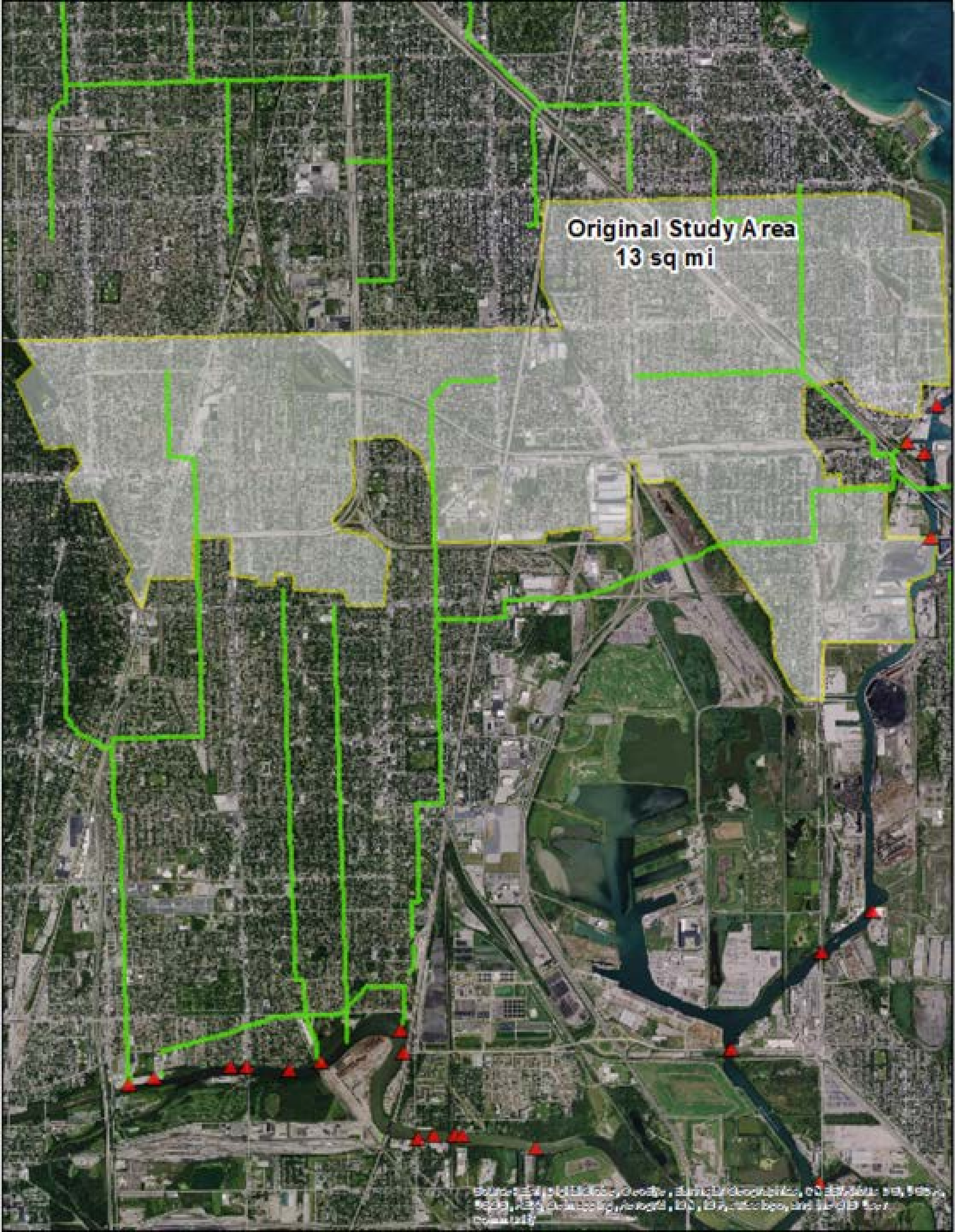
2016

Metropolitan Water Reclamation District of Greater Chicago

Phase II Pilot Study

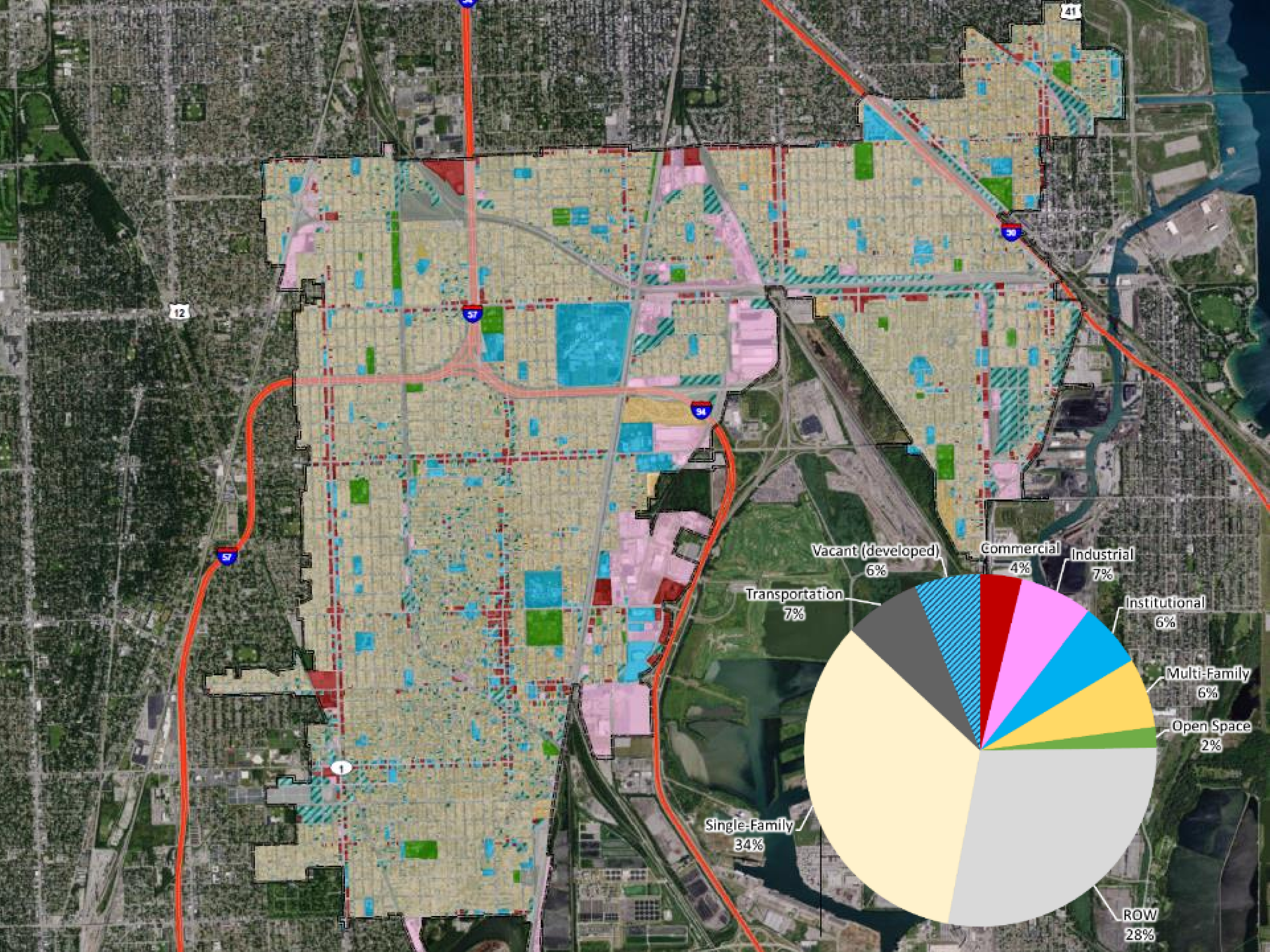
Project Overview

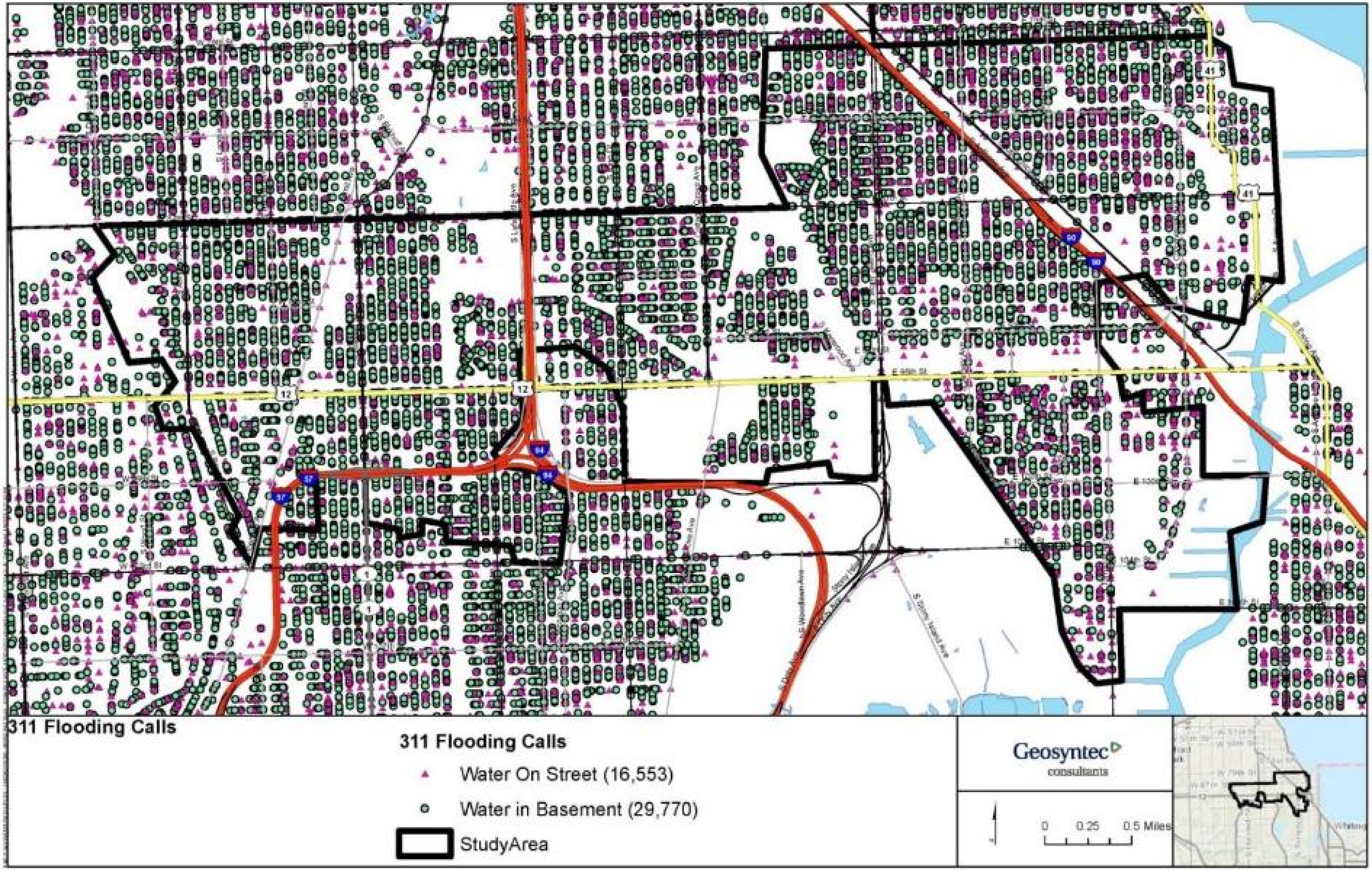
Understanding the Study Area



Original Study Area

- 13 square miles
- Within Chicago limits & MWRD service area
- 7 wards
- Densely urbanized
- Chronic urban flooding
  - Basement backups
  - Surface flooding


Vacant (developed)
6%
Commercial
4%
Industrial
7%
Transportation
7%
Institutional
6%
Multi-Family
6%
Open Space
2%
Single-Family
34%
ROW
28%



311 Flooding Calls

(2010-2014)

Project Approach

Project Approach

Approach Guidance

- Initiative 4: Cost & Benefits
  - Need to analyze costs & benefits of GI scenarios using a computer model to predict reductions in basement flooding risk
- Initiative 6: Planning
  - Build upon City's previous work and the MWRD's upcoming green infrastructure planning.
  - *"..in Chicago, we have not yet determined the costs and benefits of large-scale green stormwater infrastructure implementation."*

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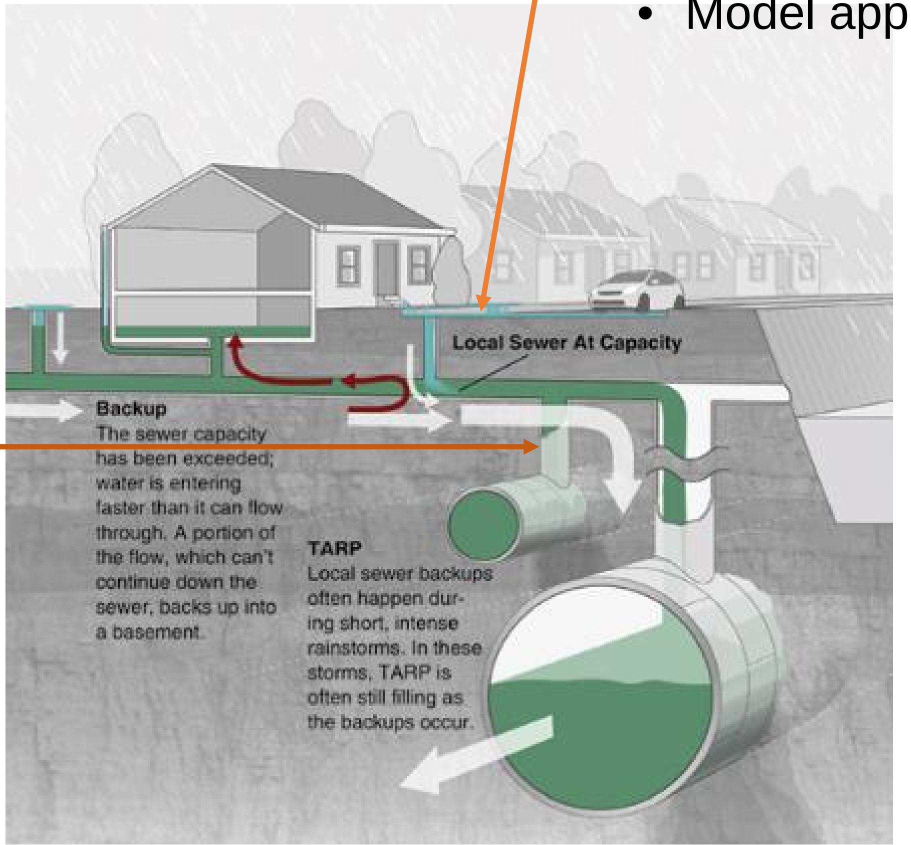
Considering both forms of flooding

1. Risk from surcharging

- System back ups & capacity issues
- Considerations:
  - Model resolution
  - Distance from network

2. Surface ponding & overland flow

- Surface ponding (stormwater prior to entering sewer system)
- Considerations:
  - Model resolution
  - Model approximations



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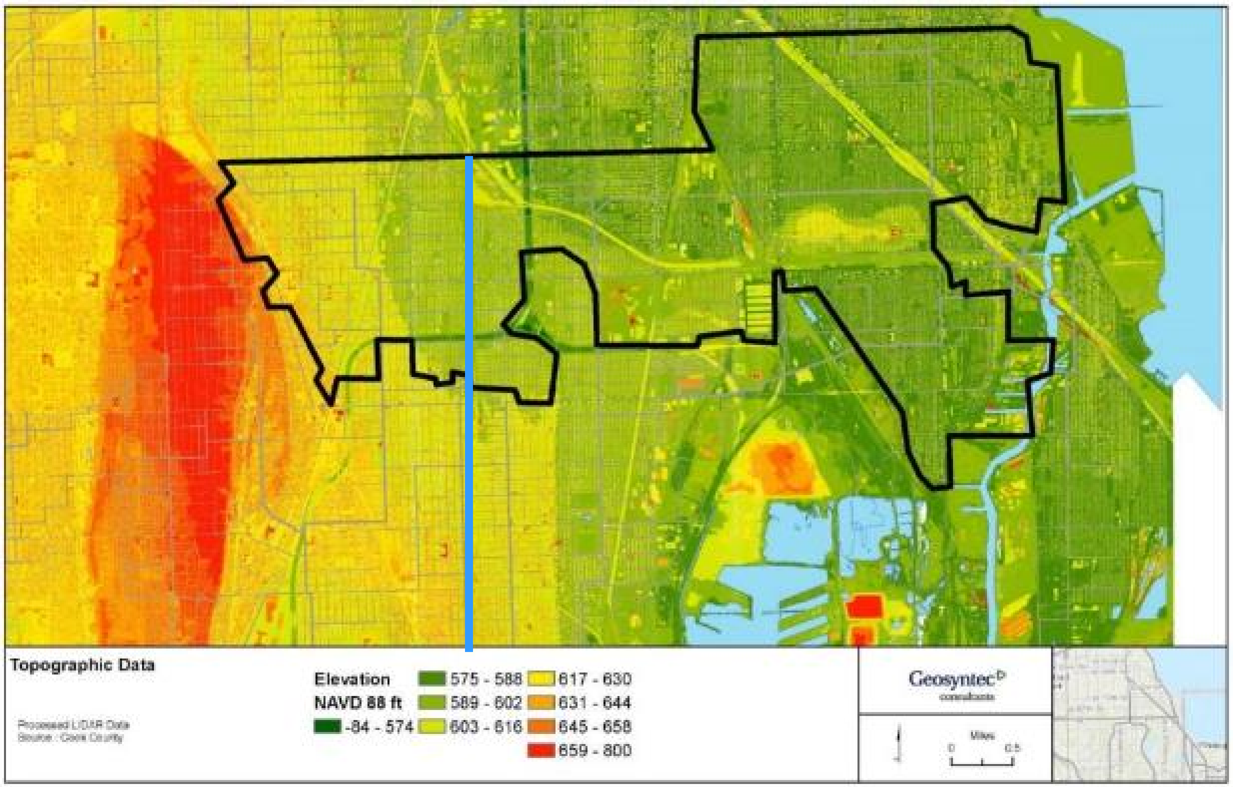
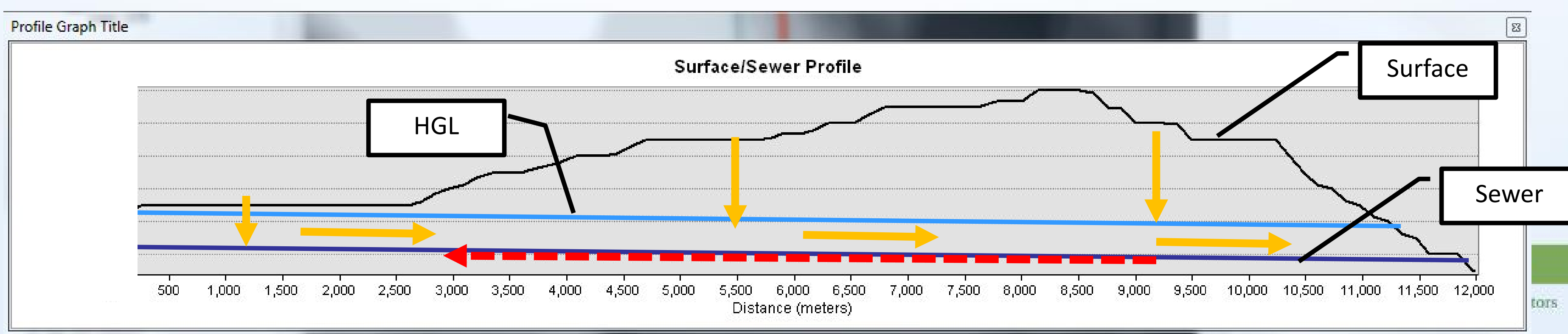
Baseline Conditions



Source of problem?

- Conveyance
- Lack of storage volume
- Topography



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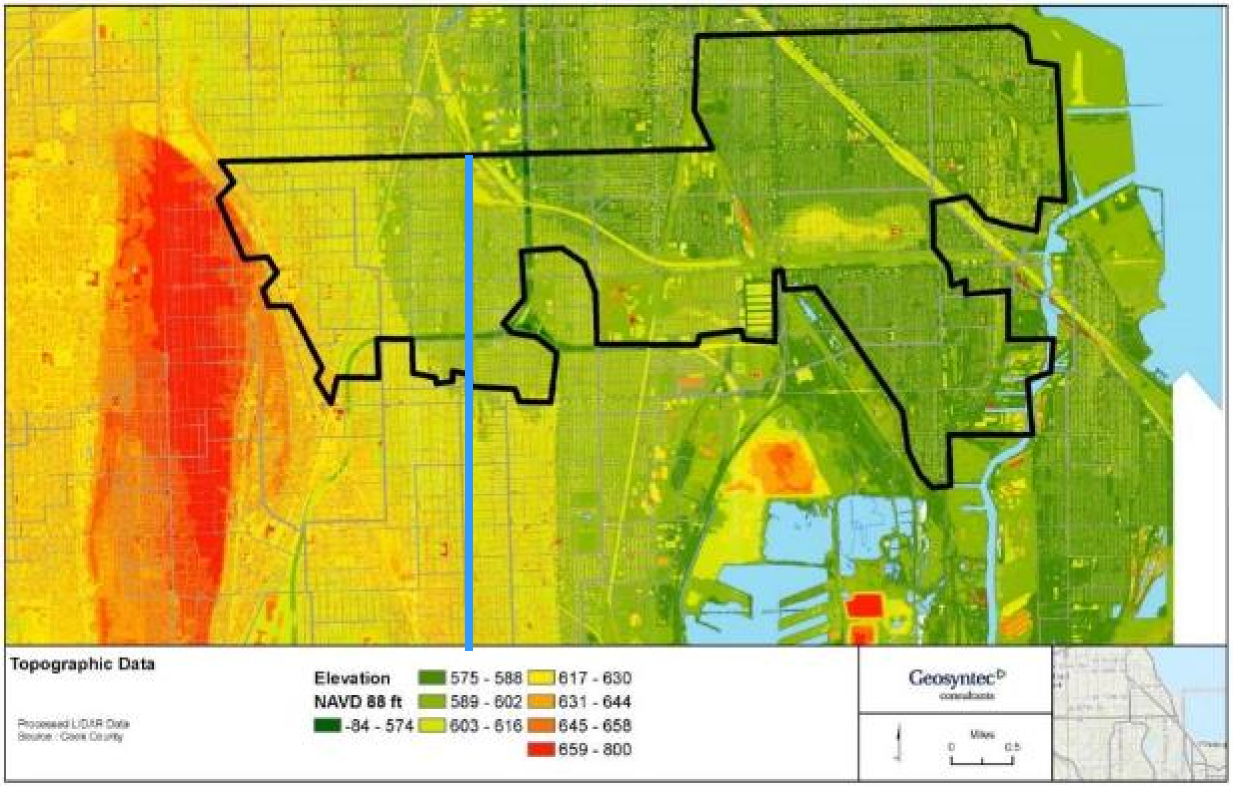
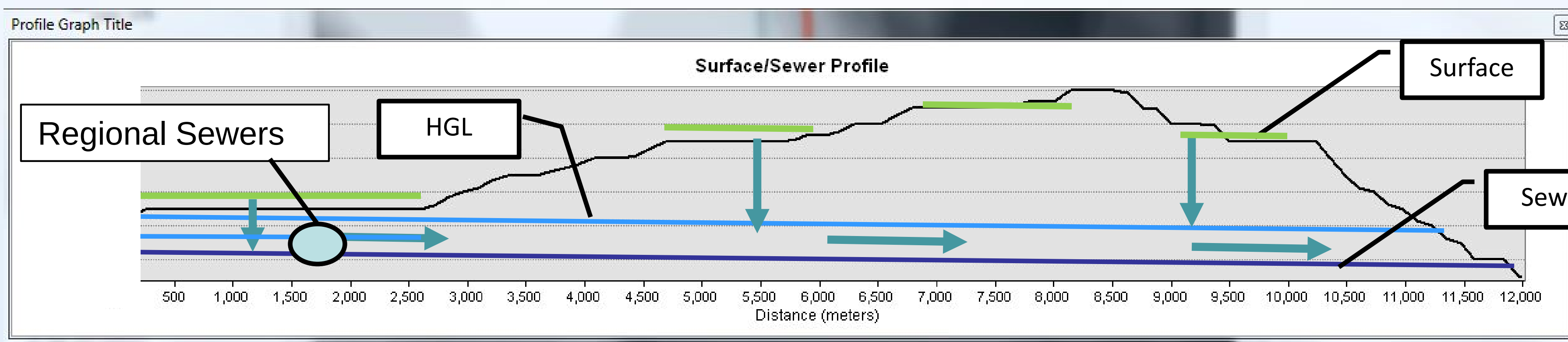
Potential Solutions



What is the solution?

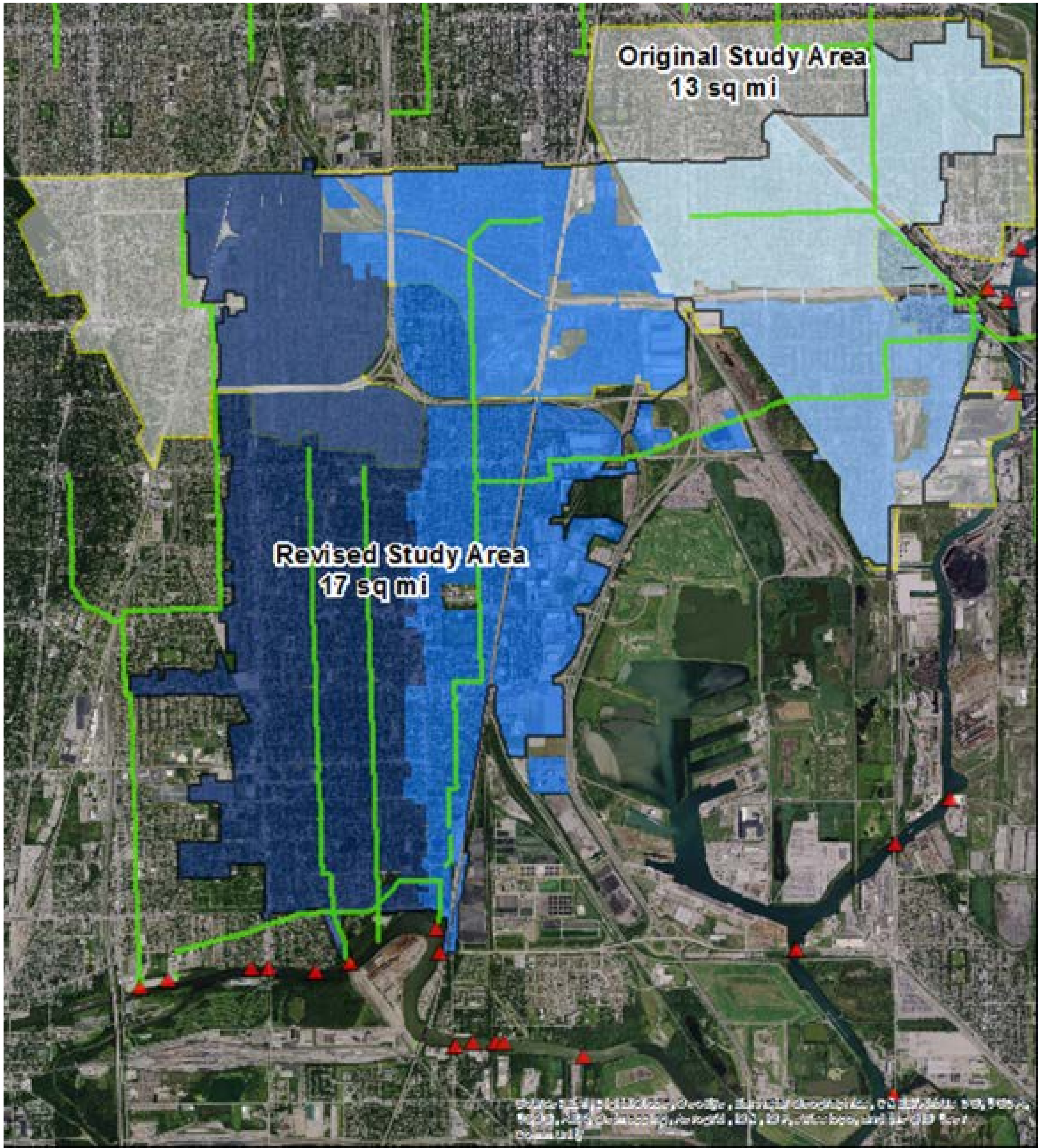
- Conveyance
- Volume
    - Green Infrastructure
    - Gray storage



Redefined Study Area

Revised study area:
- 17 square miles
- 493 catchments
- 4 major sewersheds
- 44,053 structures (excludes garages)

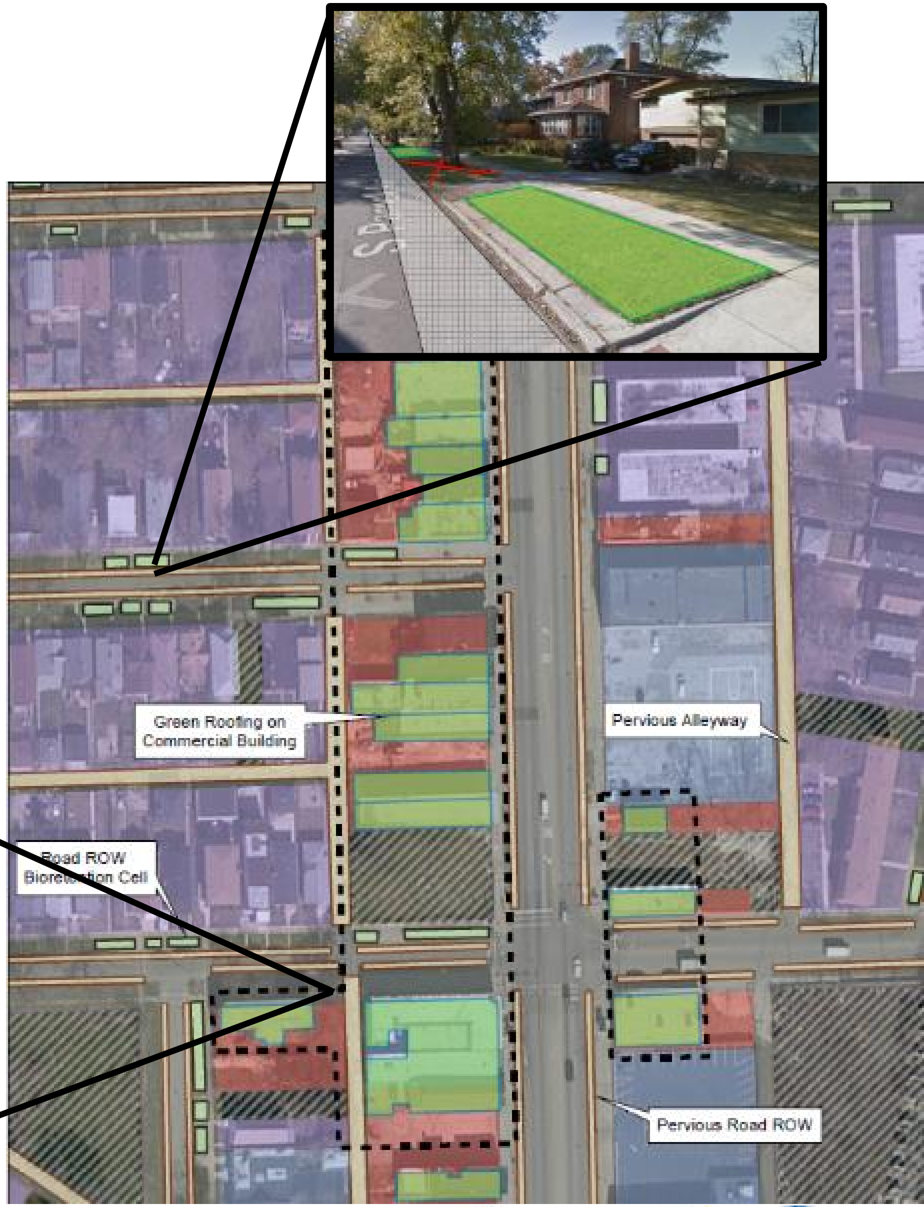
Structures flooded:
- 5 yr: 25,466 (58%)
- 25 yr: 32,610 (74%)
- 100 yr: 41,188 (93%)



Opportunity & Scenario Identification

Screening

- Performed intense screening of GI applicability within the study area
  - Identify viable GI practice alternatives for urban landscape of Chicago
  - Determine maximum extent of GI implementation
- Associated GI practices with each land use category (defined in model)



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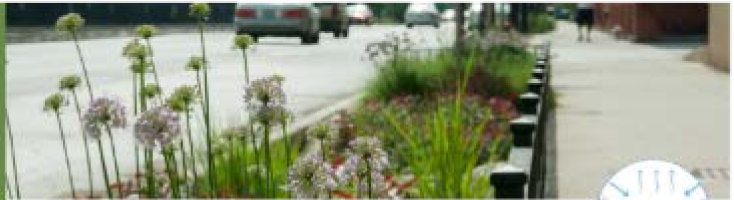
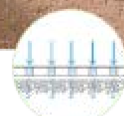
GI Tool Box




BIORETENTION

Bioretention and bioswales can be used along the right-of-way, residential properties, and in commercial/industrial/institutional settings to treat and capture stormwater volume.

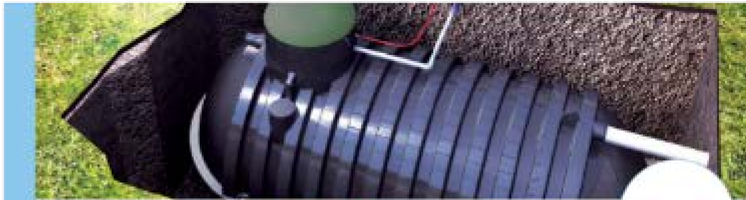



PERVIOUS PAVEMENT

Pervious Pavement can be used in residential parking lanes, parking lots, and alleyways to capture stormwater volume.


ABOVEGROUND CISTERNS

Above ground cisterns can be used in residential and commercial/industrial/institutional settings where space is available to capture stormwater volume for reuse.

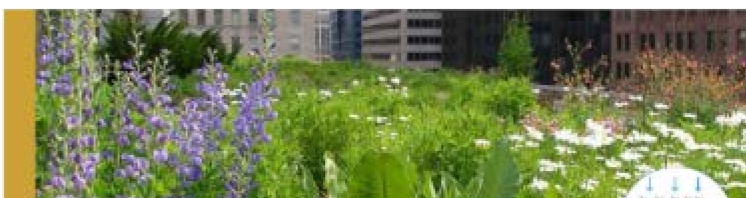



BELOWGROUND CISTERNS

Below ground cisterns can be used in residential and commercial/industrial/institutional settings where space limited to capture stormwater volume for reuse.


GREEN ALLEYWAYS

Alleyways can be retrofitted with pervious pavement and/or underground cisterns to capture stormwater volume.




GREEN ROOFS

Green roofs can be applied in commercial, industrial, and institutional settings to reduce rooftop stormwater runoff.

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Summary of GI Practices

GI Practices	
P1	Pervious Pavement (Commercial, Industrial, and Institutional)
P2/P3	Pervious Pavement (Roadway ROW and Residential Alleys)
B1	Bioretention (ROW)
B2	Bioretention (Commercial, Industrial, and Institutional)
B3	Bioretention (Residential)
C1	Aboveground Cisterns on Residential Properties
C1	Below-Ground Cisterns on Residential Properties
C1	Alleyway Concept #1—Below-Ground Aluminized CMP with Asphalt Pavement
C1	Alleyway Concept #2—Below-Ground ChamberMaxx Storm Arch with Asphalt Pavement
C1	Alleyway Concept #3—Below-Ground ChamberMaxx Storm Arch with Pervious Pavement
C1	Alleyway Concept #4—Below-Ground StormTrap with Asphalt Pavement
C2	Cisterns (Commercial)
G1	Green Roof (Commercial, Industrial, and Institutional)

Implementation Concept

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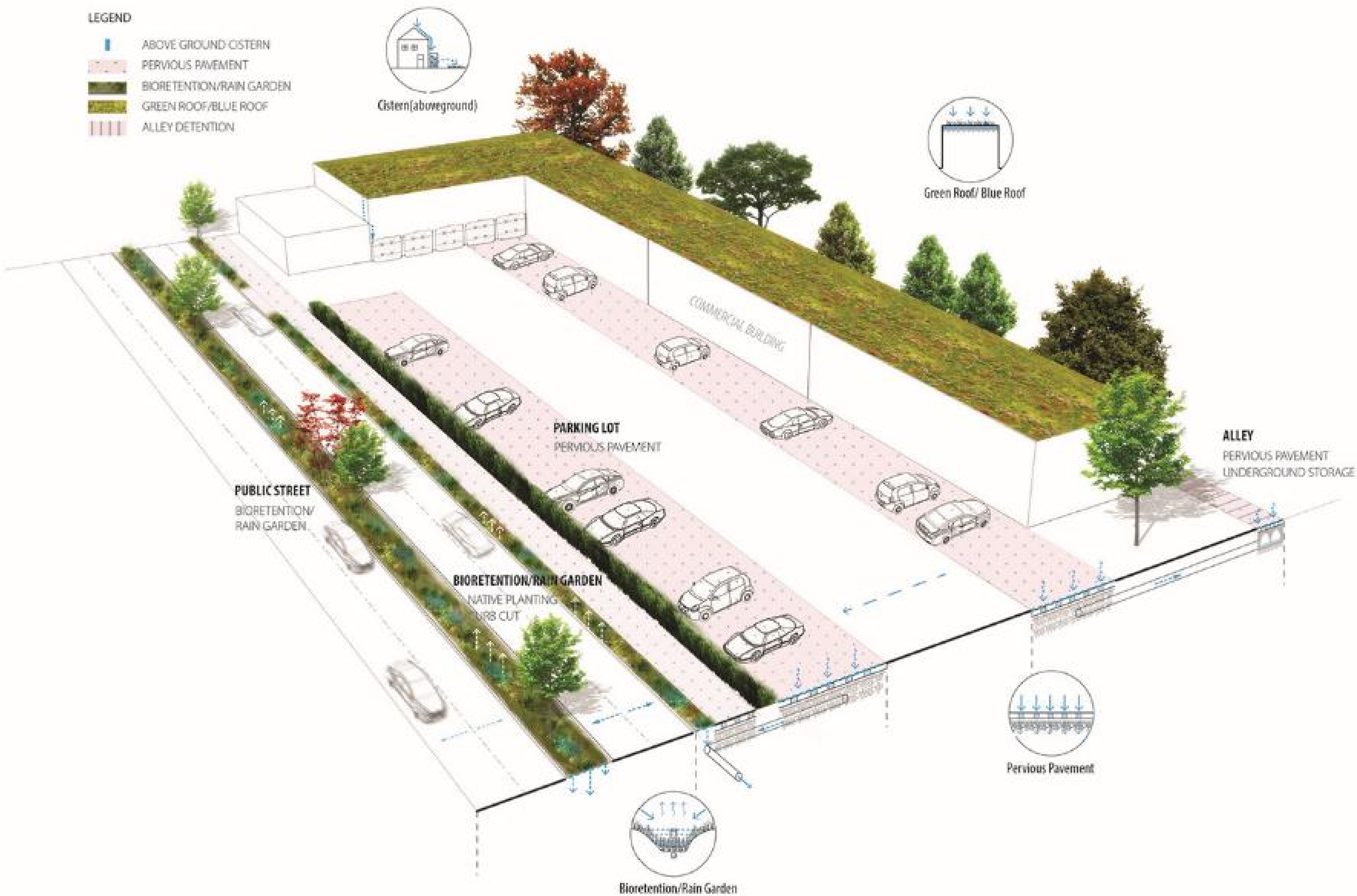

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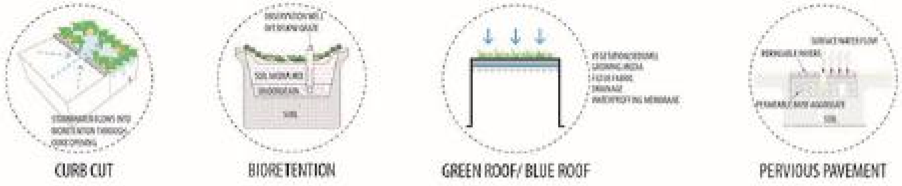
PUBLIC
COMMERCIAL
BIORETENTION
CURB CUT
COMMERCIAL CISTERN
GREEN ROOF/ BLUE ROOF
PERVIOUS PAVEMENT


CURB CUT
BIORETENTION
GREEN ROOF/ BLUE ROOF
PERVIOUS PAVEMENT

Modeling Approach

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Modeling Approach: Major Achievements

- Direct representation of GI in combined sewer model
  - Has not been accomplished prior to this study in Chicago
  - Allows direct comparison of green vs gray performance

- Leverages power of Optimizer™ analysis
  - 70,000+ combinations (comparing performance & cost)
  - Evaluates targeted scenarios (implementation strategies)

- Fully transferable protocol (& tool) to MWRD service areas
  - Removes technical barriers to evaluating GI
  - Limitless scenarios can be evaluated

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Defining Optimization…

- The process of applying an analytic process to find the best solution to a problem that has many possible solutions
- Provides **unbiased and defensible decisions** for system-wide or project specific design goals
- The project is utilizing Optimizer Software

Optimatics
PLAN SMARTER

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Optimization Approach

- **Traditional**
  - Planner develops model using iterative, trial and error process
  - Likely do not end up with the most efficient or cost effective solution

- **Optimized Approach**
  - Planner provides all possible options to the optimization system and lets the model decide
  - Automates the trial and error solution and allows the planner to test many more potential solutions

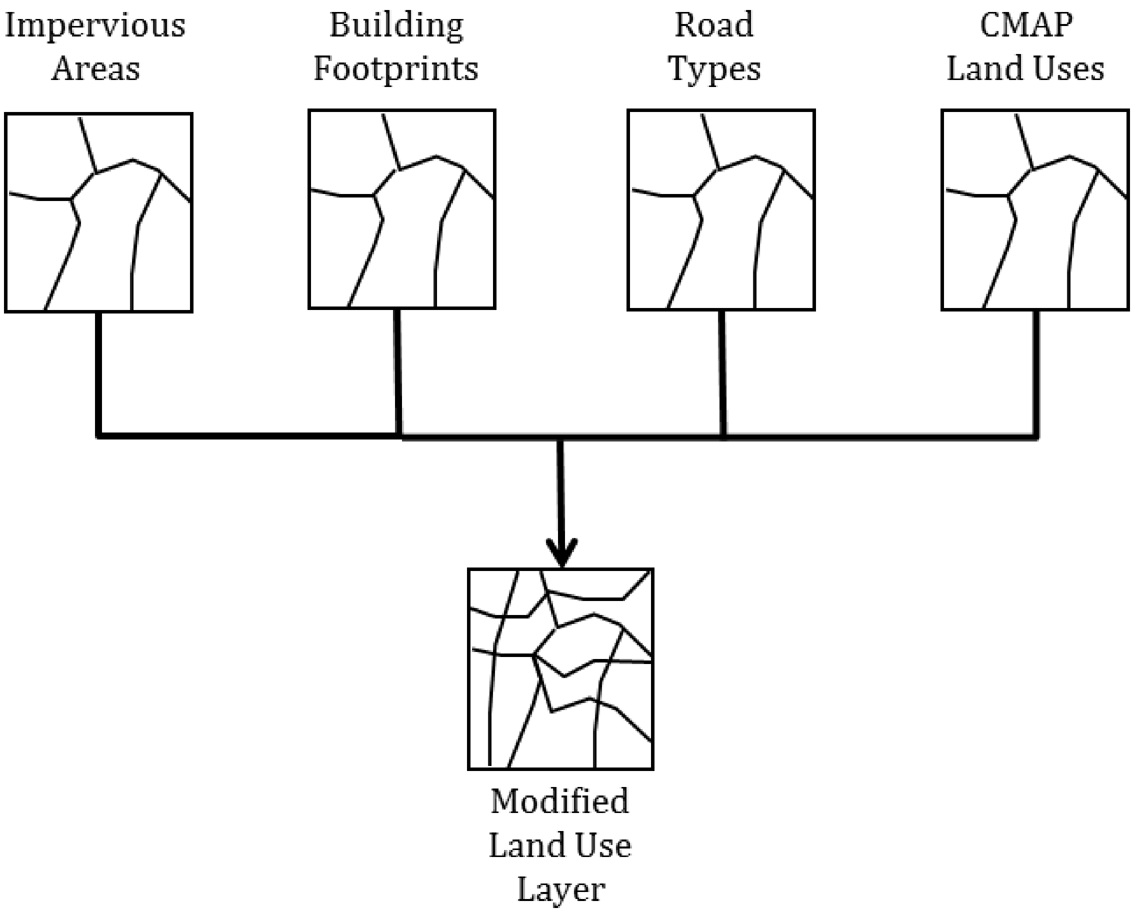
Scenario-Based Analysis

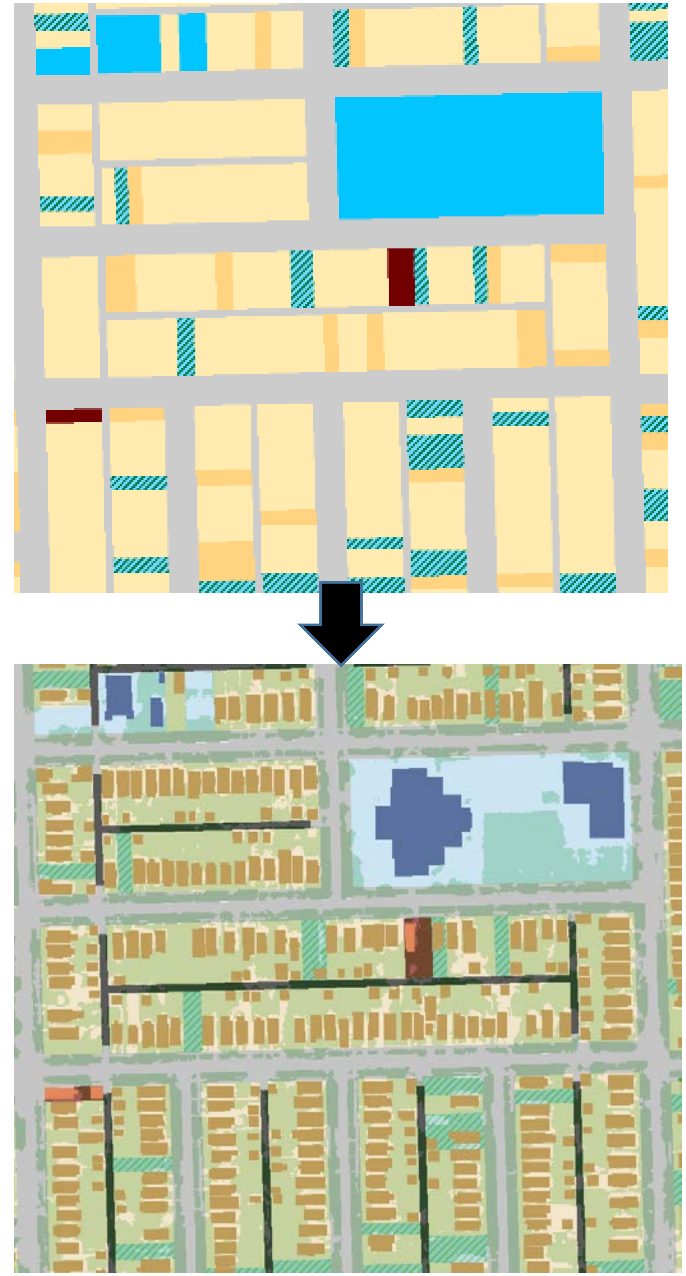
- **GI Only** *(Scenario A)*
  - Question: Can proposed tunnel be replaced with GI?
  - Quantify performance & cost of GI Implementation (5y-2hr)
- **GI & Proposed Tunnel** *(Scenario B)*
  - Question: Can a significantly higher level of service be achieved?
  - Quantify performance & cost of GI Implementation (25yr & 100yr-2hr)
- **GI & Proposed Tunnel with Supplemental Solutions** *(Scenario C)*
  - Builds upon Scenario B – adds connecting level projects per City Master Plan
  - Quantify performance & cost of GI Implementation (25yr & 100yr-2hr)

Model Framework Development

GI Scenario Management

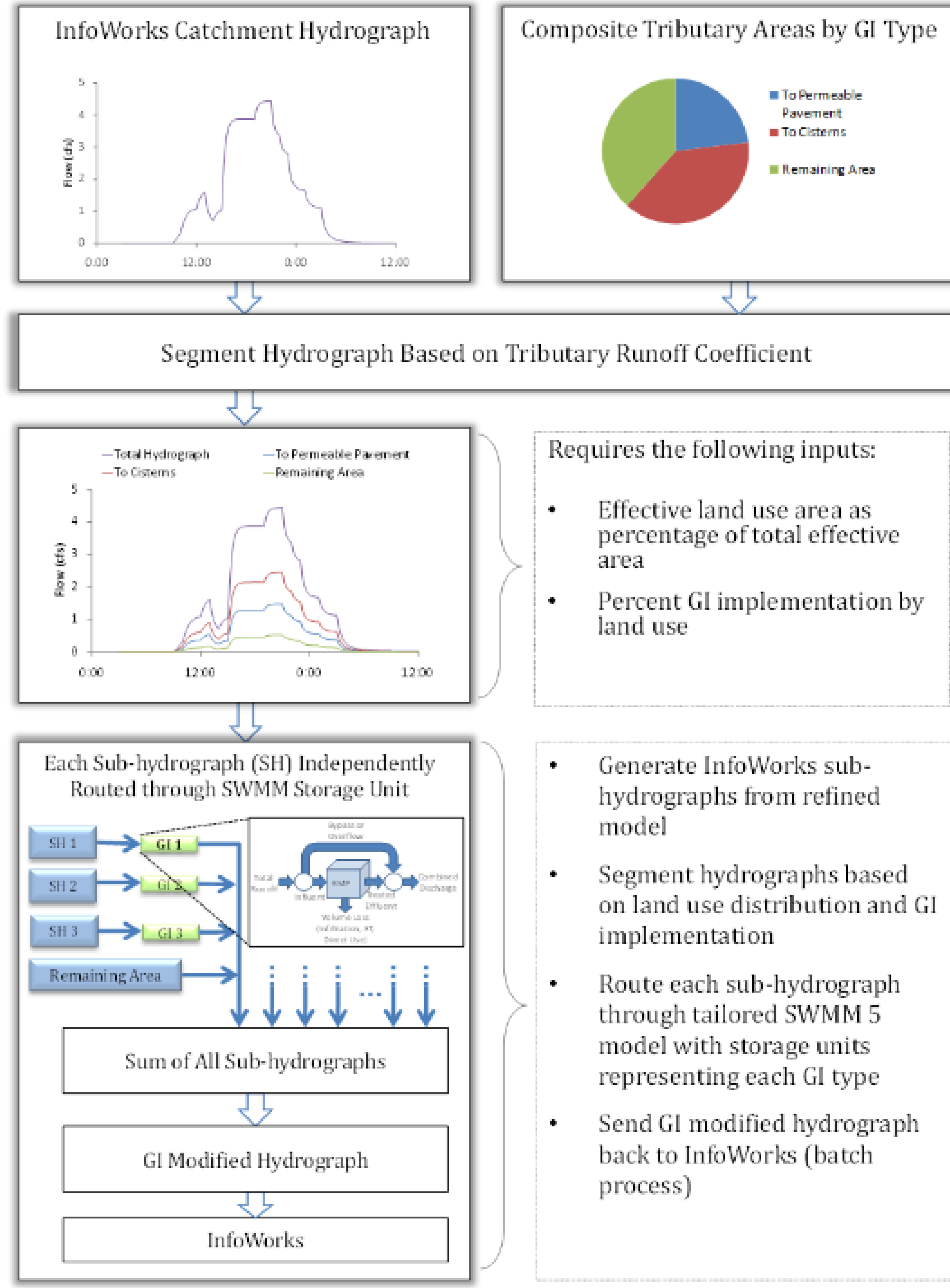
Overlay Analysis



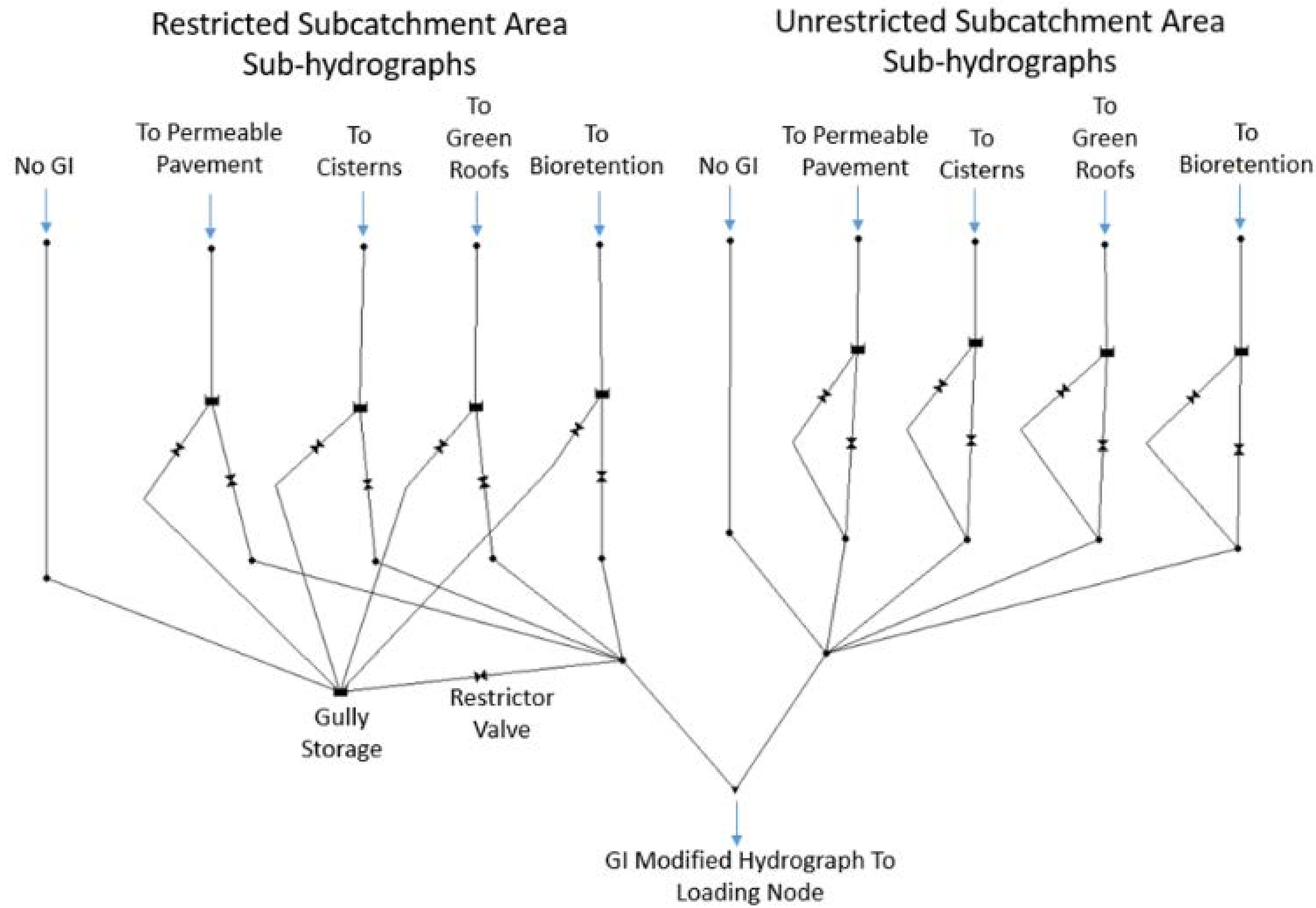


Model Framework

- Directly transferable & repeatable application for entire service area
- Preserved InfoWorks hydrology – like to like comparison of green to gray
- Conversion to EPA-SWMM – avoids excessive license fees
- Highly refined representation of GI applications in EPA-SWMM



Resolution of Catchment GI Analysis



Modeling Results

Results for Study Area - Supplimental

Overview of results

- Spatial distribution matters
- Type of BMP matters
- Intelligent selection & placement results in cost reduction of over 40% for implementation

- Will present alternative summary
  - Mapping urban flooding is very controversial (potentially impact home values)
  - Implementation costs vary
    - Length of implementation program (5 years vs 30 years?)

Scenario B: GI with Regional Gray

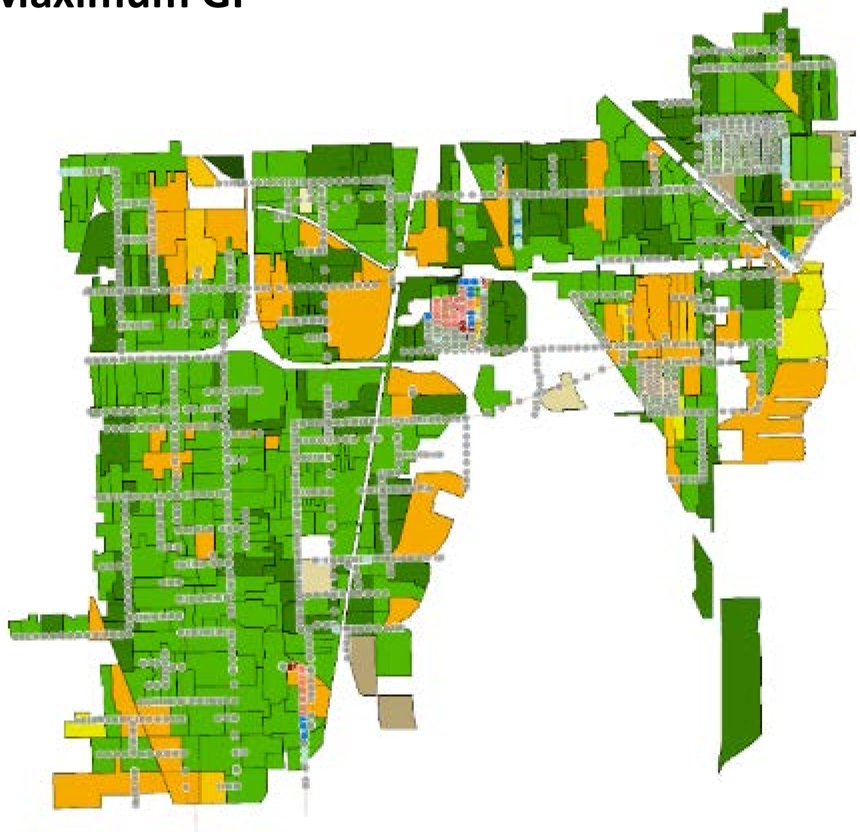
25-yr, 2-hr Storm

GI Distribution

Baseline (with gray only):
Total Structures: 44,053
Structures flooded: 32,640

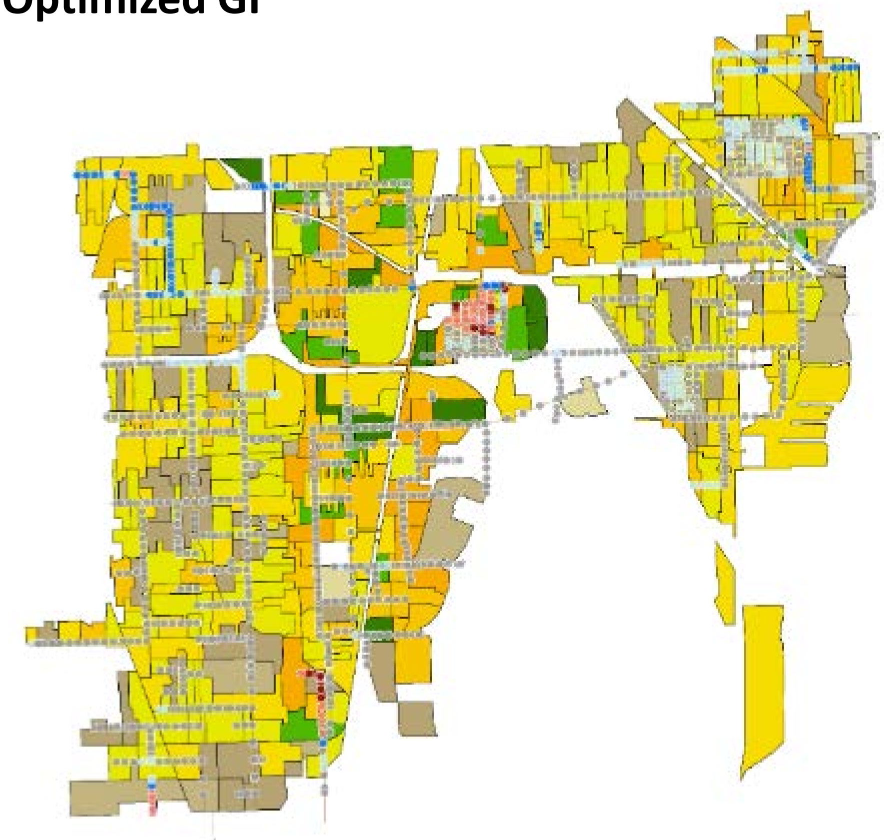
Scenario B: GI with Regional Gray– 25 yr

Maximum GI



Structures removed: 95 %

Optimized GI



Structures removed: 94 %

% of Effective Area treated by GI

0	30-40	70-80
0-10	40-50	80-90
10-20	50-60	90-100
20-30	60-70	

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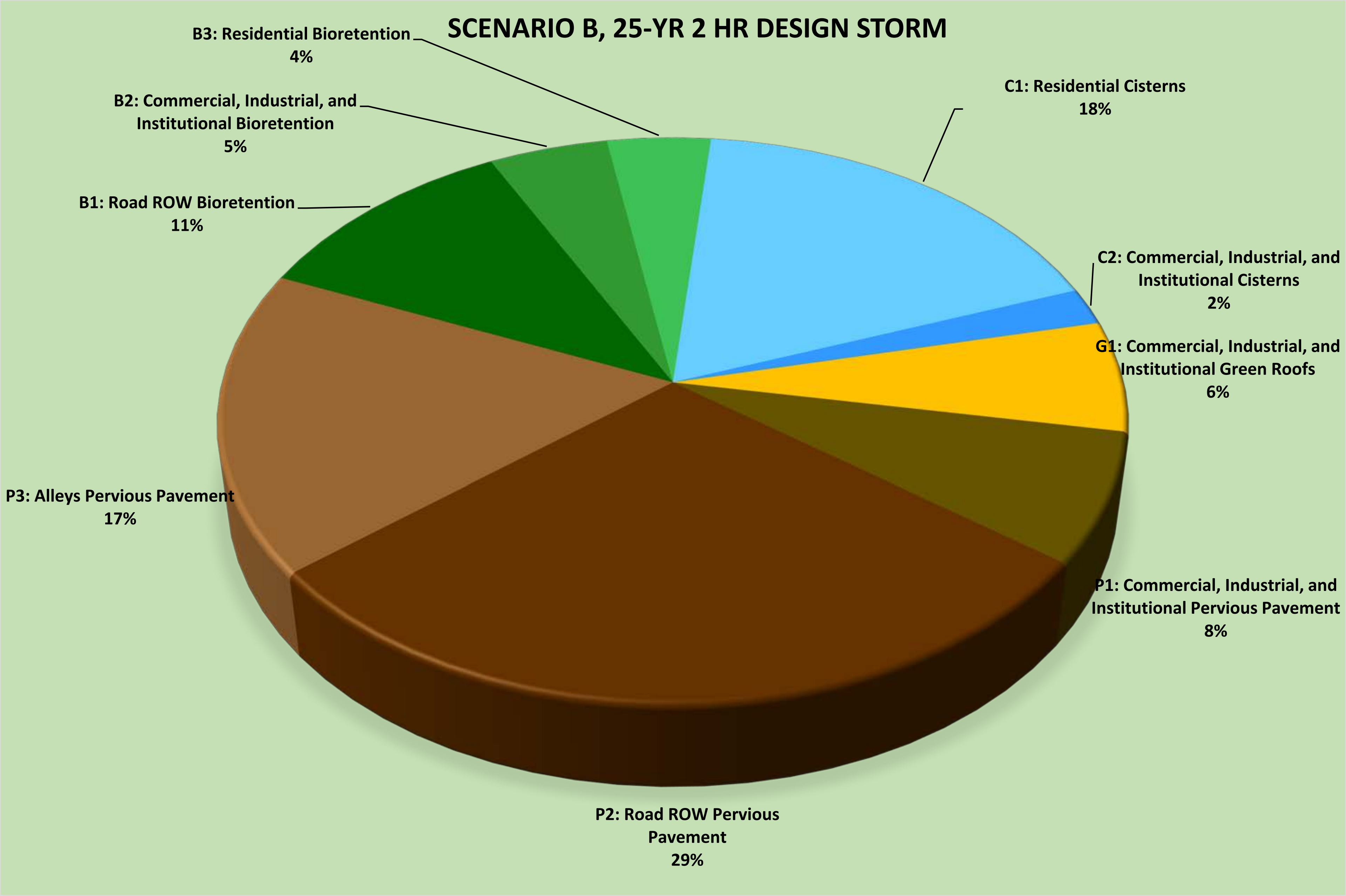

Distribution of Optimized GI

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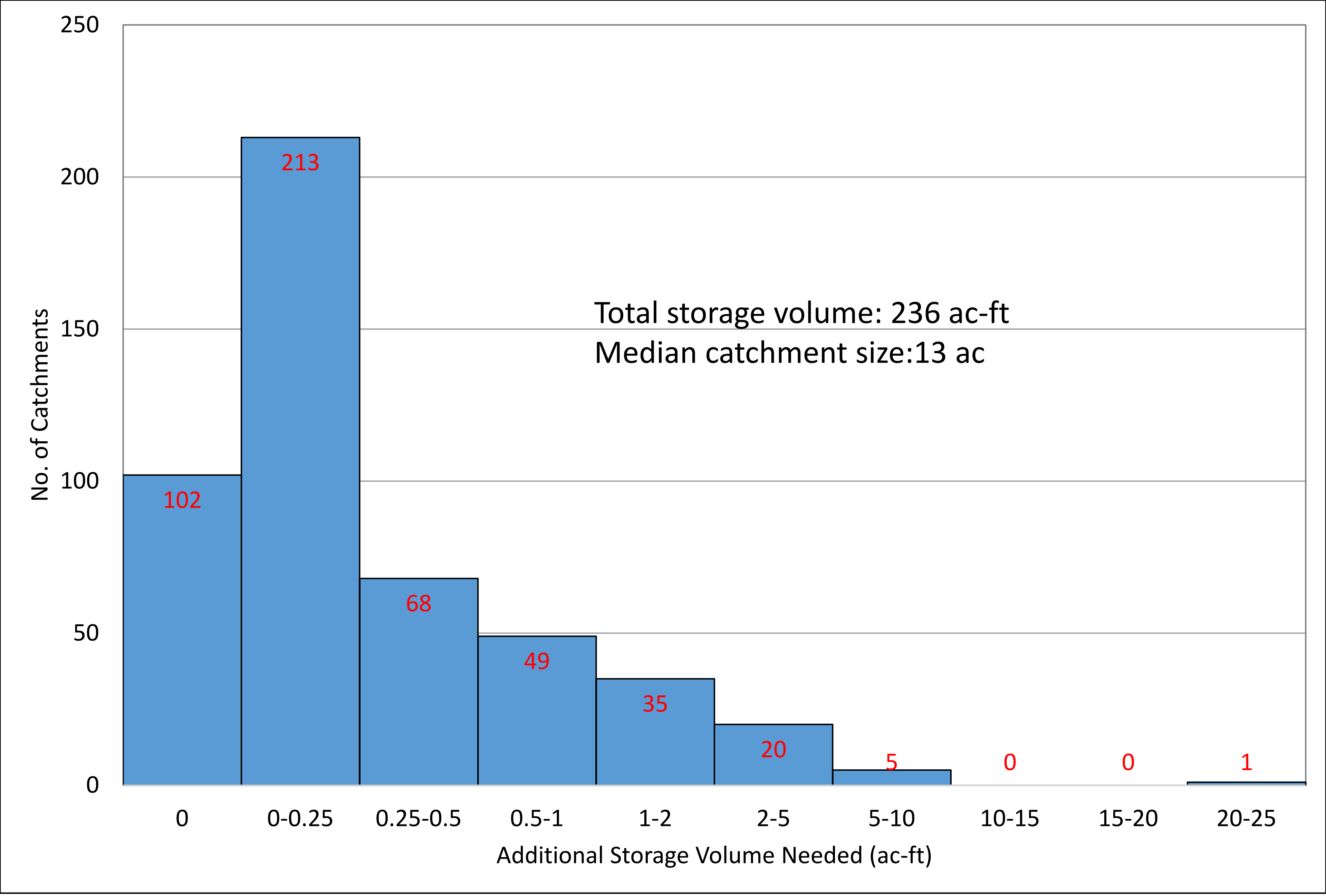
Scenario B: GI with Regional Gray

100-yr, 2-hr Storm

GI Distribution

Baseline (with gray only):
Total Structures: 44,053
Structures flooded: 41,188



Additional Storage Distribution

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Findings & Conclusion

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Findings

- ✓ Performance of GI practices can be explicitly represented in combined sewer model, quantifying performance
- ✓ Proves green infrastructure (GI) and stormwater parks are highly effective supplements to improve level-of-service
- ✓ Optimization of GI placement is crucial in plan development – intelligent placement of practices reveals significant cost reductions (over 40%)

Thank You

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