Assessing Impermeable Surface Area Impacts on Modeling

Implications for the Combined Sewer Overflow Long Term Control Plan in Omaha, Nebraska

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Project Team

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  - Dr. Zhenghong Tang
  - Prof. Gordon P. Scholz
  - Dr. Richard Sutton
- Report available online at digitalcommons.unl.edu

Photo of 72nd & Maple St.

PROJECT GOAL

Assess the accuracy of ISA estimation by the zoning code, its impact on the modeling of the LTCP, & identify areas of potential improvement

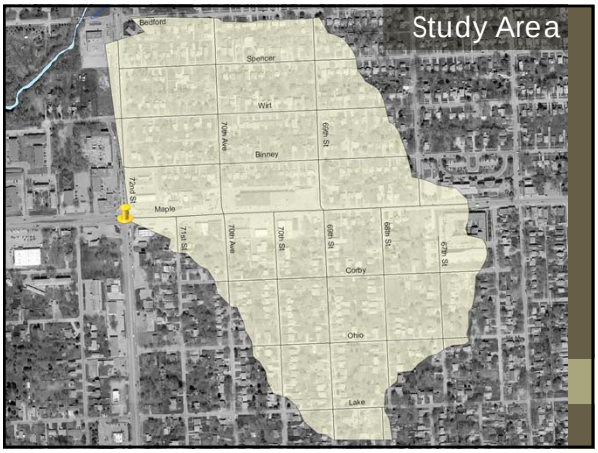
OBJECTIVES

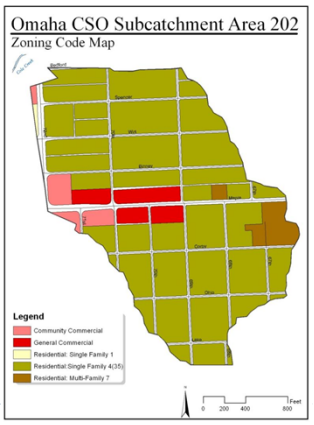
1. Digitize all ISAs in subcatchment 202 & compare with estimates
2. Model actual ISA cover & percent reductions from actual to assess modeled peak flow & volume results
3. Perform a sensitivity analysis by increasing the level of detail in existing sewer pipes & topography

Background & Existing Conditions

Summary of the Project Location & Context

Study Area





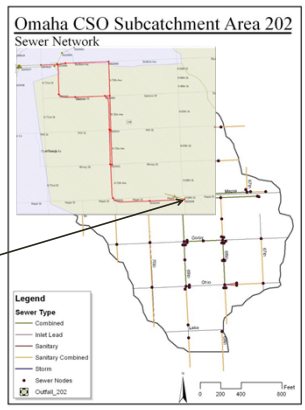
Study Area

- 101 acre subcatchment of Cole Creek study basin
- 1 CSO outfall, 72nd & Bedford (NW corner)
- Zoning breakdown

Zoning Code	% Cover
R1	0.2%
R4(35)	74.1%
R7	3.7%
CC	3.2%
GC	5.3%
Subtotal	**86.5%**
Pavement	13.6%
Total	**100%**

Current Modeling Background

- Utilizes **Infoworks** software
- Estimated ISA percent cover by **zoning code**
- Supports the development of the LTCP = **4 CSOs per year** (1969 season)
- All runoff enters system at one inlet
- **3 types of surfaces**: Roads impervious, non-roads impervious, & pervious



Project Results

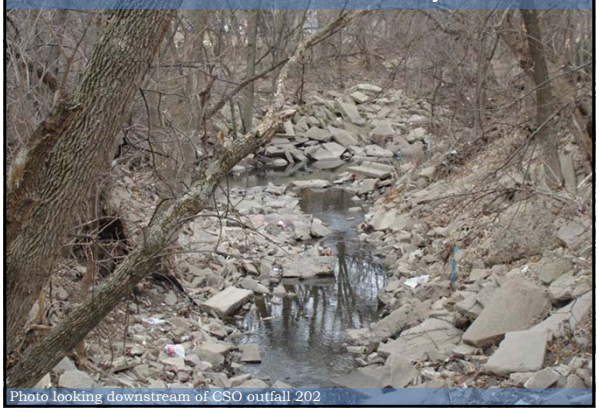
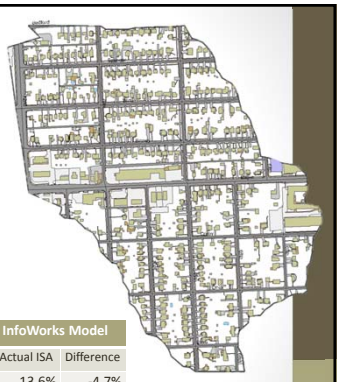


Photo looking downstream of CSO outfall 202

Objective 1:
Accuracy of Zoning Code ISA Estimation

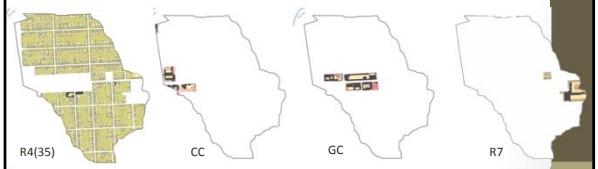
- In model, one set ISA cover value per zoning code
- Overall good: within 3.6% when summarized into 3 categories
- More pervious than estimates
- Distinct ISA patterns between zoning codes



All Digitized ISAs

Subcatchment 202 ISA Breakdown for InfoWorks Model			
InfoWorks Category	Estimated ISA	Actual ISA	Difference
Roads Impervious	18.4%	13.6%	-4.7%
Non-road Impervious	32.0%	33.2%	1.1%
Pervious	49.6%	53.2%	3.6%

Subcatchment 202 Impermeable Surface Area						
Zoning Code	Areal Cover (acre)	% Cover of Basin	Assumed ISA % Cover	Areal ISA Cover (acre)	Actual ISA % Cover	Difference
R1	0.2	0.2%	22.5%	0.03	12.6%	-9.9%
R4(35)	74.9	74.1%	37.5%	24.4	32.6%	-4.9%
R7	3.7	3.7%	52.5%	2.3	61.9%	9.4%
CC	3.2	3.2%	63.8%	2.1	66.2%	2.5%
GC	5.3	5.3%	67.5%	4.7	88.2%	20.7%
Subtotal	**87.3**	**86.5%**		**33.6**		**17.7%**
Pavement	13.8	13.6%	18.4%	13.8	13.6%	-4.7%
Total	**101.13**	**100.00%**		**47.4**		**12.9%**

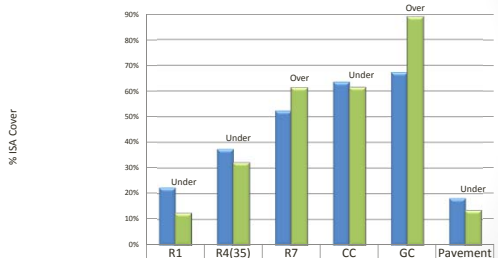


Maps of each zoning code & associated ISA

- Overall accuracy due to dominant R4(35) footprint & relative accuracy
- Zoning codes can have wide ranges of actual ISA cover
- Higher the allowable ISA percentage, higher the variability

Objective 1:
Accuracy of Zoning Code ISA Estimation

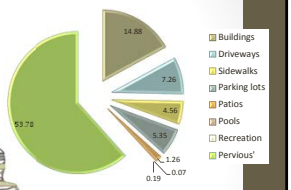
Assumed & Actual ISA Percent Coverage Comparison



	R1	R4(35)	R7	CC	GC	Pavement
CSO Assumed ISA Percent Cover	22.50%	37.50%	52.50%	63.75%	67.50%	18.35%
Actual ISA Percent Cover	12.56%	32.24%	61.46%	61.58%	89.08%	13.62%

Breakdown of ISA

by ISA Type



ISA Types within Zoning Codes (in acres)

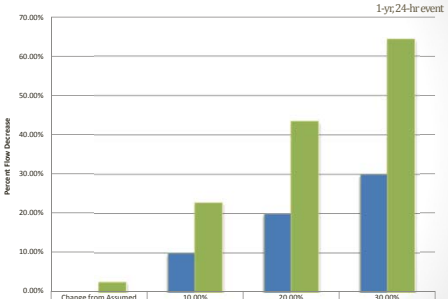
ISA – Impervious Surface Area

Objective 2: Model ISA Reduction

1% ISA reduction = approx. 2% peak flow reduction

Influence of ISA % Reduction on Peak Flow Reduction

1-yr, 24-hr event



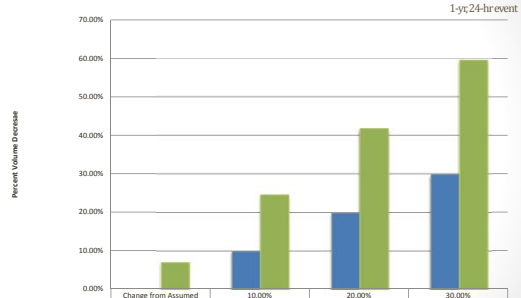
	Change from Assumed	10.00%	20.00%	30.00%
% ISA Reduction	0.00%	10.00%	20.00%	30.00%
Peak Flow Percent Decrease	2.60%	22.83%	43.59%	64.48%

ISA – Impermeable Surface Area

1% ISA reduction = approx. 2% volume reduction

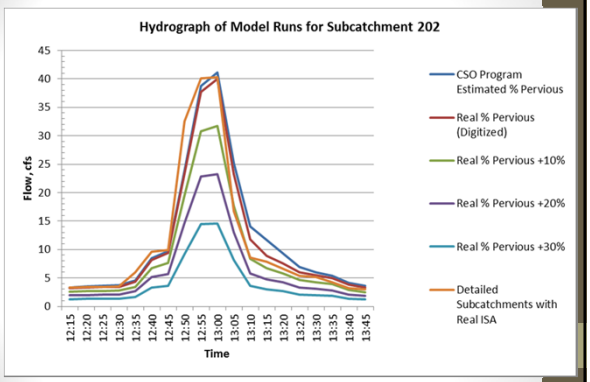
Influence of ISA % Reduction on Volume Reduction

1-yr, 24-hr event



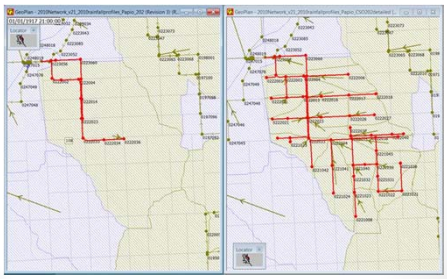
	Change from Assumed	10.00%	20.00%	30.00%
% ISA Reduction	0.00%	10.00%	20.00%	30.00%
Volume Percent Decrease	7.10%	24.69%	41.89%	59.61%

ISA – Impermeable Surface Area



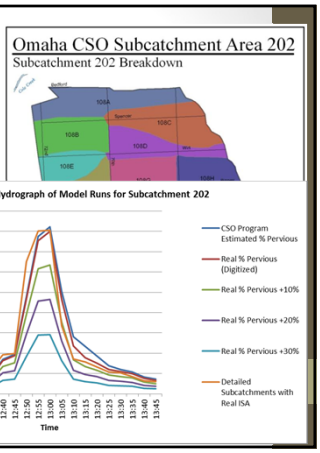
Objective 3: Increased Detail in Modeling

- All sewer pipes down to 18" diameter were added
- Actual ISA percentages inputted
- Topography & distribution of ISAs NOT taken into account, however



Objective 3: Increased Detail in Modeling

- Broken into 18 subcatchments for slope & widths
- Hydrographs utilized as metric
- Little change: -2.5% flow
- TOC: approx. 5 mins



Points of Emphasis

- Utilizing zoning for ISA estimation provides varied results, but good for initial assessment of a given watershed
- Given ISA type distribution among zoning, good indicator of possible pollutant loads
- Significant benefits associated with ISA reduction; indicating viability as part of an integrated approach in CSO Program
- InfoWorks is powerful & has capabilities to account for Green Infrastructure & greater detail in ISAs
- Increased detail did not significantly alter output, but current modeling setup lacks parameters to build upon

Going Forward

- Currently, all ISAs in the CSO service area are being digitized & modeling to be updated
- **Two key areas**
  - **Defining ISA reduction** (2 strategies)
    - Physical removal & restoration
    - Disconnection
  - **Development of a dynamic, integrated management system**
    - Tracking of post-construction BMPs
    - GIS integration
    - Modeling efforts
    - Update additions & subtractions

Comments or questions?

THANK YOU VERY MUCH!

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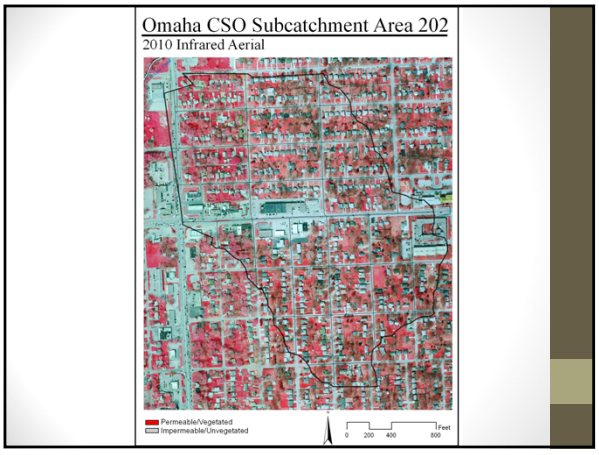
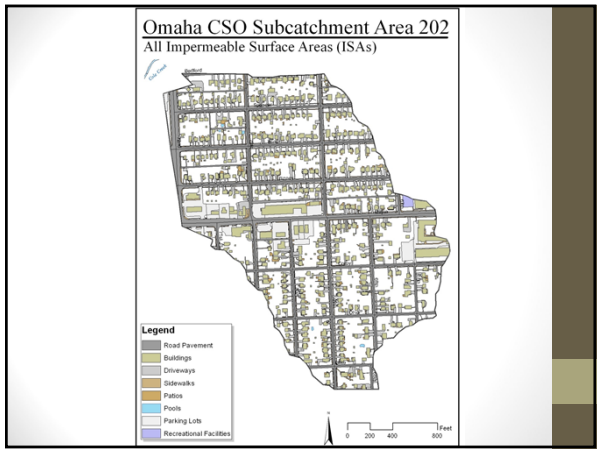
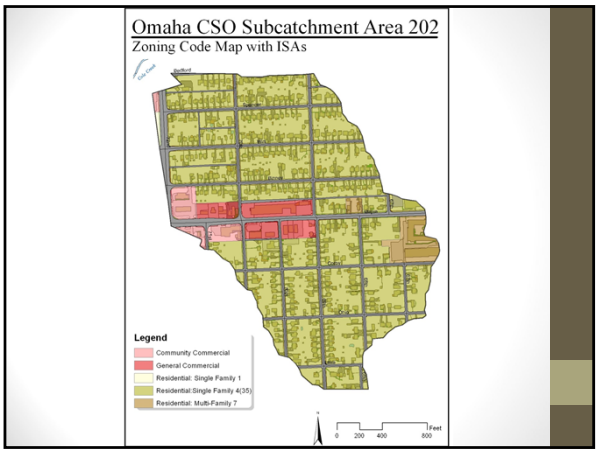
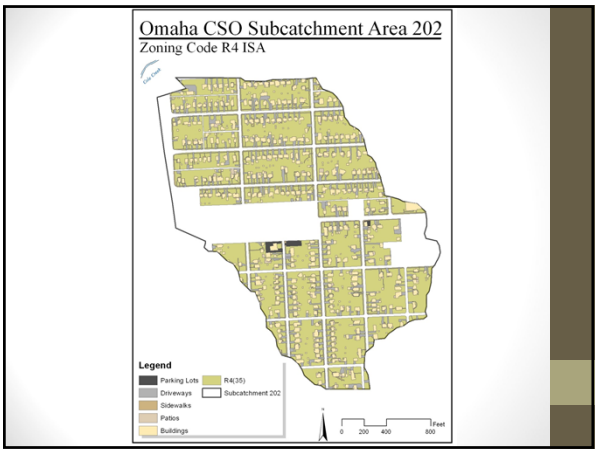
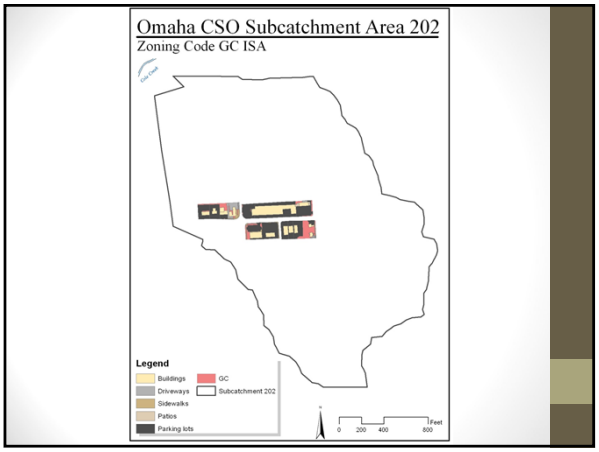
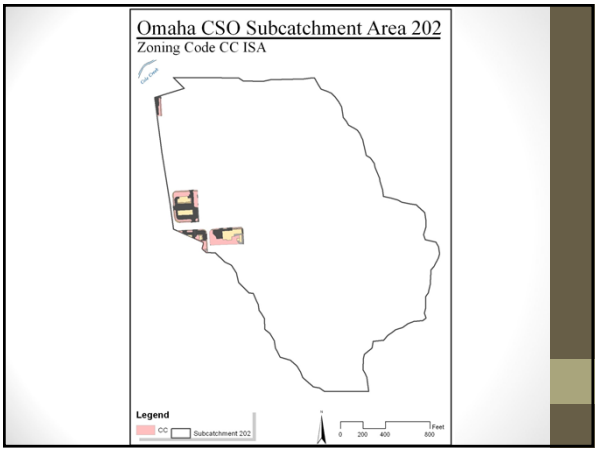


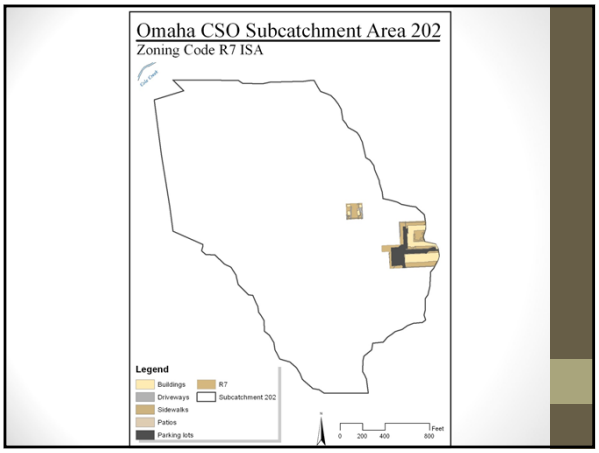


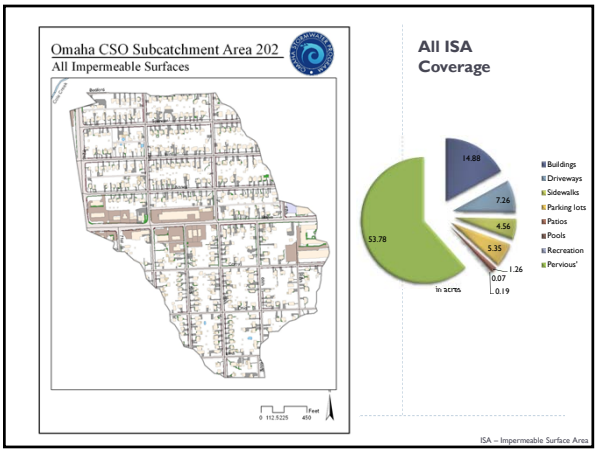

Omaha CSO Subcatchment Area 202
Zoning Code Map with ISAs
Legend
Community Commercial
General Commercial
Residential: Single Family 1
Residential:Single Family 4(35)
Residential: Multi-Family 7
0 200 400 800
Feet

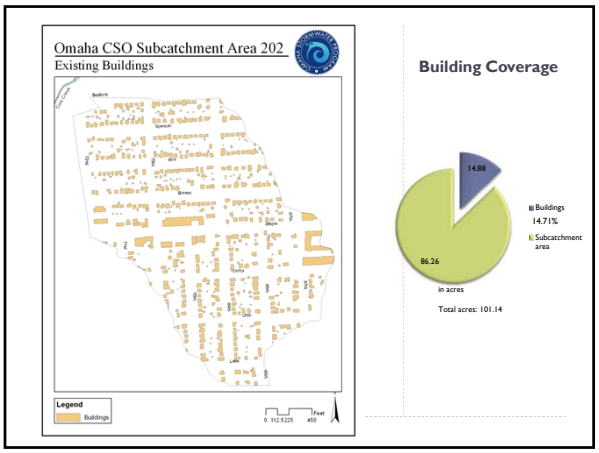

Omaha CSO Subcatchment Area 202
Zoning Code R4 ISA
Legend
Parking Lots
R4(35)
Driveways
Subcatchment 202
Sidewalks
Patios
Buildings
0 200 400 800
Feet

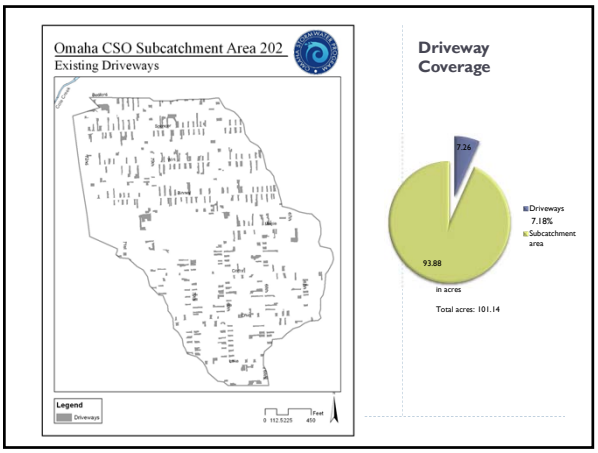

Omaha CSO Subcatchment Area 202
Zoning Code GC ISA
Legend
Buildings
GC
Driveways
Subcatchment 202
Sidewalks
Patios
Parking lots
0 200 400 800
Feet

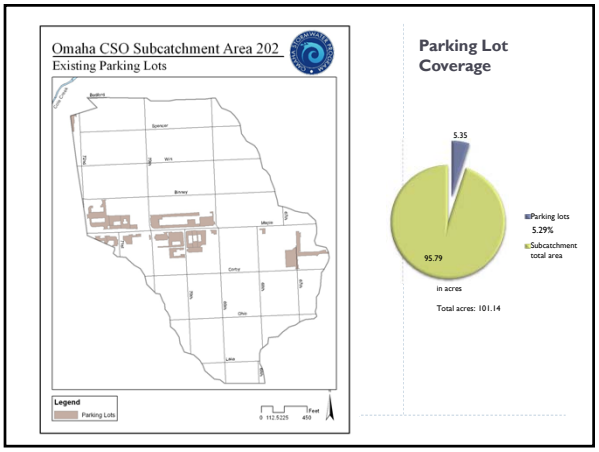

Omaha CSO Subcatchment Area 202
Zoning Code CC ISA
Legend
CC
Subcatchment 202
0 200 400 800
Feet

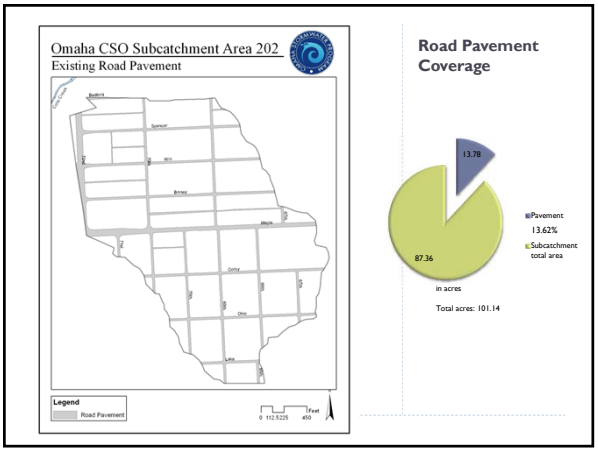

Omaha CSO Subcatchment Area 202
Zoning Code R7 ISA
Legend
Buildings
R7
Driveways
Subcatchment 202
Sidewalks
Patios
Parking lots
0 200 400 800
Feet

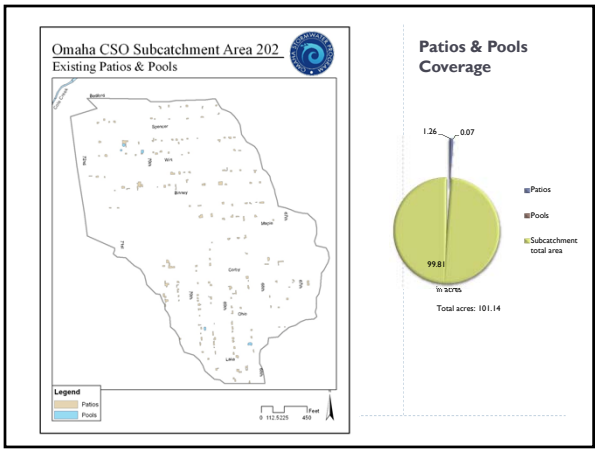

Omaha CSO Subcatchment Area 202
All Impermeable Surfaces
All ISA Coverage
14.88
7.26
4.56
5.35
1.26
0.07
0.19
53.78
In acres
Buildings
Driveways
Sidewalks
Parking lots
Patios
Pools
Recreation
Pervious'
ISA – Impermeable Surface Area

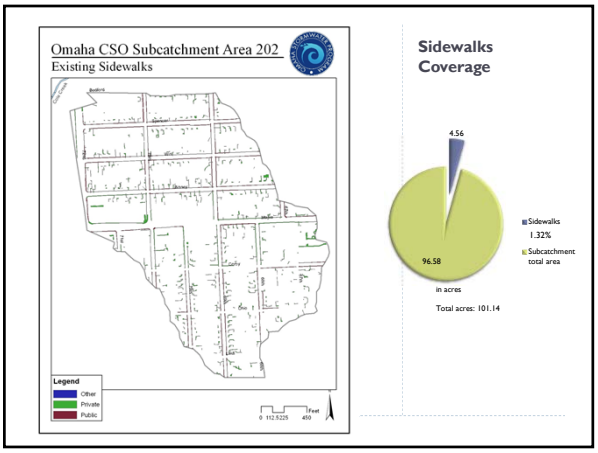

Omaha CSO Subcatchment Area 202
Existing Buildings
Legend
Buildings
Feet
0 112.5225 450
Building Coverage
14.88
86.26
in acres
Buildings
14.71%
Subcatchment area
Total acres: 101.14


Omaha CSO Subcatchment Area 202
Existing Driveways
Legend
Driveways
Feet
0 112.5225 450
Driveway Coverage
7.26
93.88
in acres
Driveways
7.18%
Subcatchment area
Total acres: 101.14


Omaha CSO Subcatchment Area 202
Existing Parking Lots
Legend
Parking Lots
Feet
0 112.5225 450
Parking Lot Coverage
5.35
95.79
in acres
Parking lots
5.29%
Subcatchment total area
Total acres: 101.14


Omaha CSO Subcatchment Area 202
Existing Road Pavement
Legend
Road Pavement
Feet
0 112.5225 450
Road Pavement Coverage
13.78
87.36
in acres
Pavement
13.62%
Subcatchment total area
Total acres: 101.14


Omaha CSO Subcatchment Area 202
Existing Patios & Pools
Legend
Patios
Pools
Feet
0 112.5225 450
Patios & Pools Coverage
1.26
0.07
99.81
in acres
Patios
Pools
Subcatchment total area
Total acres: 101.14


Omaha CSO Subcatchment Area 202
Existing Sidewalks
Legend
Other
Private
Public
Feet
0 112.5225 450
Sidewalks Coverage
4.56
96.58
in acres
Sidewalks
1.32%
Subcatchment total area
Total acres: 101.14


Bedford
Spencer
Wirt
Binney
Maple
Corby
Ohio
Lake
70th Ave
69th St
71st St
70th St
68th St
67th St