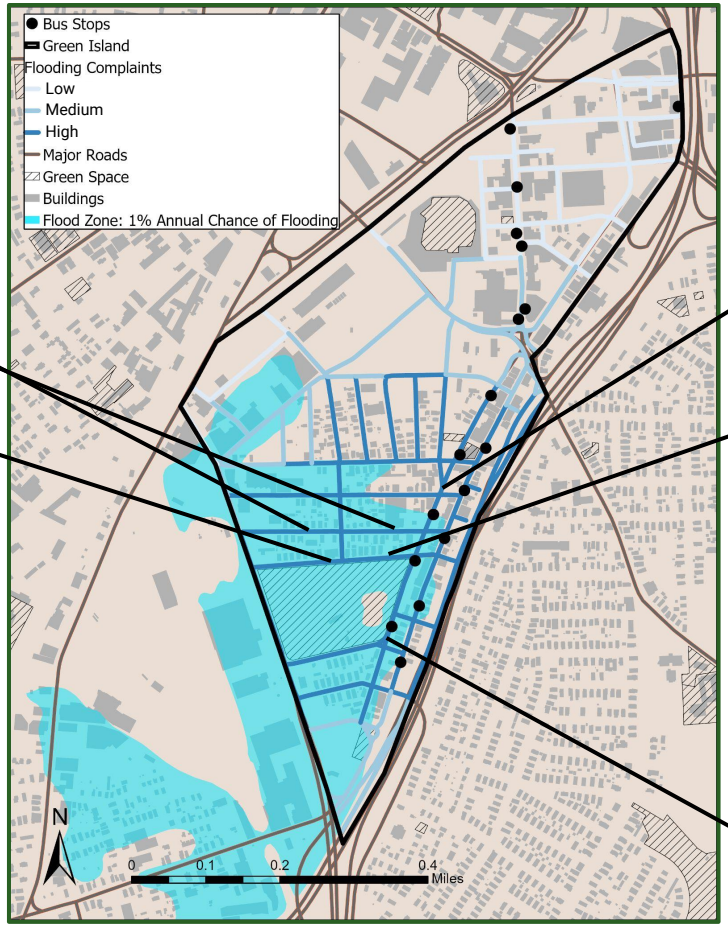
2) East Endicott St

3) West Endicott St

4) Sigel St

5) Lower Harding St

FEMA 2017 Flood Zones and Top 5 Reported Flooded Streets



1) Upper Harding St

2) East Endicott St

3) West Endicott St

4) Sigel St

5) Lower Harding St

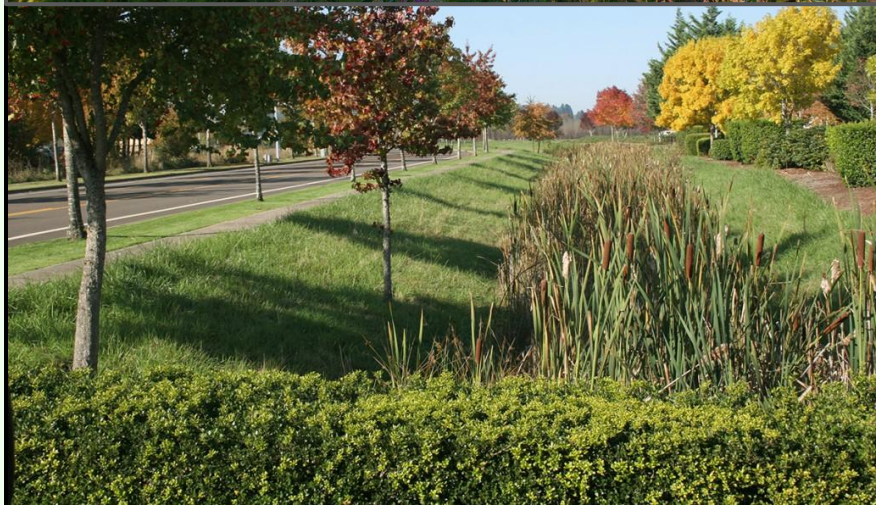
Historical Wetlands Summary

01 Delineate historical wetlands in Worcester and compare them with modern day floodplain characteristics

1. Several of Worcester's current water bodies were formally wetlands
2. Green Island's low elevation, high impervious cover, and hydrologic history explain the high rates of flooding seen today
3. There is consistent flooding in southern Green Island, especially around the streets of Harding, Endicott, and Sigel

02

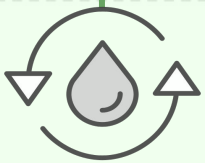
Identify potential green infrastructure solutions for flood mitigation in Green Island



Two Approaches: Localized and Watershed

Localized Approach:

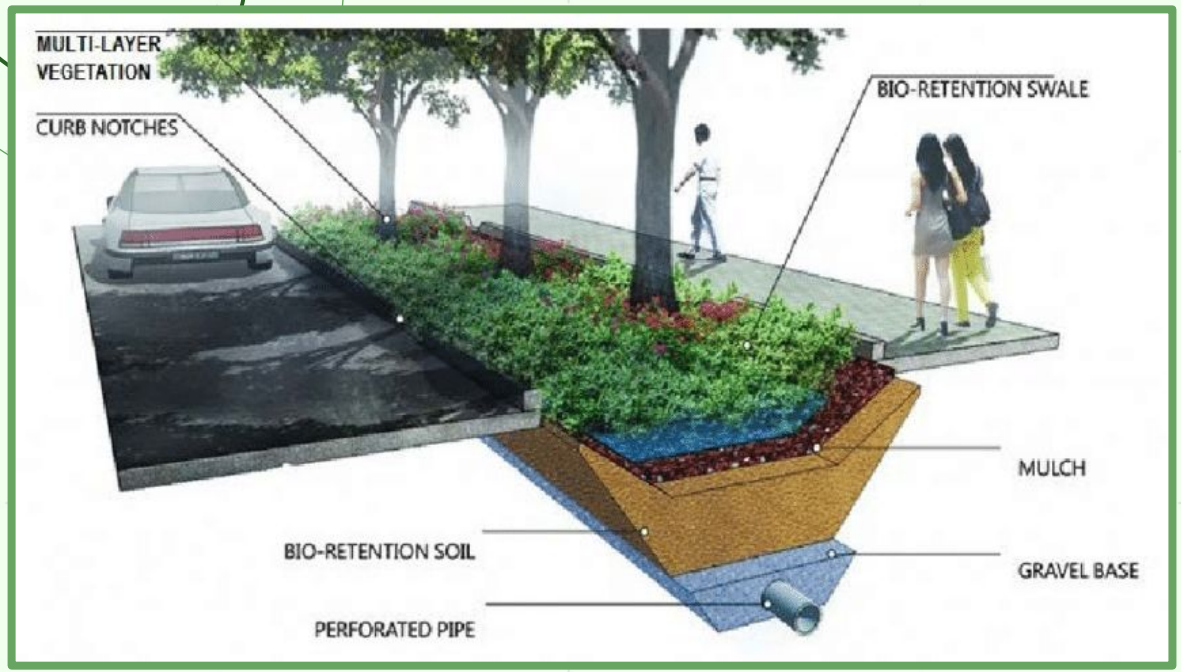
Bioswales at the street level



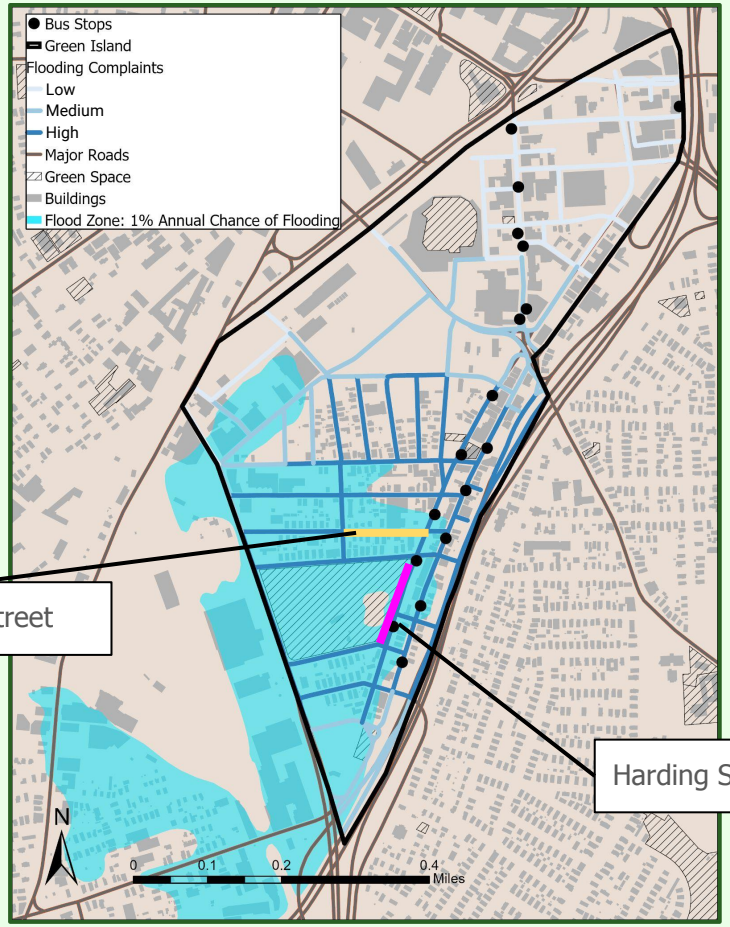
Watershed Approach:

Green infrastructure within the watershed

Localized Flood Mitigation



Localized Flood Mitigation Example Streets



Ellsworth Street

Harding Street

Harding Street:

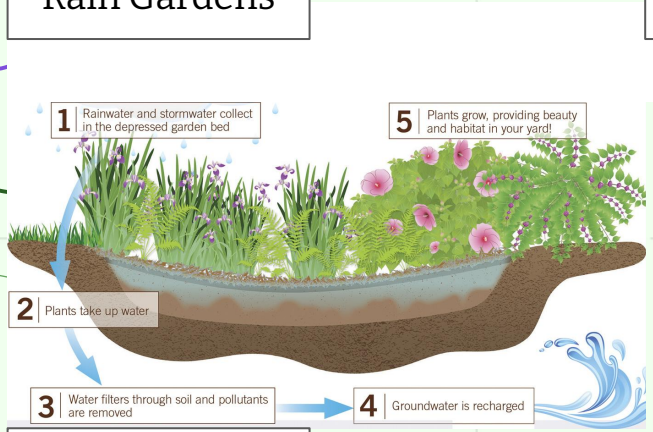
- Upper Harding: Street with **the highest** reported flooding
- Lower Harding: Street with the 5th highest reported flooding

Ellsworth Street:

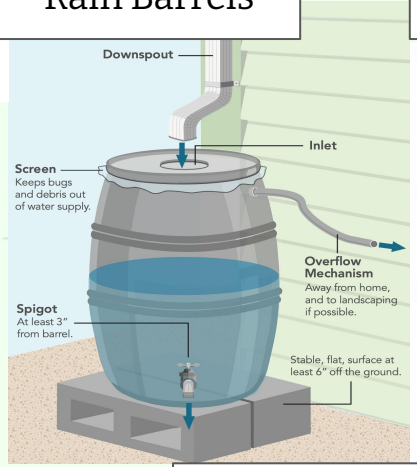
- Street with the 13th highest reported flooding

Watershed Scale Flood Mitigation

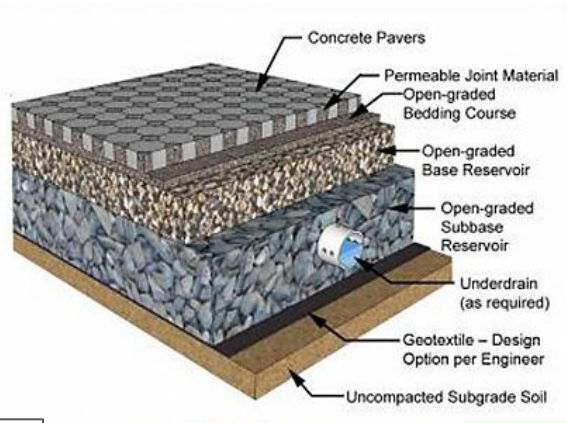
Rain Gardens



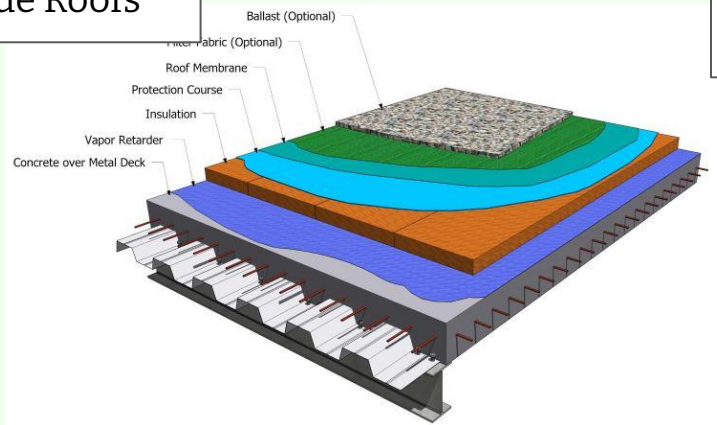
Rain Barrels



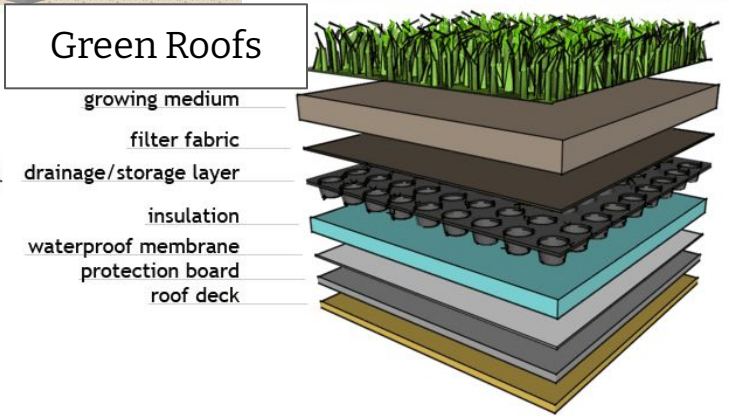
Permeable Pavements



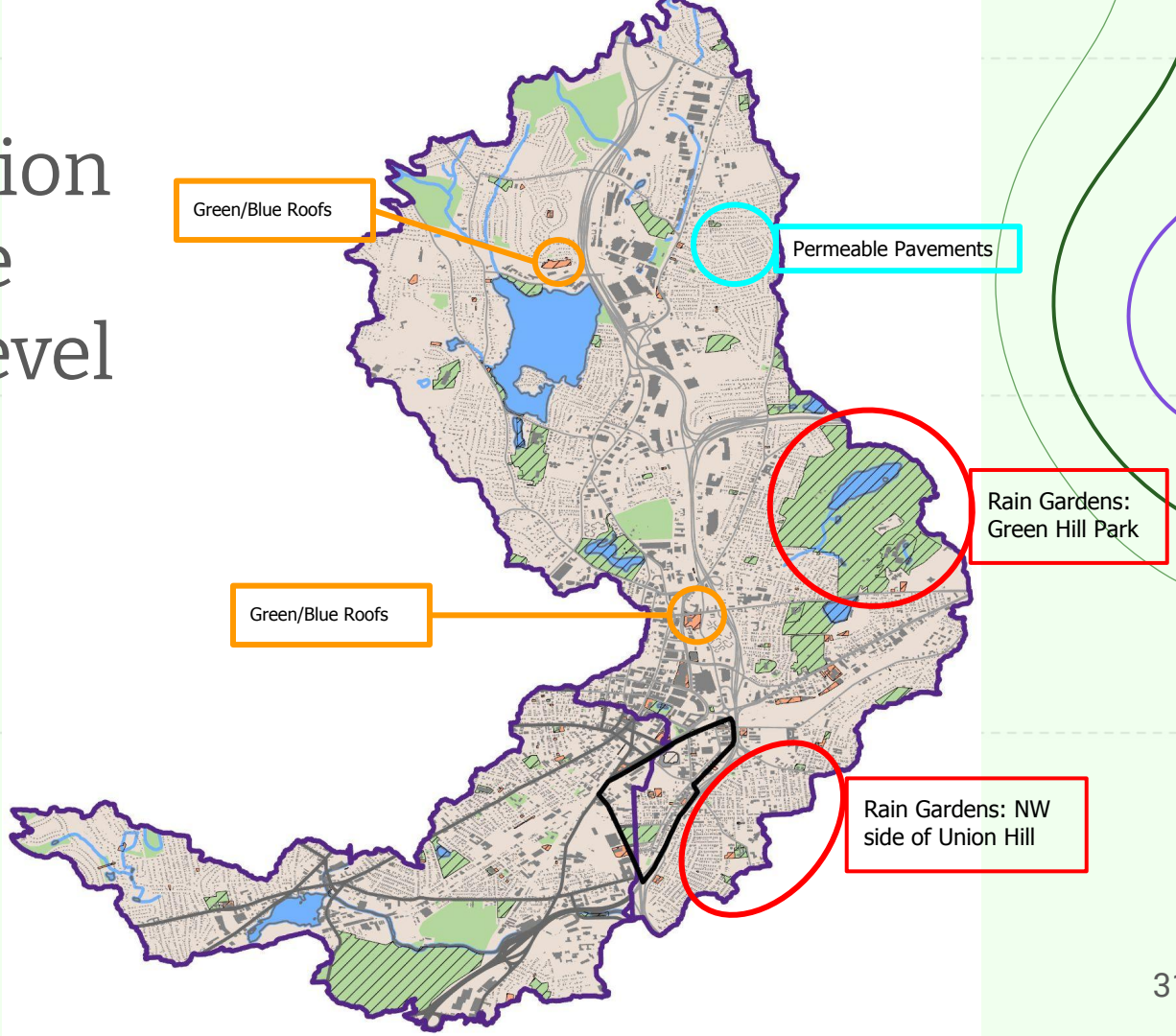
Blue Roofs



Green Roofs



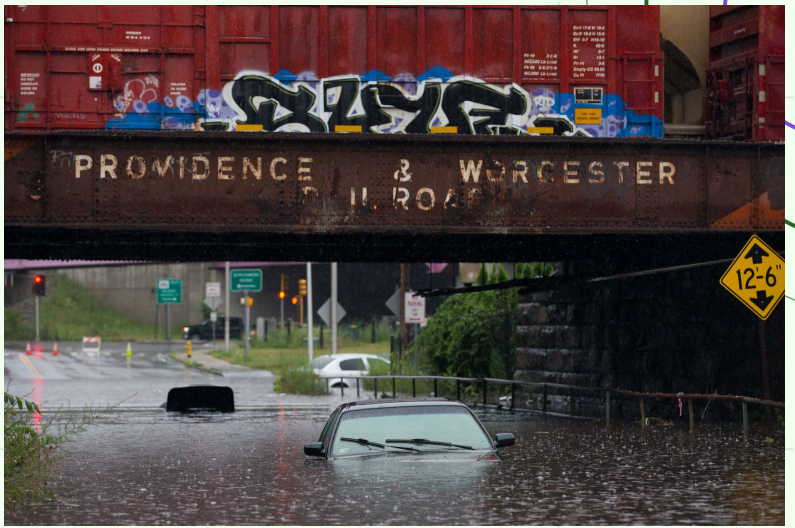
Flood Mitigation Sites at the Watershed Level



Flood Mitigation Solutions Summary

02 Identify potential green infrastructure solutions for flood mitigation in Green Island

1. There are many solutions to mitigate flooding, some fall within a localized approach such as Bioswales, others at a watershed approach such as rain gardens and green roofs
2. Holistically, changes from gray to green infrastructure at a watershed scale is key for long term resiliency
3. Each solution is case by case; focusing on city owned land and buildings to implement green infrastructure is a good place to start



Main Takeaways

1. Historical wetlands and waterways overlap with current flood zones and should be used to plan future green infrastructure interventions
2. In South Green Island, north of Crompton Park streets such as Sigel, Endicott, Ellsworth, and Harding are high in reported flooding and extreme heat instances
    a. These streets would benefit the most from flood mitigation solutions (bioswales) and street tree planting
3. The highest ozone concentration is in pockets around heavy industry and I-290 in Green Island
4. Many green infrastructure solutions will have positive effects on reducing both UHI and flood mitigation
    a. **A 5% increase in tree canopy cover, 1 degree F in temperature reduction**
5. Other green infrastructure will only reduce UHI such as white roofs
    a. **0.411 Acres treated with white roof/solar panels, 1 degree F in temperature reduction**

Future Research/Next steps

Flood Mitigation:

- More specific green infrastructure recommendations as well as possible sites
- Cost benefit analysis of green infrastructure options
- Explore Worcester's capacity to implement green infrastructure for flooding focusing on institutions

Urban Heat:

- Further research into benefits of green roofs
- Finish Columbus Park Tree Census
- Look at a neighborhood with the highest canopy cover in Worcester

Acknowledgements

People

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Martha Gach (Broad Meadow Brook)

Janet & Steve McLaren

Remy Geron

*City of Worcester Conservation Planning Office

Other

Clark University Geography Department

Residents of Green Island & Columbus Park

Thank You!
Any Questions?

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