Worcester Drainage Master Plan

Building Worcester's Resilience to Climate Change

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Will Blais
Weston & Sampson

Kara Keleher, P.E.
Weston & Sampson

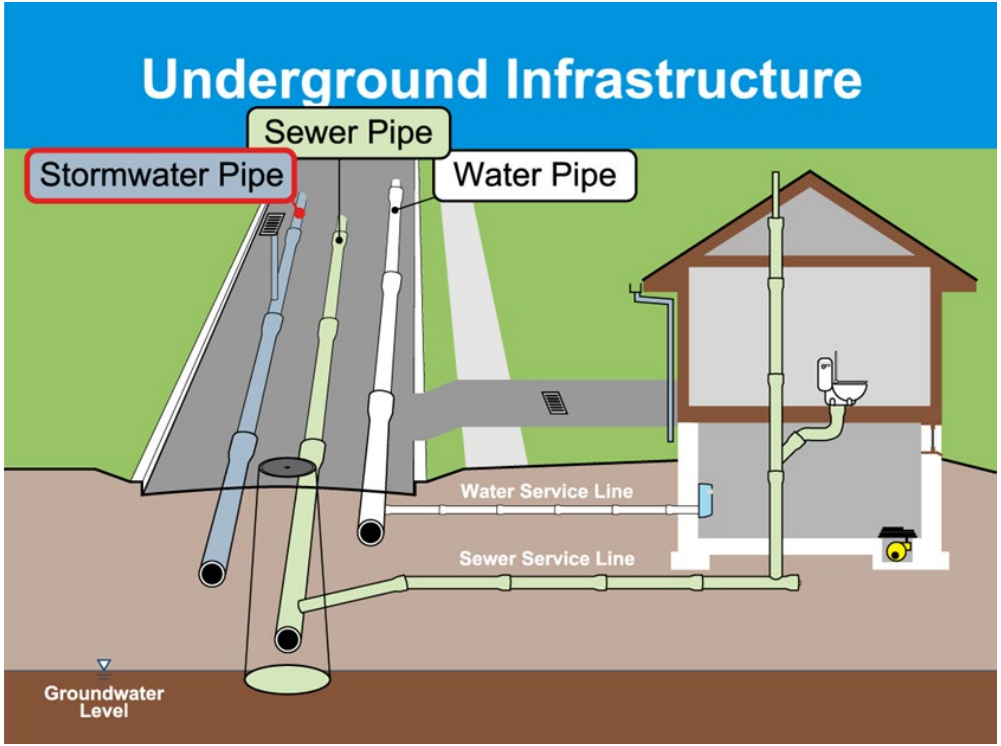
Weston & Sampson℠

Worcester Municipal Stormwater System

- 374 miles of drain
- 370 outfalls
- 29,000 catch basins

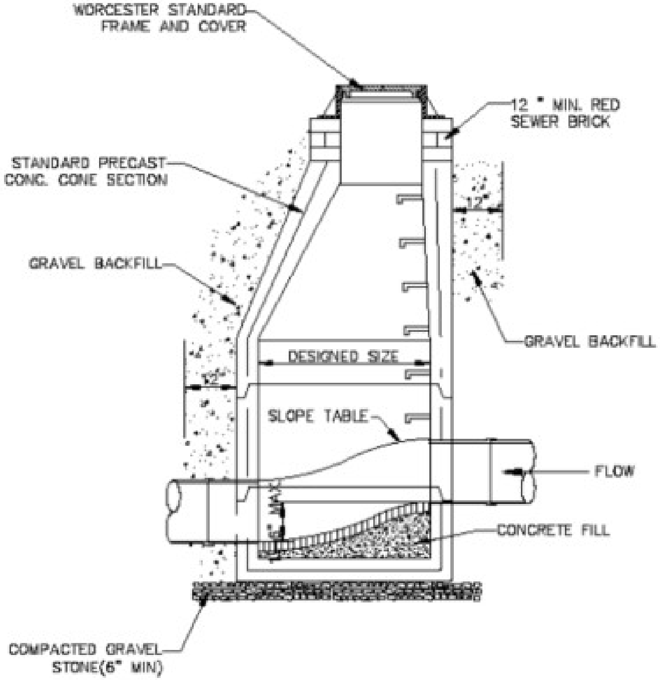
What is a Stormwater System

- A stormwater system is made up of:
  - Drain Manholes
  - Drain Pipes
  - Catch Basins
  - Outfalls



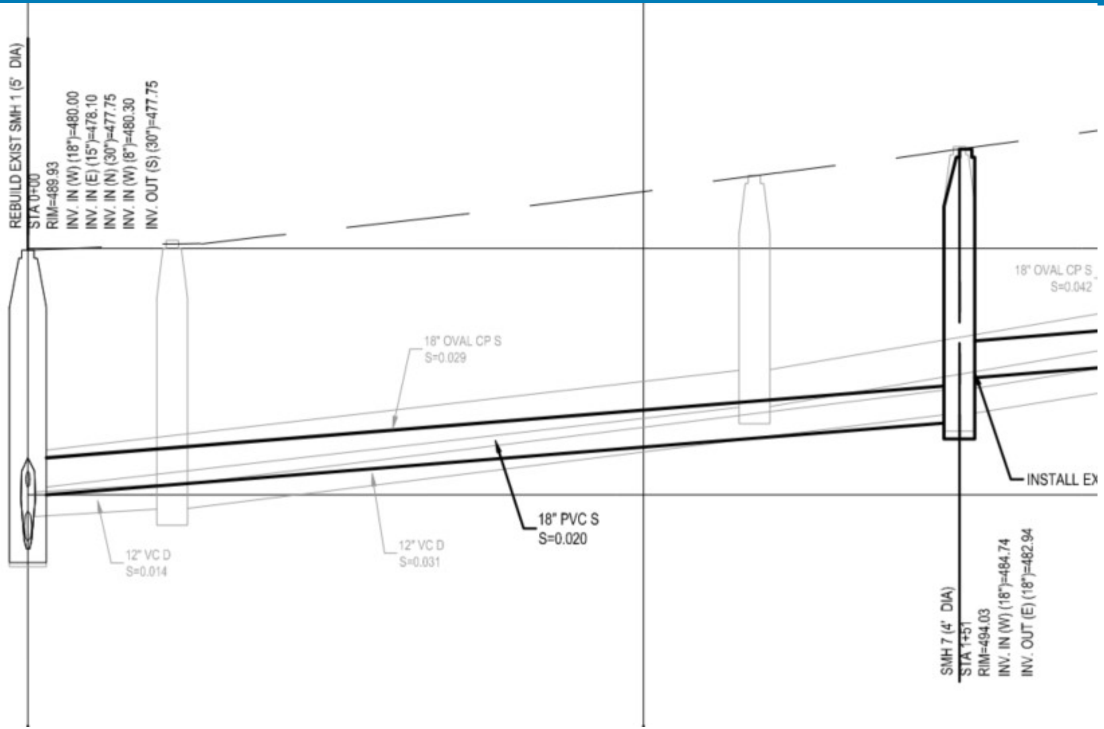
Drain Manhole

Drain manholes are structures that allow access to the drainage system for inspection and cleaning. Drain manholes are located where pipes change direction.



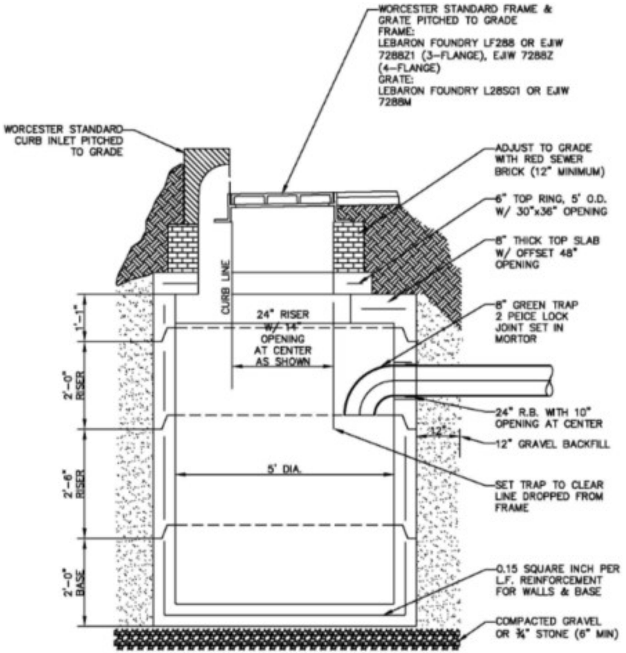
Pipe Invert and Slope

- A pipe coveys stormwater through the system between manholes to the outfall.
- The pipe Invert is lowest part of the interior of pipe.
- Pipe slope, also know as pitch, keeps liquids and solids moving. It is calculated by dividing the change in depth over the length.



Catch Basins

Catch Basins are structures with grates that collect water from city streets



Outfall

An outfall is the location in the drainage system where stormwater exits the pipe network and discharges to a waterbody, wetland, drainage swale, or culvert.

Culvert

A culvert is a tunnel-like structure that carries a stream or open drain under a road or railroad

City Commitment To Stormwater System

Worcester DPW has existing programs to address both water quality and capacity issues:

- City conducts outfall sampling annually
- City has completed numerous analyses, evaluations, design and construction improvements over the past 10 years

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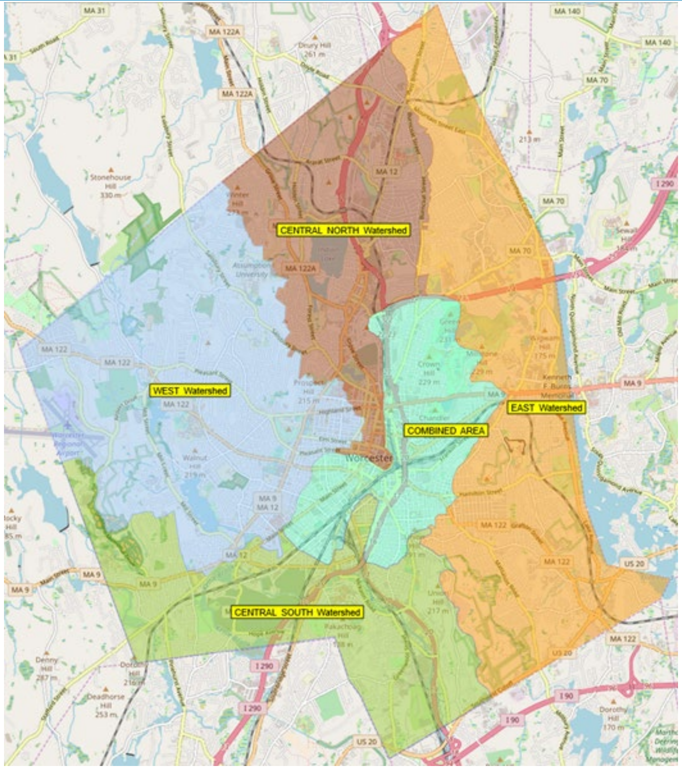
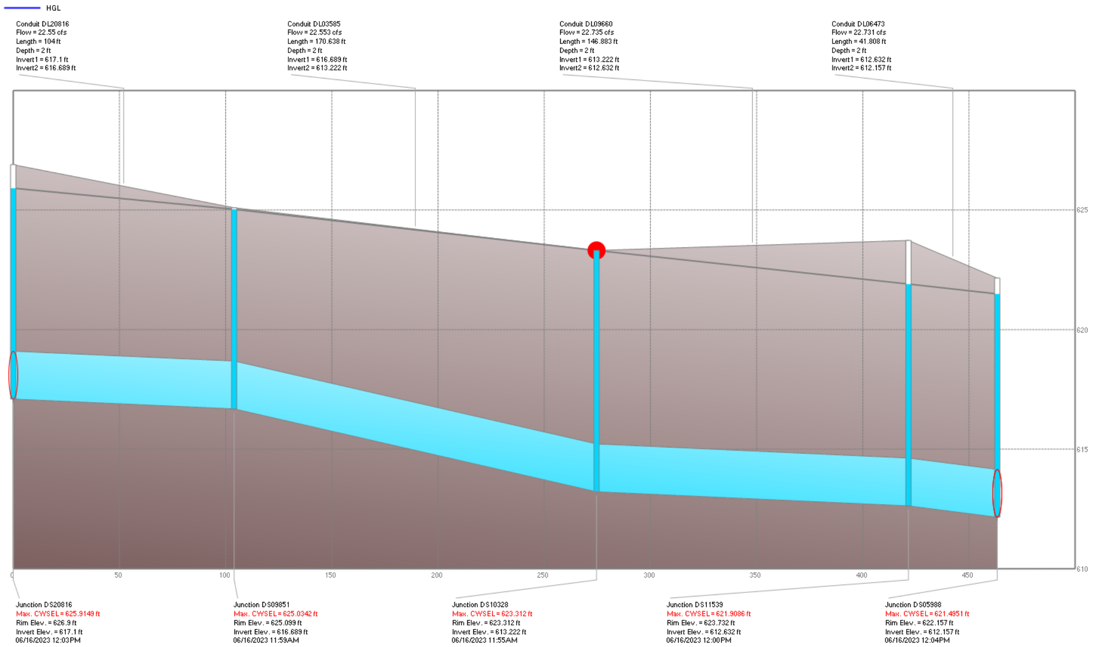
Worcester Drainage Master Plan Objective

Develop a plan to identify areas where flooding occurs throughout the City except for the Combined Sewer/Green Island Area, which is located in the center of Worcester



Worcester Drainage Master Plan Approach

- For the 2022-2024 Worcester Drainage Master Plan the main task includes the development of a computer (hydrologic/hydraulic) model for the local drainage pipes.
- Future phases of the Master Plan will include existing city-wide tributary streams, open channels, and natural storage areas.



Hydrologic/Hydraulic Model Process

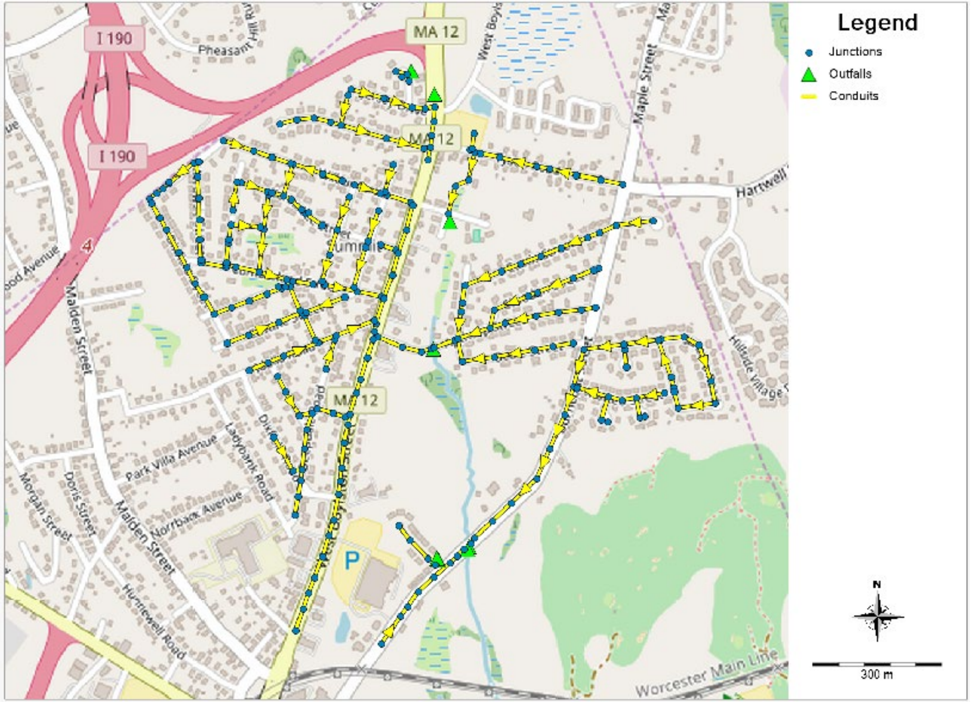
- Compile and review previous drainage studies for context.
- Identify the limits of the pipe network to be analyzed through review of City stormwater GIS. (privately owned drains were not included in the evaluation).
- Review City Stormwater GIS to identify missing information needed for the Model including:
  - manhole depths
  - pipe elevations
  - pipe size (diameter and shape)
  - pipe length
  - pipe material

Hydrologic/Hydraulic Model Process (Cont'd)
Collect Stormwater System Data

- Review existing City provided stormwater GIS to identify missing system data needed for the H/H model.
- Developed manhole inspection work plan to determine number of inspections required.
- Conducted 4,380 manhole inspections to establish pipe size and pipe invert elevations.

Hydrologic/Hydraulic Model Process (Cont'd)

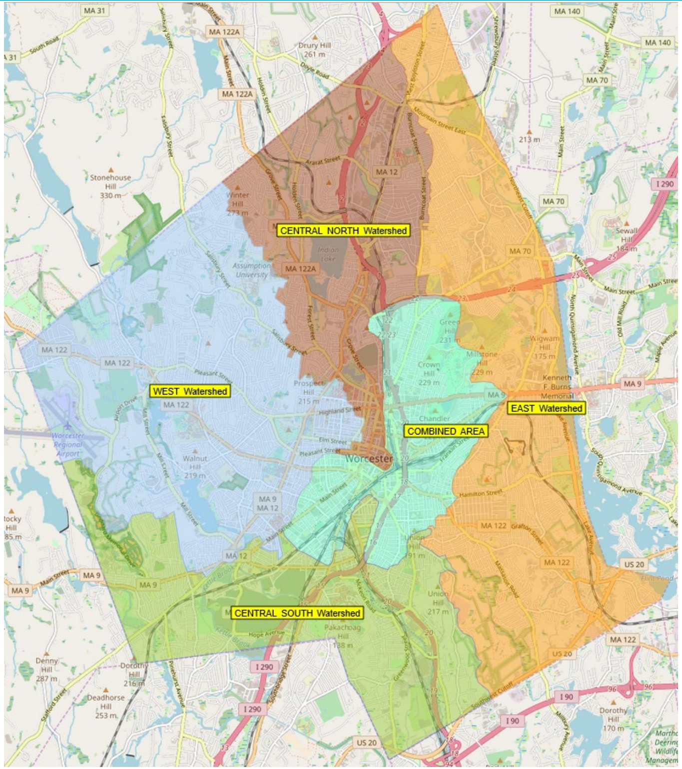
- Develop hydraulic model by importing city GIS information into the software to identify data conflicts.
- Identify system components, including stormwater drain pipes, drain manholes, and outfalls to be used to identify the subcatchment areas.
- Create subcatchments on the existing conditions map.



Hydrologic/Hydraulic Model Process (Cont'd)

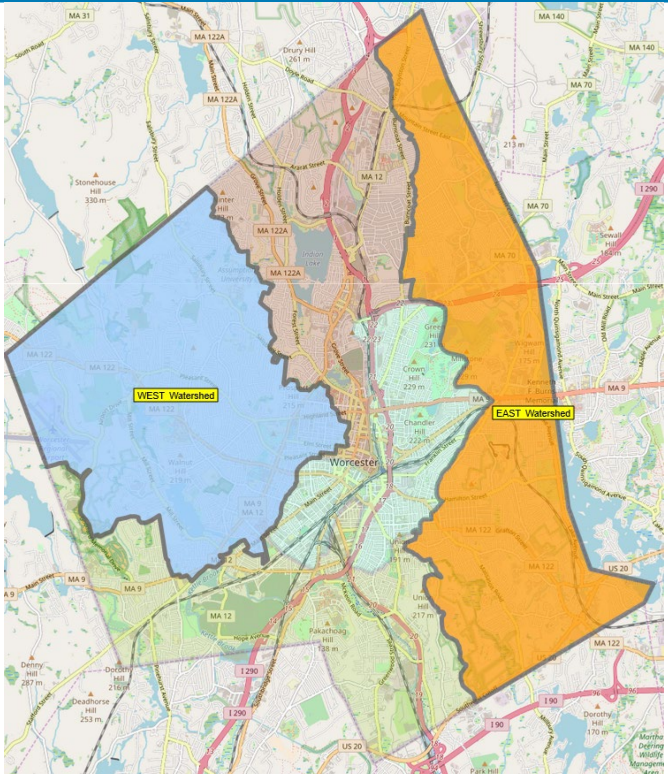
- Using the subcatchment information, run the model to develop runoff hydrographs (discharge rates) for:
  - Existing 10-Year Rainfall Event
  - Future predicted 2070 10-Year Rainfall Event
- Develop model validation via field observations.

Data Collection and Hydrologic/Hydraulic Model



- City-wide drainage master plan limits of work included:
- East Watershed
- West Watershed
- Central North Watershed
- Central South Watershed
- The Combined Sewer Area was not included in current analysis and will be performed under a separate project

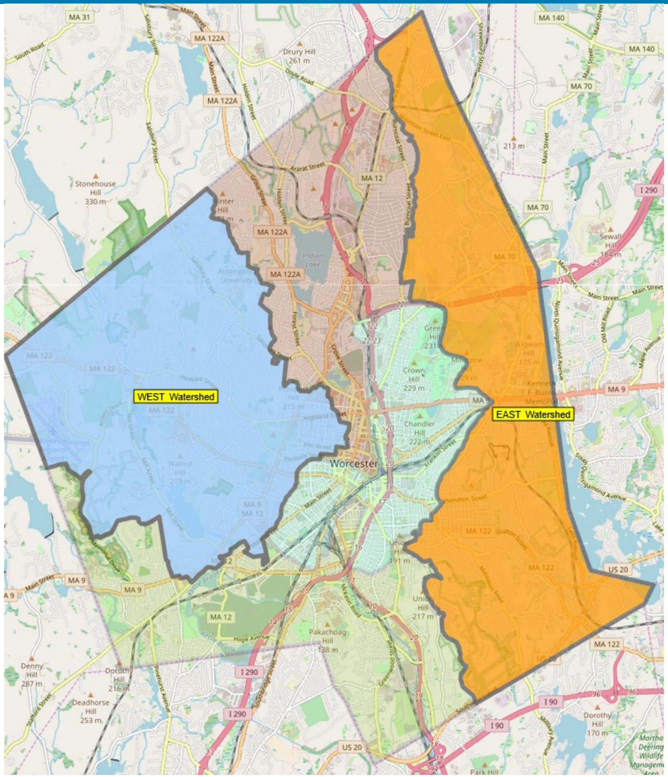
Subareas



Each watershed was split up into subareas based on the existing drainage system components:

- Manholes
- Pipes
- Outfalls

Nodes and Subcatchments



- Nodes are locations within the model where additional flow is added or where there is a change in slope or pipe size

- Each subareas was split up into subcatchments based on the entry points into the system, which are mainly catch basins.

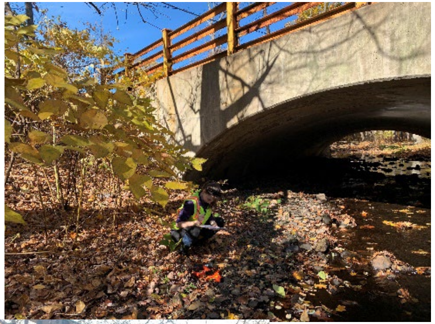
Collect Stormwater System Data

- Conducted stormwater outfall inspections (33 locations) 10%

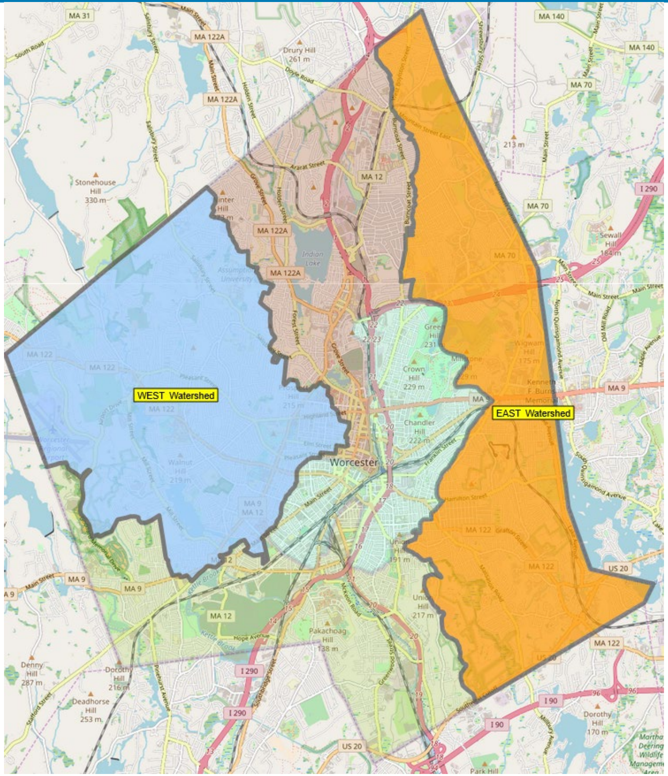
Collect Stormwater System Data

- Conducted 41 culvert inspections



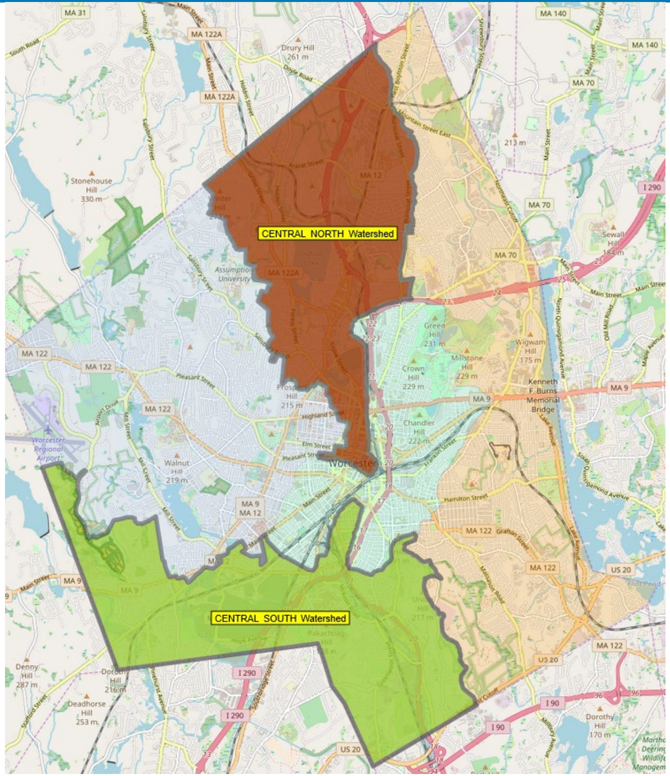


Hydraulic Model Metrics



- **East Watershed**
  - 17 Subareas
  - 1,850 Subcatchments
  - 3,100 Nodes and 100 Outfalls
  - 83 Miles Drainpipes
  - 2,760 acres
  - 49% Impervious (average)
- **West Watershed**
  - 10 Subareas
  - 2,430 Subcatchments
  - 4,160 Nodes and 15 Outfalls
  - 106 Miles of Drainpipes
  - 4,700 acres
  - 51% Impervious (average)

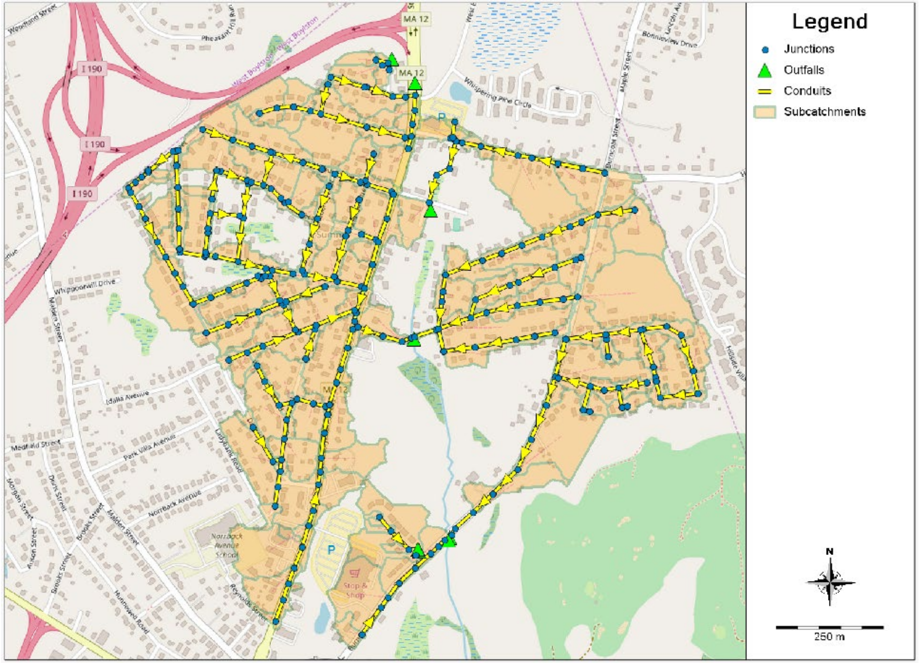
Hydraulic Model Metrics



- **Central North Watershed**
  - 10 Subareas
  - 1,950 Subcatchments
  - 3,200 Nodes and 90 Outfalls
  - 79 Miles of Drainpipes
  - 3,015 acres of area
  - 59% Impervious (average)

- **Central South Watershed**
  - 11 Subareas
  - 1,050 Subcatchments
  - 1,900 Model Nodes and 70 Outfalls
  - 49 Miles Feet of Drainpipes
  - 2,075 acres of area
  - 50% Impervious (average)

H/H Model Example Subarea Map



Hydrologic/Hydraulic Model analyzed:

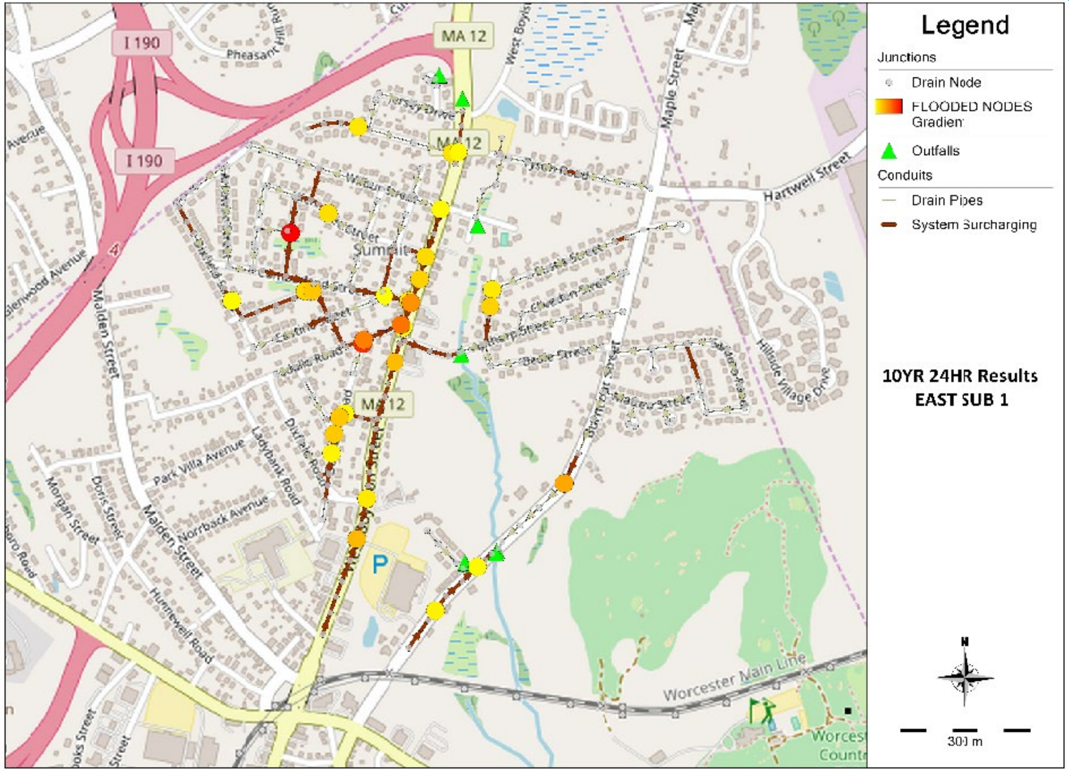
- 48 Subareas City Wide
- 7,280 Subcatchments
- 12,550 Total Acres
- 12,250 Model Nodes
- 370 Outfalls
- 315 Miles of Drainpipe

H/H PCSWMM Model Scenarios Completed

- **City Wide 48 Subareas/7,280 Subcatchments**
  - Present day 10-year rainfall event
  - 2070 projected 10-year rainfall event for resiliency

- **Six (6) Areas Detailed Evaluation and Alternatives Solution Analysis**
  - Present day 10-year rainfall event
  - 2070 projected 10-year rainfall event for resiliency
  - 2-Year rainfall event for Green Infrastructure and Nature Base Design Components

Model Results Sample



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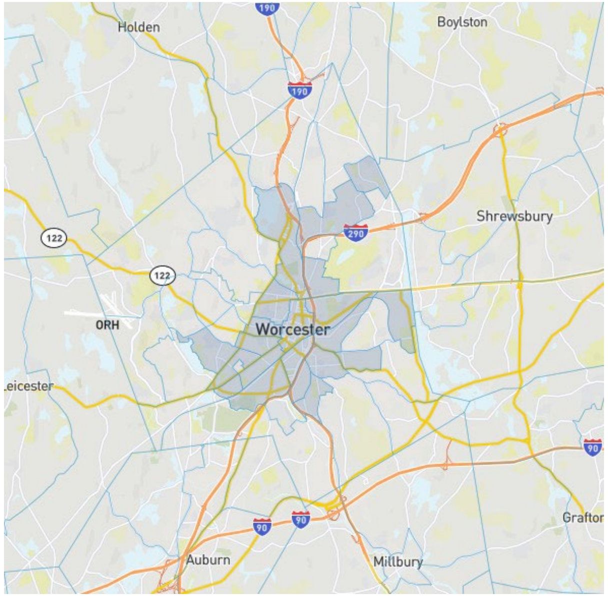
Six Priority Locations for Alternatives Development

- City is finalizing selection of priority locations for detailed analysis and alternatives development. Criteria used for selection includes:
  - Observed flooding documentation and correlation
  - Community impacts of flooding
  - Environmental Justice Communities



Explore the map - Climate & Economic Justice Screening Tool (geoplatform.gov)

Six Priority Locations for Alternatives Development

- Weston & Sampson will develop alternative analysis for the selected areas of flooding concern. Solutions to be considered may include a combination of the following:
  - Green Infrastructure/Nature Based Solutions such as bioretention basins, swales, and permeable paving.
  - Gray infrastructure such as Culvert Upgrades, Underground Storage, Drain Piping Upgrades, and Maintenance
- This work is ongoing.

Green Infrastructure / Nature-based Solutions

- Flood reduction
- Water quality improvement
- Urban Heat Island reductions
- Ecological Habitat
- Maintenance reduction
- Increase Property Values

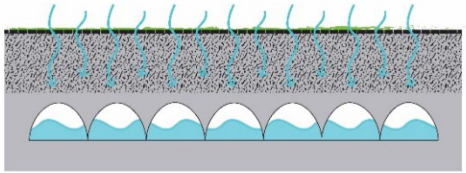
Green Infrastructure / Nature Based Solutions

Gravel / Constructed Wetland

- Large open spaces where ecological restoration and nutrient uptake is a priority
- Can be installed in existing pervious or impervious environments with full site redesign, or a retrofit for an existing wetland

Underground Storage

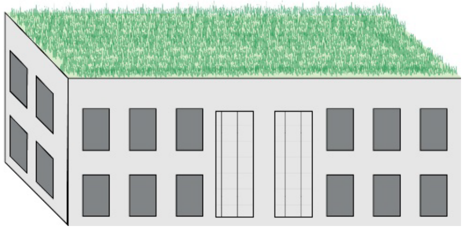
- Large open spaces
- Can be placed underneath pervious or impervious landscapes (i.e. parking lots and athletic fields)



Green Infrastructure / Nature Based Solutions

Green Roof

- Buildings without surrounding space to depave (highly developed areas)



Permeable Paving

- Open areas that must remain paved (i.e. parking lots) that do not have significant tree cover or heavy traffic
- Walkways / community paths

Note: this includes porous pavement & permeable pavers

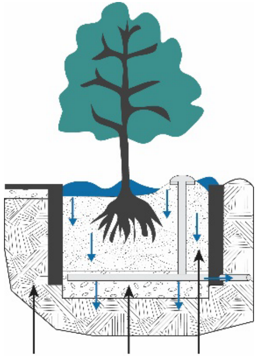
Green Infrastructure / Nature Based Solutions

Bioretention Basin

- Areas with size constraints
- Parking lot medians or edges, sidewalks, along roadways

Tree Box Filter

- Areas with size constraints
- Parking lot medians or edges, sidewalks, along roadways



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Green Infrastructure / Nature Based Solutions

Planter Box

- Areas with size constraints
- Parking lot medians or edges, sidewalks, along roadways

Main difference between planters and bioretention basins is engineered soils and piping!

Swale

- Linear transport of water, can be used in tandem with other nature-based solutions
- Road side or in open areas (fields), sloped to encourage directional flow

Next Steps

- Develop alternative analysis for the priority subareas that were selected by the City including:
  - Permits
  - Estimated construction cost
- Develop 2070 model runs for all subareas
- Project is expected to be completed by the end of 2024

thank you

Will Blais, Weston & Sampson, blaisw@wseinc.com
Kara Keleher, Weston & Sampson, keleherk@wseinc.com