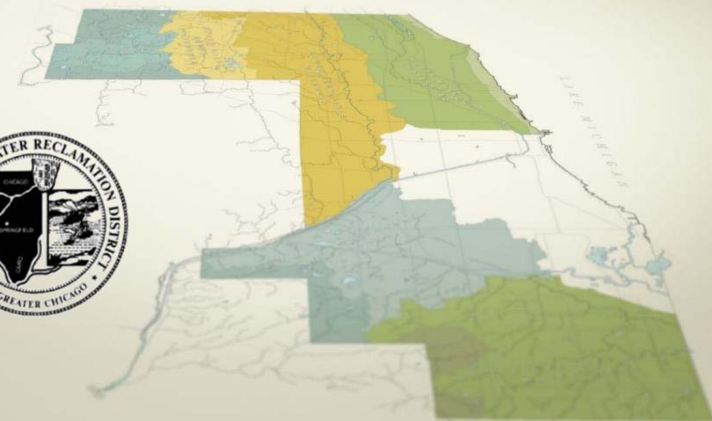
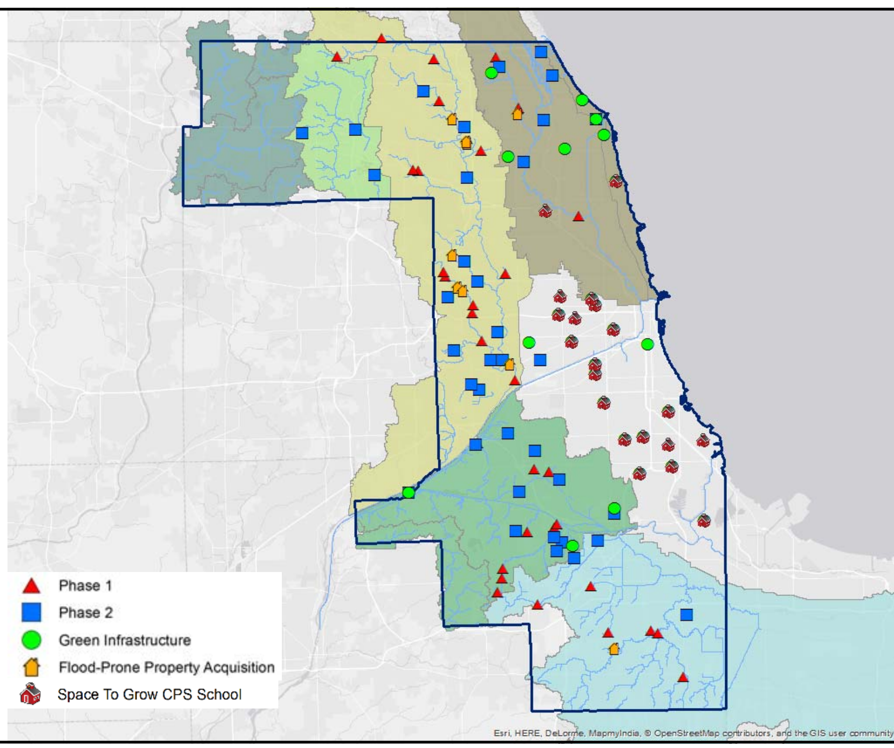
Stormwater Masterplan Pilot Studies



- **Study Session**
- August 17, 2017

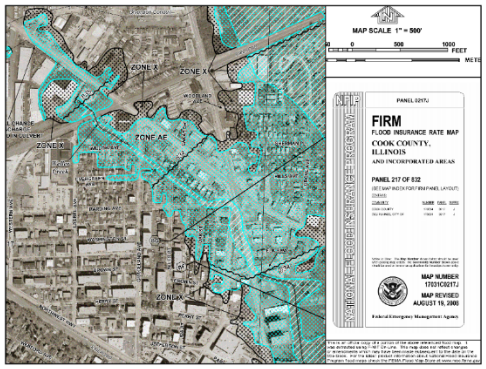
1



2

Riverine vs. Urban Flooding

"Riverine flooding" occurs when excess run-off causes a natural drainage-way (river, creek, etc.) to exceed its capacity. These areas are identified as flood hazards by FEMA.



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Riverine vs. Urban Flooding

"Urban Flooding" is the inundation of property in a built environment caused by rainfall overwhelming the capacity of local drainage systems.

4

Riverine vs. Urban Flooding

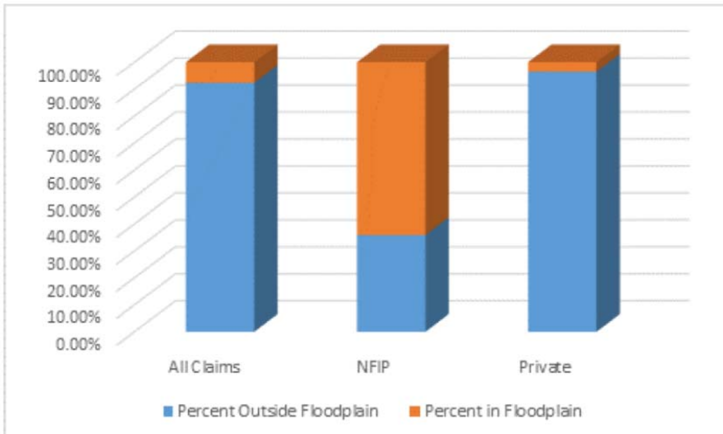
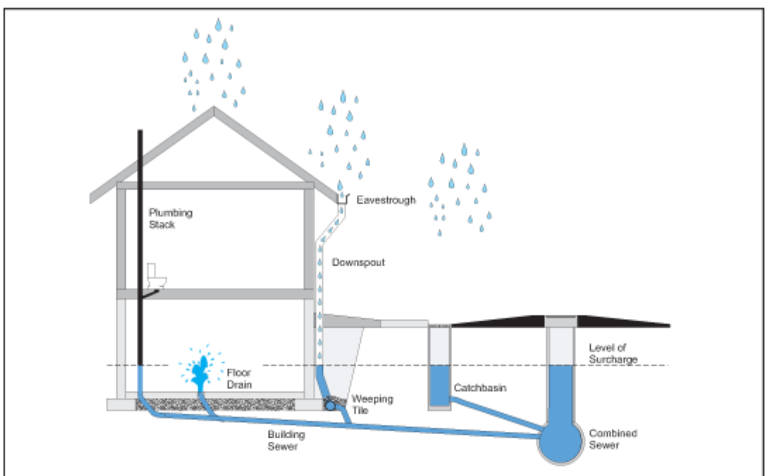


Figure 1.3: Between 2007 and 2014, most (96.5%) of private insurance claims are for structures outside the mapped floodplain; however, a significant number of NFIP claims (35.9%) are outside the mapped floodplain.

5

Basement Backups



BASEMENT FLOODING DUE TO COMBINED SEWER BACKUP
During periods of heavy rainfall, or snowmelt, the municipal sewer system becomes overloaded and the surcharge backs up and floods basements through low plumbing connections. It is essential to properly clean up the flooded area after the flooding subsides because the sewage may contain numerous harmful bacteria and contaminants.

6

Stormwater Masterplan Pilots

- Pilot study areas identified by four Councils of Government and the City of Chicago
- Study areas comprised of both separate or combined sewer areas
- Goal was to identify solutions to flooding of structures experienced in storms up to and including a 100-year event
- Analysis of existing overland flooding and basement backup issues found in each study area, including detailed (H&H) modeling of flooding issues and alternative solutions
- Sought input from local municipalities, other stakeholders, and general public through questionnaires, public workshops, and other outreach tools to get full understanding of flooding impacts, and to identify preferences for green, gray, and/or private property solutions
- Public outreach effectiveness was also measured to evaluate the change in public attitude and willingness to participate in stormwater solutions

7

Presentations

Northbrook – ERA

John Mayer
Marty Michalisko
Jenny Loewenstein

Roberts Road – V3

Jennifer Maercklein

Little Cal / Cal-Sag – Arcadis

Gunilla M. Goulding
Katie Lazicki

Harwood Heights – Cardno

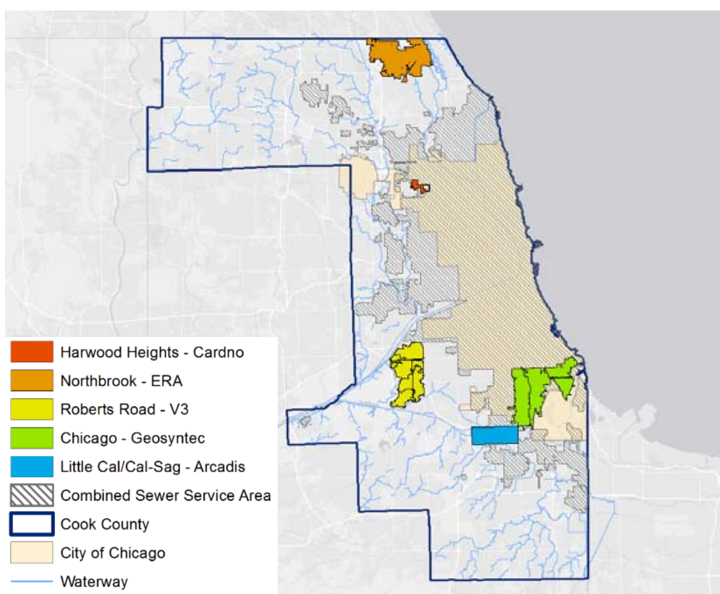
Heather Schwar
Mark Wagstaff

Chicago - Geosyntec

Matt Bardol
Adrienne Nemura

CH2M Hill

Mason Thorneburg



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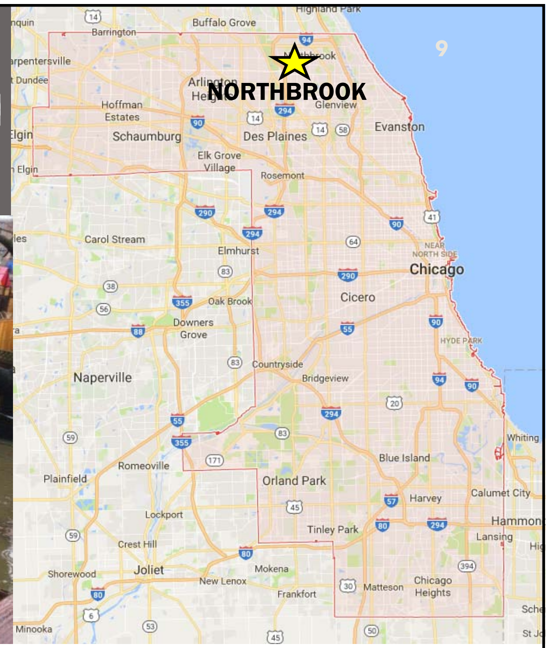
STORMWATER MASTER PLAN FOR NORTHBROOK



Prepared by: Engineering Resource Associates, Inc.

Presenters: John Mayer, P.E., Marty Michalisko, P.E., Jenny Loewenstein, P.E.

Pilot Study Overview

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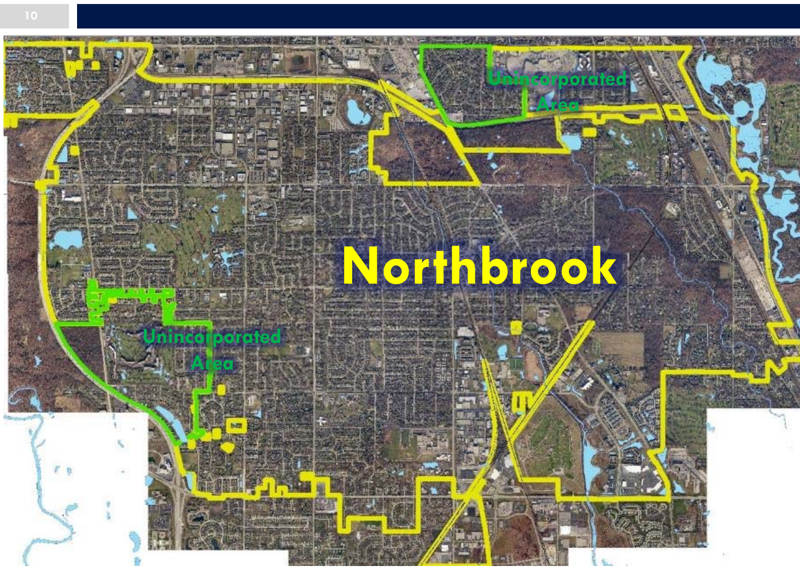

Study Area: 15.4 Sq. Mi.

- Village of Northbrook: 14.3 Sq. Mi.
- Northfield Twp: 0.9 Sq. Mi.

Population: 33,435

Habitable Structures: 12,631

Separated Storm Sewer System

Zoning District	% Project Area
Residential	40%
Commercial	21%
Institutional	7%
Open Space	13%

Urban Flooding

11

7x

Structures Impacted in 100-yr Storm

- Riverine Flooding: 141
- Urban Flooding: 1,007

Existing Flooding Limits

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Urban Flooding 100-yr Limits (Light Blue)

Floodplain 100-yr Limits (Dark Blue)

At Risk Structures (Red)

Tool Box Measures

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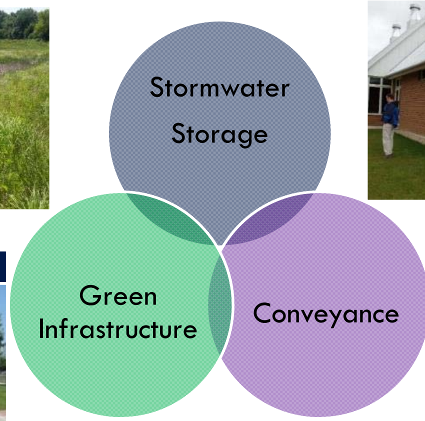
Rain Gardens/Bioswales

Stormwater Storage



Cistern/Rain Barrel

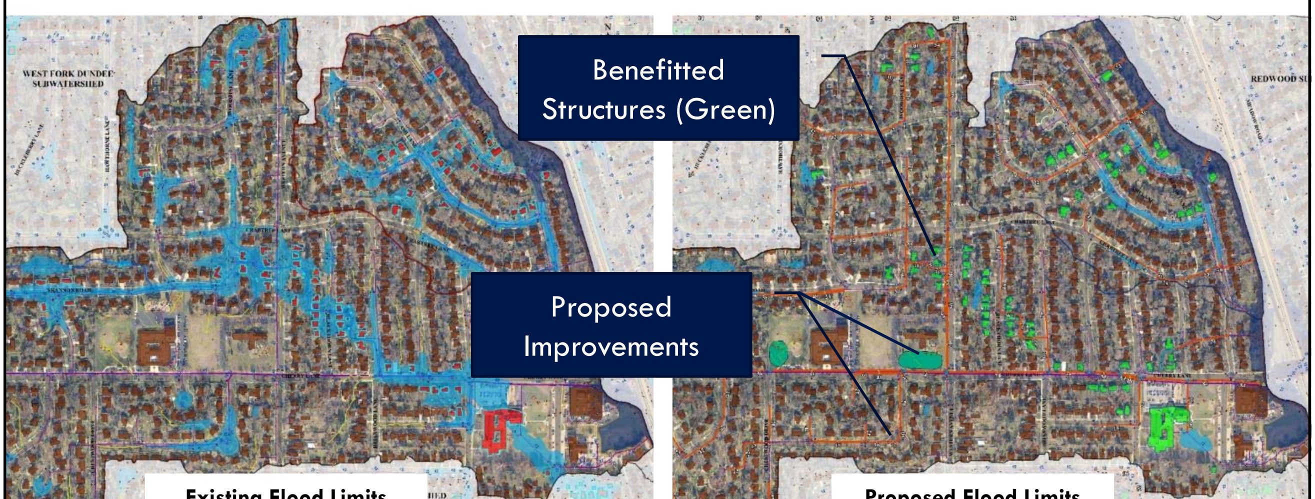
Green Roofs

Permeable Driveway/Roads

Storm Sewers

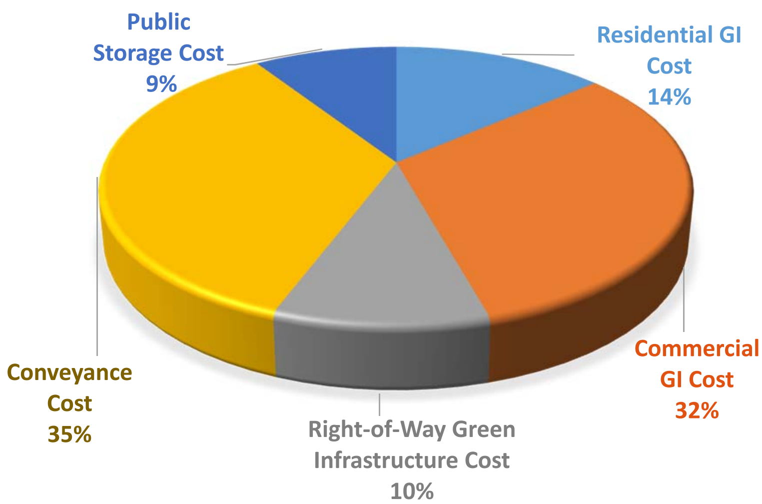
Proposed Flooding Limits

14



100-Year Storm Cost Distribution

15



Type	Cost
Residential GI	$ 70,756,000
Commercial GI	$ 165,258,000
Public ROW GI	$ 52,380,000
Conduit	$ 180,954,000
Public Storage	$ 47,632,000
Total Cost	**$ 516,980,000**

$33.6 Million/Sq. Mile

Optimizing Transportation Funding

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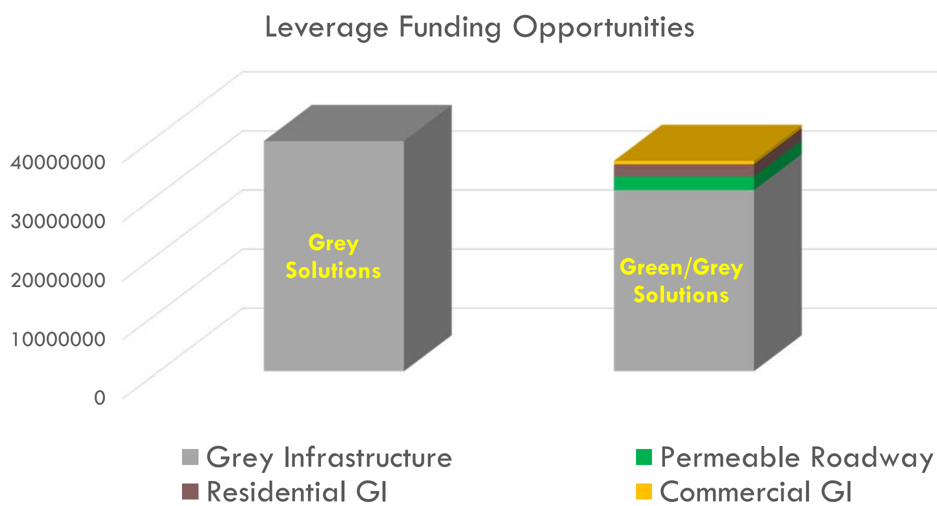

9% Overall Decrease in Cost

21% Decrease in Grey Cost

Optimized Placement of GI Improvements

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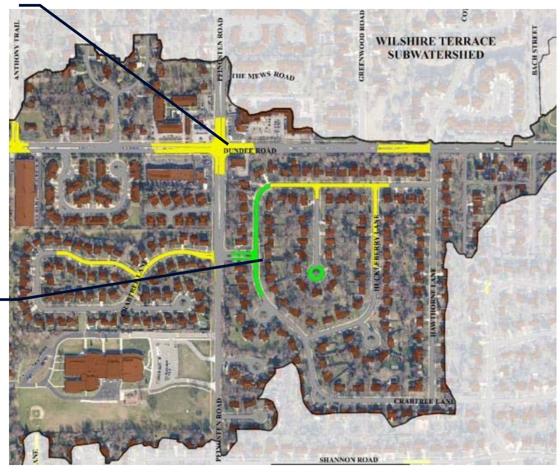
Permeable Roadway
(Partial Width Section)
Yellow

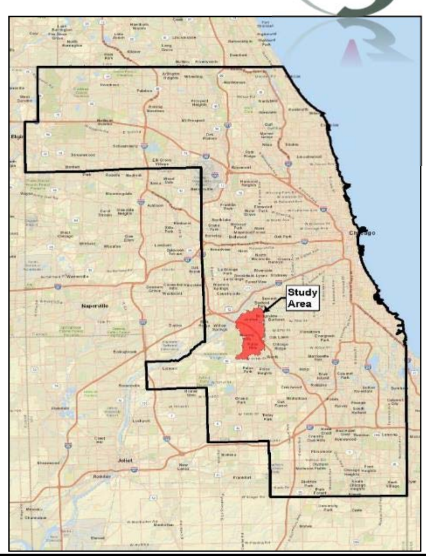


Permeable Roadway
(Full Width Section)
Green

Roberts Road SMP

Presented by Jennifer Maercklein, P.E., CFM, V3

- Bridgeview, Justice, Palos Hills, Hickory Hills, and small part of Bedford Park
  - 12 square mile drainage area
  - 12,000 homes
  - Separate sewer area
  - Basement backups uncommon
  - Headwaters of 6 small drainage-ways
  - Proximity to Canals
  - Some large parcels of open space (cemeteries, parks, golf)



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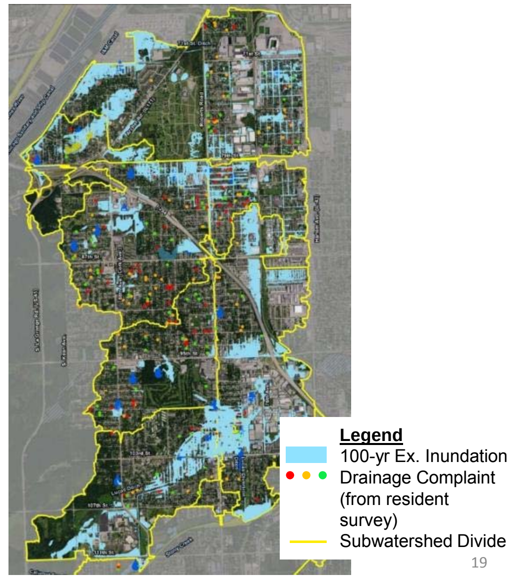
Existing Conditions

Drainage issues:
- Undersized ditches, sewers
- Insufficient storage
- Lack of defined drainage system

Estimated Number of homes with flood damage:

	2-hr 100-yr Exist	24-hr 100-yr Exist
Water against foundation	781	828
Water above low entry elevation	307	236



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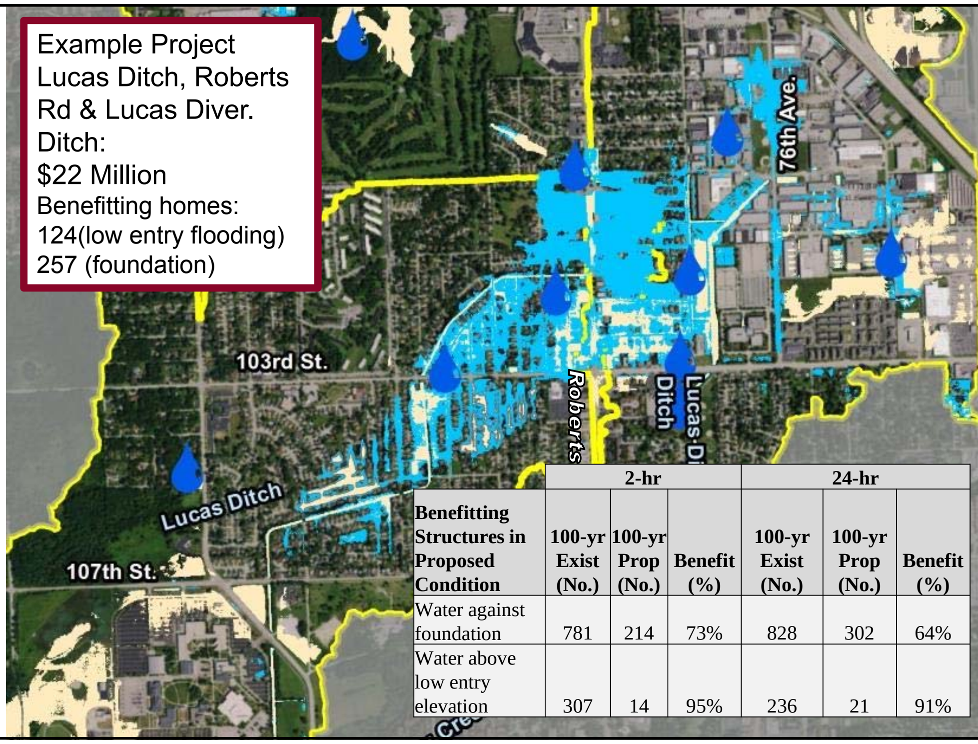
Proposed Alternatives

- Increased Sewer Capacity;
- Realign flow routes;
- Partnerships for new storage:
  - Archdiocese of Chicago (cemeteries)
  - Park Districts & private golf courses
  - Illinois Tollway
- Urban redevelopment to reduce flooding and create open space
- Green Infrastructure
  - Public ROW
  - Private property storage

20



Benefitting Structures in Proposed Condition	2-hr 100-yr Exist (No.)	2-hr 100-yr Prop (No.)	2-hr Benefit (%)	24-hr 100-yr Exist (No.)	24-hr 100-yr Prop (No.)	24-hr Benefit (%)
Water against foundation	781	214	73%	828	302	64%
Water above low entry elevation	307	14	95%	236	21	91%

21

Proposed Alternatives

- 9 projects ranked Immediate / High / Medium Priority
- Total cost: $73.6M (with transportation cost sharing)
- 566 Benefitting Structures
- Cost per Benefitting Structure:
  - Ranges from $54k – $324k,
  - 7 of 9 projects under $250k

- 10 projects ranked Medium-Low / Low Priority
- Total cost: $73.5M (with transportation cost sharing)
- 75 Benefitting Structures
- Cost per Benefitting Structure:
  - Ranges from $270k - $1.5M,
  - 6 of 10 projects over $900k

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Year-Long Public Outreach Campaign

- A successful outreach campaign is targeted and speaks to the values of the community
- One-size-fits-all campaigns don't work
- 4-step process:
  - Research to determine initial attitudes, values
  - Develop value-focused campaign
  - Implement the campaign
  - Measure results

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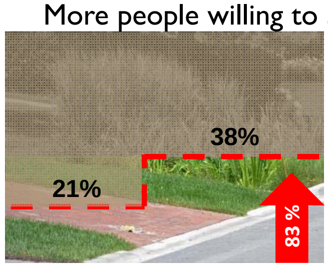
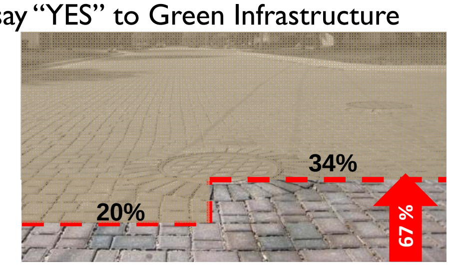
RESULTS: Public Attitudes After 1-yr Public Outreach Campaign

More people willing to say "YES" to Green Infrastructure

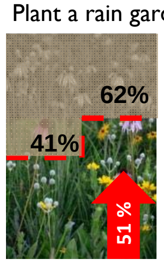
2015 → 2016



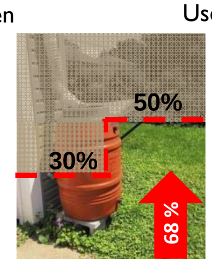
Plant a rain garden



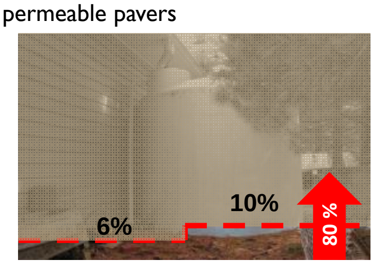
Use permeable pavers



Use native plants



Install a rain barrel



Install a rain cistern

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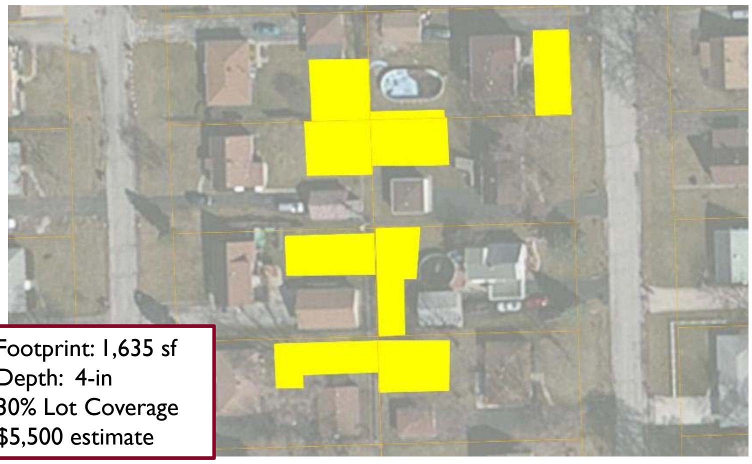
Analyzed Impact of Residential-scale Alts (GI) on Every Property (incl ROW)

Rain Garden for 0.6 inches of rain:



Footprint: 1,635 sf
Depth: 4-in
30% Lot Coverage
$5,500 estimate

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FINDINGS: Residential-scale Alts (GI)

	2-hr (GI stores 0.6" rain)			24-hr (GI stores 1.1" rain)		
Benefit with Green Infrastructure Alone (Reduction in Homes with Damage)	**100-yr Exist (No.)**	**100-yr Prop (No.)**	**Benefit (%)**	**100-yr Exist (No.)**	**100-yr Prop (No.)**	**Benefit (%)**
Water against foundation	781	544	30%	828	503	39%
Water above low entry elevation	307	167	46%	236	124	47%

- $5,000 - $15,000 per house; 12,000 households; $60-180M total
- Public attitudes about GI shifting in positive direction
- Need to overcome cost, aesthetic, space barriers

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Stakeholder Feedback

- Municipal Feedback:
  - Supportive
  - Ideas appear achievable
  - Concerned with time, funding, and resident acceptance for GI
- Transportation Agency Feedback:
  - Outcome engineering – partnership to jointly address problems
  - Currently coordinating with CCDOTH on Roberts Rd
  - Coordinating / sharing data with Illinois Tollway at 95th St

UNDERSTANDING ENGAGING

27

ARCADIS Design & Consultancy for natural and built assets

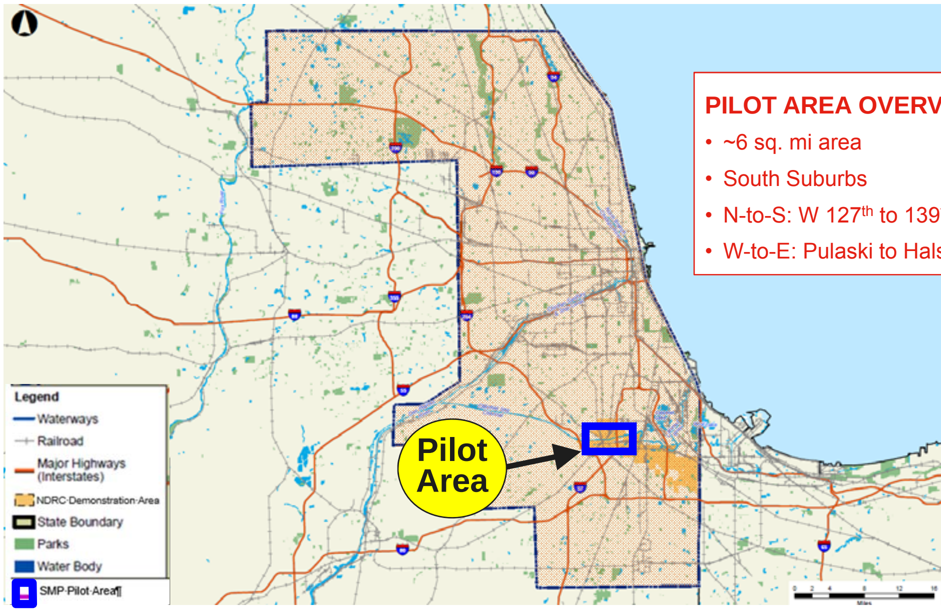
Metropolitan Water Reclamation District of Greater Chicago

Stormwater Master Plan

Little Calumet River / Cal-Sag Channel Drainage Area

Katie Lazicki, Arcadis
Gunilla Goulding, Arcadis
August 17, 2017

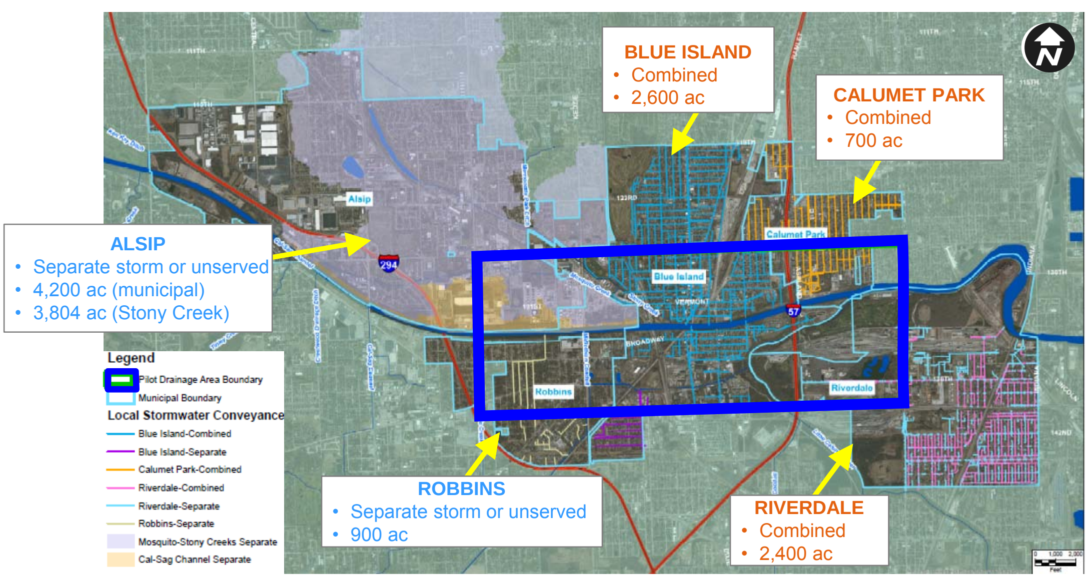
Little Calumet River/ Cal-Sag Channel Pilot Area



PILOT AREA OVERVIEW

- ~6 sq. mi area
- South Suburbs
- N-to-S: W 127th to 139th St
- W-to-E: Pulaski to Halsted

Study Area Local Stormwater Conveyance

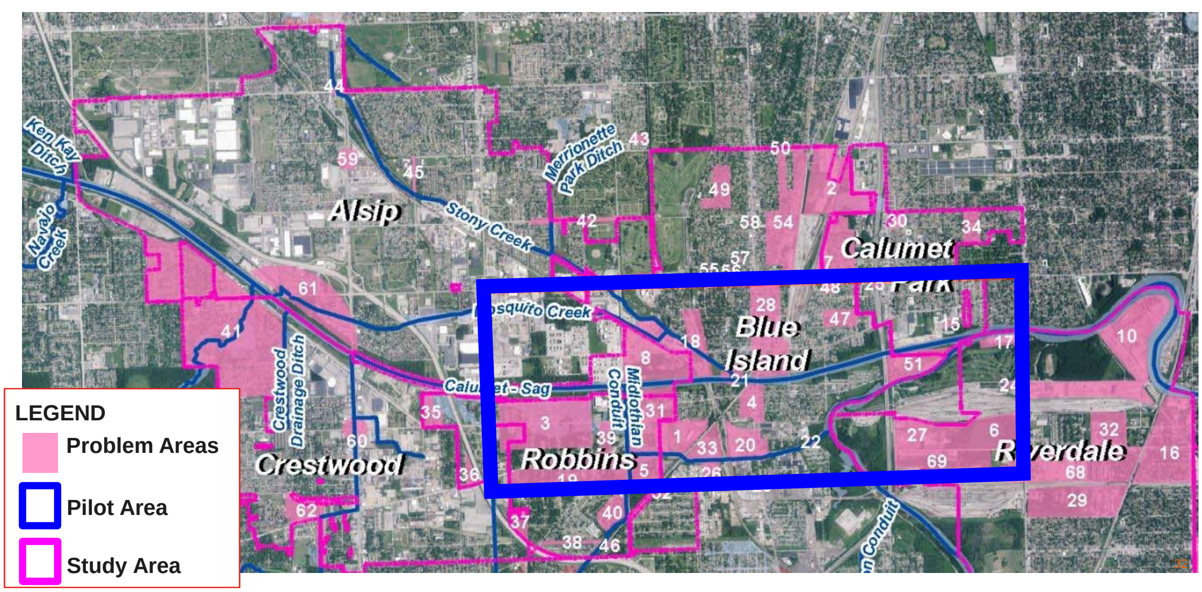


ARCADIS

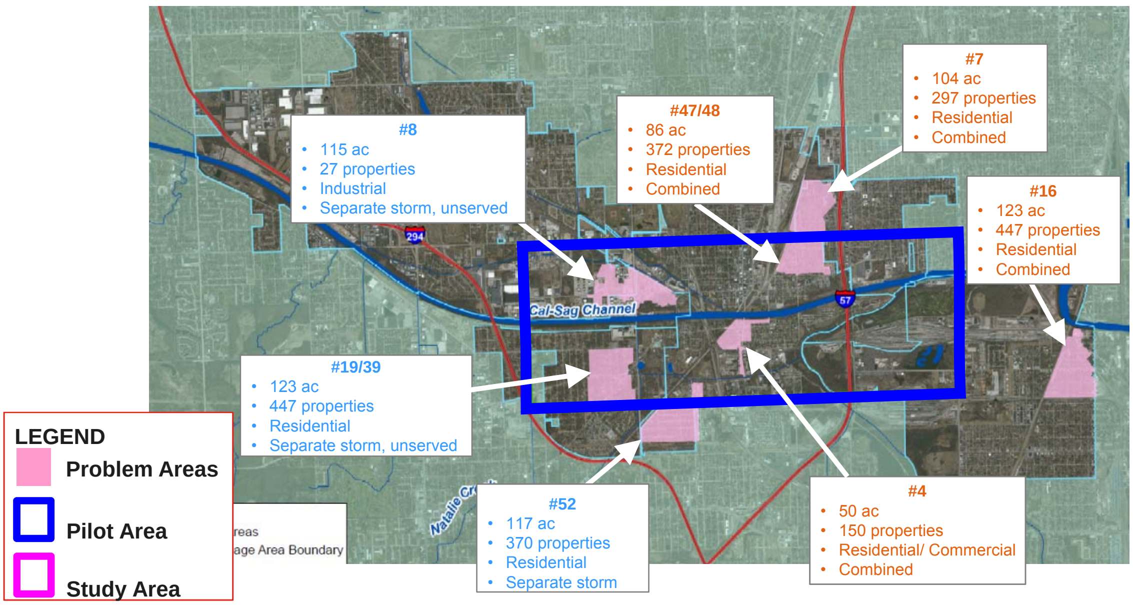
Master Plan Approach and Options

ARCADIS

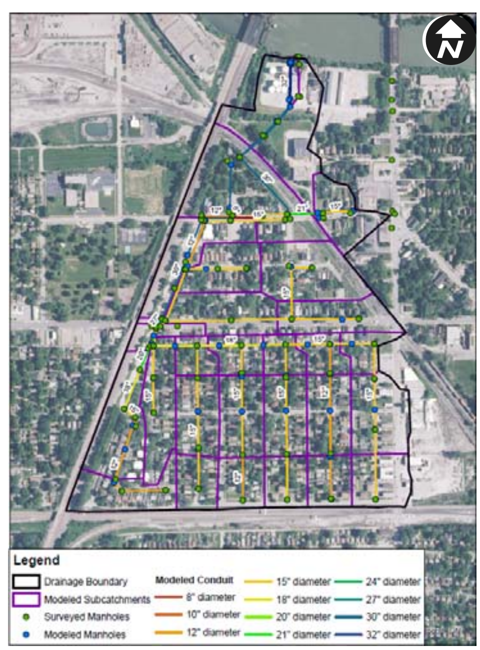
Many problem & opportunity areas were identified



Seven problem areas were ultimately selected

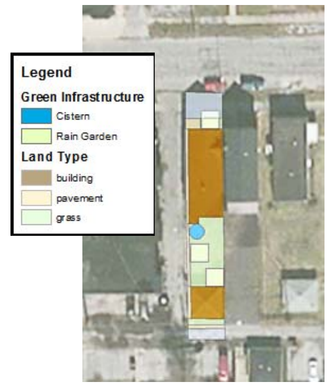


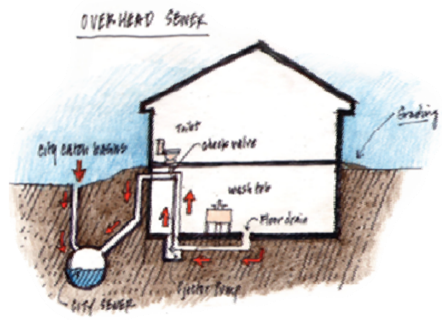
Consistent evaluations were made across the problem areas

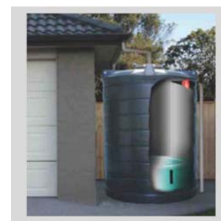


Several alternative types were evaluated

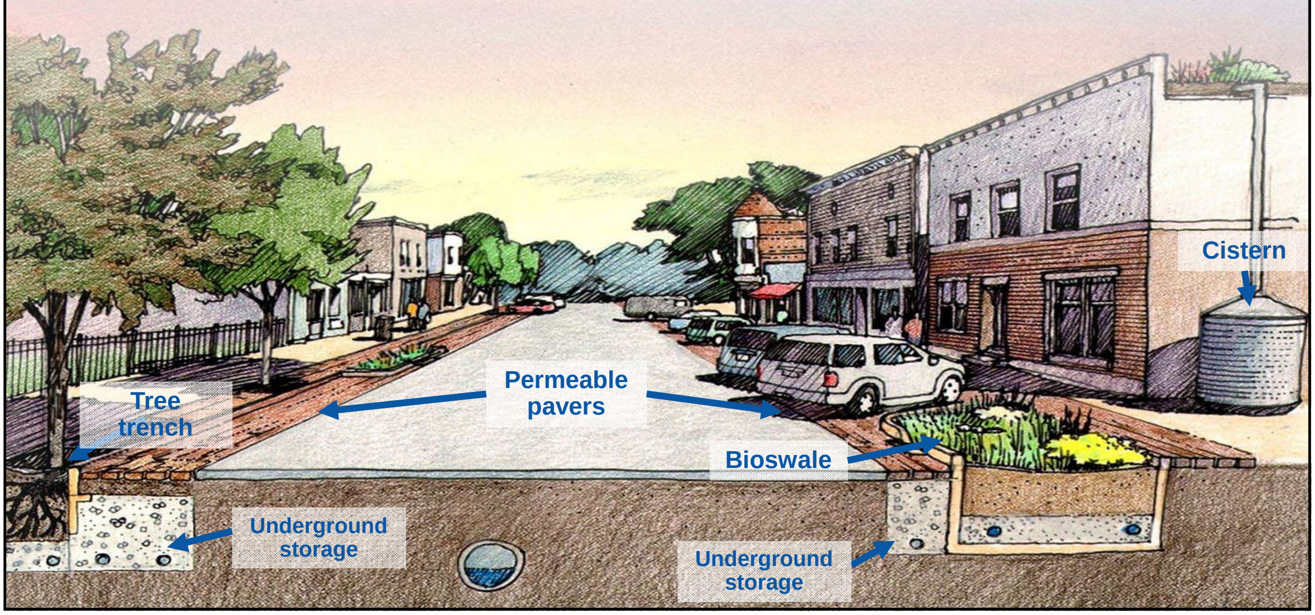
- Gray
- Green infrastructure (GI)
- Green/gray in public ROW
- Gray on private property
- Green/gray on private property
- Property buyouts







Super-sized GI layers green & gray options to the maximum extent possible across public & private property



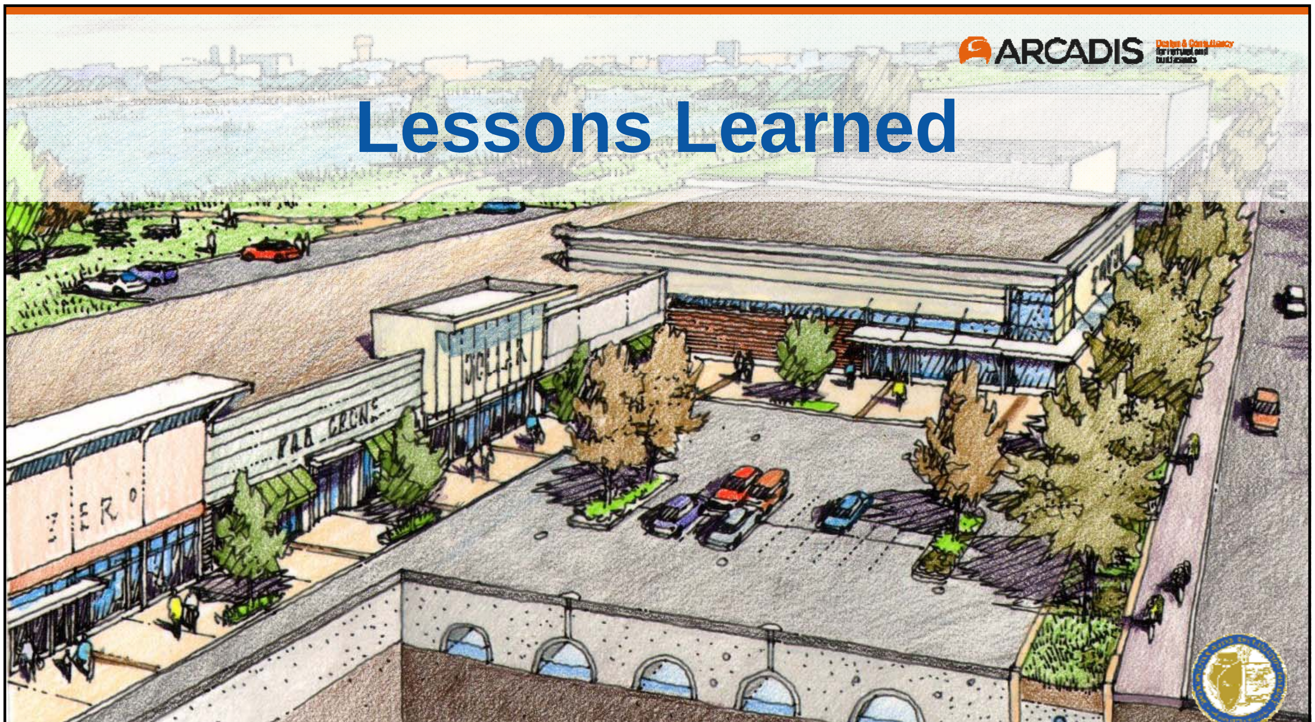
Problem Area Evaluations Summary

Problem Area Types	Recommended Alternatives	Level of Control	Flooding Eliminated	No. of Benefitting Structures	Capital Costs	Capital Costs Per Benefitting Structure
Combined - Residential	*Overhead Sewers*	100-yr	Basement backups	501	$7.1 M	$14,000
	Overhead Sewers plus Bioswale	100-yr 1-yr	Basement backups Overland flooding	297* 4	$5.7 M	$19,000*
	Sewer Separation	100-yr	Basement backups Overland flooding	428* 154	$11.7 M	$27,000*
Separate – Industrial	*Storm Sewers & Ditches*	100-yr	Overland flooding	<27	$4.6 M	$170,000
Separate – Residential	*New Outfall Sewer*	10-yr		26	$2.8 M	$108,000
Separate/ Unserved – Residential	*Green Streets*	10-yr		<205	$12.5 M	$61,000

1,226 basement backups eliminated at 100-yr
181 properties w-overland flooding eliminated at 100-yr
231 properties w-overland flooding eliminated at 10-yr
4 properties w-overland flooding eliminated at 1-yr

$44.4 M

Lessons Learned

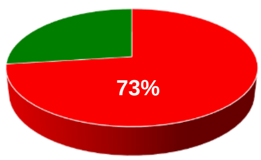


Existing basement backups occurred widely and frequently

- During small-to-medium storms
- Sewer systems are significantly undersized

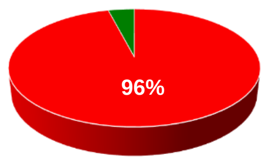
Northeast Riverdale (Problem Area #16)

% Affected Structures for 2-yr Storm



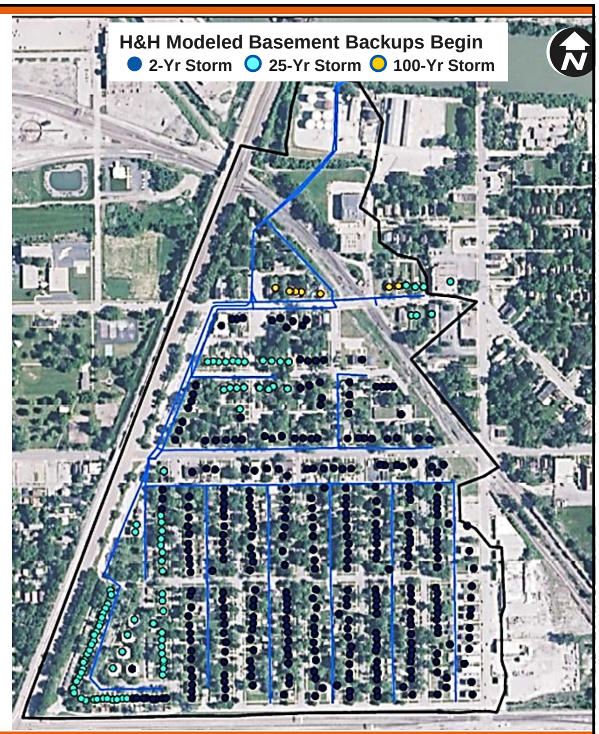
327 of 447 properties

% Affected Structures for 100-yr Storm



428 of 447 properties

Affected structures shown in red

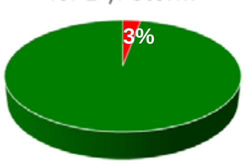


Existing overland flooding occurred less in combined areas

- Flooding occurs, but not widely
- Substantial structure impacts during largest storms only
- Peak depths: ~11” at structures
  ~16” in street

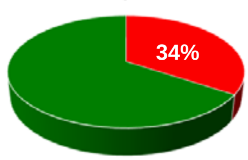
Northeast Riverdale (Problem Area #16)

% Affected Structures for 2-yr Storm



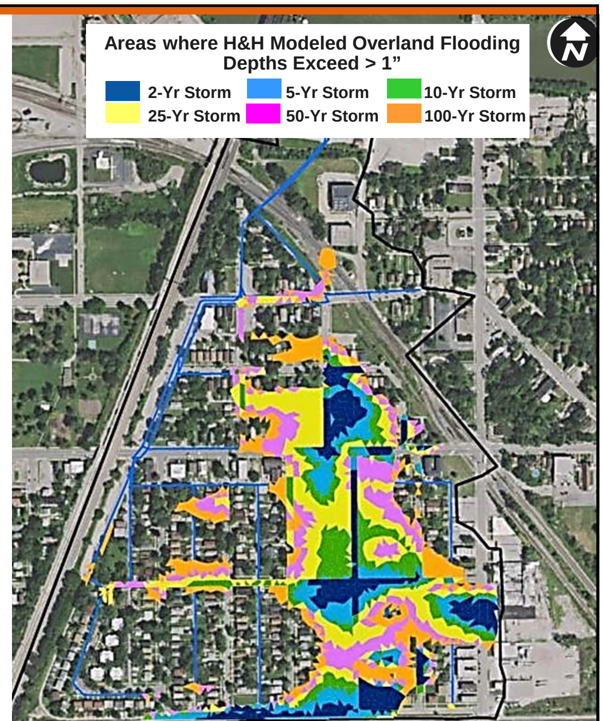
13 of 447 properties

% Affected Structures for 100-yr Storm



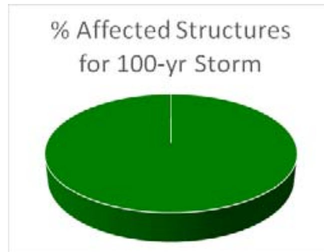
154 of 447 properties

Affected structures shown in red

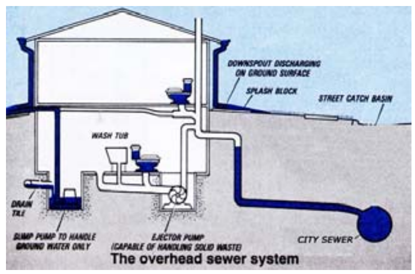


Overhead sewers cost-effectively solve basement backups

- Performance does not depend on sewer system
- Flooding reductions begin immediately
- Installations easily phased over time
- Backwater valves
  - Lower cost
  - More maintenance
- Overland flooding not addressed



All basement backups eliminated



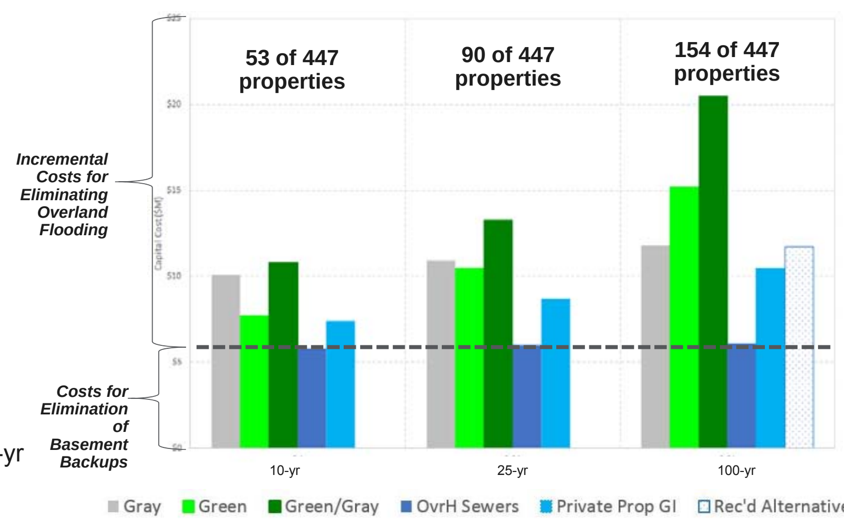
Backwater valve

Public ROW options become cost-competitive with substantial overland flooding

Incremental Costs Per Structure for Eliminating Overland Flooding

- Buyouts: $166K
- Private GI: $25K for 10-yr
  $29K for 100-yr
- Gray: $75K for 10-yr
  $37K for 100-yr
- Green: $30K for 10-yr
  $59K for 100-yr
- Rec'd Alternative: $36K for 100-yr

Northeast Riverdale (Problem Area #16)

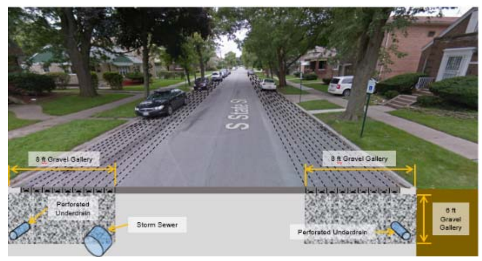


Public green/gray options cost-effectively solve basement backups for 10-yr storms

Public GI options are often more expensive than gray infrastructure and overhead sewers

Lack of capacity in drainage system

Poorly draining soils increase necessary storage volumes

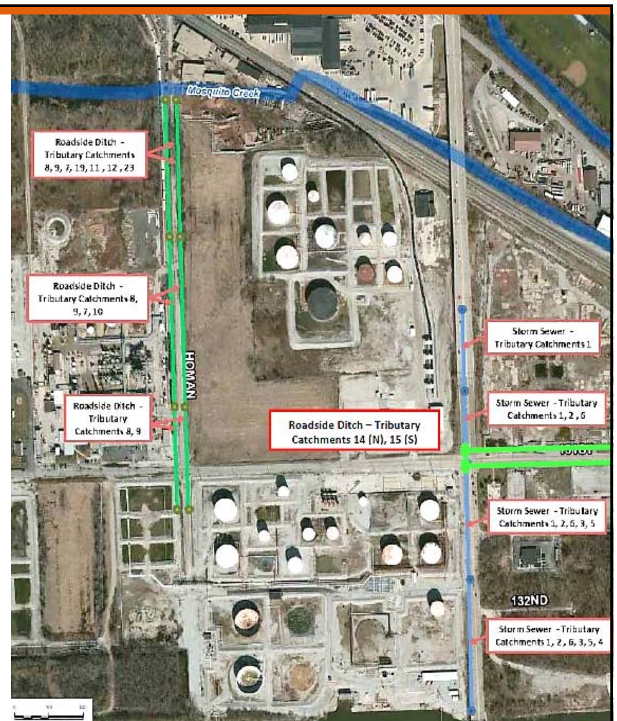


Public ROW can be used to mitigate flooding from larger storms

Cost-effective solutions for 100-yr storms are possible

Areas with little existing infrastructure or minimal capacity

Small drainage areas near waterways



ARCADIS Design & Consultancy for natural and built assets

Committing to routine maintenance facilitates long-term system performance

- Existing sewer systems
- Private property improvements
- Green & gray in public ROW

ARCADIS Design & Consultancy for natural and built assets

Thank You!

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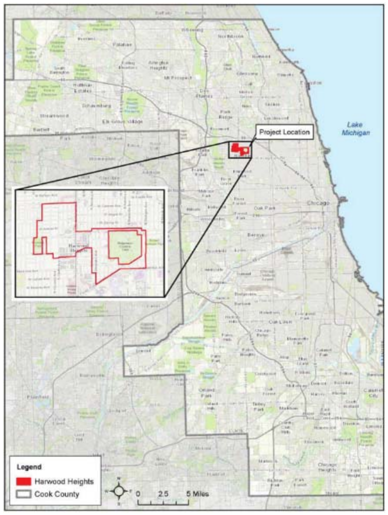
Harwood Heights Stormwater Master Plan Pilot Study: Summary of Findings



Heather Schwar, Cardno

Mark Wagstaff, GHD

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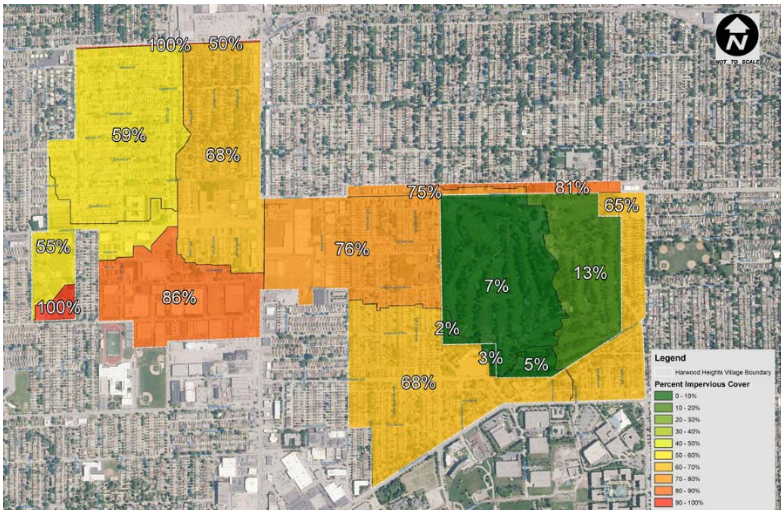
Harwood Heights is a fully-developed community, with little open space

- Population of 8,300
- About 1,600 structures
- About 1 square mile
- Primarily residential, with a few commercial corridors
- Combined sewer system

48

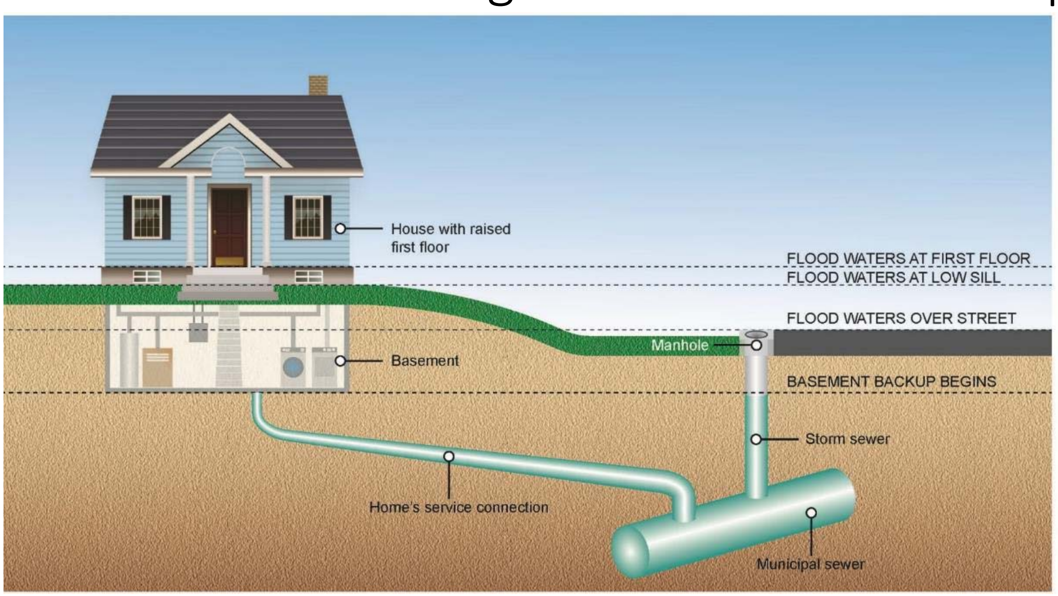
Very high proportion of impervious surface



- Lots of developed land and paved surfaces means lots of runoff from storms

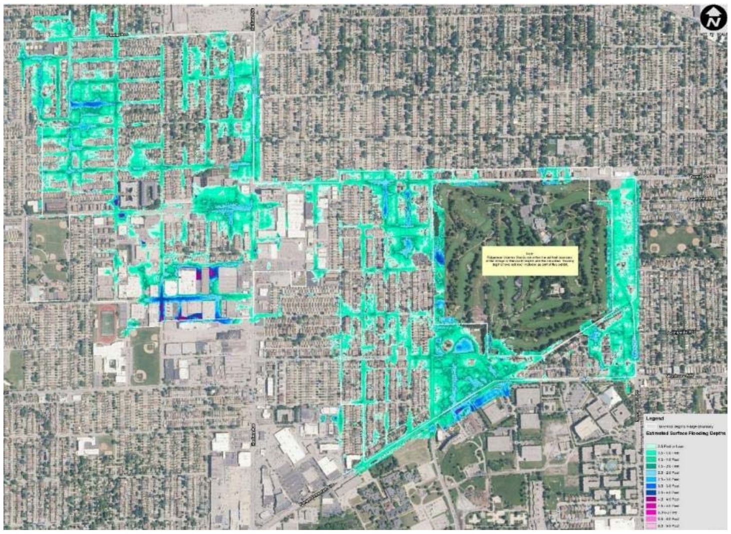
49

Vulnerable to flooding and basement back-up



50

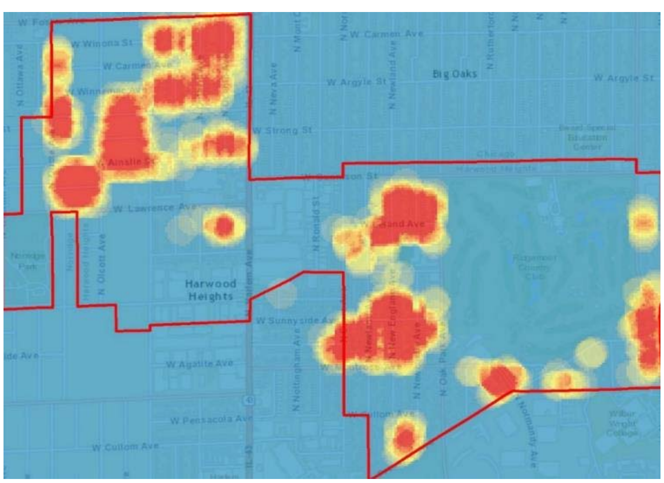
Widespread flooding during 100-yr storm



- No natural outlet
- Existing sewers can't handle the runoff
- Ponding in many parts of the village

51

And widespread risk of basement back-up



- Estimated over 800 homes vulnerable to basement back-up
- Harwood Heights has subsidized some residential protection projects

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Short, intense rainfall events cause widespread property damage

Existing Conditions Metrics	100-year event	10-year event	2-year event
Properties vulnerable to first floor flooding	48	15	11
Structures vulnerable to “low sill” flooding	848	~250	~100
Properties vulnerable to basement back-up	> 800	> 800	> 800

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Study looked at 3 different solutions

1) Public Infrastructure – Traditional Methods
2) Public / Private Infrastructure – “Green” & “Grey”
3) Public / Private Infrastructure – Damage Reduction

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Solution 1) Public Infrastructure – Traditional Methods

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Solution 1) Public Infrastructure protects against flooding, but still basement back-up risk

(Existing conditions in italics) **Metrics (for Full Implementation)**	100-year event	10-year event	2-year event
Properties vulnerable to first floor flooding	*48* **0**	*15* **0**	*11* **0**
Structures vulnerable to "low sill" flooding	*848* **0**	*~250* **0**	*~100* **0**
Properties vulnerable to basement back-up	*> 800* **~700**	*> 800* **~600**	*> 800* **~500**

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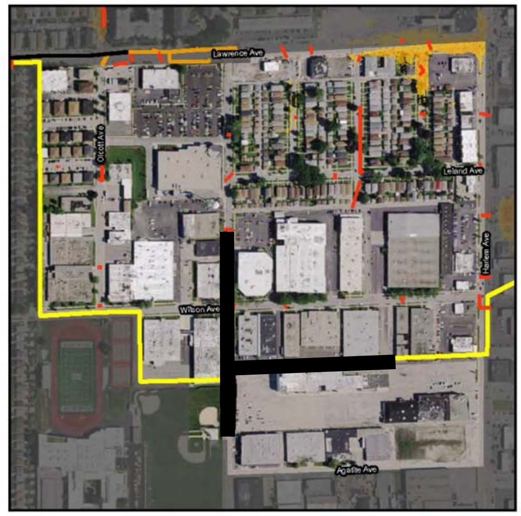
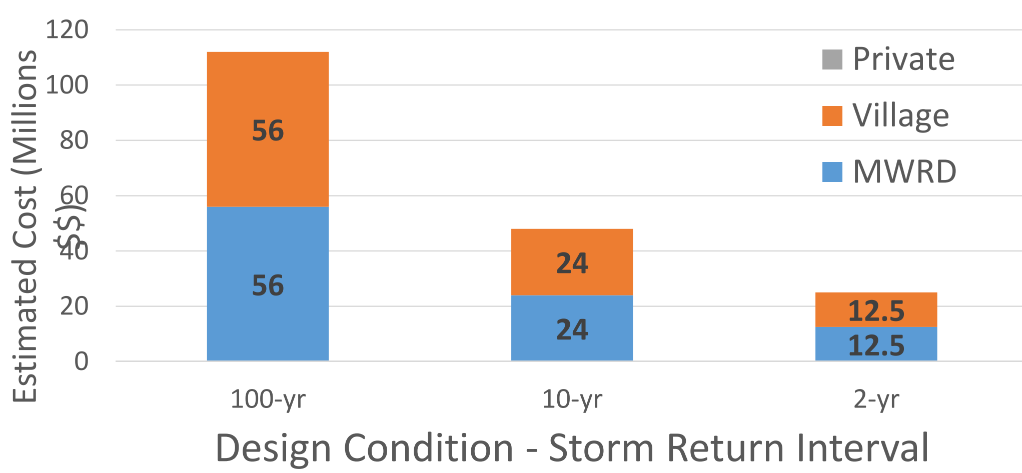
Solution 1 - Example

Existing conditions

Future Conditions



Solution 1) Traditional Public Infrastructure options are very expensive



Solution 2) Public / Private Infrastructure – "Green" & "Grey"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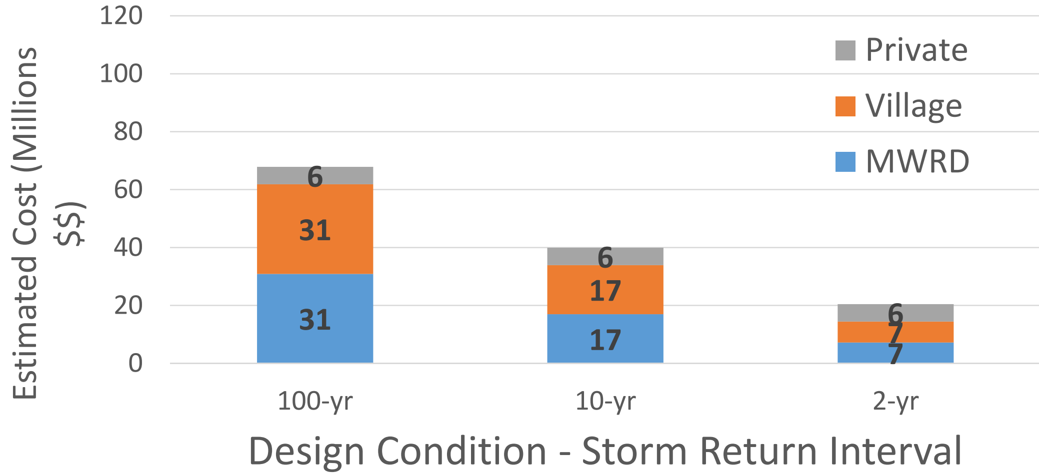
Solution 2) Public / Private Infrastructure with blend of "Green" & "Grey"

(Existing conditions in italics) **Metrics (for Full Implementation)**	**100-year event**	**10-year event**	**2-year event**
Properties vulnerable to first floor flooding	*48* **0**	*15* **0**	*11* **0**
Structures vulnerable to "low sill" flooding	*848* **0**	*~250* **0**	*~100* **0**
Properties vulnerable to basement back-up	*> 800* **~700**	*> 800* **~500**	*> 800* **~200**

60

Solution 2) Public / Private Infrastructure with blend of “Green” & “Grey” is less expensive



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Solution 3) Public / Private Infrastructure – Damage Reduction

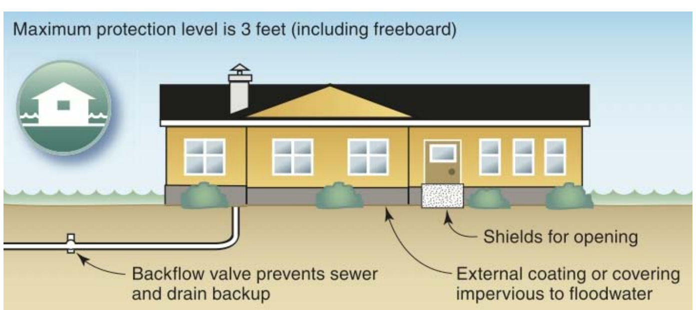
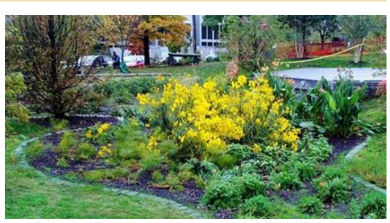


Image from: FEMA Homeowner’s Guide to Retrofitting, June 2014



- Flood-proofing
- Basement backflow prevention
- Flood-prone property buyouts (conversion to stormwater parks)

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Solution 3) Damage Reduction can reduce flood damage ***and*** address basement back up risk

(Existing conditions in italics) **Metrics (for Full Implementation)**	**100-year event**	**10-year event**	**2-year event**
Properties vulnerable to first floor flooding	*48* **0**	*15* **0**	*11* **0**
Structures vulnerable to "low sill" flooding	*848* **0***	*~250* **0***	*~100* **0***
Properties vulnerable to basement back-up	*> 800* **0**	*> 800* **0**	*> 800* **0**

* Solution 3 includes floodproofing to eliminate "Low Sill" flooding damage

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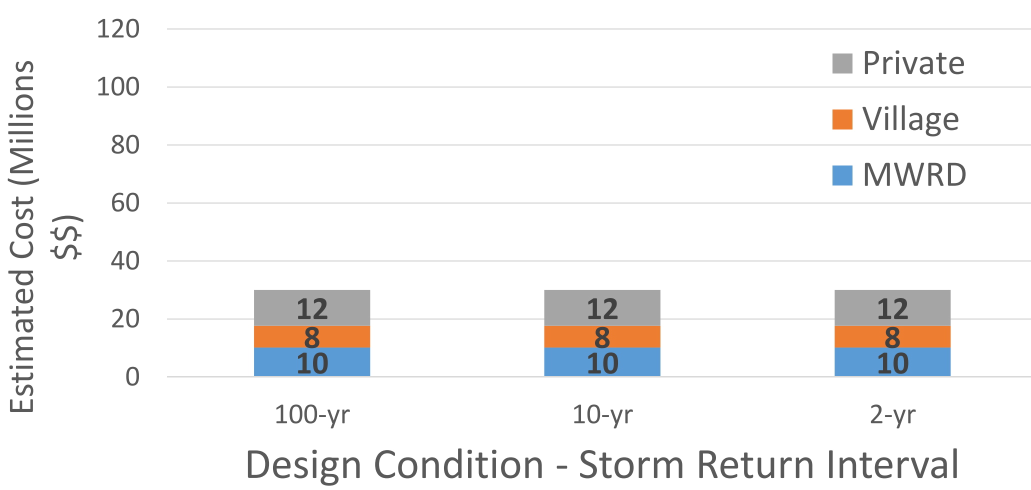
Solution 3) Damage reduction can be most cost-effective way to reach desired outcomes



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The most cost-effective approach may be to focus on private property damage reduction

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Metropolitan Water Reclamation District of Greater Chicago

City of Chicago (Southeast Side) Phase II Pilot Study

Geosyntec consultants

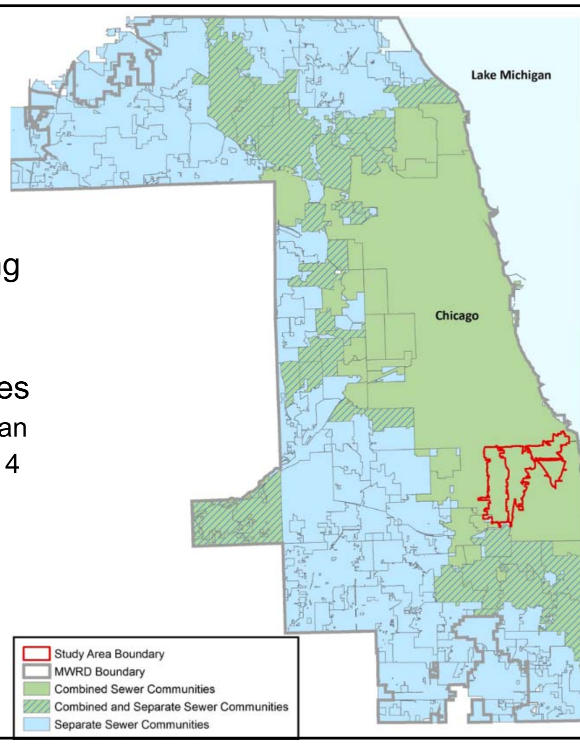
Matt Bardol, PE, CFM, CPESC, D.WRE
Adrienne Nemura, PE

Findings

- **Traditional solutions can lack resiliency**
  - **DWM Area 4 Tunnel**
- **Strategically placed green infrastructure optimizes performance**
  - **Uniform distribution is inefficient**
- **Outcome engineering provides resiliency and conserves resources**
  - **Green infrastructure**
  - **Structural measures (i.e. backflow preventers)**
  - **Private, municipal, and MWRD resources**

Study Area

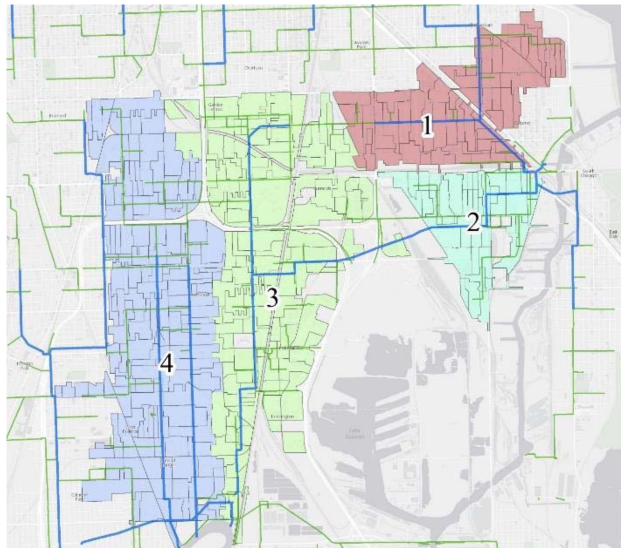
- 7 wards
- Chronic urban flooding
  - Basement backups
  - Surface flooding
- Prior & ongoing studies
  - City Area 4 Master Plan
  - Proposed DWM Area 4 Tunnel



Study Area

Modeled 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%**)



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Traditional Solutions

Traditional Engineering

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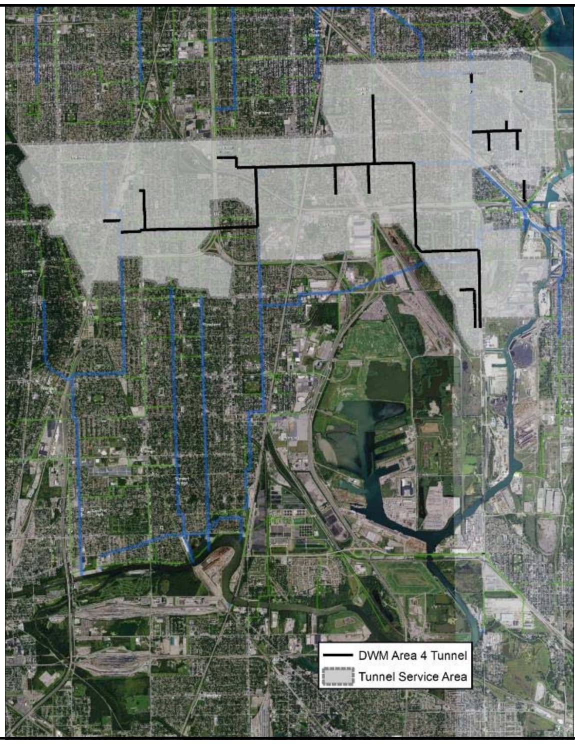

DWM Area 4 Tunnel

- 5 year level of service (only)
- Northern portion of Area 4 (only)
- Preliminary estimate: $255M +
- Structures removed: 27,131
- Cost per structure: $9,400

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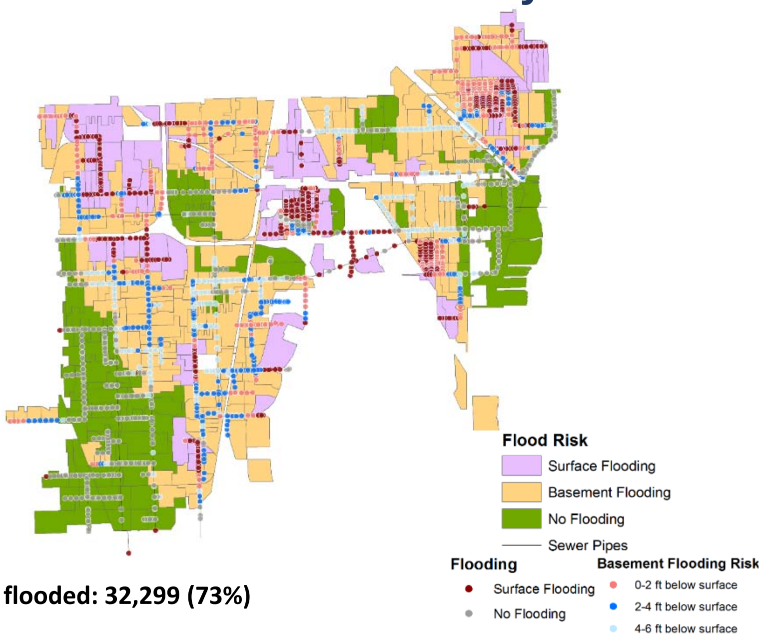
DWM Area 4 Tunnel – 25 year



Structures flooded: 32,299 (73%)

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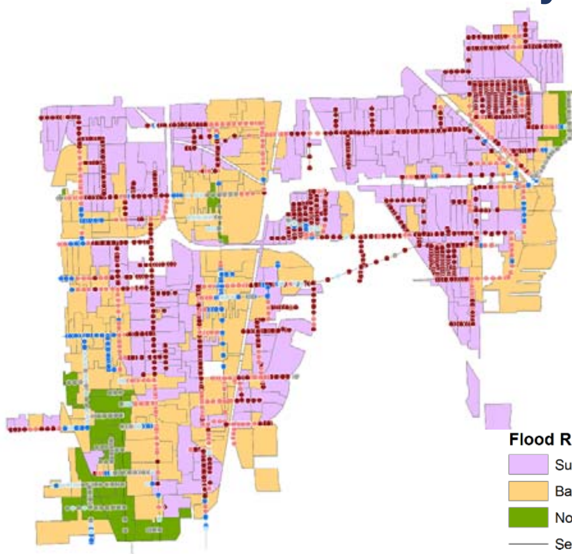
DWM Area 4 Tunnel – 100 year



Flood Risk
- Surface Flooding
- Basement Flooding
- No Flooding
- Sewer Pipes

Flooding
- Surface Flooding
- No Flooding

Basement Flooding Risk
- 0-2 ft below surface
- 2-4 ft below surface
- 4-6 ft below surface

Structures flooded: 41,188 (93%)

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Innovative Solutions

Alternatives to Traditional Engineering

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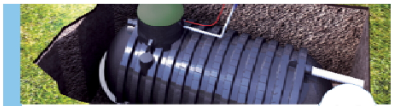
GI Tool Box

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.



BELOWGROUND CISTERNS

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

PERVIOUS PAVEMENT

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

GREEN ALLEYWAYS

Alleyways can be retrofitted with pervious pavement and/or underground cisterns 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.

GREEN ROOFS

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

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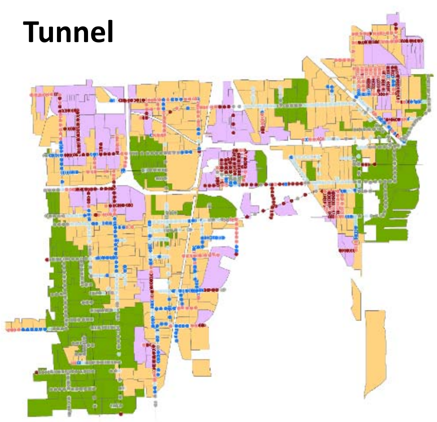
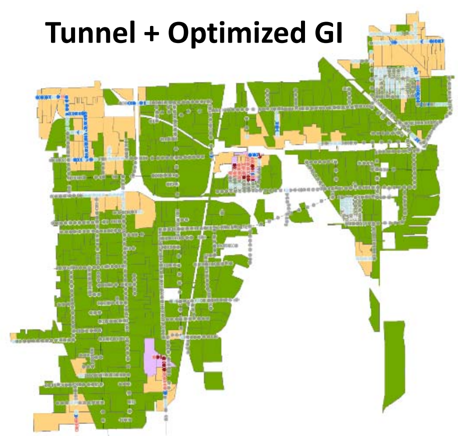
25 year Storm

Tunnel



Tunnel + Optimized GI



Structures flooded: 32,299 (73%)
Cost: $255M

Flood Risk
- Surface Flooding
- Basement Flooding
- No Flooding
- Sewer Pipes

Flooding
- Surface Flooding
- No Flooding

Basement Flooding Risk
- 0-2 ft below surface
- 2-4 ft below surface
- 4-6 ft below surface

Structures flooded: 11%
Cost: $1,114M

$255M (tunnel) + $809M (GI) + $50M (back flow)

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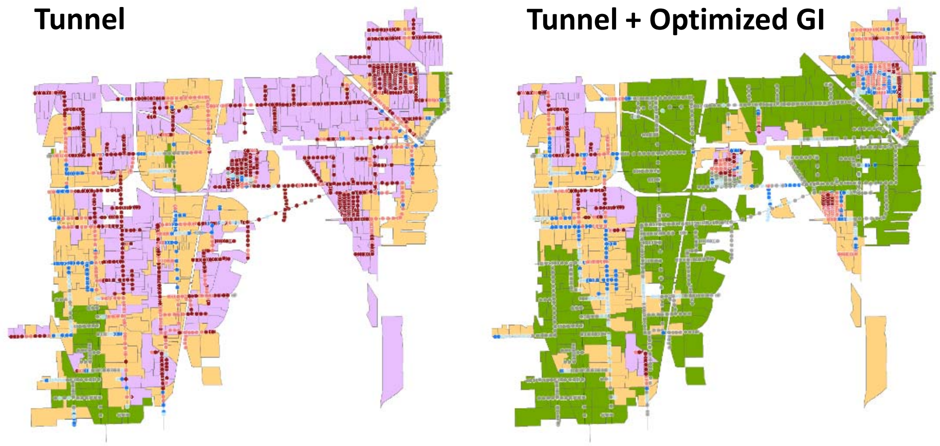
100 year Storm

Tunnel | **Tunnel + Optimized GI**



Structures flooded: 41,188 (93%)
Cost: $255M

Structures flooded: 32%
Cost: $1,114M

$255M (tunnel) + $809M (GI) + $50M (back flow)

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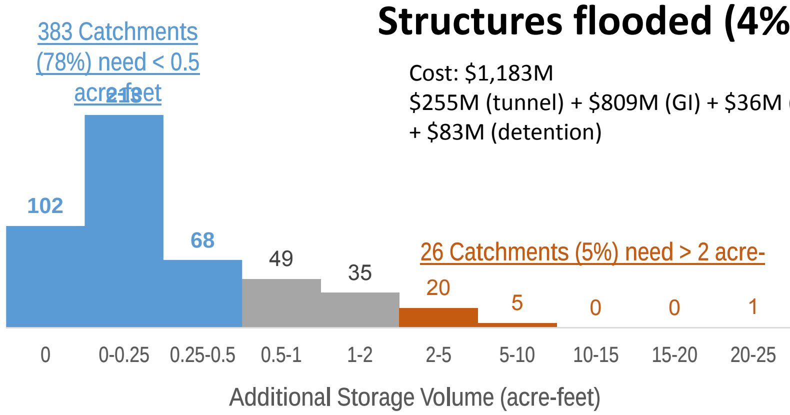
Additional Storage Distribution (for 100 year Level of Service)

Structures flooded (4%)

Cost: $1,183M
$255M (tunnel) + $809M (GI) + $36M (back flow) + $83M (detention)



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Stormwater Parks

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Leveraged Optimization Software (Optimizer™)

Traditional Modeling **Optimization Modeling**

Innovative Approach Confidently Guides Major Investments; Saves Time/Money

100 options >>> in 486 Days using traditional InfoWorks modeling

VS.

315,000,000 Options using Geosyntec's SWMM/Optimizer approach >>> in 10 days

- Optimization – expansive search for better solutions
- Over 40% in cost savings

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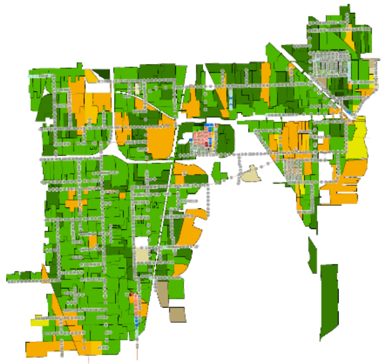
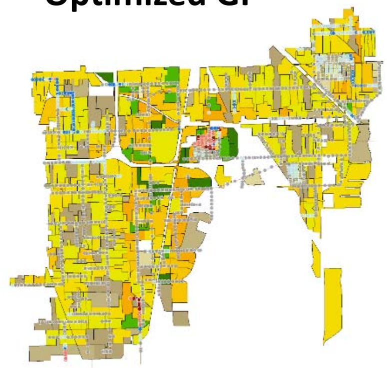
Optimizing GI Placement – 25 year

Maximum GI



Optimized GI



% 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	

Flooding
- Surface Flooding
- No Flooding

Basement Flooding Risk
- 0-2 ft below surface
- 2-4 ft below surface
- 4-6 ft below surface

Structured flooded: (1%)
Cost: $1,752M
$1,497M of GI

Structured flooded (11%)
Cost: $1,114M
$809M of GI (40% reduction)
*does not fully leverage backflow preventers

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Shifting to Outcome-Based Solutions

Outcome Engineering

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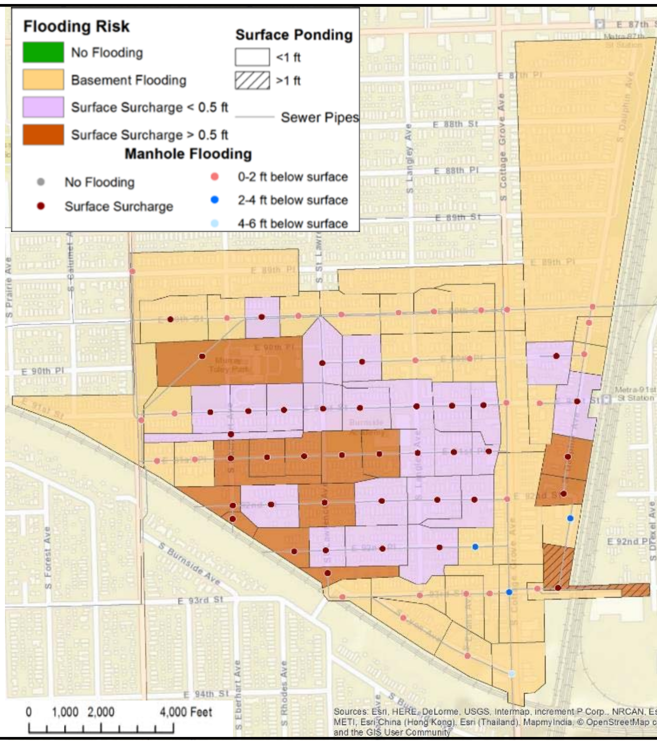

A Closer Look:

Existing Conditions

5 year

Total Structures: 1,036

Basement flooding risk: 1,030

Surface flooding risk: 6

All but 6 can be readily protected with backflow preventers

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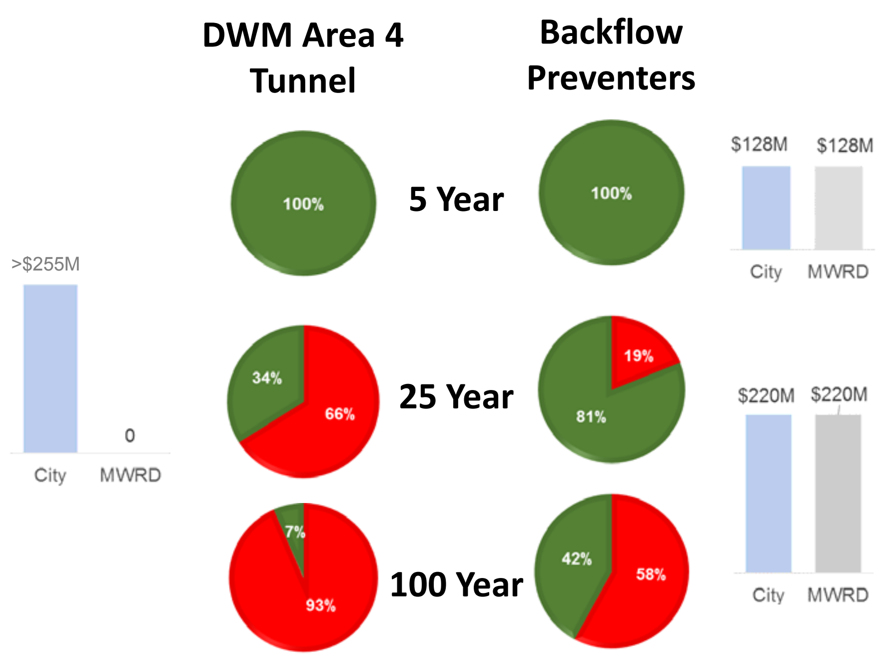
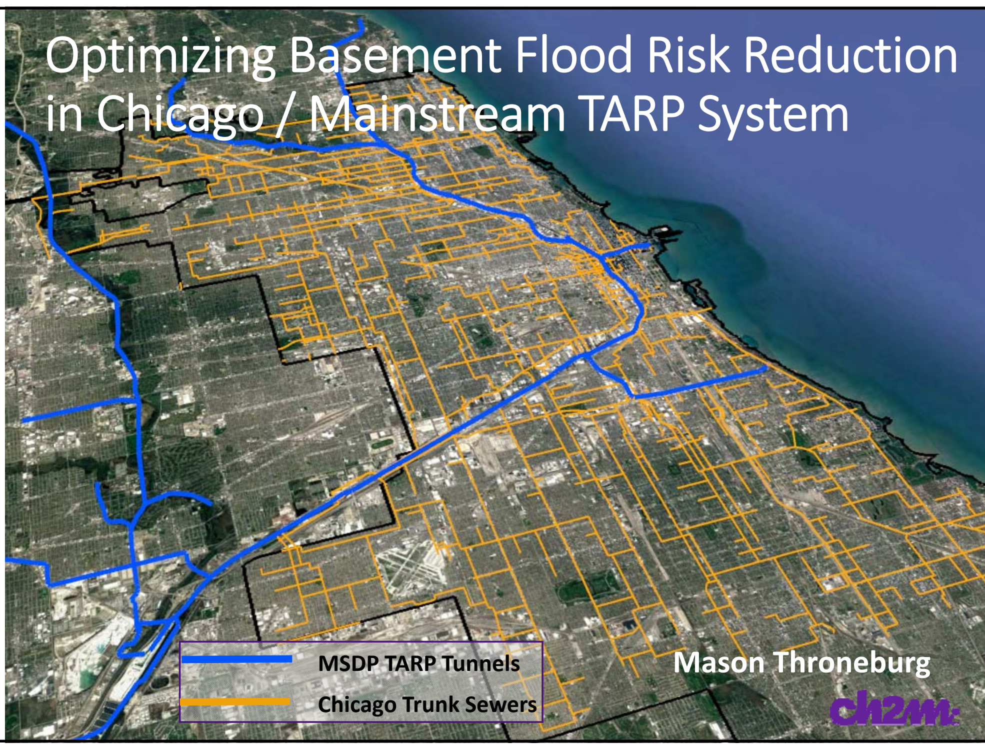


Findings & Next Steps

- Traditional solutions can lack resiliency
- GI is effective & placement can be optimized
- Outcome engineering provides resiliency

- Modify sequence of evaluations:
  - 1st: Highly flexible solutions (i.e. backflow preventers)
  - 2nd: Stormwater parks
  - 3rd: Optimized placement of GI
  - 4th: Implementation strategy - private vs public funds

Optimizing Basement Flood Risk Reduction in Chicago / Mainstream TARP System



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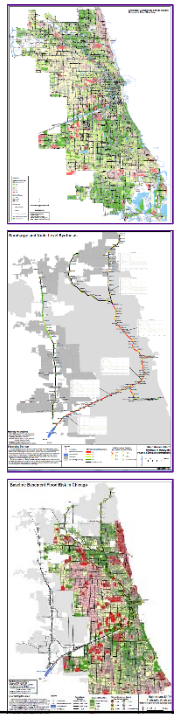
Chicago / TARP System Scale Hydraulic Models



Model	TARP Hydraulics	Basement Flooding	Primary Driver
Chicago Combined Trunk Sewer Model		✓	CIP Project Identification and Evaluation
MWRDGC Mainstream TARP (CS-TARP)	✓		Quantify TARP benefits under existing and future conditions
Integrated Chicago / Mainstream-TARP Model	✓	✓	Assess TARP and local sewer impact on flooding / CSO

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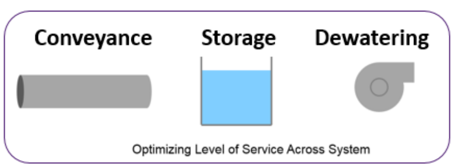
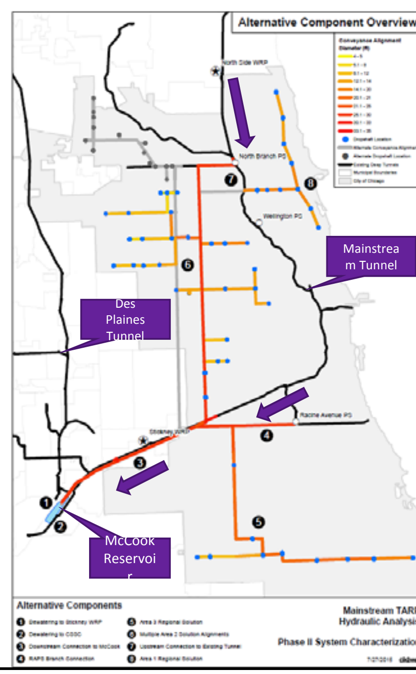
Assessing TARP Phase II Improvements

Technologies Evaluated



- Many Options
  - Alignment
  - Size
  - Combinations
- Multiple Performance Criteria
  - CSO reduction
  - Basement flood risk reduction



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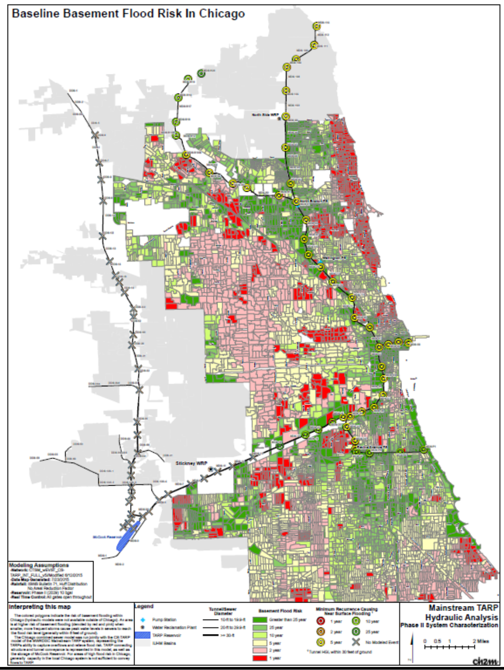
Solving 5-Year Basement Flooding with Inland Tunnel Solutions is Costly

- Cost \$23k – \$28k per structure benefitting to solve regional 5-year flooding problems

Service Area	Structures benefitting	Estimated Cost
Area 3 (south of CSSC)	~56,000	\$1.3B
Area 2 (west of Chicago River)	~64,000	\$1.8B
Mainstream Des-Plaines	~129,000	\$2.89B

- Conveyance bottlenecks
  - local sewers
  - trunk sewers
  - regional interceptors / TARP



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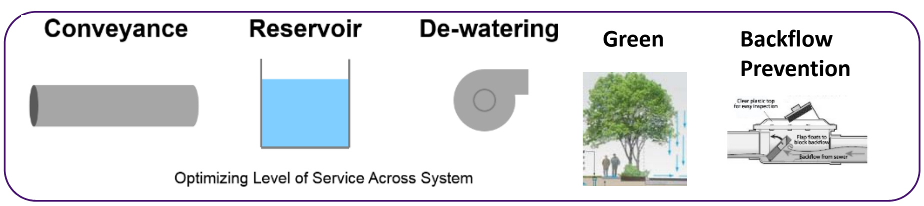
Outcome Engineering to Maximize Cost-Benefit

Consider additional technologies for addressing basement backups



Concepts

- Backflow prevention devices – direct protection vs. backups
- Distributed green infrastructure – reduce peak water levels

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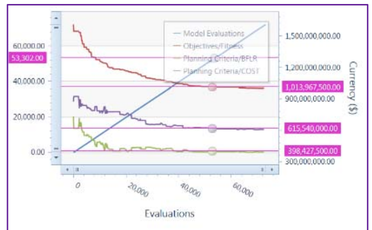
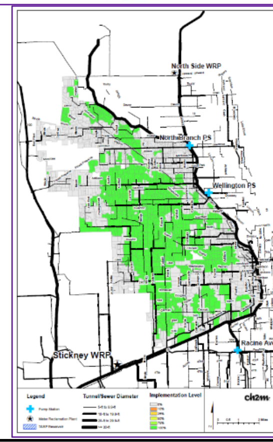
Leveraging Optimization Tools for Cost-Effective Improvement

- Performance Goals
  - Address areas with highest flood risk
  - Reduce stormwater inflow where most effective
- Additional Considerations / Constraints
  - Cost (Total, to MWRDGC, to residents)
  - Socioeconomic equity
  - Spatial distribution (across City, neighborhoods, wards)

Optimization tool exhaustively searches for better solutions





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Comparing Optimization Findings to Previous Analysis

Area 2 Focus

Alternative	Structures Implemented	5-Year Structures Protected	25-Year Structures Protected	Estimated Cost ($)	Private Share ($)	City Share ($)	District Share ($)	Dollars per 5-Year Structure Removed
Area 2 Tunnel[ab]	-	51,406 (36%)	13,026 (8%)	$1,150 M	$0	$0	**$1,150 M**	$22,367
Preliminary Private Property Solution	86,691	81,117 (56%)	86,691 (54%)	$866 M	$433 M	$216 M	**$216 M**	$10,867[c]
Optimized Private Solution (Mid level)	97,677	112,300 (78%)	98,289 (62%)	$977 M	$488 M	$244 M	**$244M**	$8,698
Optimized Private Solution (High level)[d]	125,253	144,005 (100%)	126,038 (79%)	$1,253 M	$626 M	$313 M	**$313 M**	$8,698

a – 173,382 structures in Area 2; 144,005 at 5-yr risk; 159,363 at 25-yr risk
b – all results for CTSM "baseline conditions"
c – cost assumed to be $10,000 per structure
d – Benefits extrapolated from mid-level solution

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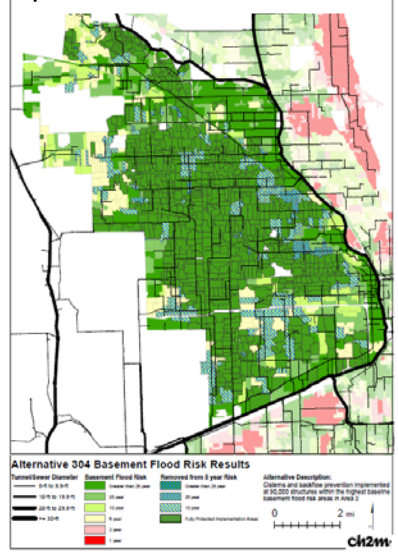
Summary

Models help understand system limitations.
"Think beyond grey" for cost-effective solutions

- Models provide **strong technical foundation**
- Outcome: Technical foundation for implementing **combination of green and grey solutions**
- **Coming soon:** More detailed analysis of cost-sharing options for 100 year protection

$313 M Private Solution



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Thank You

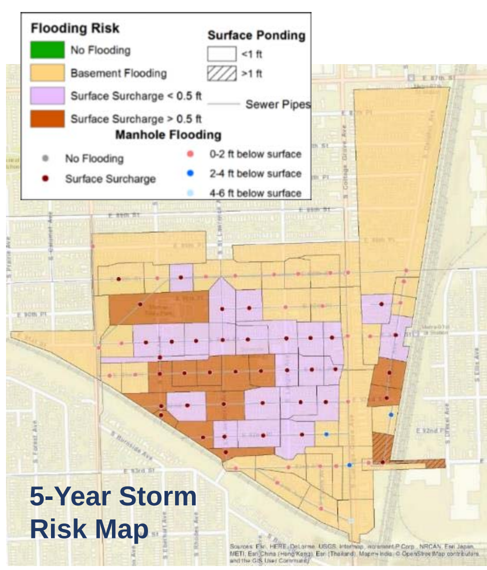
ch2m

Key Findings

- Traditional and even blended green and grey solutions require exorbitant investments
- In combined sewer areas private property interventions can be more cost effective to address basement backups
- Solutions in separate sewer areas should be examined to identify efficiencies in constructing along with local transportation or other utility improvements
- Outcome Engineering approach reinforced the need to embrace non-traditional approaches to managing stormwater.

Chatham Pilot Study

- MWRD Partnering with City of Chicago
- Install backflow prevention and passive storage systems in up to 40 residential homes
- South end of the Chatham neighborhood
- To gain insight into the efficacy of these technologies.



Moving Forward

- Evaluate Master Planning needs throughout county
- Develop adaptive approach, centered on managing local stormwater issues with multi-disciplined teams
- Program Managers for separate and combined areas
- Create standards communities can utilize to implement green infrastructure
- I & I a significant public and private issue that will need continued effort to resolve.

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