SURFICIAL GEOLOGIC MAPPING FOR GREEN STORMWATER INFRASTRUCTURE SITING AND SUITABILITY

Drew Phillips, Dave Grimley – Illinois State Geological Survey
Mary Pat McGuire – UIUC Dept. Landscape Architecture
Reshmina William, Ashlynn Stillwell – UIUC Dept. Civil & Env. Eng.
Piotr Szocinski, Avery Clark – Illinois State Geological Survey

Sea Grant
ILLINOIS - INDIANA

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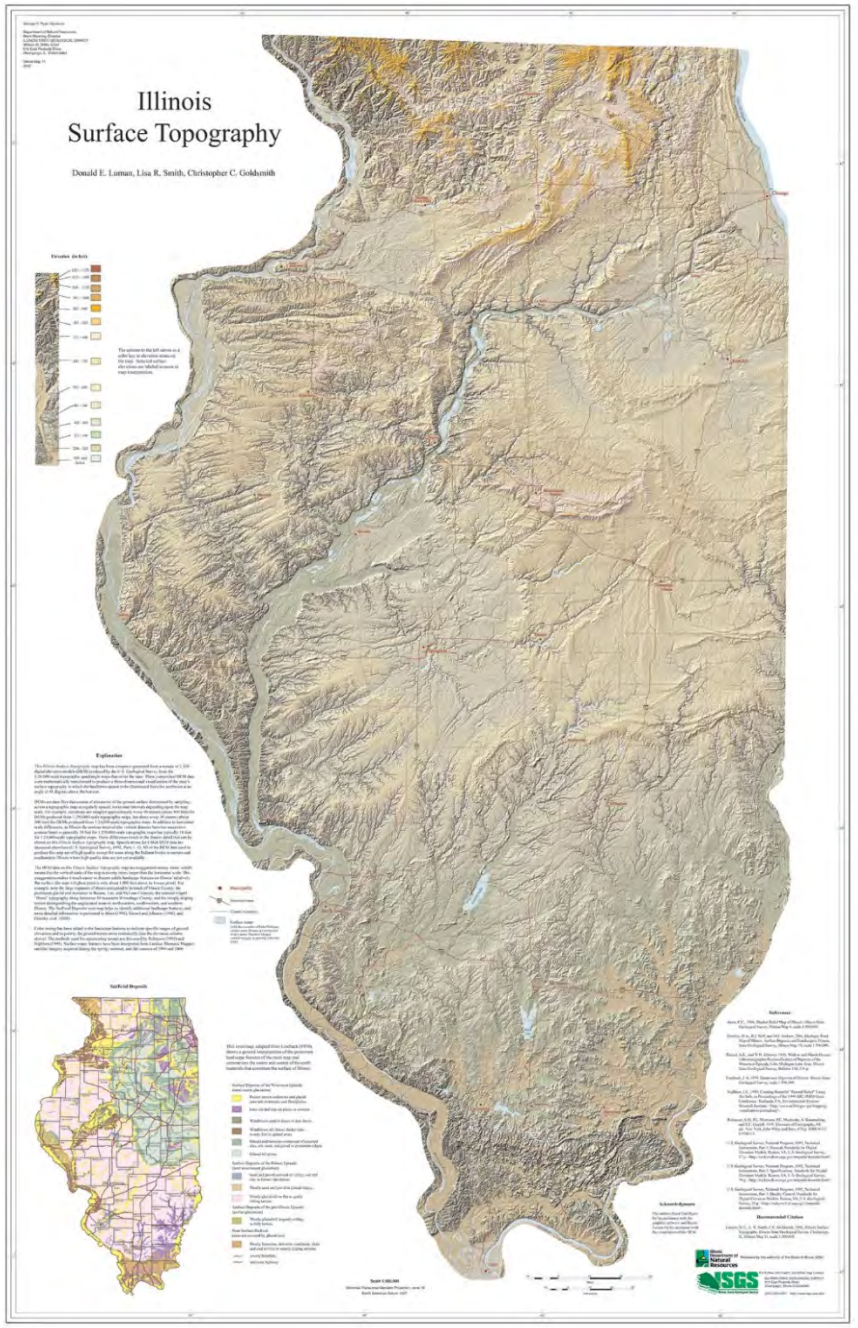
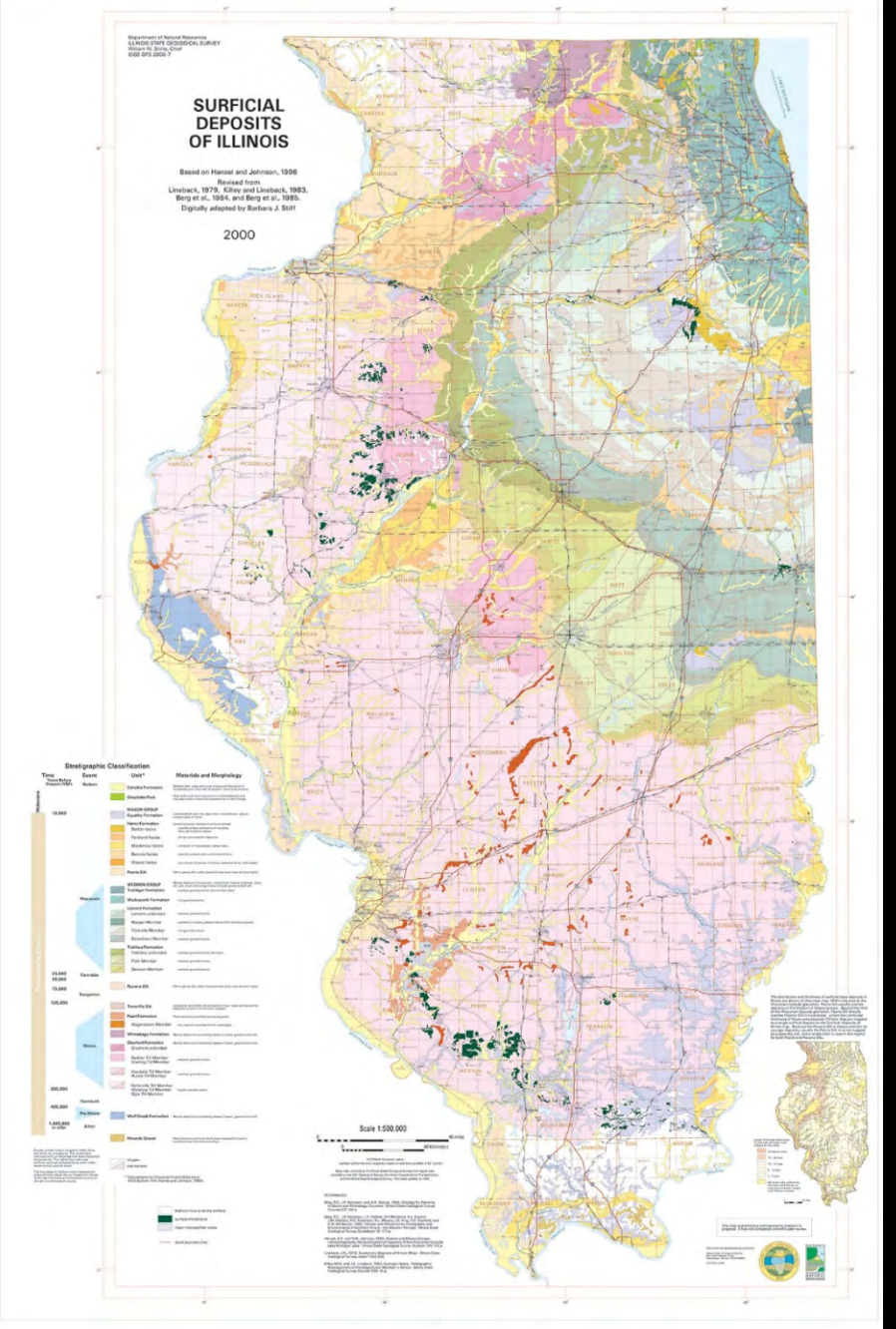
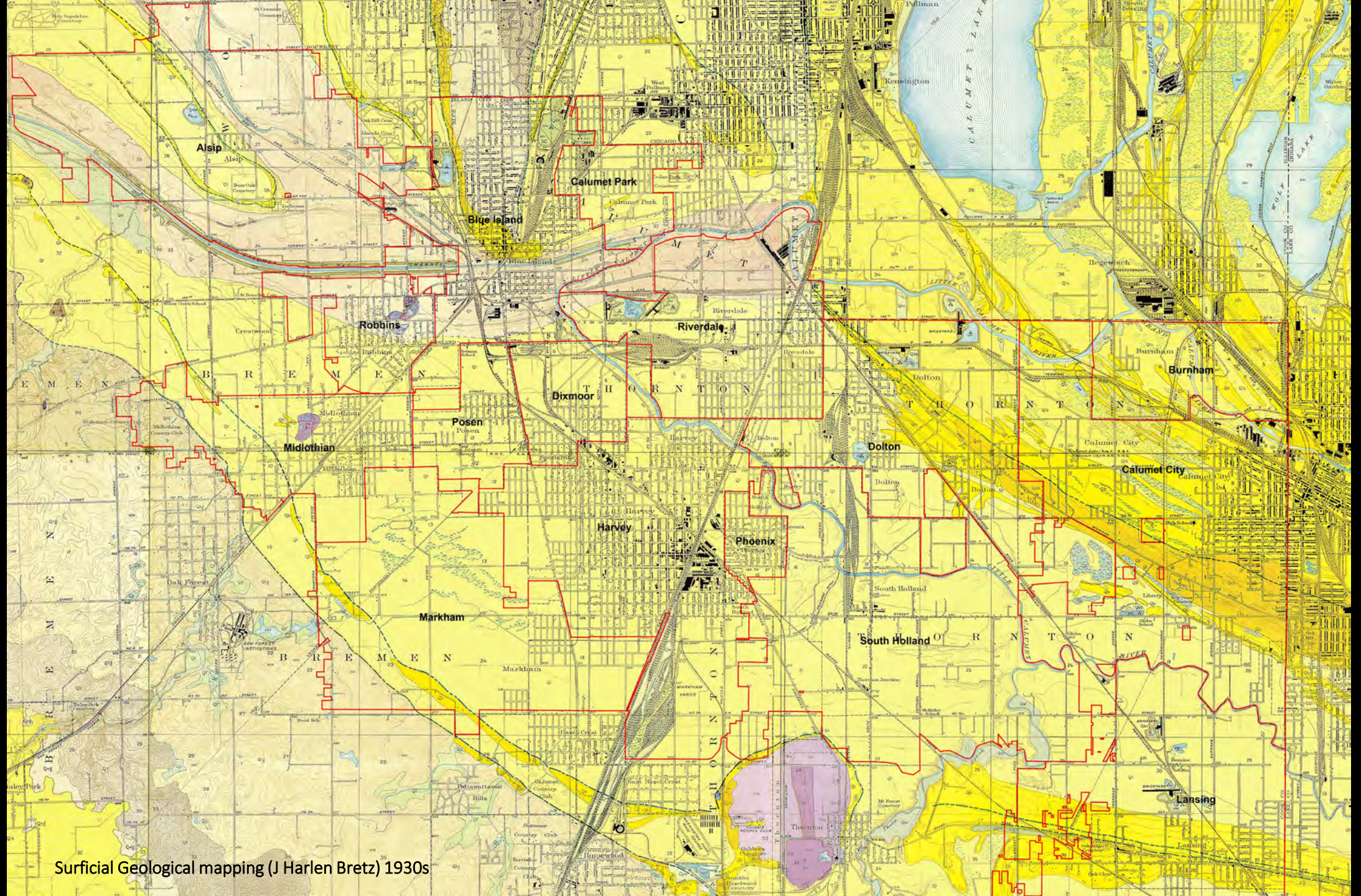
Also?

- Landscape Architecture Design Studio
- USDA United States Department of Agriculture Natural Resources Conservation Service

Sea Grant ILLINOIS - INDIANA


Illinois
Surface Topography
Donald E. Luman, Lisa R. Smith, Christopher C. Goldsmith


SURFICIAL
DEPOSITS
OF ILLINOIS
Based on Hansel and Johnson, 1996
Revised from
Lineback, 1979, Kilfey and Lineback, 1983,
Berg et al., 1994, and Berg et al., 1985.
Digitally adapted by Barbara J. Stiff
2000
Stratigraphic Classification
Scale 1:500,000



Surficial Geological mapping (J Harlen Bretz) 1930s

April 17-18, 2013: **5” rain in 24 hours**

CALUMET CITY

meatpackers, beer brewers,
printmakers, bootleggers

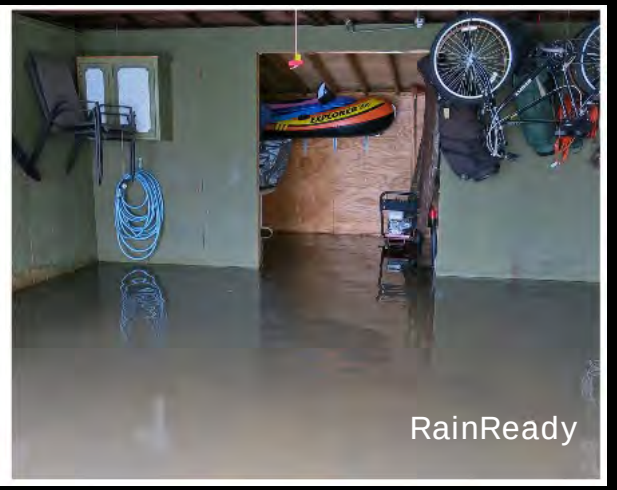
NBC Chicago

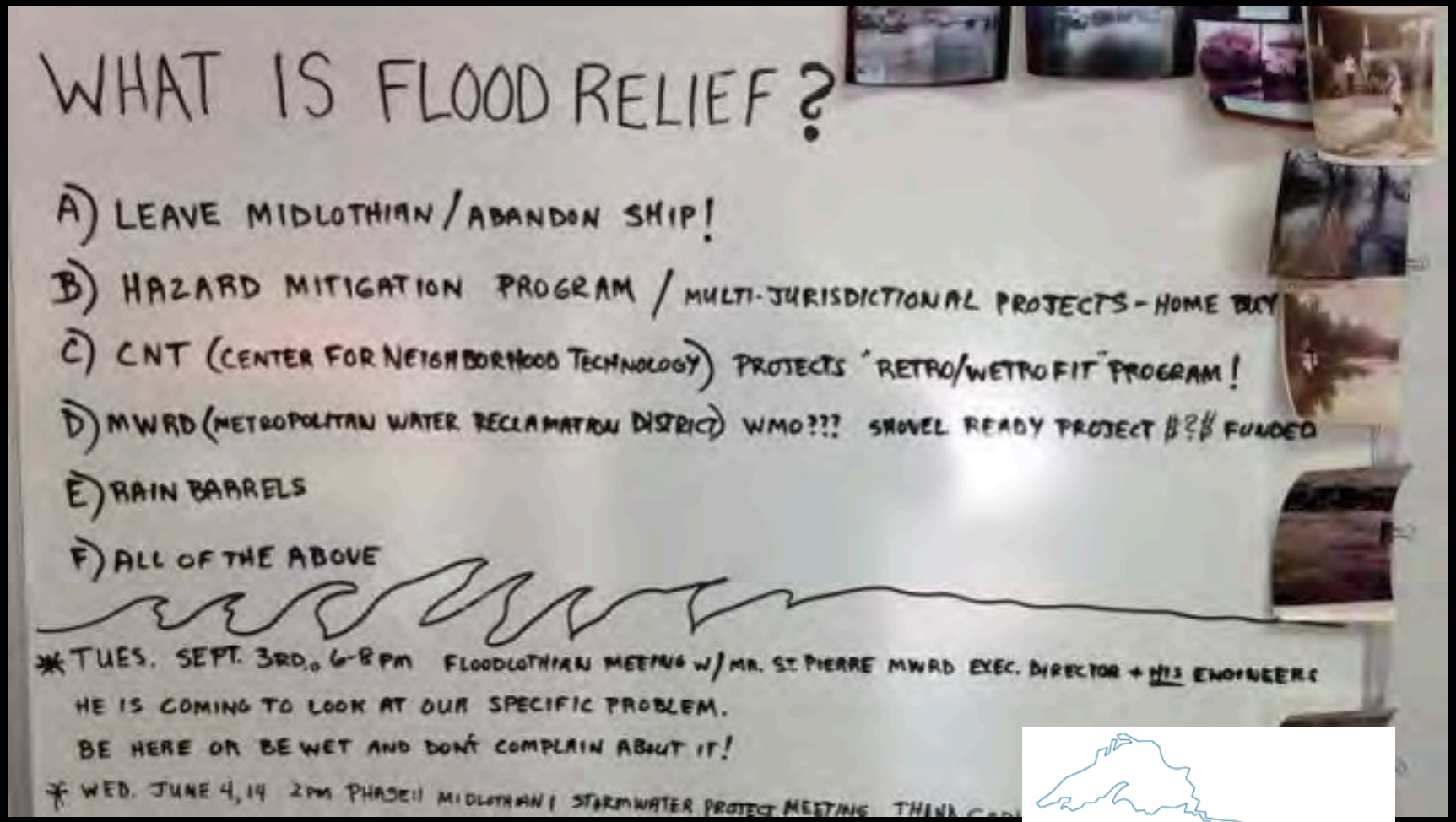

1929, source: Chicago History Museum


Chicago Tribune

MIDLOTHIAN

golfers





GREAT LAKES
Water Infrastructure Project

RainReady
Center for Neighborhood Technologies

DEEP TUNNEL: THORTON QUARRY STORMWATER BASIN

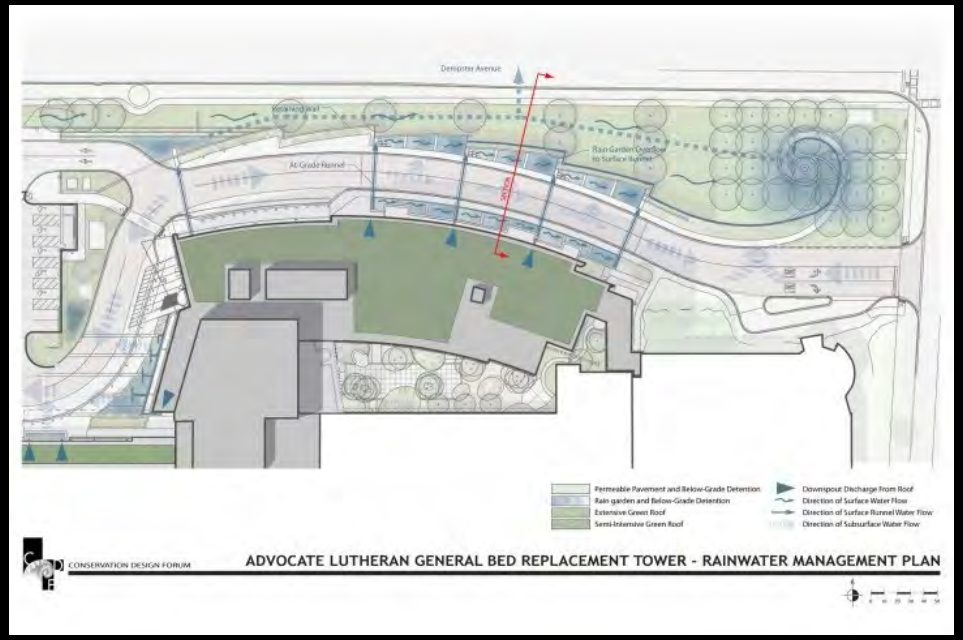
GSI PROJECT

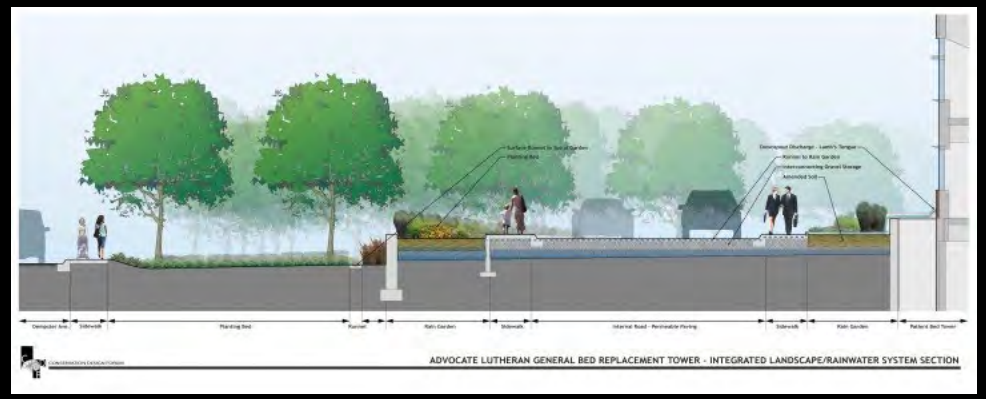
GOAL: Alleviate recurring urban flooding in the Calumet Corridor

HOW: Study the role that soils play in alleviating flooding (currently not part of GI planning or regulatory approvals)

April 17-18, 2013: 5” rain in 24 hours

Green strategy precedent: Advocate Lutheran Patient Bed Tower





Every surface converted to capture 100% of stormwater

Green Stormwater Infrastructure Design, based on underlying soils

key principles:
- intercept water directly (or, as close as possible)
- create underlyng layers of material (organic and/or open-graded) to further capture water
- reduce energy and erosion (make capture very direct)
- convey water downward through soils, through gravity and/or soil properties
- use planting to uptake (everywhere possibe)

GI Surfaces
(e.g. parking lots)

- designed to handle water directly through the surface
- optional to receive from adjacent surfaces
- lower loading ratio

GI Features
(e.g. bioswales)

- designed to receive water from adjacent surfaces
- higher loading ratio

Illinois-Indiana Sea Grant Program (NOAA) 2018-2019 #NA18OAR4170082
Hydrogeologic soil research for green stormwater infrastructure planning and design: new methods for adapting urban coastal communities
(Drawn by M.P.McGuire)

Surfaces vs Features - Concept Methodology: Loading ratio plays a key role in performance

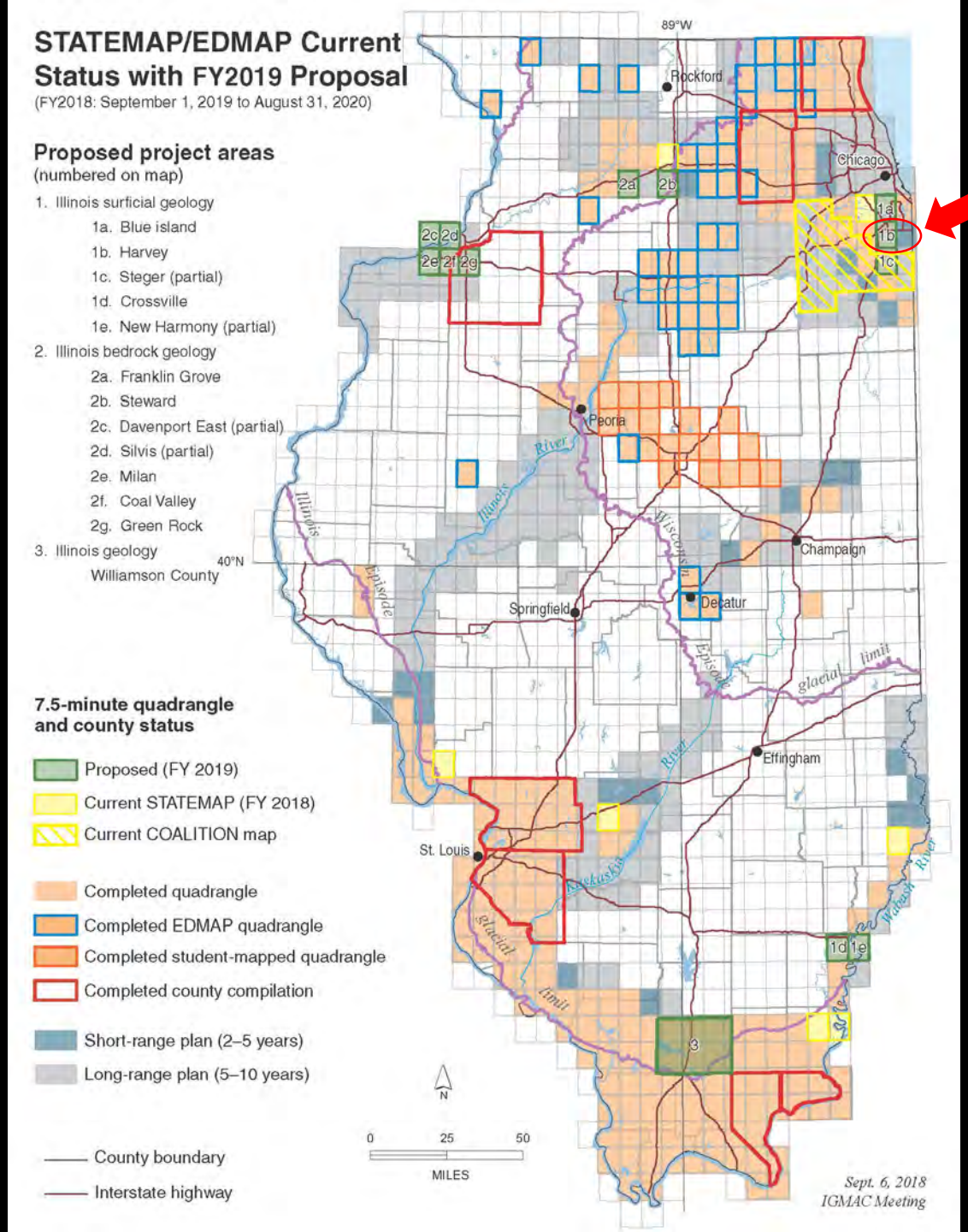
PROJECT MOTIVATIONS

- **Retrofit the land** for GSI
- Test perception that the region is dominated by impervious soils
  - Limits GSI design and implementation
- Demonstrate value of considering natural soils in GSI designs.
  - Traditional GSI design practice relies only on amended soil layers
- Can high-resolution mapping of the near-surface geology, soils, and hydrologic properties improve site-specific GSI planning and design?

MY MOTIVATIONS TODAY

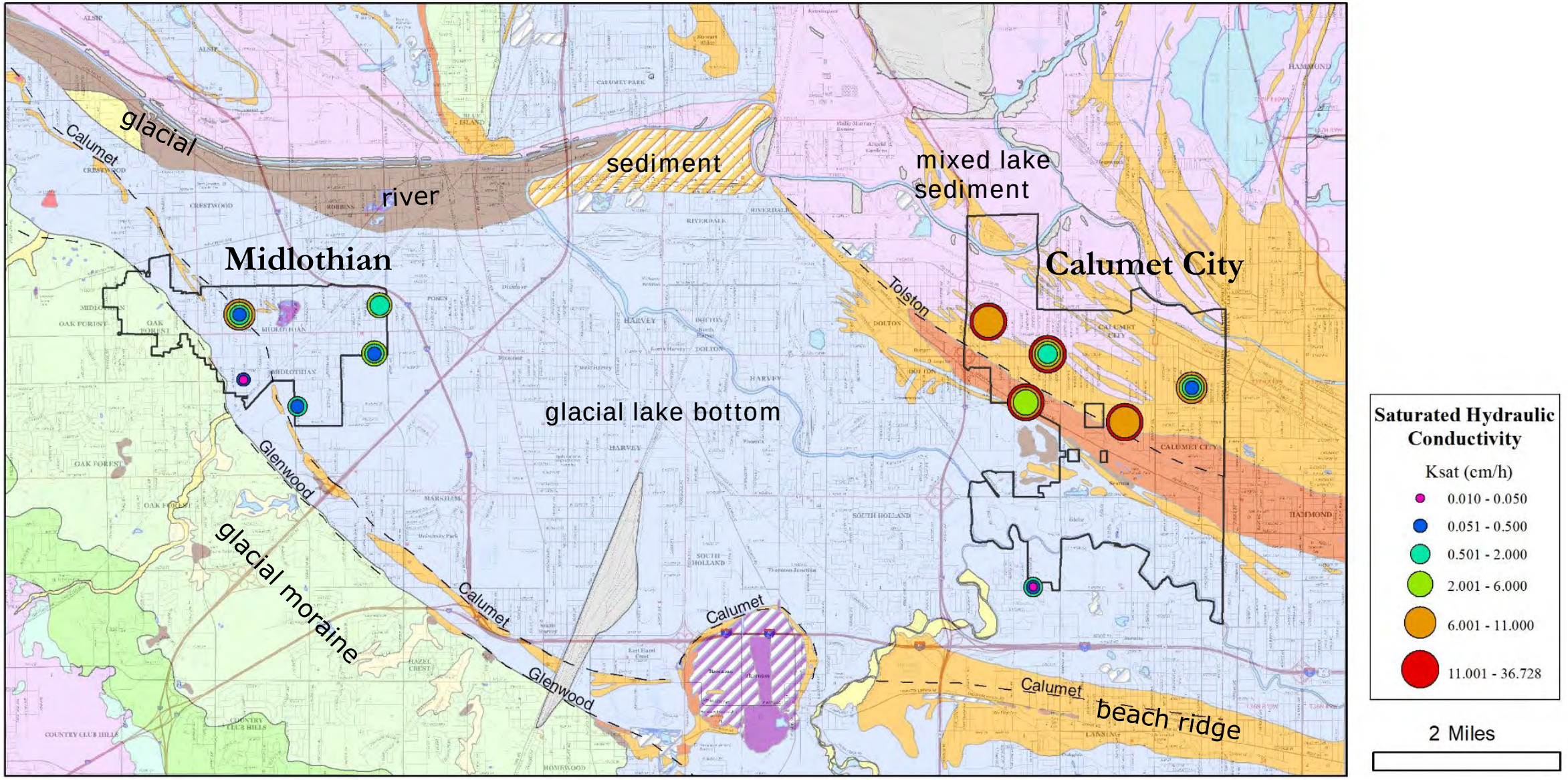
- Applied geology example
- Direct, early stakeholder involvement:
  understand needs, understand deliverables
- It's nice to work with people that want the information!
- Multidisciplinary
- Collaboration with USDA-MLRA: direct use of soils data
- Feedback with StateMap-Coalition mapping

Study anticipates StateMap projects



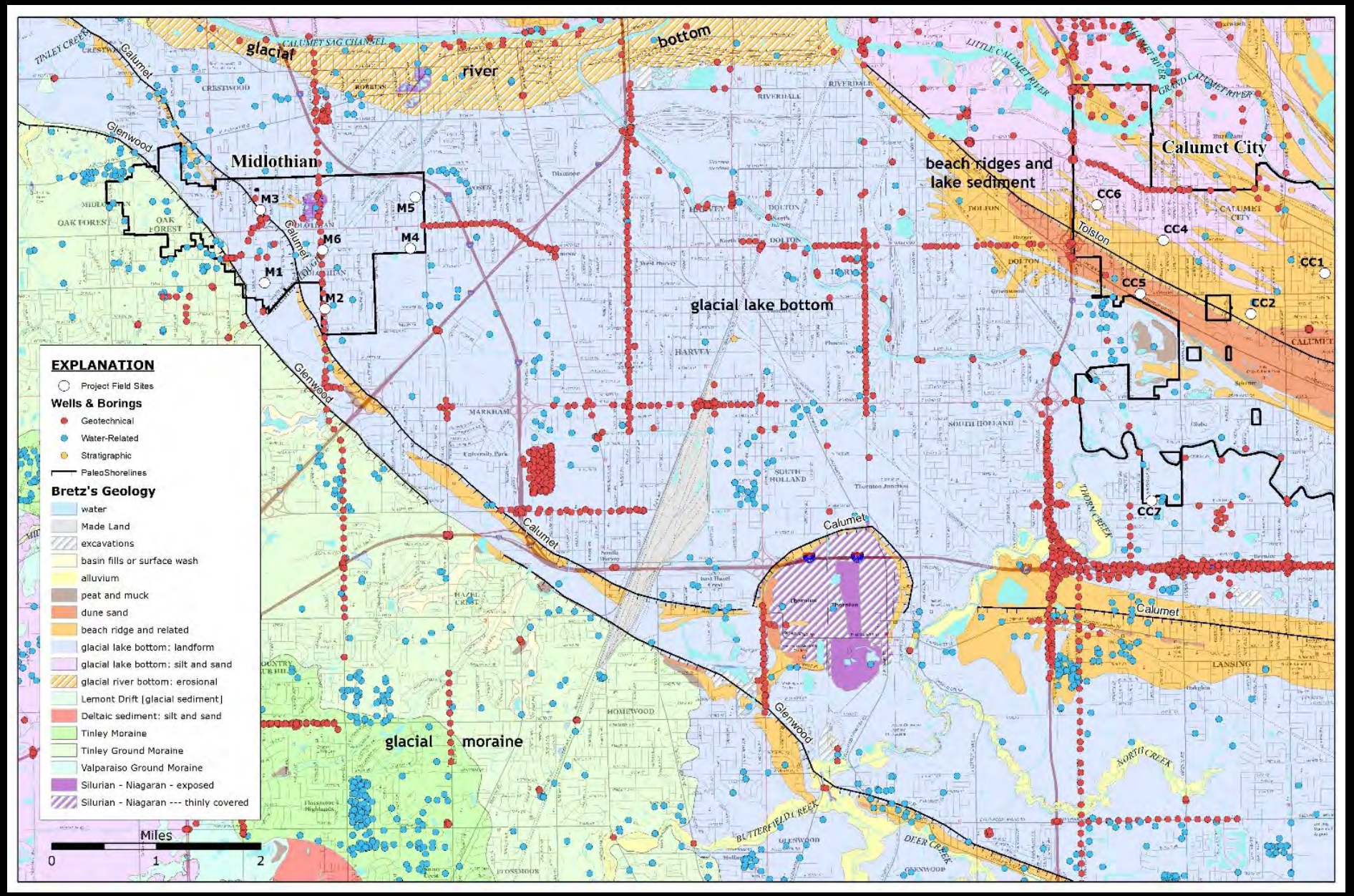
Study Area

Soil Characteristics for Green Infrastructure Planning

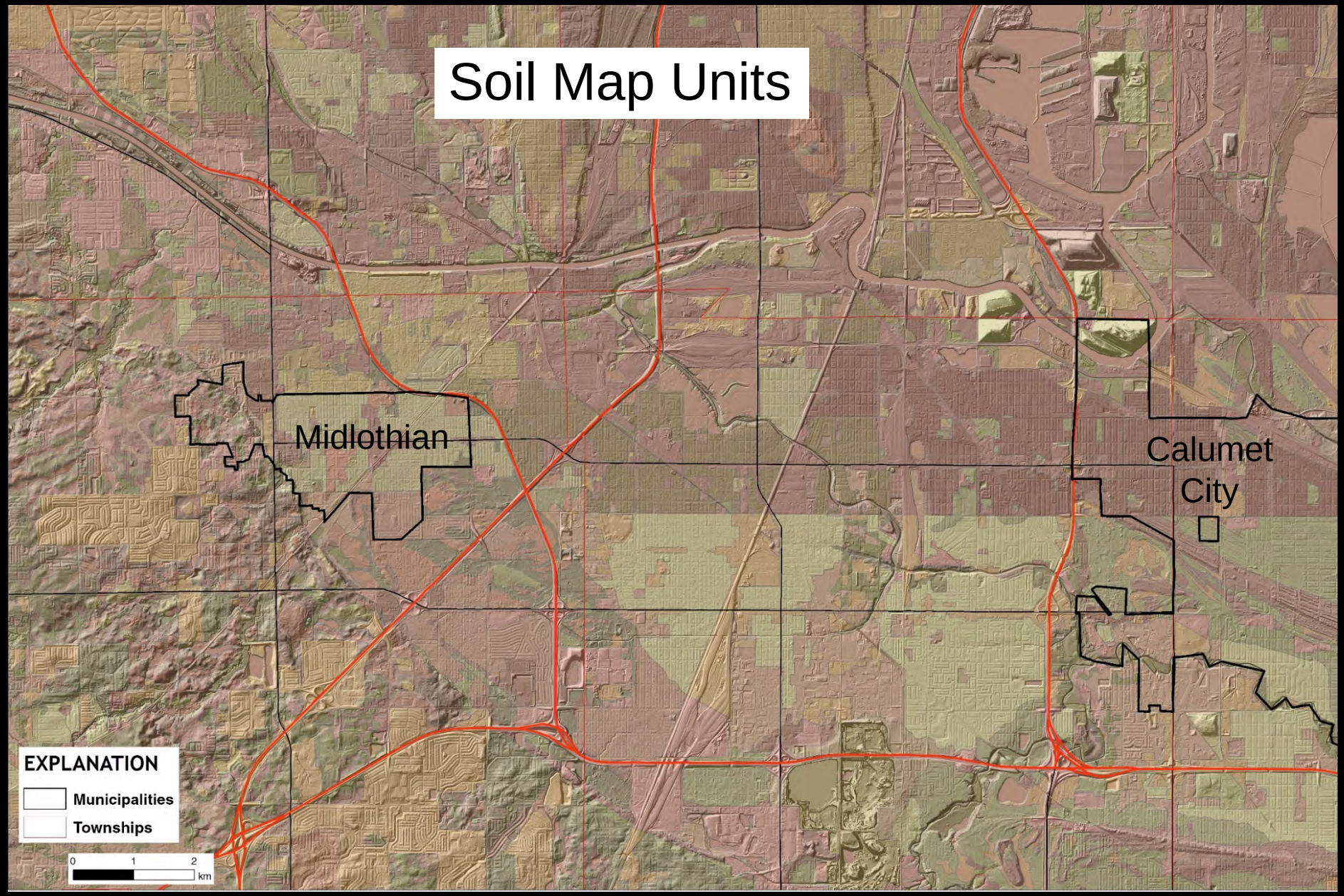


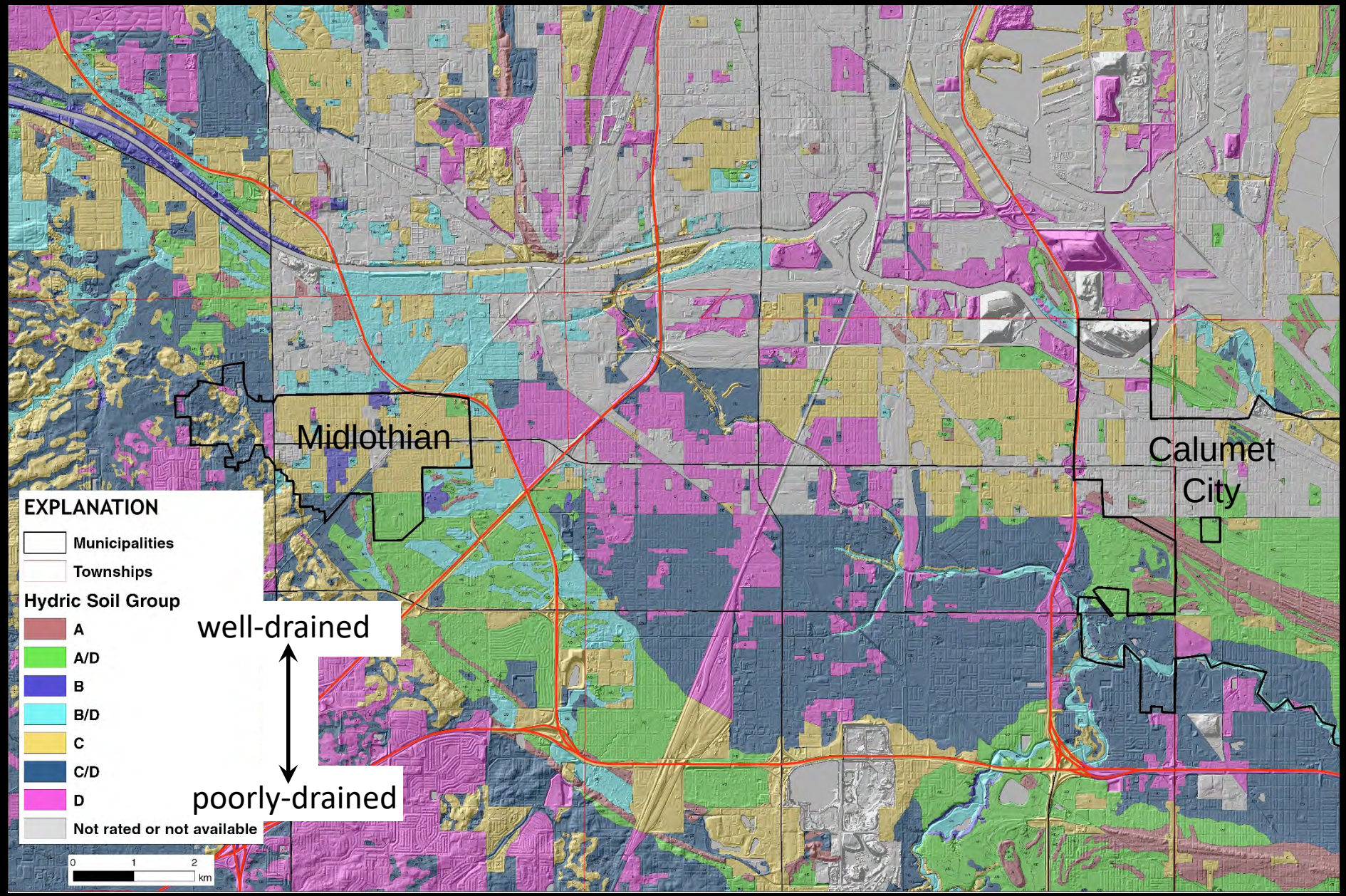
Geology after J.H. Bretz (1943)

Map analysis included geotechnical, water wells

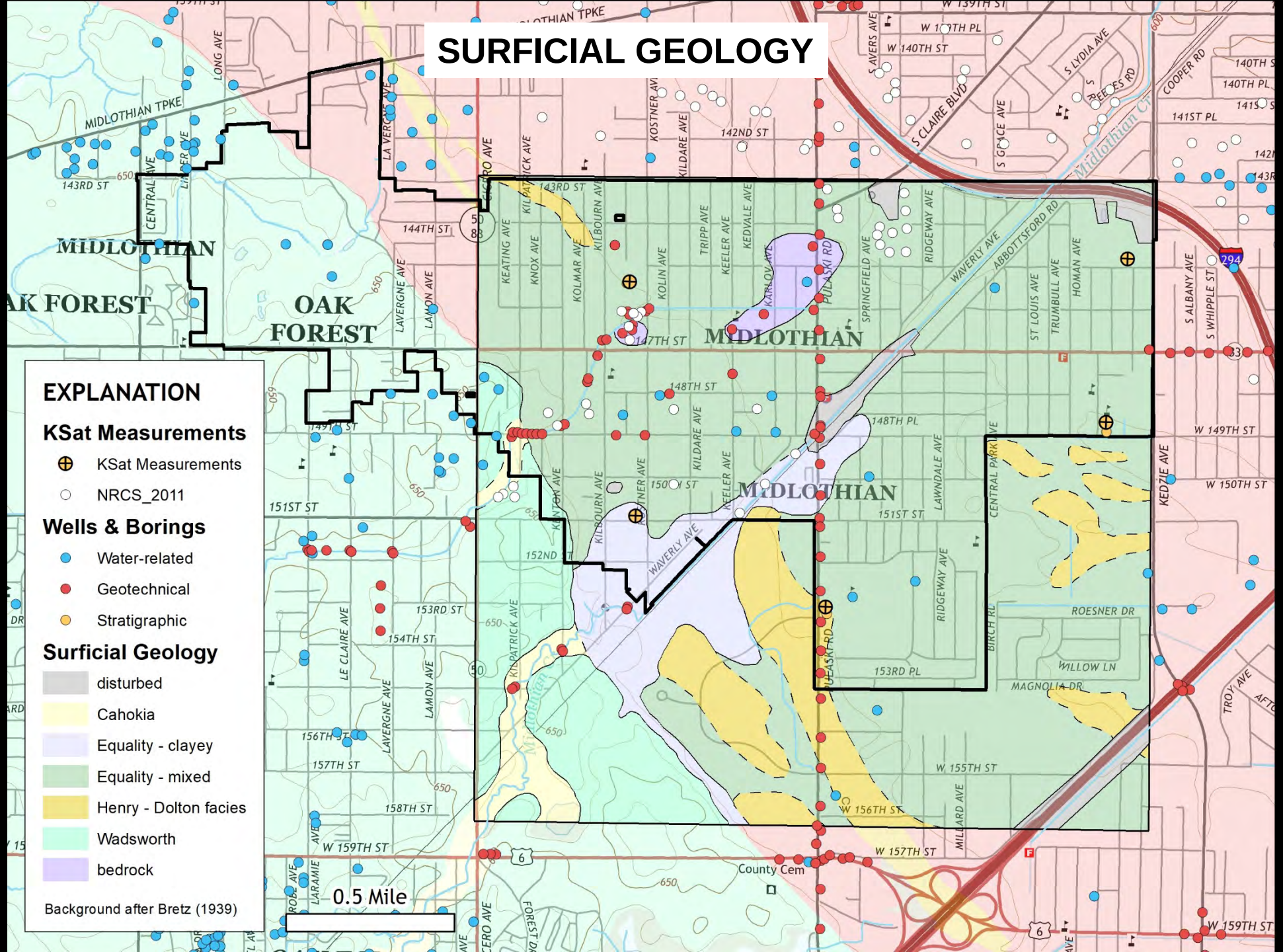


and


Soil Map Units
Midlothian
Calumet City
EXPLANATION
Municipalities
Townships
0
1
2
km


Midlothian
Calumet City
EXPLANATION
Municipalities
Townships
Hydric Soil Group
A
A/D
B
B/D
C
C/D
D
Not rated or not available
well-drained
poorly-drained
0
1
2
km

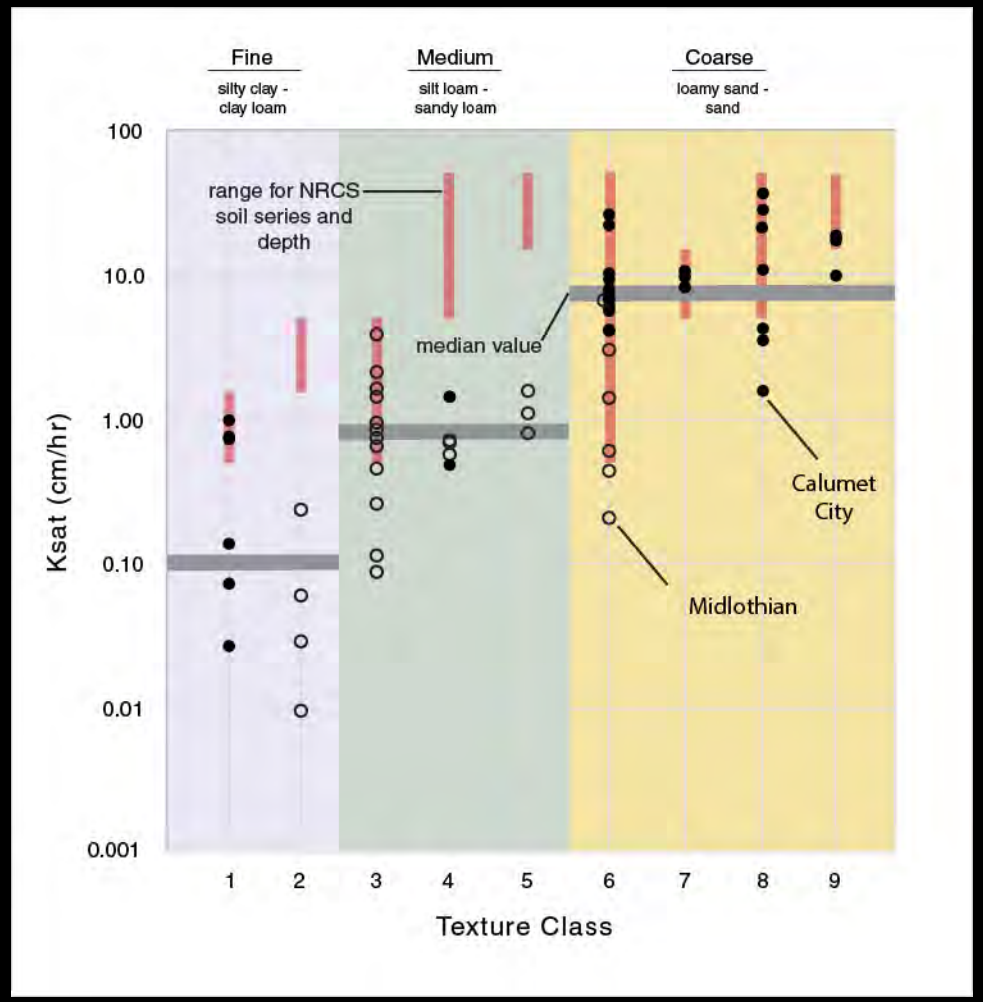
SURFICIAL GEOLOGY



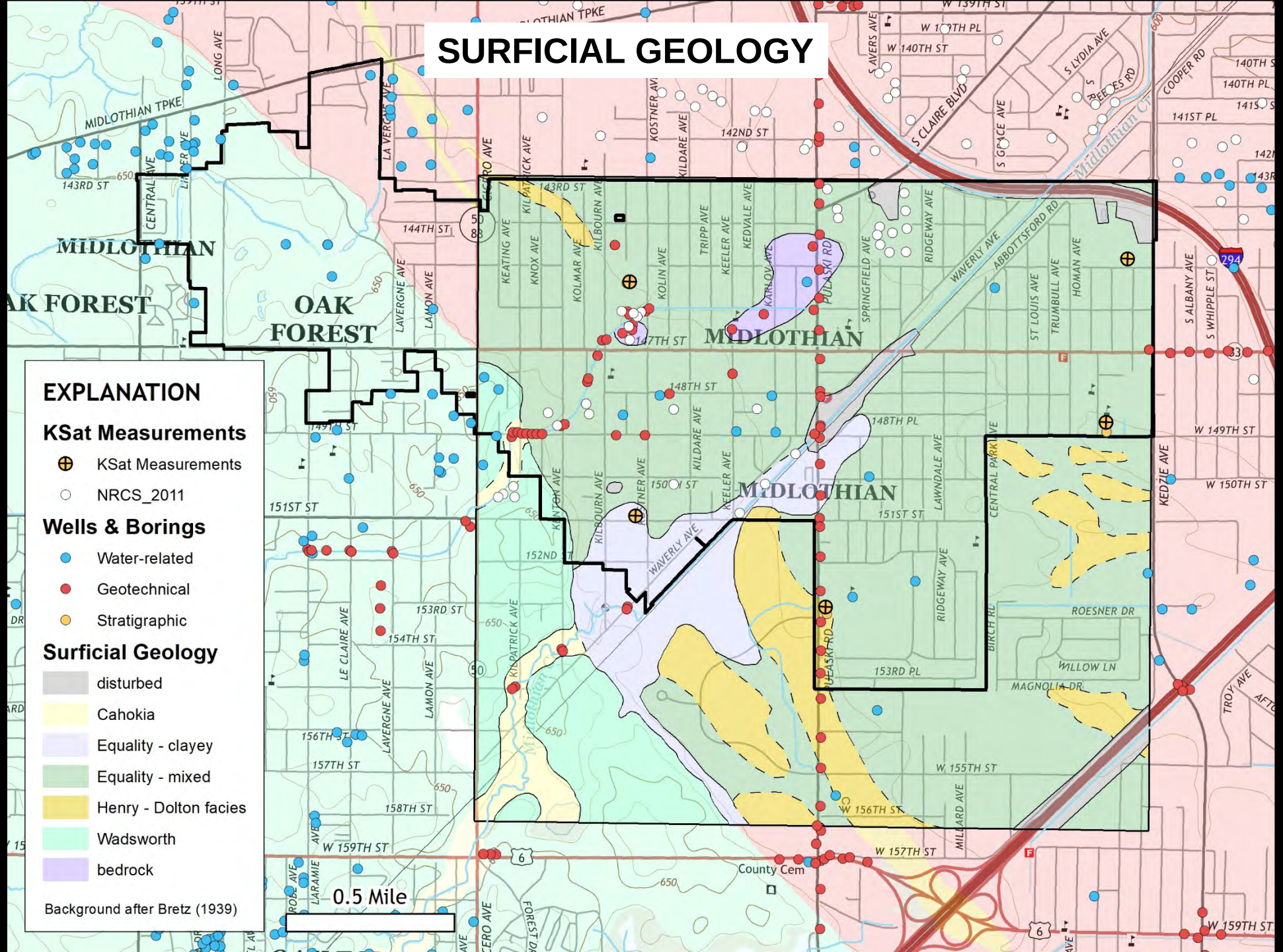
Field studies in Midlothian

Field Constant Head Test with Amoozemeter (Amoozegar 1989)

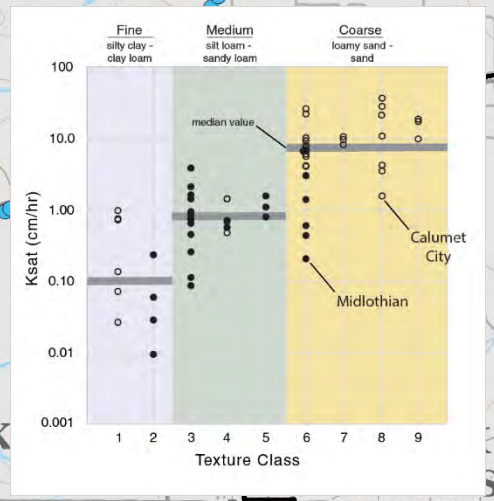
USDA United States Department of Agriculture
Natural Resources Conservation Service


Fine
silty clay - clay loam
Medium
silt loam - sandy loam
Coarse
loamy sand - sand
range for NRCS soil series and depth
median value
Calumet City
Midlothian
Ksat (cm/hr)
100
10.0
1.00
0.10
0.01
0.001
1
2
3
4
5
6
7
8
9
Texture Class

SURFICIAL GEOLOGY



TEXTURE CLASS



EXPLANATION

KSat Measurements

- KSat Measurements
- NRCS_2011

Wells & Borings

- Water-related
- Geotechnical
- Stratigraphic

Texture Group

- coarse
- mixed
- fine
- disturbed

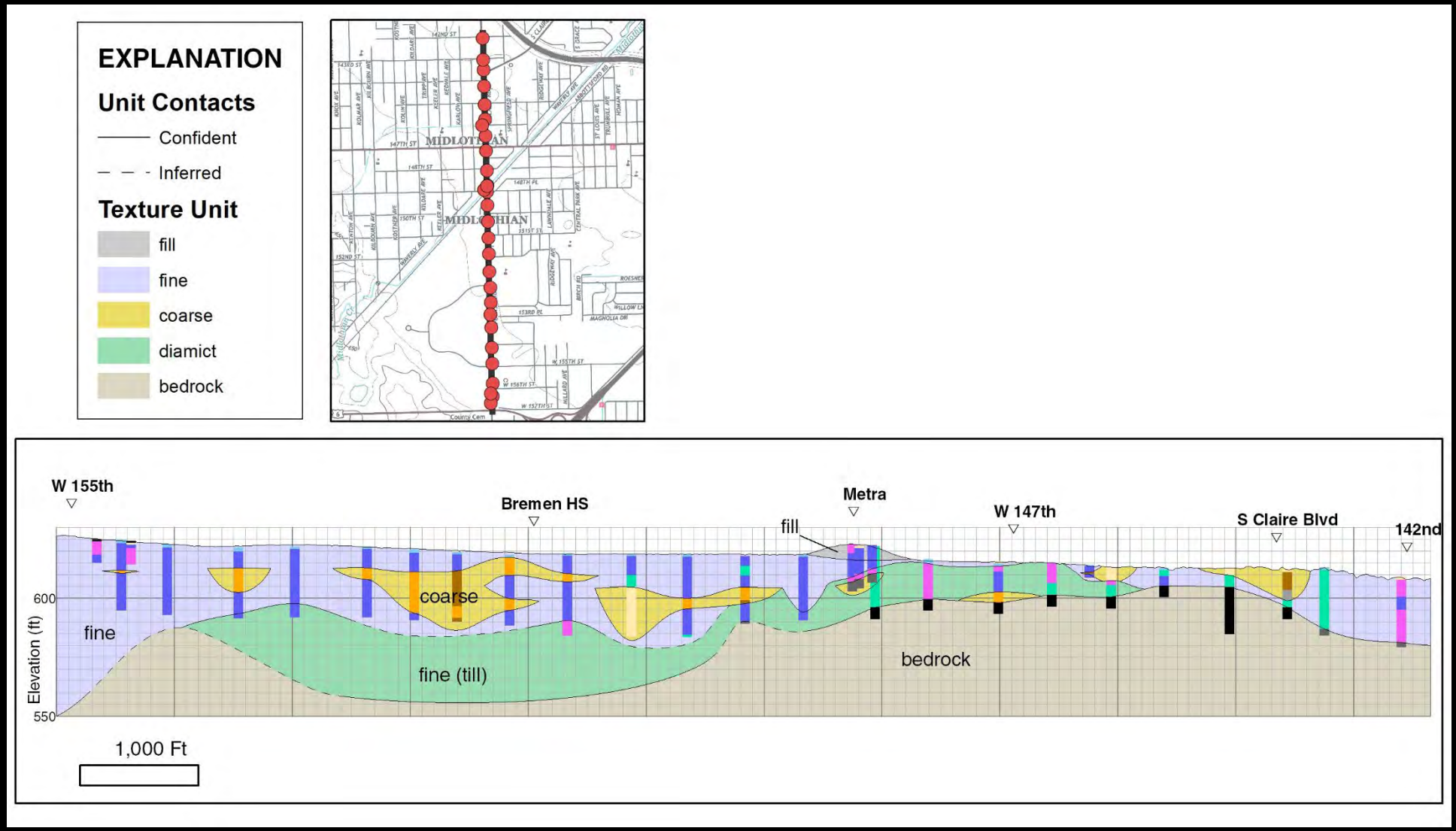
0.5 Mile

MIDLOTHIAN

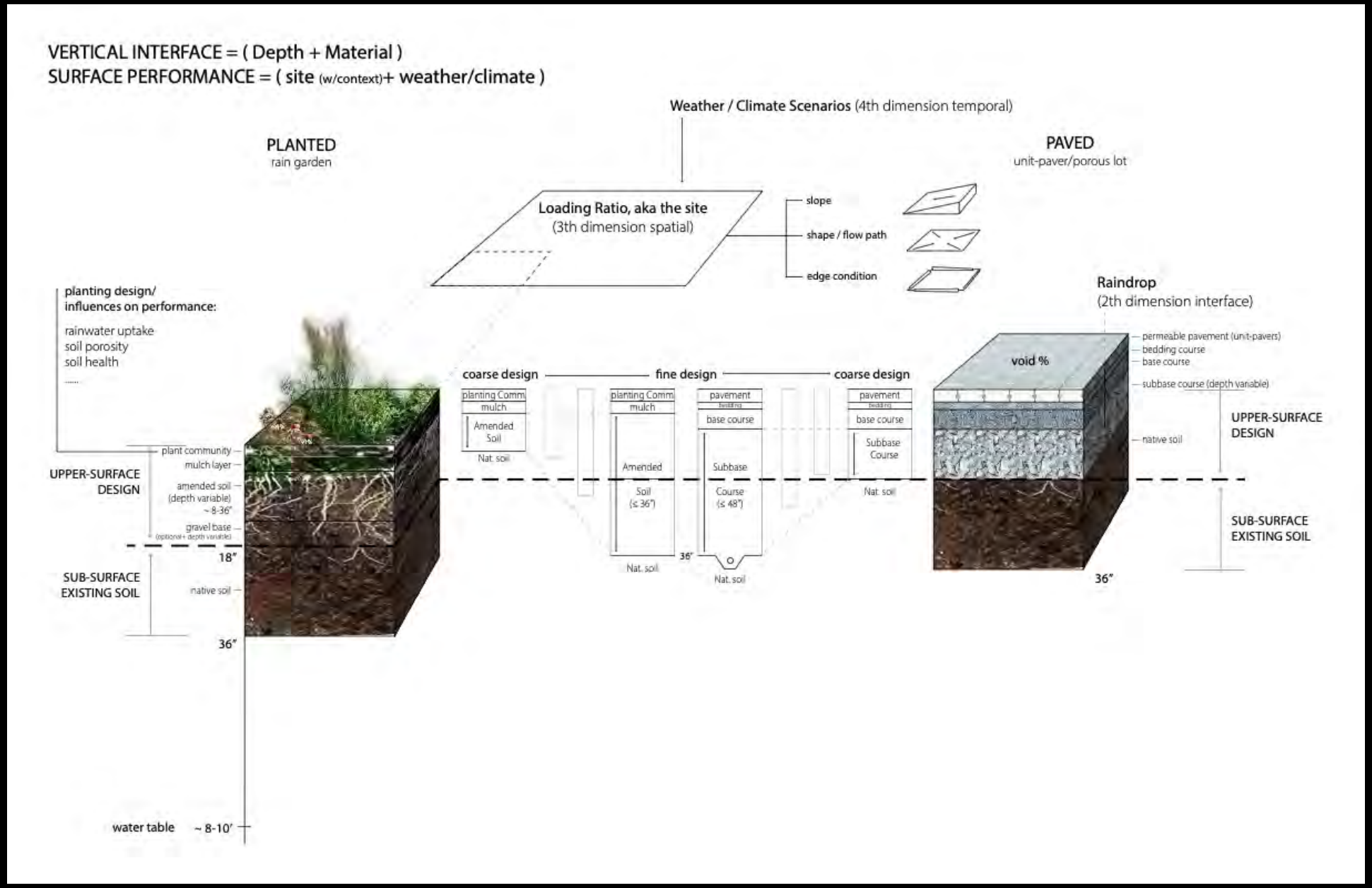
MIDLOTHIAN

County Cem

Lithologic Cross Section

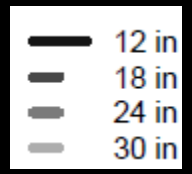


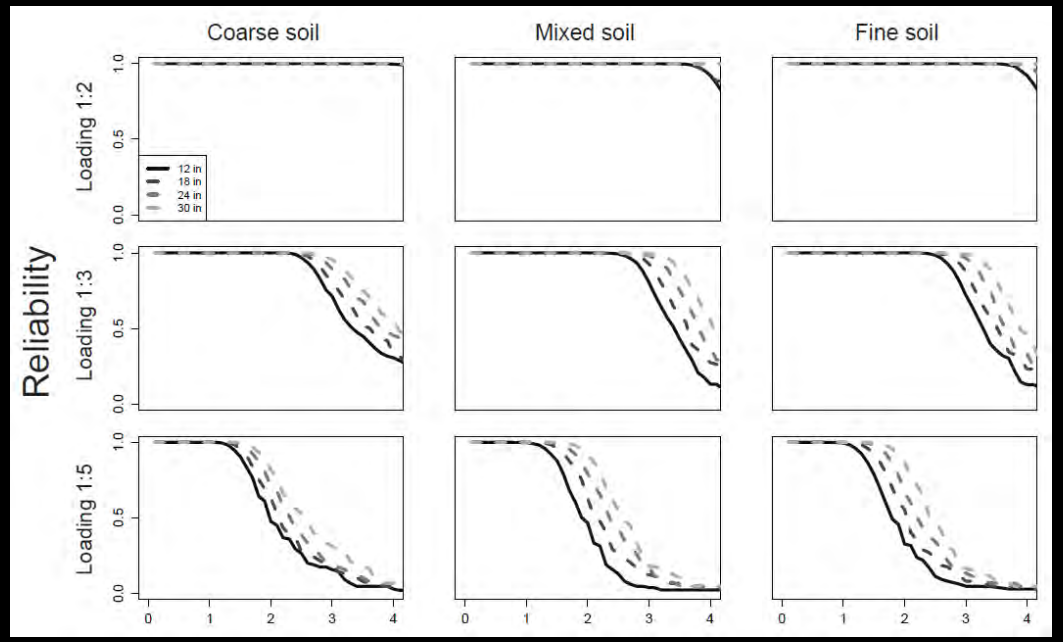
GI Design Prototype - Concept Methodology



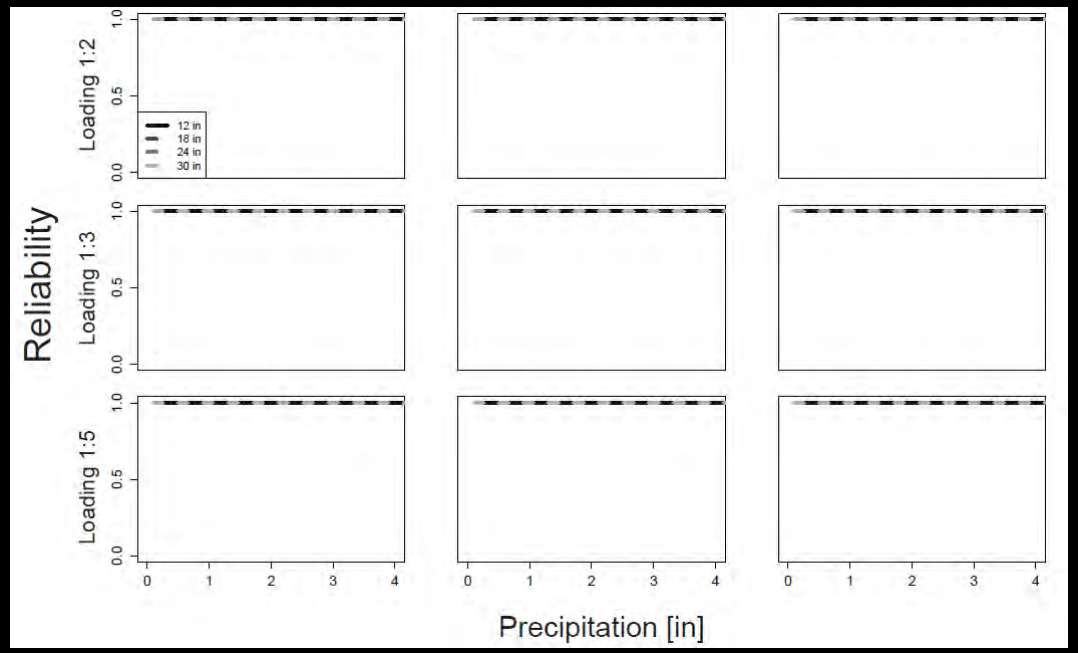
Modeling prototype reliability

2 hour





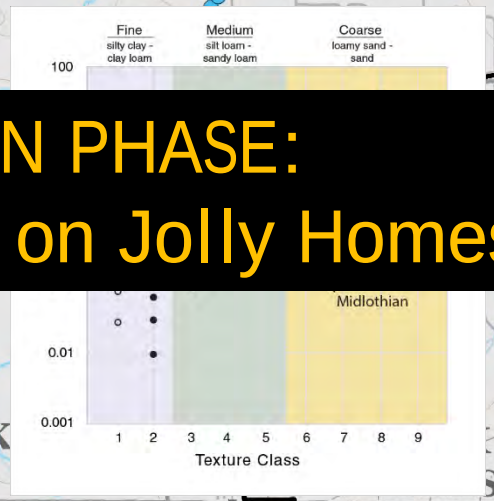
24 hour



Planted

- Rain garden **performance variability** can be quantified.
- Rain gardens can effectively reduce runoff **even with fine native soils**.
- **Media thickness is most important for mixed and fine native soils.**
- **Loading ratio is the most important design consideration for improved reliability**

DESIGN PHASE:
Focus on Jolly Homes



TEXTURE CLASS

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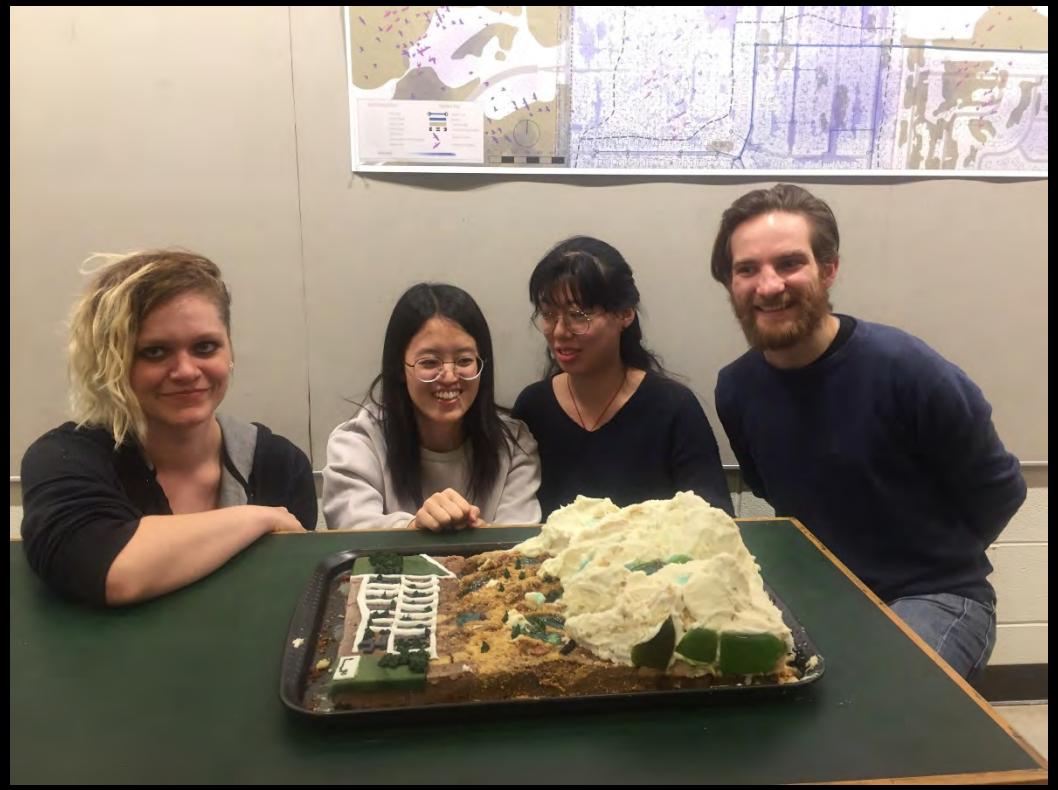
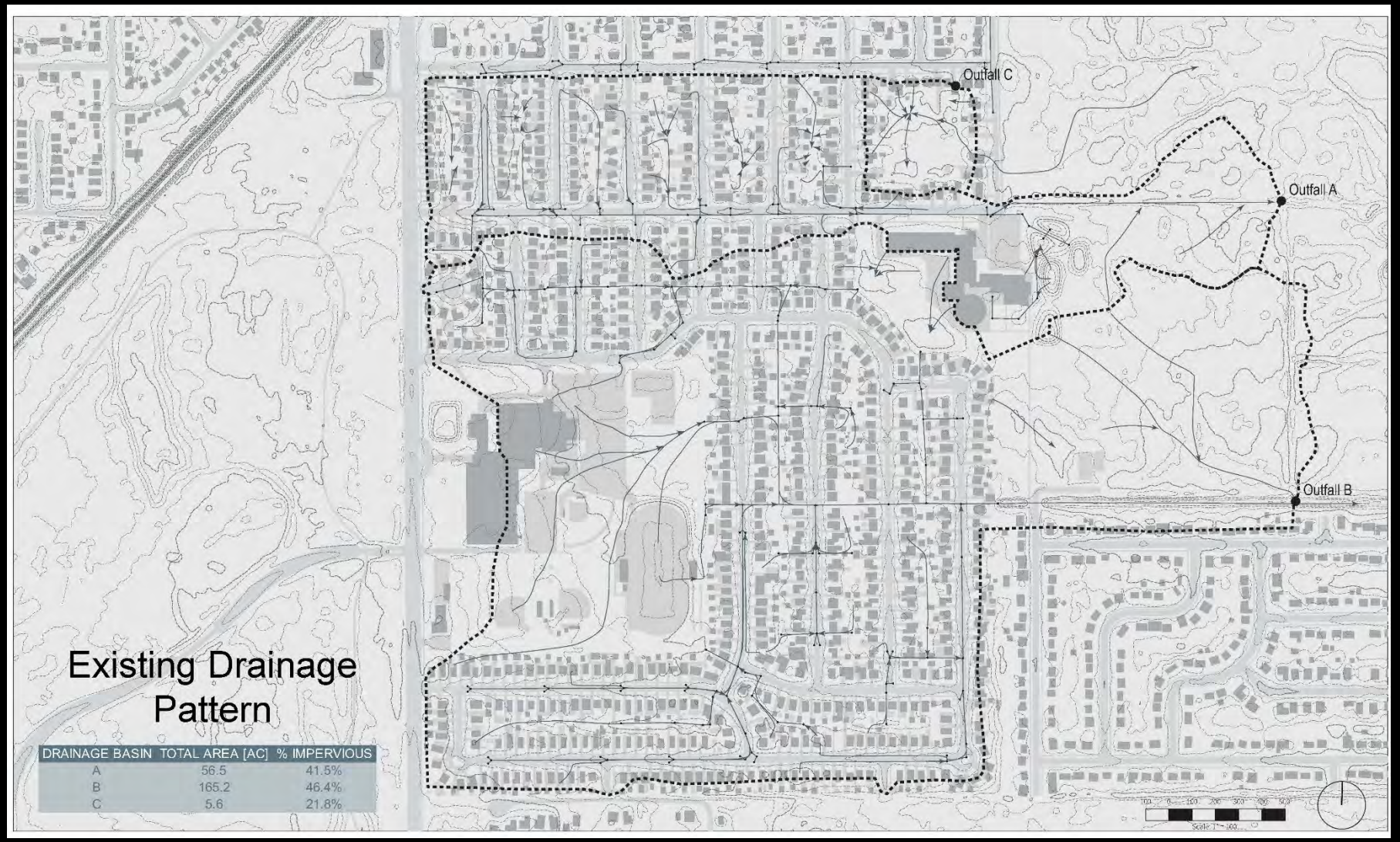
MIDLOTHIAN

County Cem

STUDENT DESIGN COMPONENT

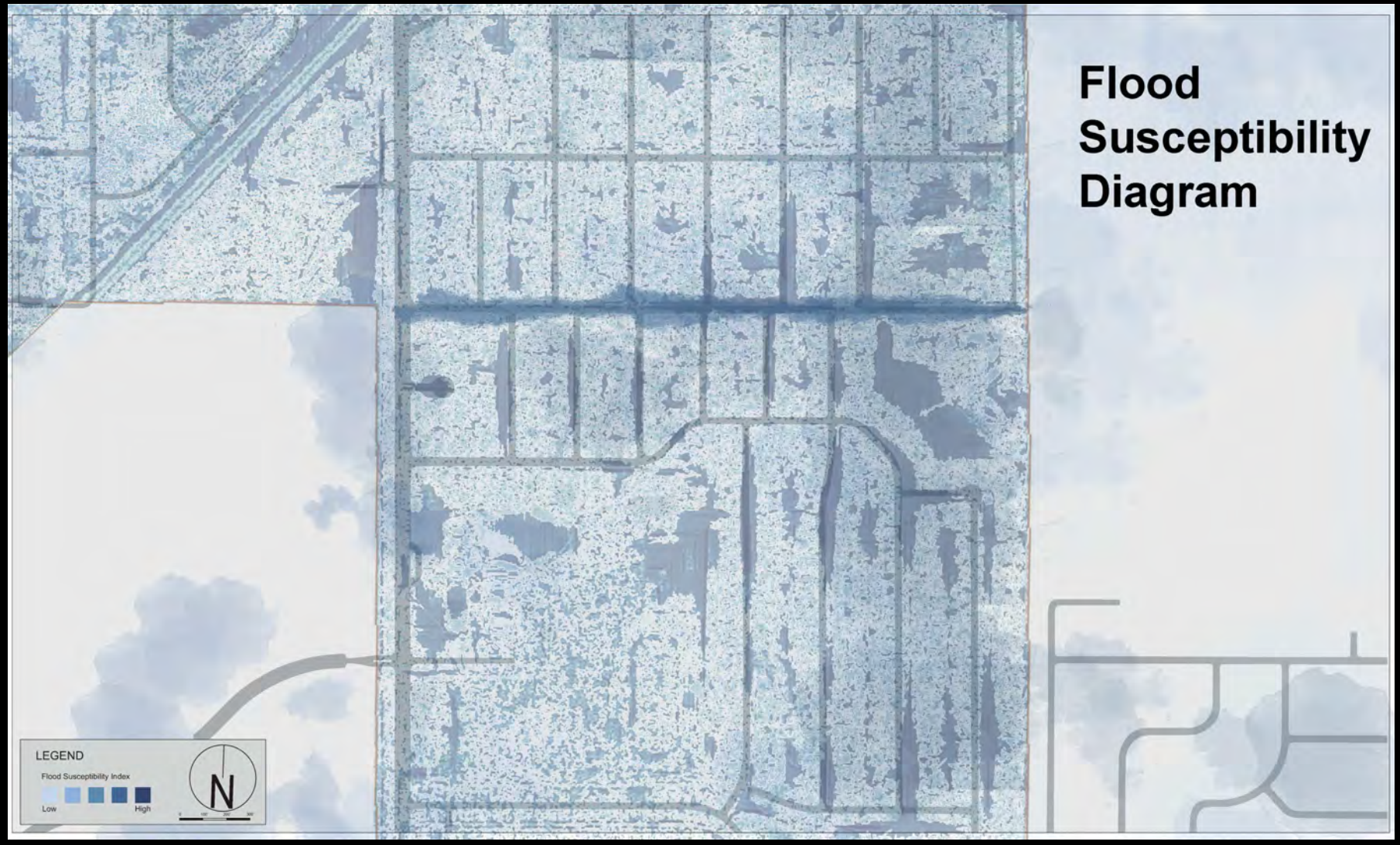


Back to The Land

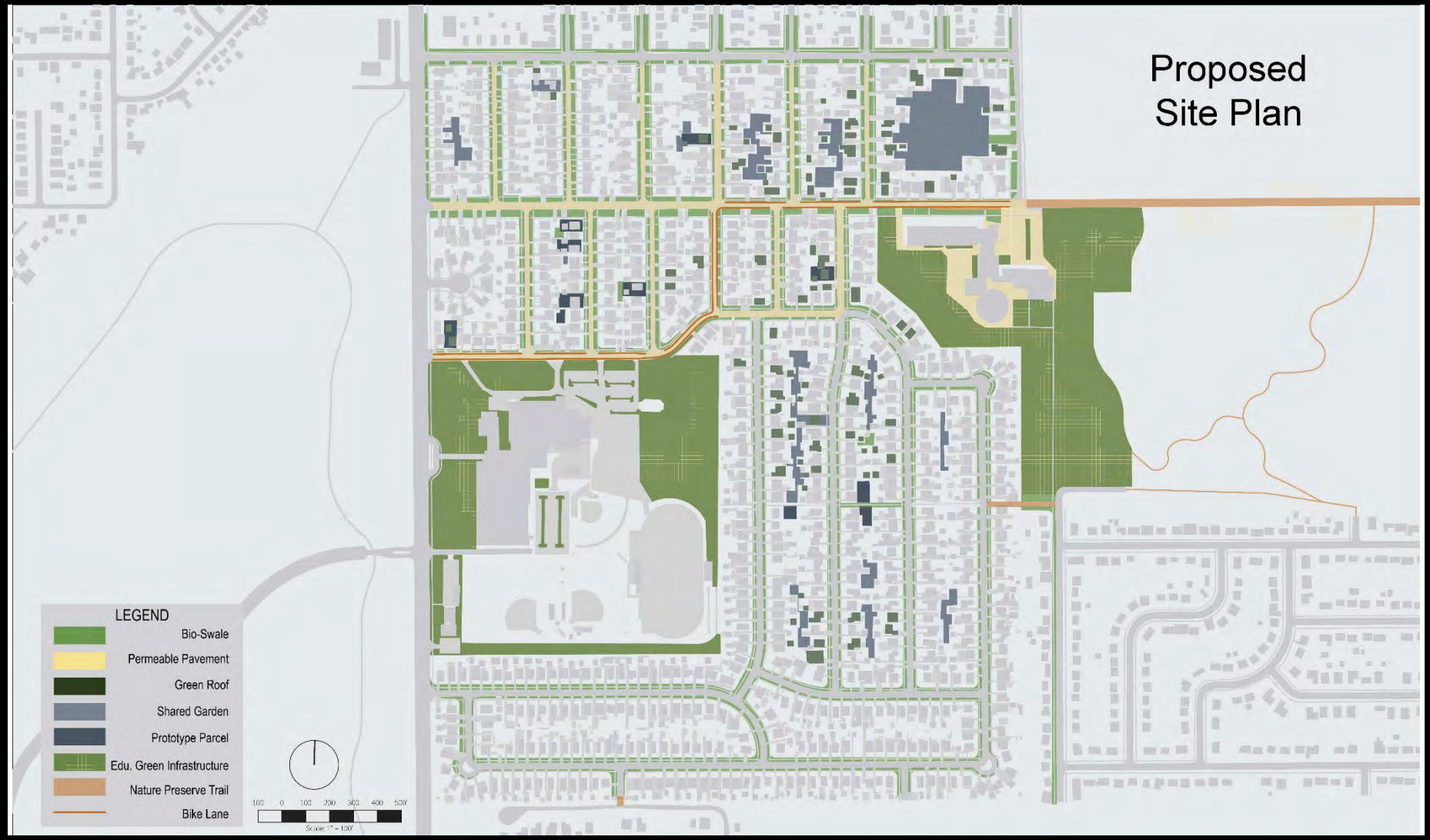


Existing Drainage Pattern

DRAINAGE BASIN	TOTAL AREA [AC]	% IMPERVIOUS
A	56.5	41.5%
B	165.2	46.4%
C	5.6	21.8%


Flood
Susceptibility
Diagram
LEGEND
Flood Susceptibility Index
Low
High
N


Opportunity Surface Diagram
Surface Opportunity
high
low
Surface Type
parking lots
private property
preserved area


Proposed
Site Plan
LEGEND
Bio-Swale
Permeable Pavement
Green Roof
Shared Garden
Prototype Parcel
Edu. Green Infrastructure
Nature Preserve Trail
Bike Lane

PRESENTATION TO CITIES