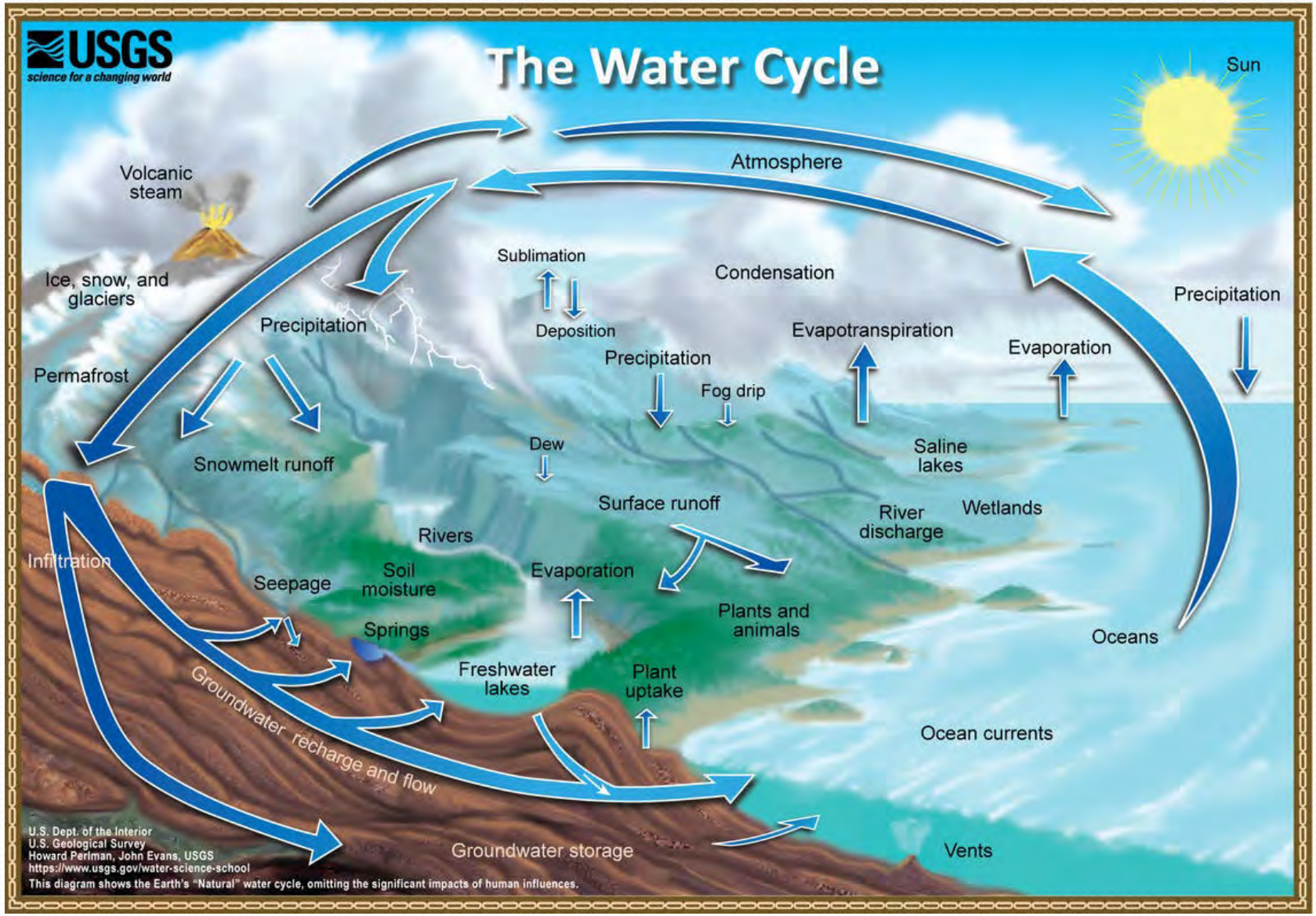
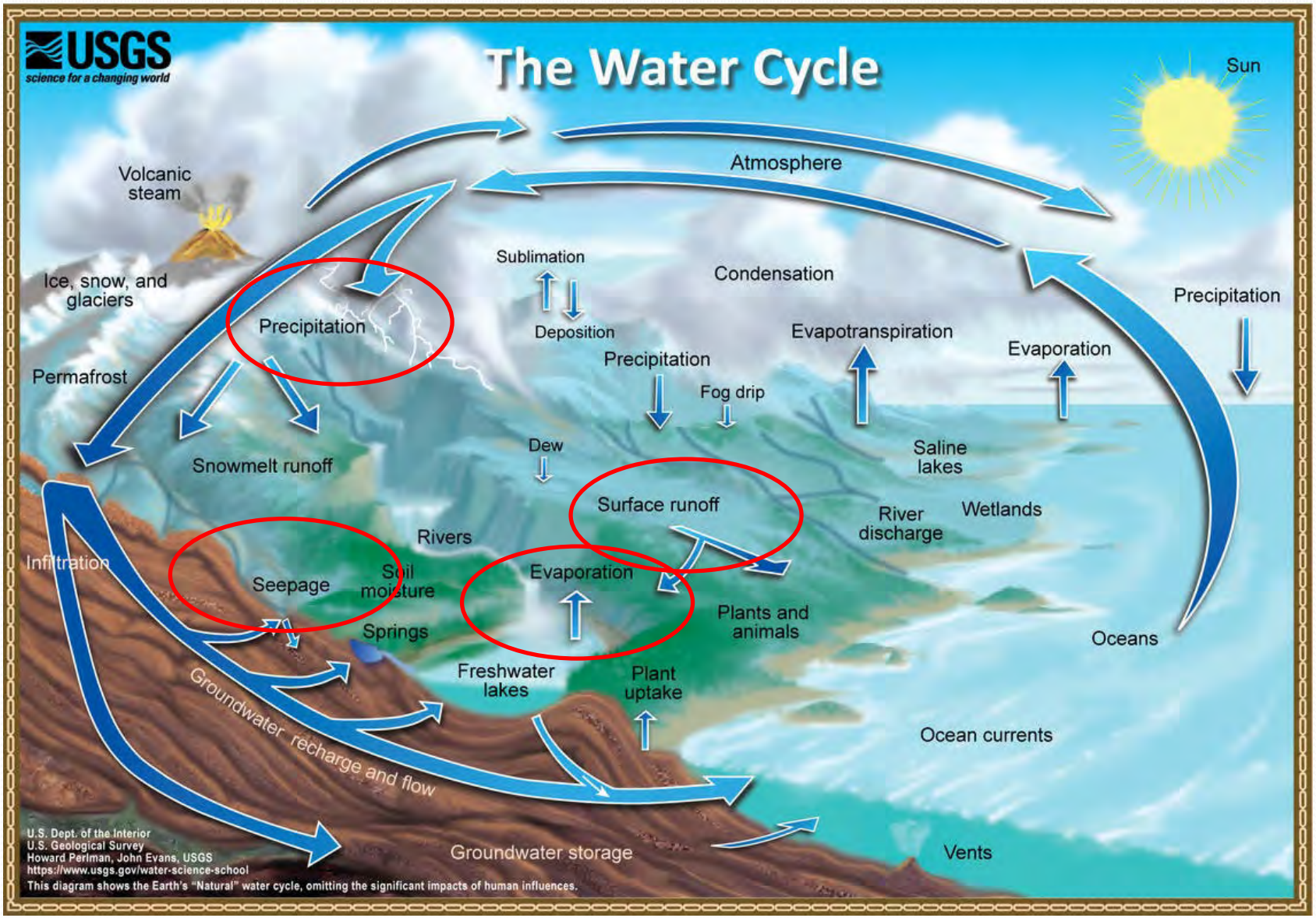
Madison Stormwater Management

Phil Gaebler

City of Madison - Engineering



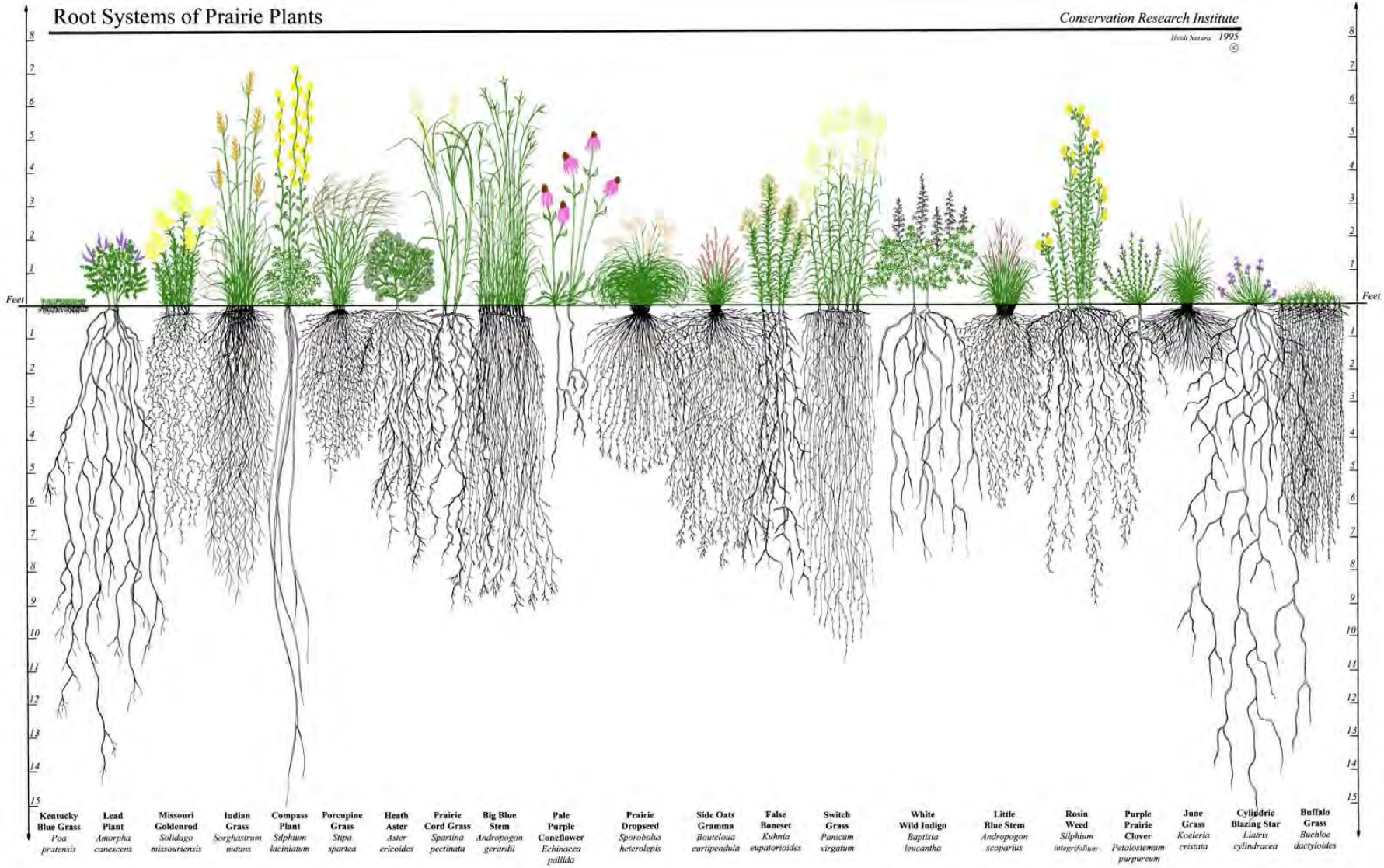
Credit: Howard Perlman, USGS. Public domain.

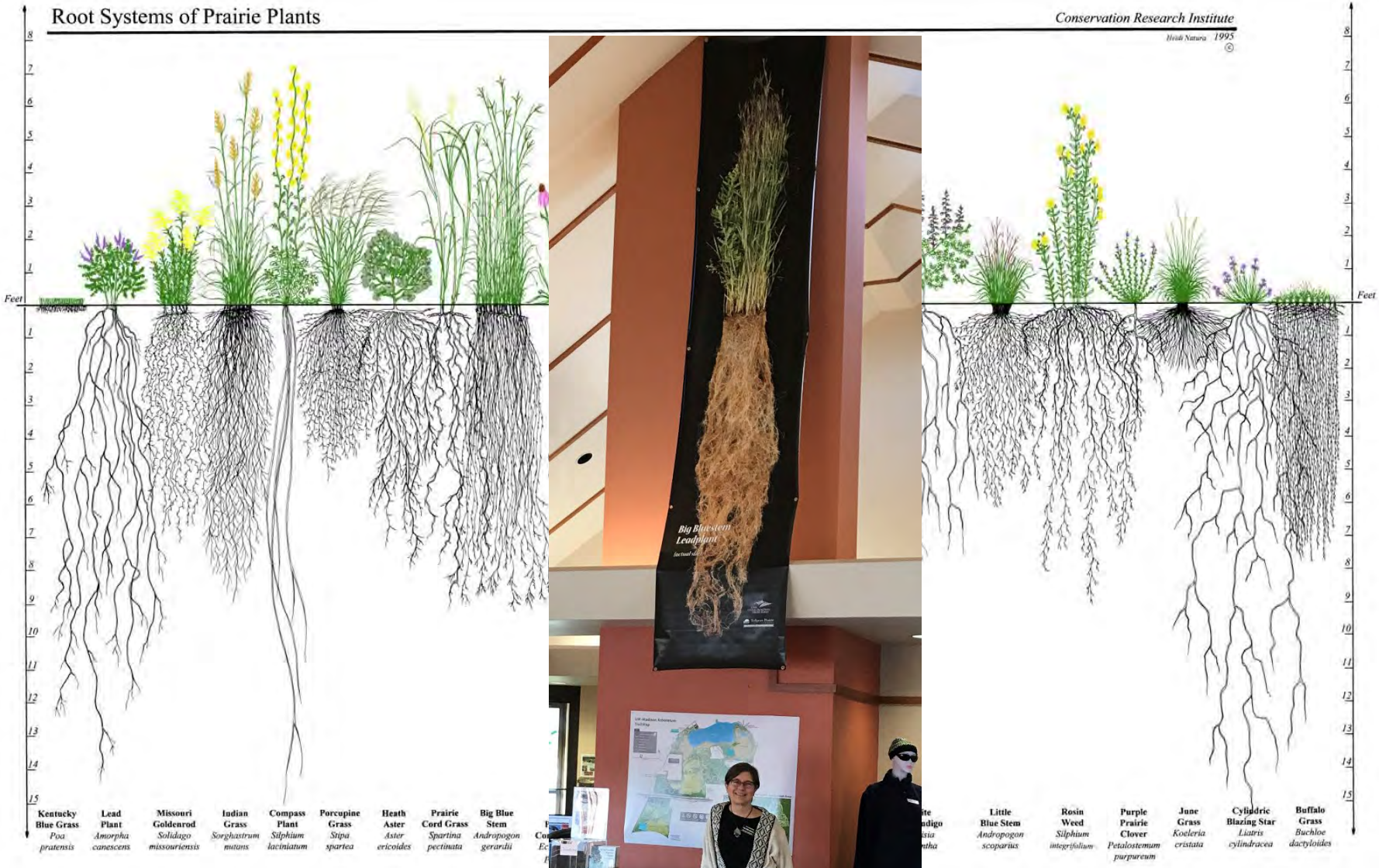

USGS
science for a changing world
The Water Cycle
Sun
Atmosphere
Volcanic steam
Ice, snow, and glaciers
Sublimation
Condensation
Deposition
Precipitation
Precipitation
Evapotranspiration
Evaporation
Precipitation
Permafrost
Fog drip
Dew
Snowmelt runoff
Saline lakes
Surface runoff
River discharge
Wetlands
Rivers
Infiltration
Seepage
Soil moisture
Evaporation
Springs
Plants and animals
Oceans
Freshwater lakes
Plant uptake
Groundwater recharge and flow
Ocean currents
Groundwater storage
Vents
U.S. Dept. of the Interior
U.S. Geological Survey
Howard Perlman, John Evans, USGS
https://www.usgs.gov/water-science-school
This diagram shows the Earth's "Natural" water cycle, omitting the significant impacts of human influences.

Factors Determining Runoff

- Surface
  - Area
  - Infiltration
  - Storage
  - Conveyance
- Rainfall
  - How long it rains
  - How much it rains

Factors controlling runoff


Root Systems of Prairie Plants
Conservation Research Institute
Heidi Natura 1995 ©
Feet
Feet
Kentucky Blue Grass Poa pratensis
Lead Plant Amorpha canescens
Missouri Goldenrod Solidago missouriensis
Indian Grass Sorghastrum nutans
Compass Plant Silphium laciniatum
Porcupine Grass Stipa spartea
Heath Aster Aster ericoides
Prairie Cord Grass Spartina pectinata
Big Blue Stem Andropogon gerardii
Pale Purple Coneflower Echinacea pallida
Prairie Dropseed Sporobolus heterolepis
Side Oats Gramma Bouteloua curtipendula
False Boneset Kuhnia eupatorioides
Switch Grass Panicum virgatum
White Wild Indigo Baptisia leucantha
Little Blue Stem Andropogon scoparius
Rosin Weed Silphium integrifolium
Purple Prairie Clover Petalostemum purpureum
June Grass Koeleria cristata
Cylindric Blazing Star Liatris cylindracea
Buffalo Grass Buchloe dactyloides


Root Systems of Prairie Plants
Conservation Research Institute
Heidi Natura 1995
Feet
Big Bluestem
Leadplant
Kentucky Blue Grass Poa pratensis
Lead Plant Amorpha canescens
Missouri Goldenrod Solidago missouriensis
Indian Grass Sorghastrum nutans
Compass Plant Silphium laciniatum
Porcupine Grass Stipa spartea
Heath Aster Aster ericoides
Prairie Cord Grass Spartina pectinata
Big Blue Stem Andropogon gerardii
Little Blue Stem Andropogon scoparius
Rosin Weed Silphium integrifolium
Purple Prairie Clover Petalostemum purpureum
June Grass Koeleria cristata
Cylindric Blazing Star Liatris cylindracea
Buffalo Grass Buchloe dactyloides

Landscapes Change

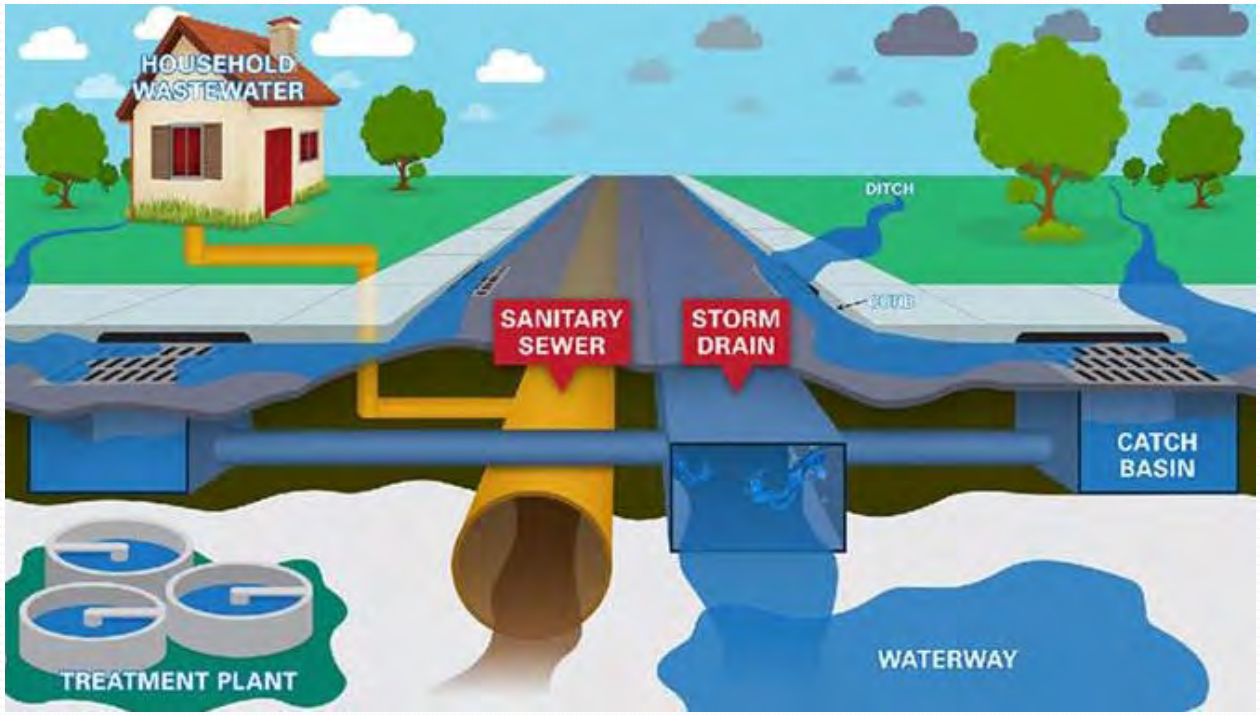
Pre-European Settlement
Oak Savannah
Fires every 5-10 yrs

Urbanization

Farming

Madison's Stormwater Infrastructure

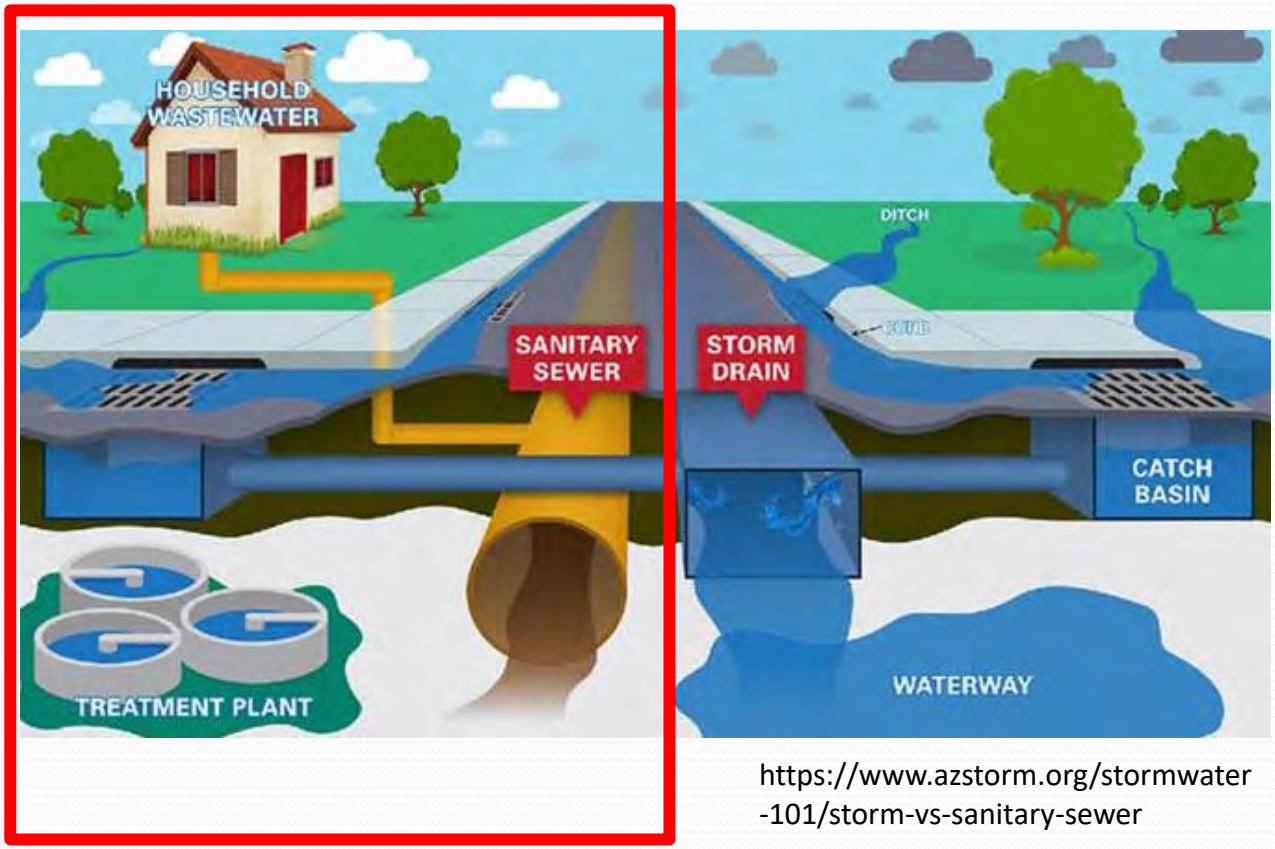
- Madison has separate storm and sanitary sewers
- Storm sewer system is NOT the same as the sanitary sewer system



https://www.azstorm.org/stormwater-101/storm-vs-sanitary-sewer

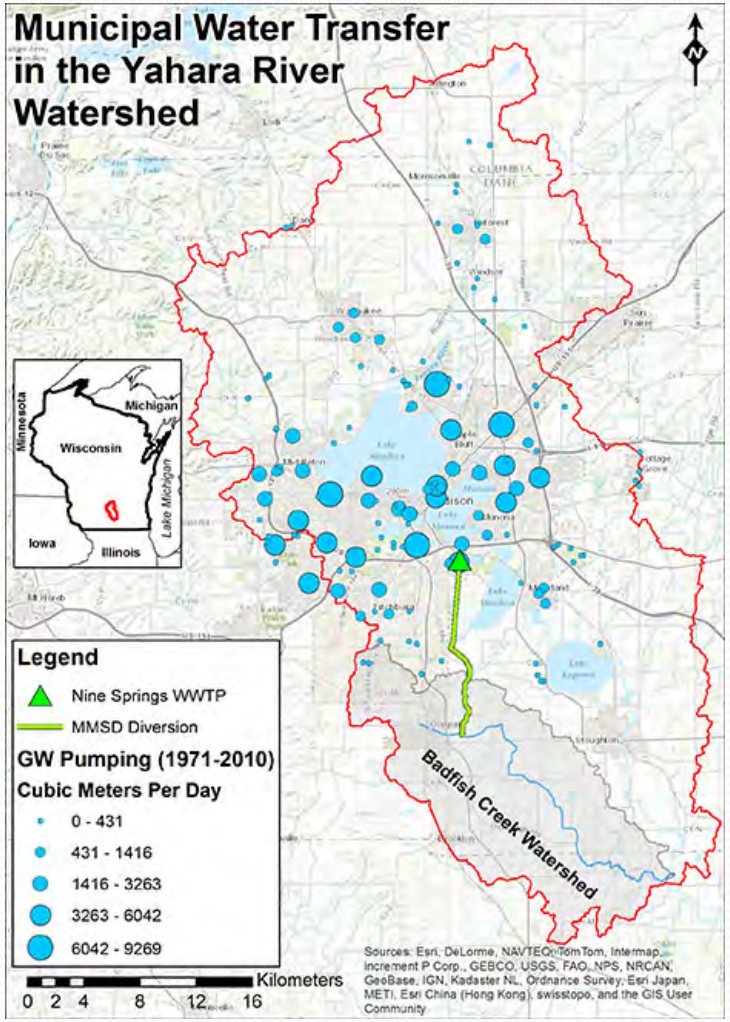
Madison's Stormwater Infrastructure

- Sanitary sewer drains residential (toilets, showers, kitchen sinks, etc.), commercial and industrial wastewater streams
- Sanitary sewer transports wastewater to Madison Metropolitan Sewerage District (MMSD) treatment plant
- Sanitary infrastructure includes:
  - Manholes
  - Household lateral pipes
  - Main collector pipes

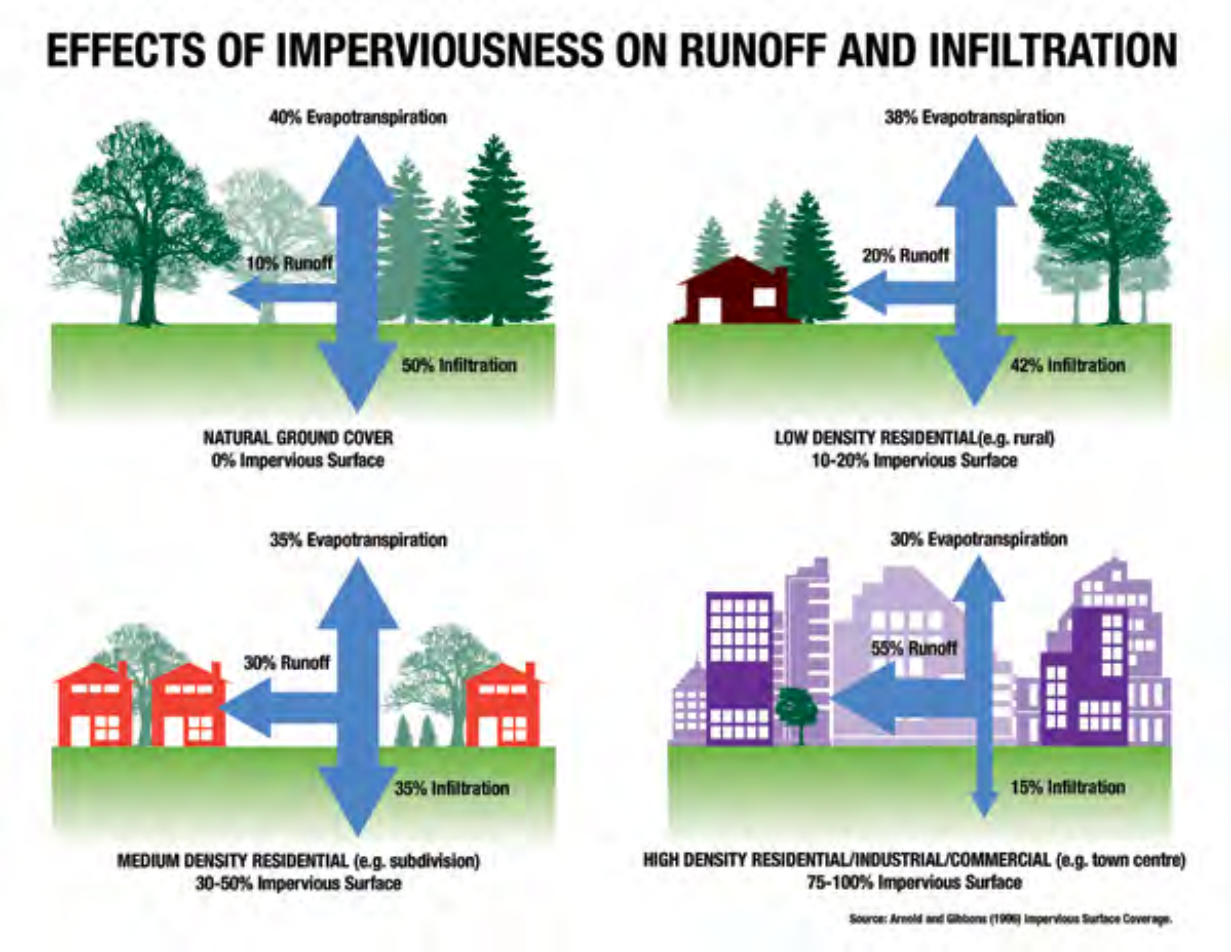


https://www.azstorm.org/stormwater-101/storm-vs-sanitary-sewer

MMSD


Municipal Water Transfer in the Yahara River Watershed
N
Minnesota
Michigan
Wisconsin
Lake Michigan
Iowa
Illinois
Legend
Nine Springs WWTP
MMSD Diversion
GW Pumping (1971-2010)
Cubic Meters Per Day
0 - 431
431 - 1416
1416 - 3263
3263 - 6042
6042 - 9269
Badfish Creek Watershed
Kilometers
0 2 4 8 12 16
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

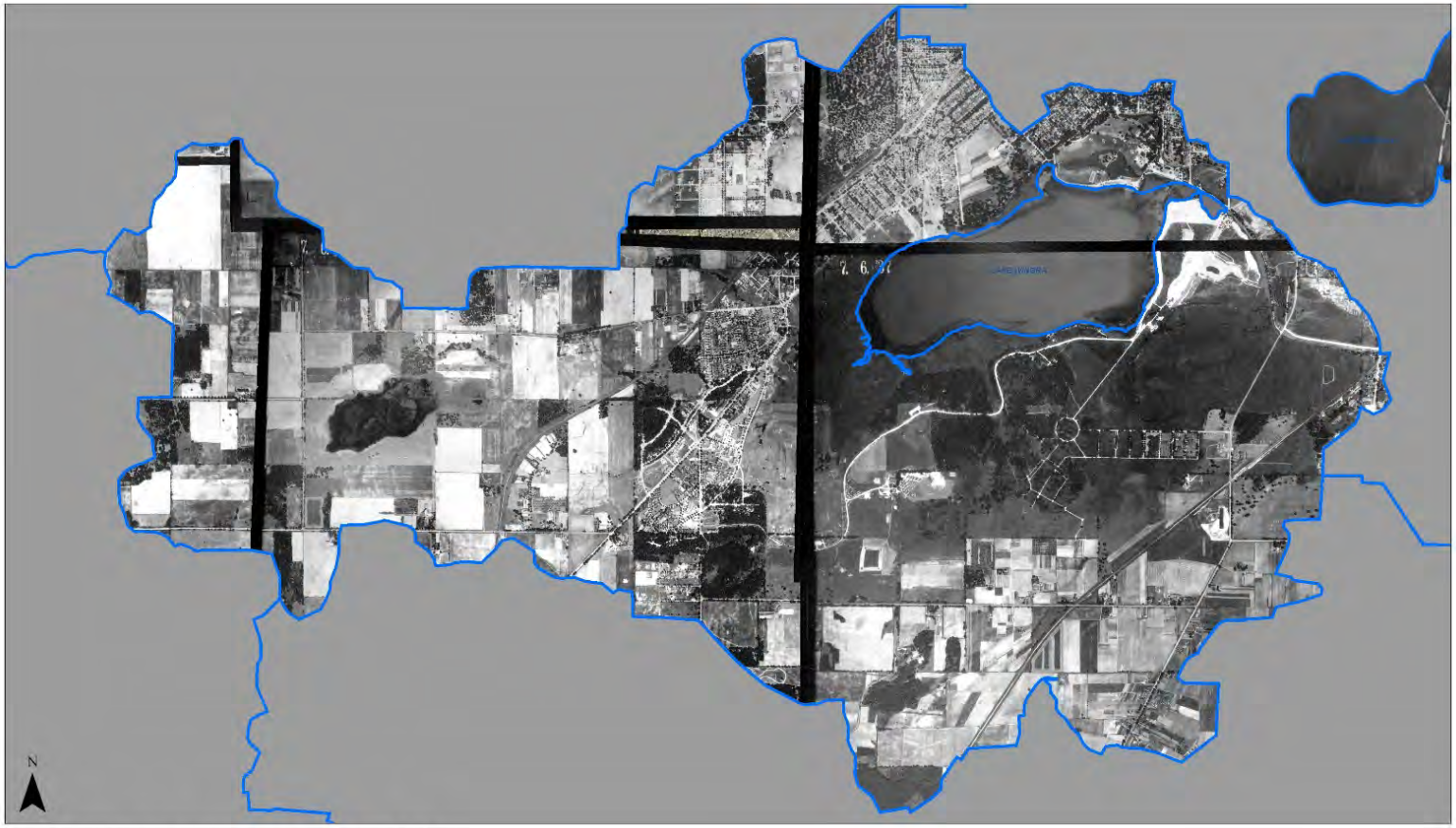
Impervious Up , Infiltration Down



Present East Washington Development

Not only more, but faster….

Lake Wingra Watershed - 1937

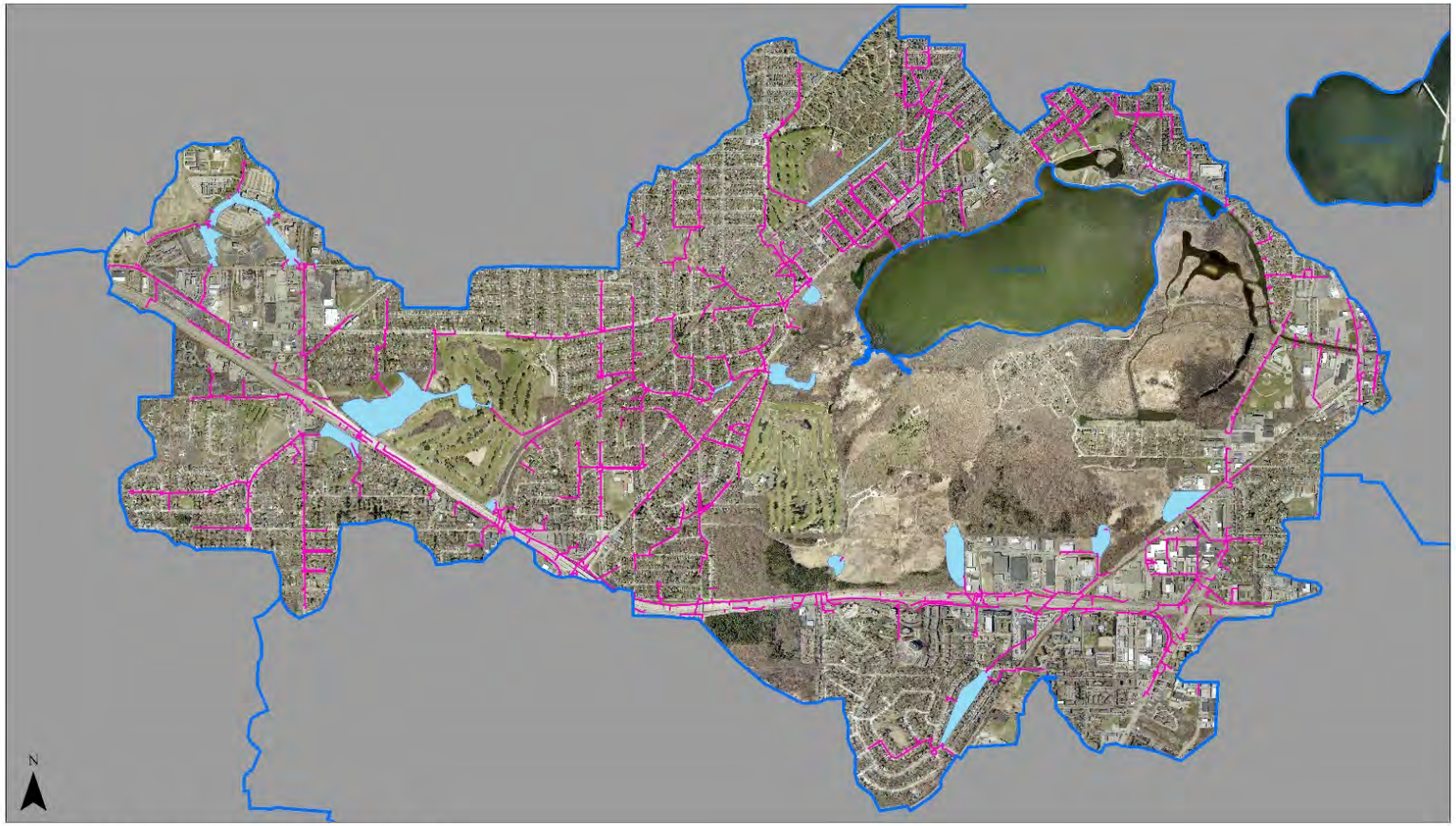


Lake Wingra Watershed 1937

Area = 1740.5 acres

0 0.25 0.5 Miles

Lake Wingra Watershed- 2018



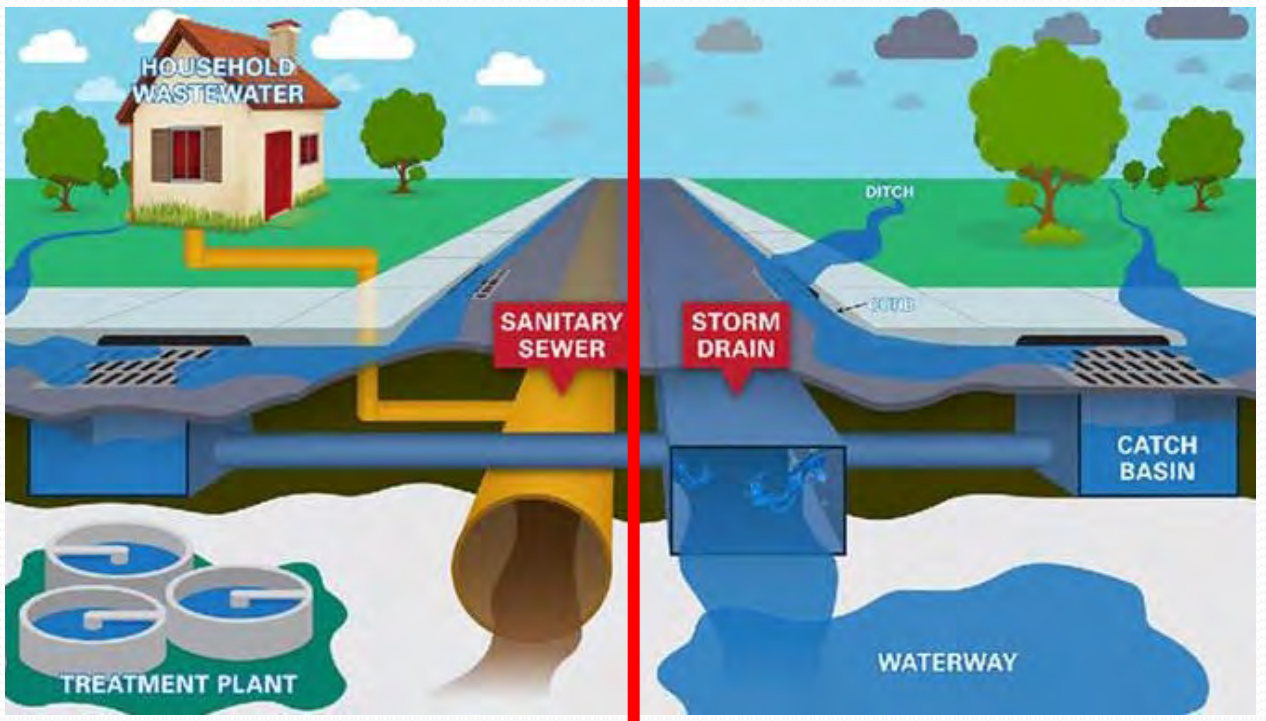
Lake Wingra Watershed 2018

Area = 1740.5 acres

0 0.25 0.5 Miles

Madison's Stormwater Infrastructure

- Our stormwater drains to local surface waters
- We try to treat for nutrients and sediment
- Storm infrastructure includes:
  - Curbs and gutters
  - Inlets
  - Pipes
  - Green Infrastructure
    - Channels (greenways)
    - Ponds
    - Rain gardens



https://www.azstorm.org/stormwater-101/storm-vs-sanitary-sewer

How does Madison Convey Stormwater

Green Infrastructure: reduces and treats stormwater at it's source while delivering environmental, social and economic benefits

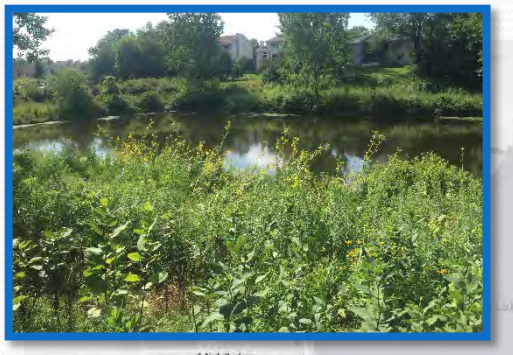
Greenway at Owen Conservation Park

Gray infrastructure: conventional piped drainage that moves urban stormwater away from the built environment

Left: 96" pipe on University Ave (2013)
Below: storm sewer inlet on W Doty St

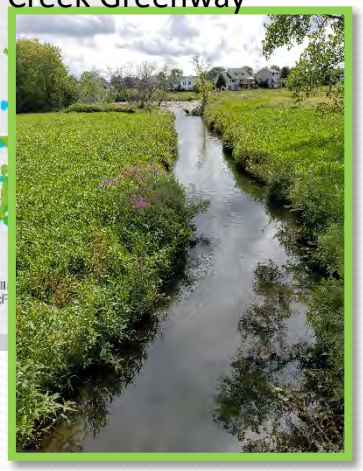
Green Infrastructure: Ponds and Greenways

- Madison has a 1,500+ acre system of greenways and 300+ ponds designed to slow the velocity of stormwater and promote infiltration of stormwater.
- The stormwater system provides stormwater drainage and conveyance. The goals are:
  - Improve water quality
  - Minimize potential for flooding

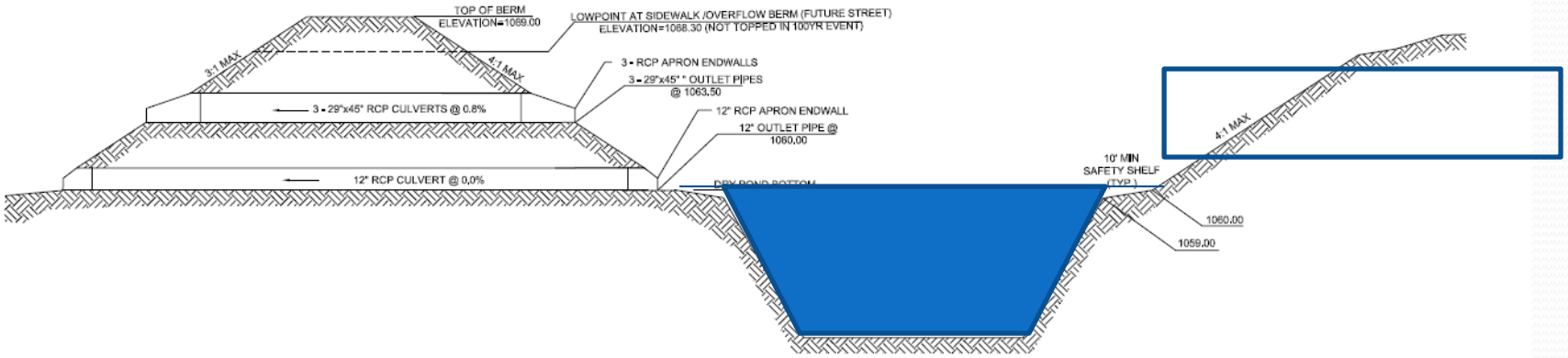


Attic Angel pond

Main Badger Mill Creek Greenway



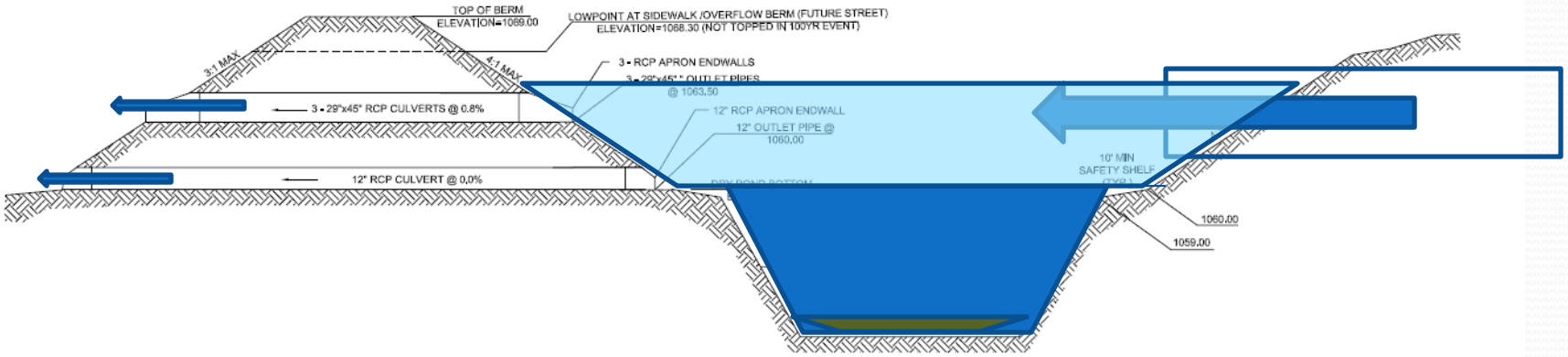
Detention Basins Control Peak Flow



PROFILE VIEW

PROPOSED OUTLOT 6 PERMANENT DETENTION BASIN
NOT TO SCALE

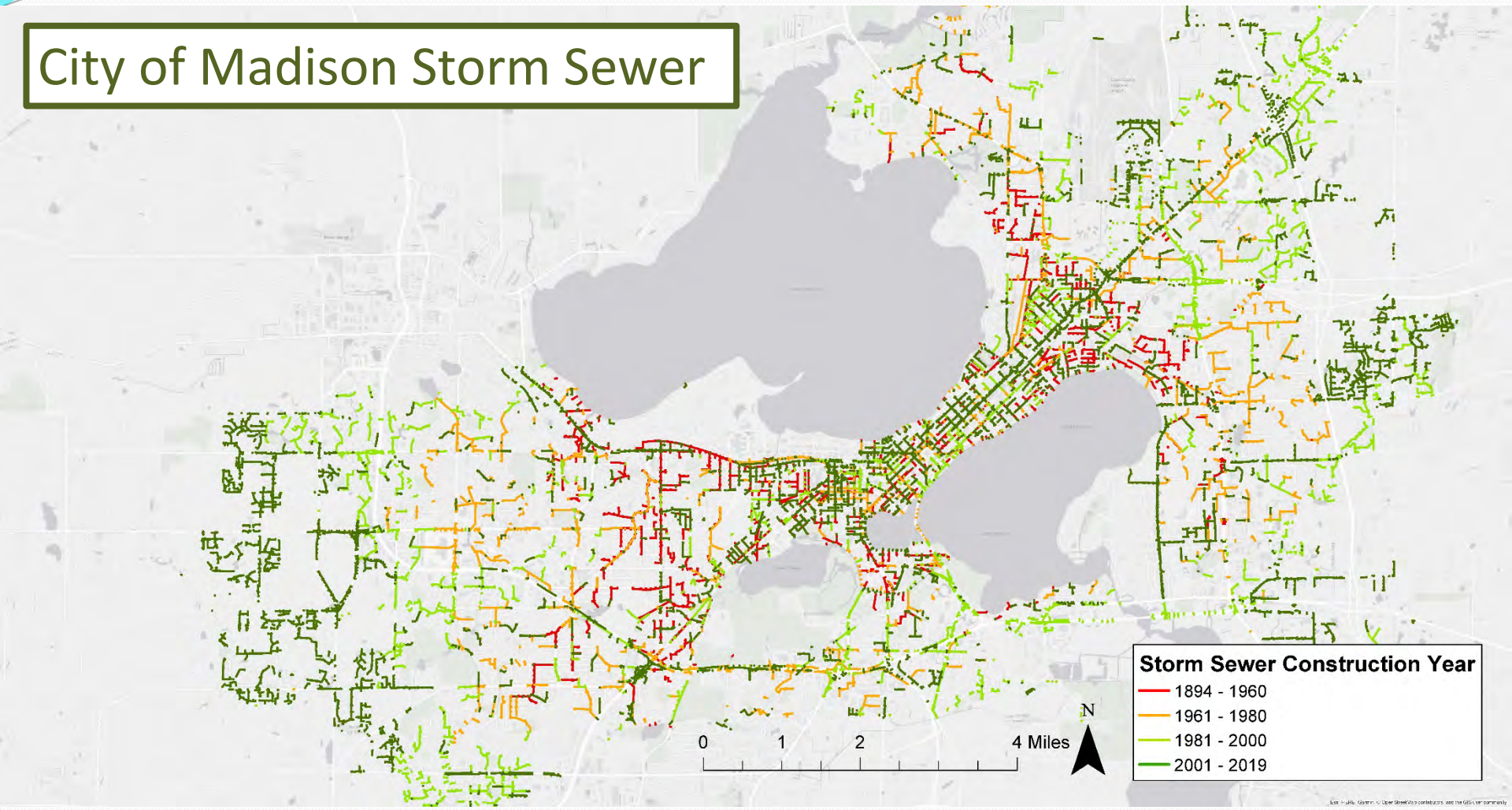
Detention Basins Control Peak Flow



PROFILE VIEW

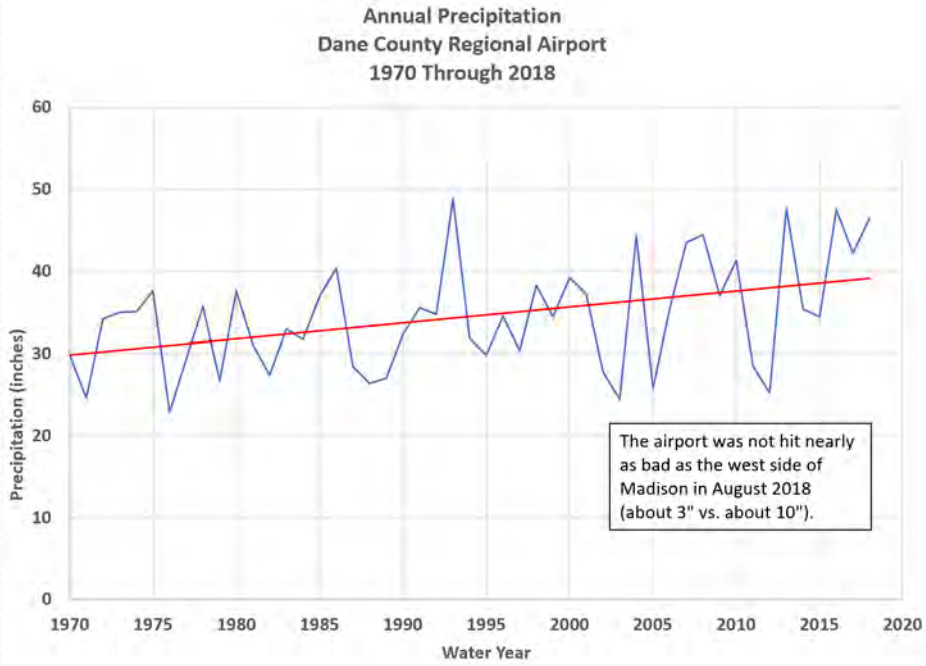
PROPOSED OUTLOT 6 PERMANENT DETENTION BASIN
NOT TO SCALE

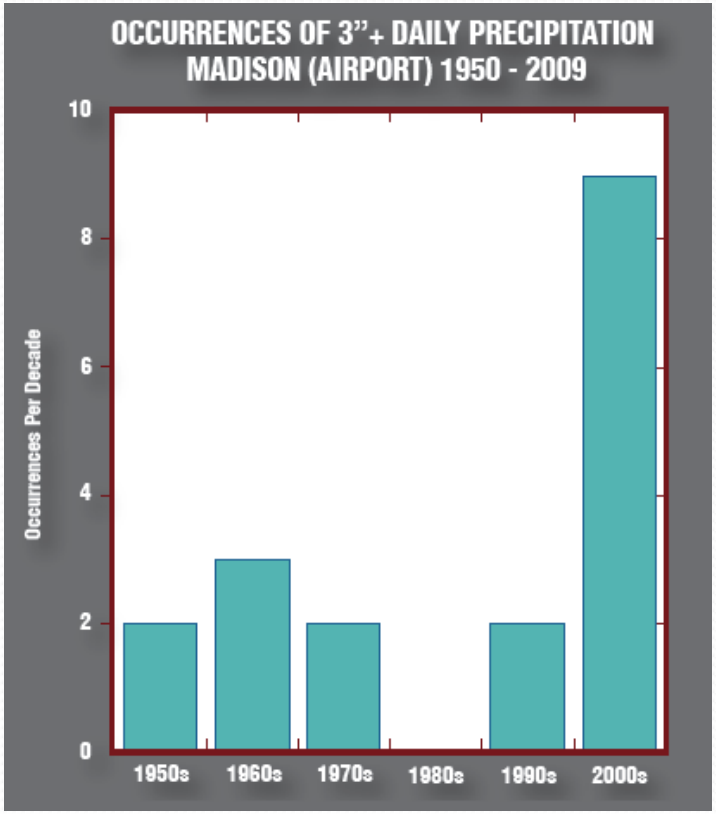
City of Madison Storm Sewer



Rainfall volume and intensity impact runoff

- In the last 30 years
  - More rain
  - More rain events greater than 3”





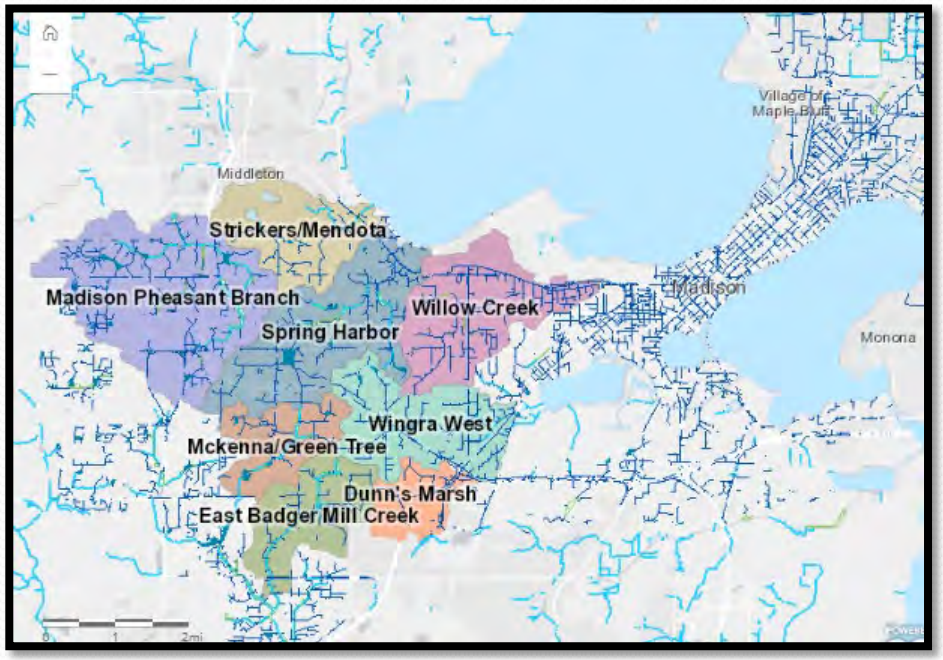
Wisconsin's Changing Climate: Impacts and Adaptation. 2011. Wisconsin Initiative on Climate Change Impacts. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, Wisconsin.

Stormwater Summary

- Rainfall , Land Cover, and Soils Dictate Stormwater Runoff
- Runoff volume and speed of runoff impacts lakes
  - Flooding (both on the way to the lake and around the lake)
  - Transport pollutants
  - High flows can cause failures in the drainage system
- Storms are classified based on the probability that they will occur.
- Tools to minimize the impacts of land use change exist

Watershed Studies

- A watershed is the area of land that drains precipitation (rain, snow, etc.) to a common low point, such as an inlet, stream, or lake.
- Goals of studies
  - Find out why flooding happens in certain locations
  - Find out how frequently flooding occurs
  - Test solutions to help prioritize and budget future projects



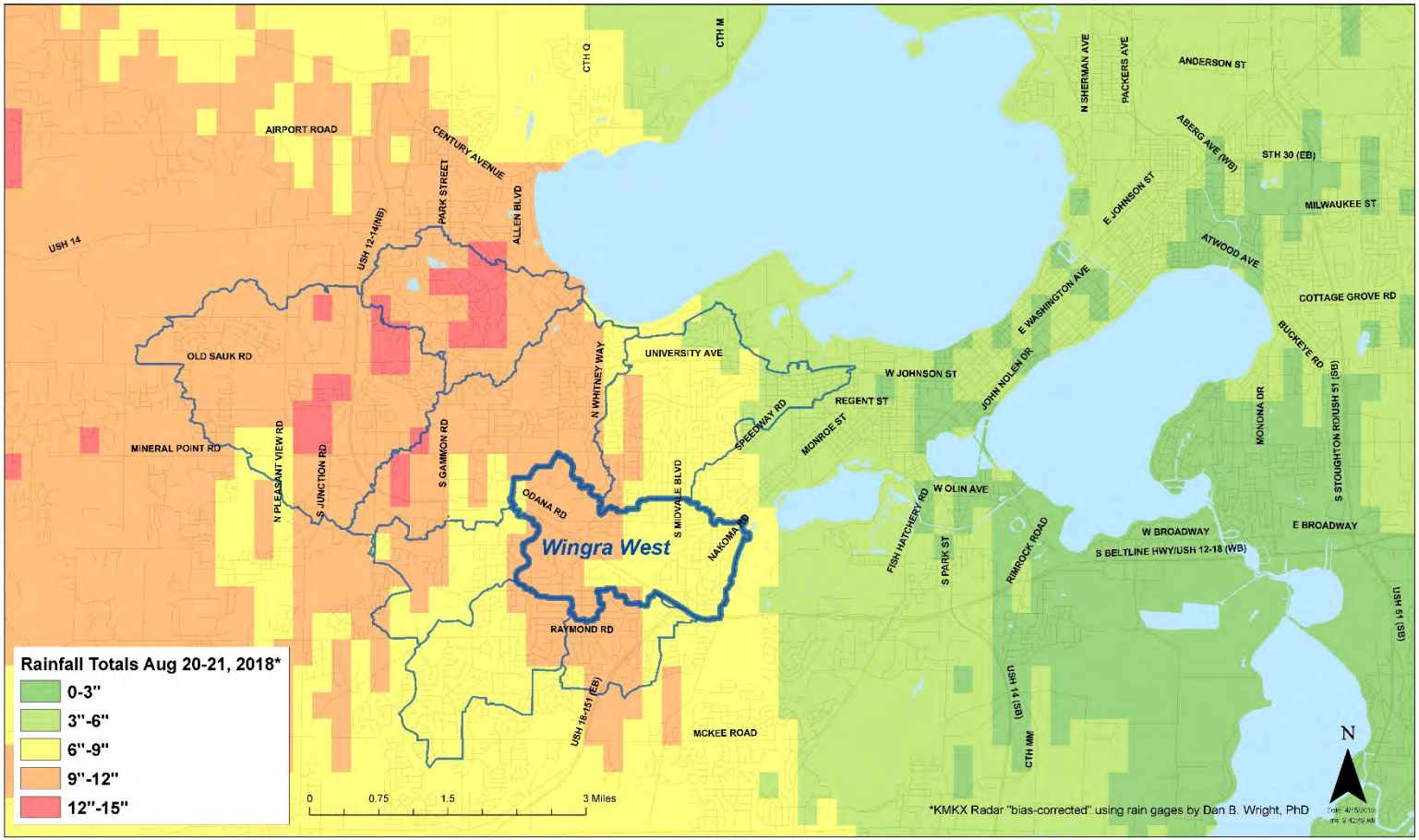
2019 City Watershed Studies

Flash Flooding Damage: August 20, 2018

- August 20th event: substantial damage
  - Public infrastructure: $4 million
  - Private property: $30 million, estimated

Deming Way, Madison, WI

Rainfall Totals August 20-21, 2018



KMKX Radar that was "bias corrected" using rain gauges by UW Professor Dan Wright

Watershed Study Goals

- Find out why flooding happens in certain locations.

Example output from watershed modeling

Watershed Study Progress

Model Existing Conditions & Predict Future Flood Risk

Analyze Solutions on Watershed Scale, Rank & Budget

Create Drainage Model

Identify Flooding Impacts

Develop Engineering Solutions

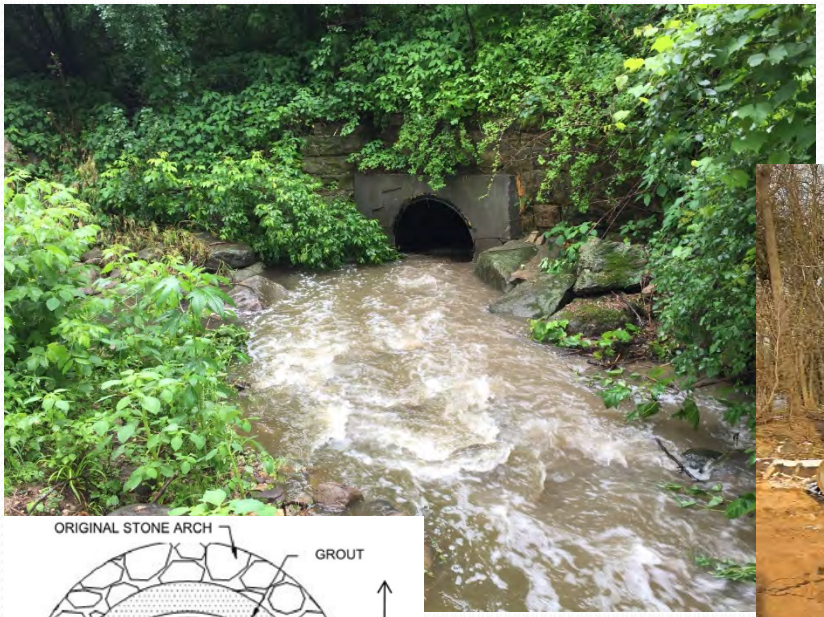
Prioritize & Budget

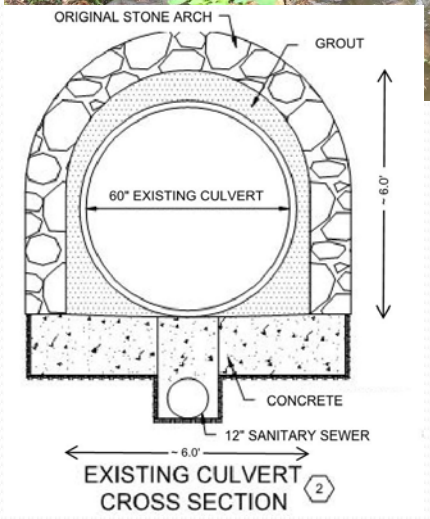
Next Public Information Meeting
March 16th , 2020 Sequoya Library 6-8 p.m.

Watershed Study Limitations

- Retrofitting infrastructure takes time and money
- Repairs are not always easy, popular, or cheap
- Not always a good solution
- Property owners will need to create solutions too
- Solutions will need broad community cooperation
- Groundwater problems not easily addressed by watershed modeling and surface infrastructure

Waite Circle






CAT
CAT
335F

Wingra Wateshed Plan

Watershed based plan to improve water quality

Focused on:

- Chloride Reduction
- Phosphorus Reduction
- Infiltration

Green Infrastructure: Native Vegetation

- Native vegetation helps infiltrate stormwater and filter pollutants out
  - Important for pollution reduction, as well as maintaining habitat for wildlife
- Native vegetation, once established, requires less maintenance as the plants have evolved over many years to thrive in this soil, climate etc.
- Native vegetation is used with the following stormwater infrastructure:
  - Ponds
  - Greenways
  - Raingardens
  - Bioretention
  - Shorelines

Nesbitt Pond

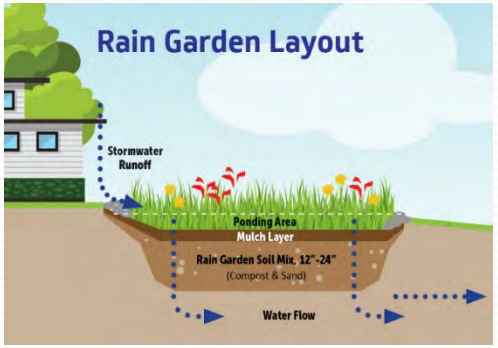
Confluence Pond

Attic Angel

Green Infrastructure: Rain Gardens

Clean and Infiltrate Stormwater Runoff

- Treats street runoff
- Designed, built and planted by City

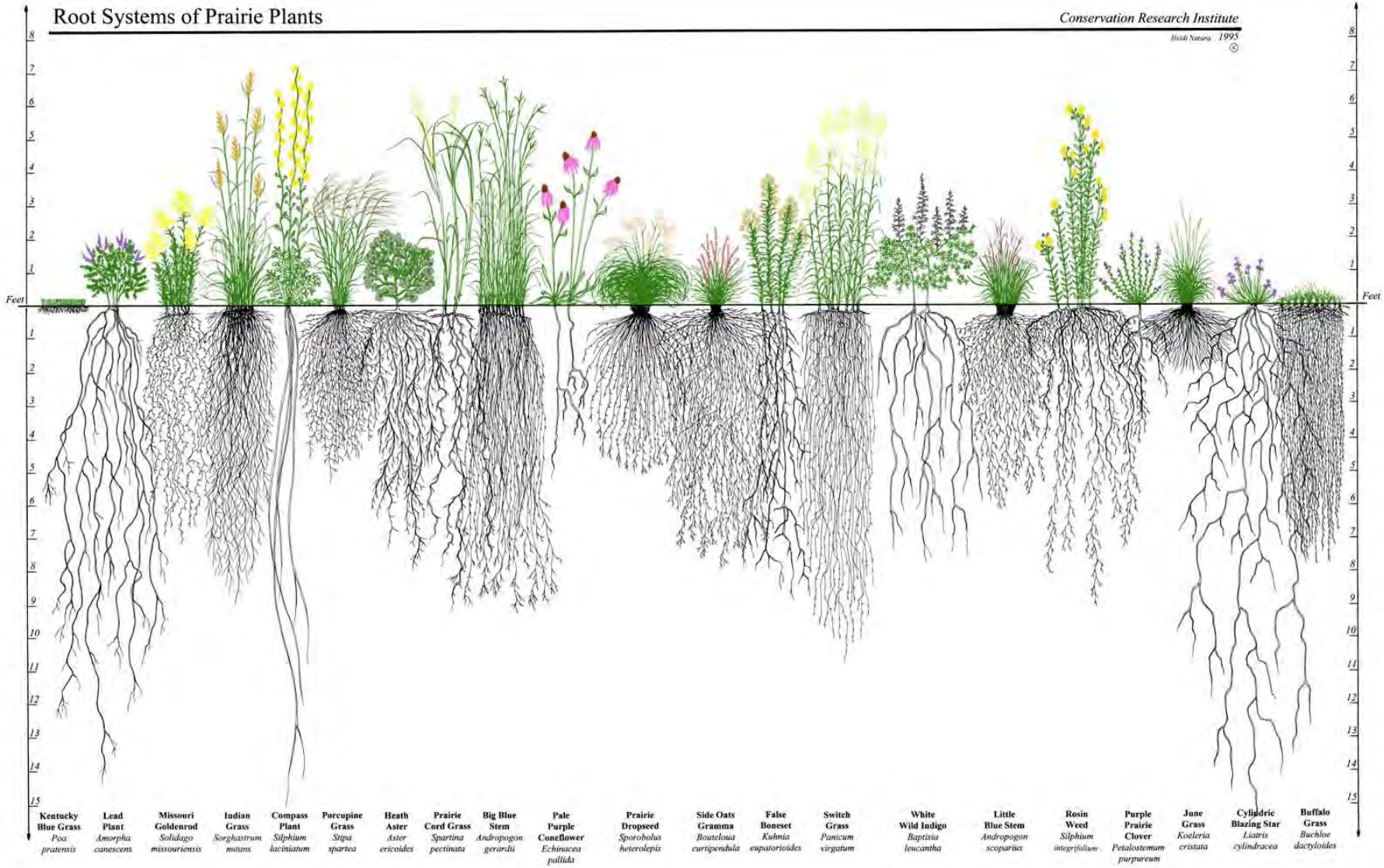


Rain Gardens can reduce your property's runoff by over 90%

Together rain gardens can help reduce watershed runoff volume

- Infiltrates roof and yard runoff
- Built by homeowner

Learn More at:
www.Ripple-Effects.com or search for Rain Gardens on the City of Madison Webpage
Contact Carissa Wegner 608-261-9822 or cwegner@cityofmadison.com with Questions


Root Systems of Prairie Plants
Conservation Research Institute
Heidi Natura 1995 ©
Feet
Feet
Kentucky Blue Grass Poa pratensis
Lead Plant Amorpha canescens
Missouri Goldenrod Solidago missouriensis
Indian Grass Sorghastrum nutans
Compass Plant Silphium laciniatum
Porcupine Grass Stipa spartea
Heath Aster Aster ericoides
Prairie Cord Grass Spartina pectinata
Big Blue Stem Andropogon gerardii
Pale Purple Coneflower Echinacea pallida
Prairie Dropseed Sporobolus heterolepis
Side Oats Gramma Bouteloua curtipendula
False Boneset Kuhnia eupatorioides
Switch Grass Panicum virgatum
White Wild Indigo Baptisia leucantha
Little Blue Stem Andropogon scoparius
Rosin Weed Silphium integrifolium
Purple Prairie Clover Petalostemum purpureum
June Grass Koeleria cristata
Cylindric Blazing Star Liatris cylindracea
Buffalo Grass Buchloe dactyloides

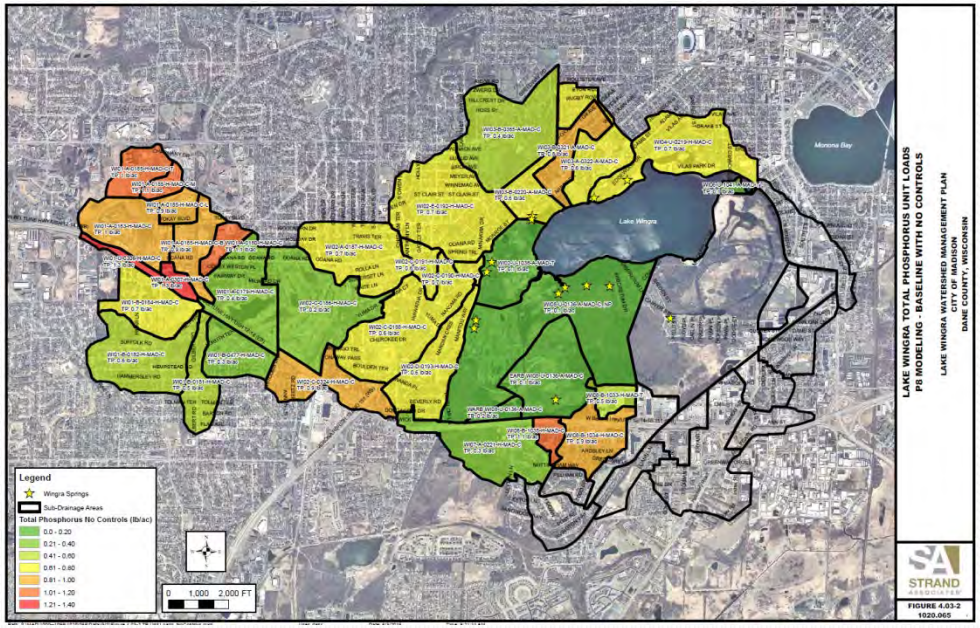
Prepared in cooperation with the City of Madison and Wisconsin Department of Natural Resources

Evaluation of Turf-Grass and Prairie-Vegetated Rain Gardens in a Clay and Sand Soil, Madison, Wisconsin, Water Years 2004–08

Scientific Investigations Report 2010–5077

Phosphorus

- No Control Load = 1899 lb/ year
- Existing Controls Reduction= 728 lb/yr (38.5%)
- Short Term Goal = 50%
  - 218 lb phosphorus
- Long Term Goal=80%
  - 570 lb phosphorus to reach 80% long term goal



Leaf Piles on Grass

City of Madison has an Ordinance prohibiting leaves in the street but it is complaint driven

Leaves in street

Rain

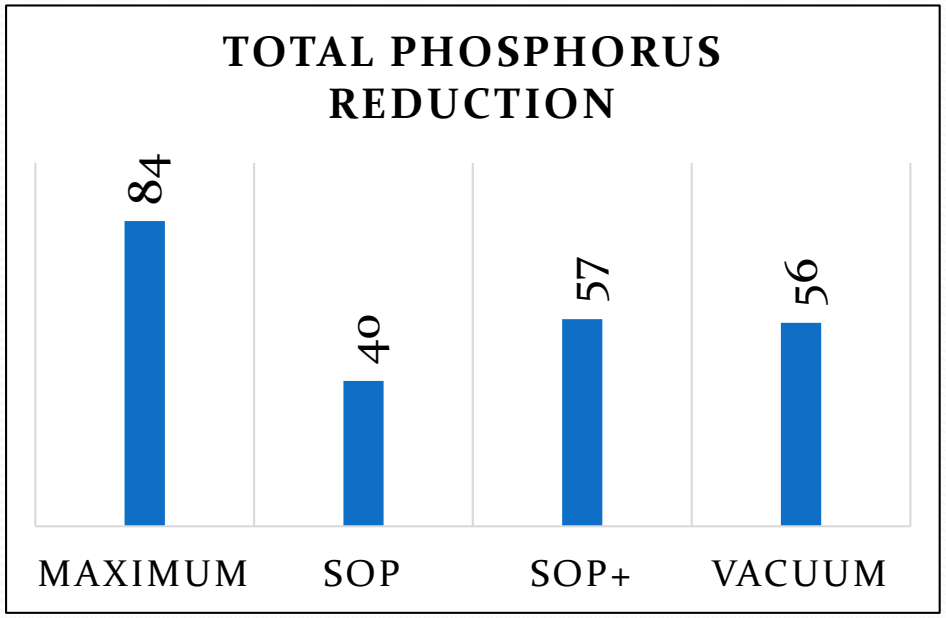
Leaf Tea = Low Particulate, High Dissolved Phosphorus

Curb Line Clear

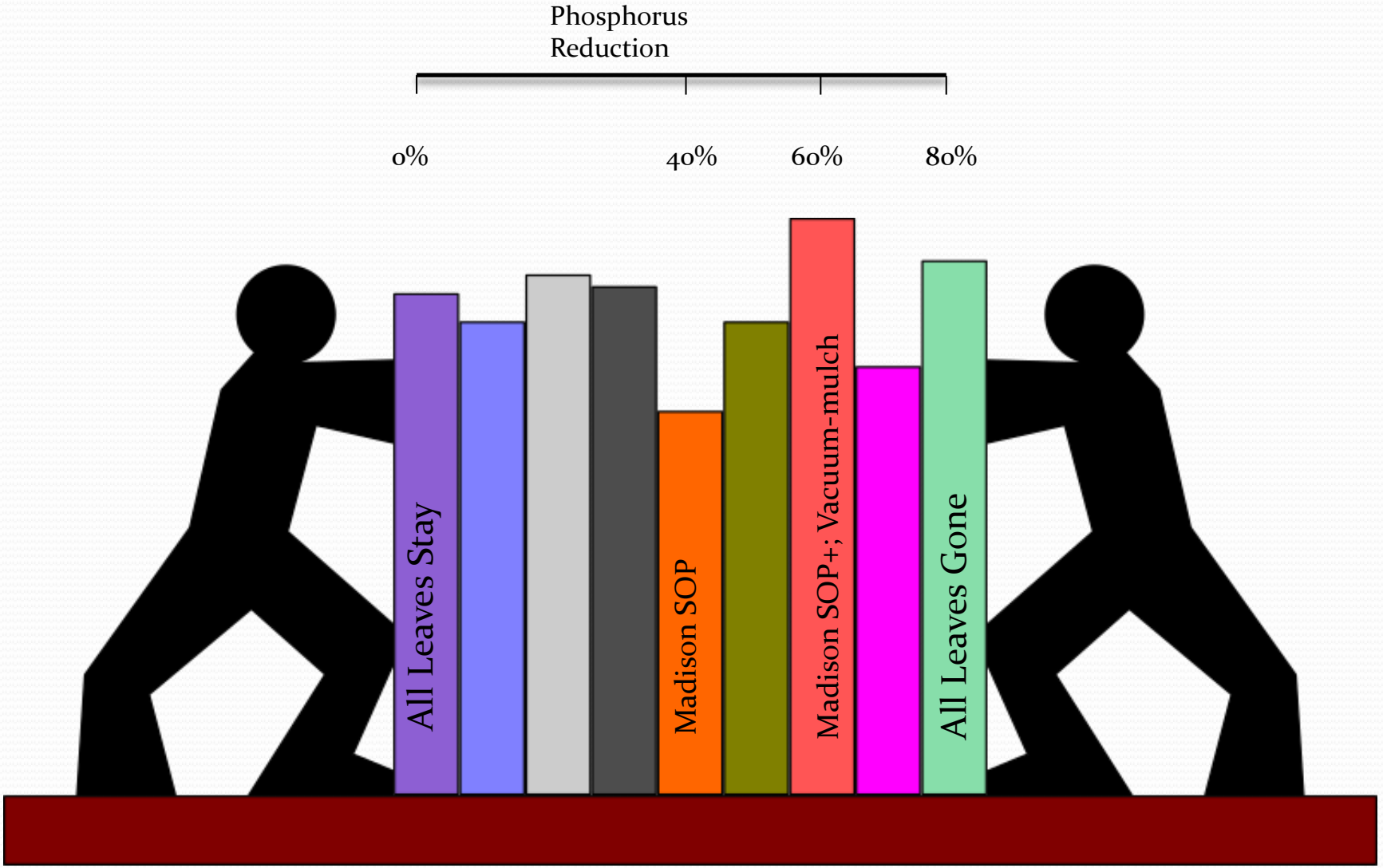
City of Madison – Leaf Collection plus Sweeping "Madison SOP, SOP+, and Vacuum-Mulch"

Leaf Collection		Street Cleaning			
Method	**Frequency**	**Method**	**Frequency**	**Year Completed**	**Title**
Transfer	Weekly	Mechanical/blower	Pre-event	2015	Upper Maximal
Transfer	Biweekly	Mechanical	Biweekly	2016	Madison SOP
Transfer	Biweekly	Regenerative Air	Weekly	2017	Madison SOP+
Vacuum	Weekly	Regenerative Air	Weekly	2017	Vacuum Mulch
Transfer[1]	Biweekly	Regenerative Air	Weekly	2018	Madison SOP+

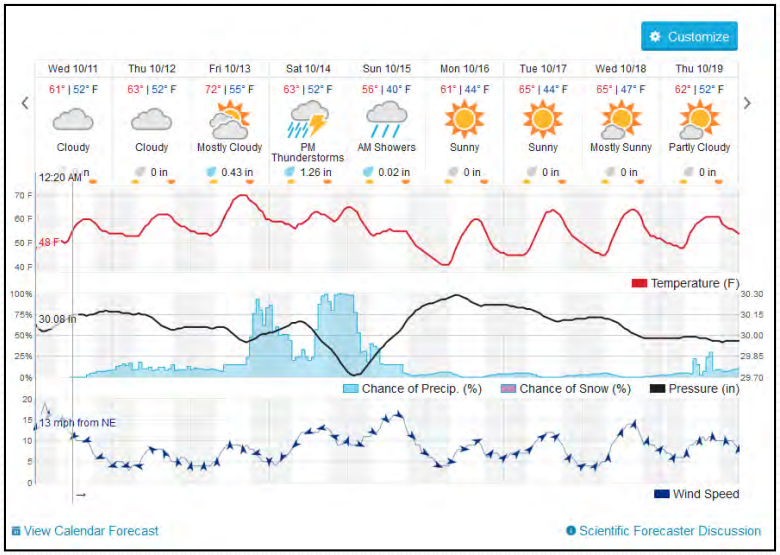
[1] Medium density canopy

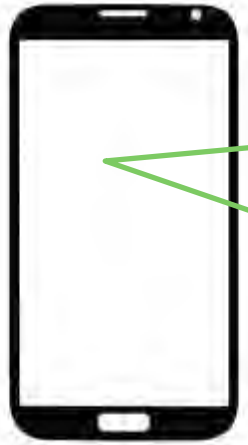


Collection Impacts on Total Phosphorus



Text Alerts when Rain is Coming





Rain is predicted.
Time to rake leaves
from the gutter.

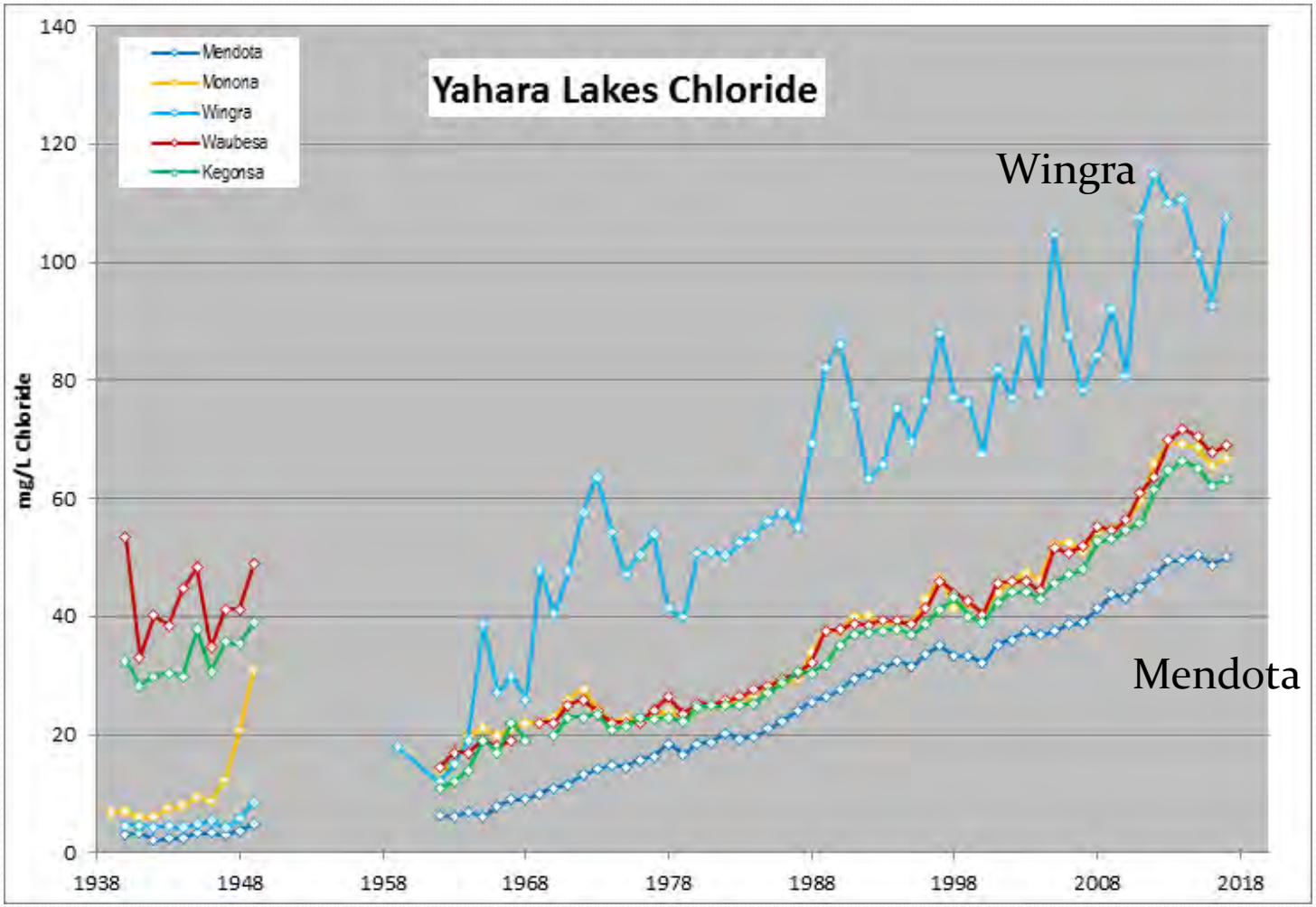
~200 residents
signed up so far

www.Ripple-Effects.com

What did we learn?

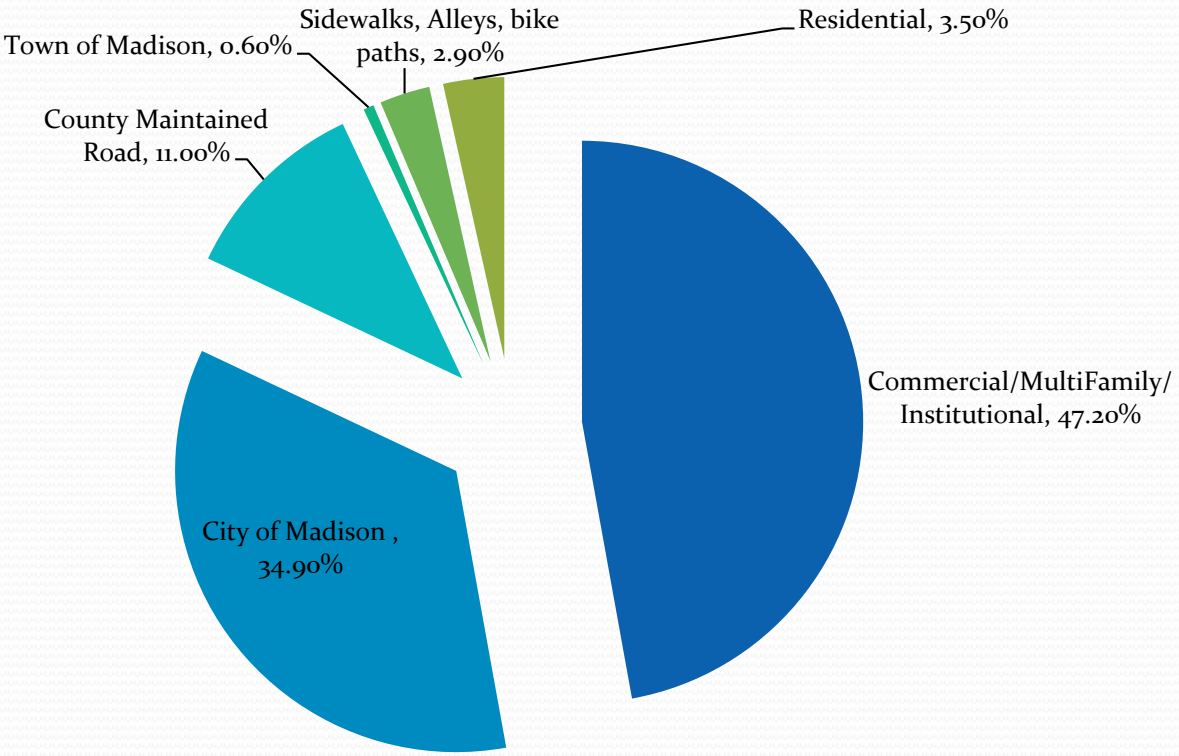
- Reducing leaves on the street means less phosphorus in the lakes
- Key is to speed up removal
- Tree species mix plays a role
- Resident action may be the key to improved collection

Chlorides

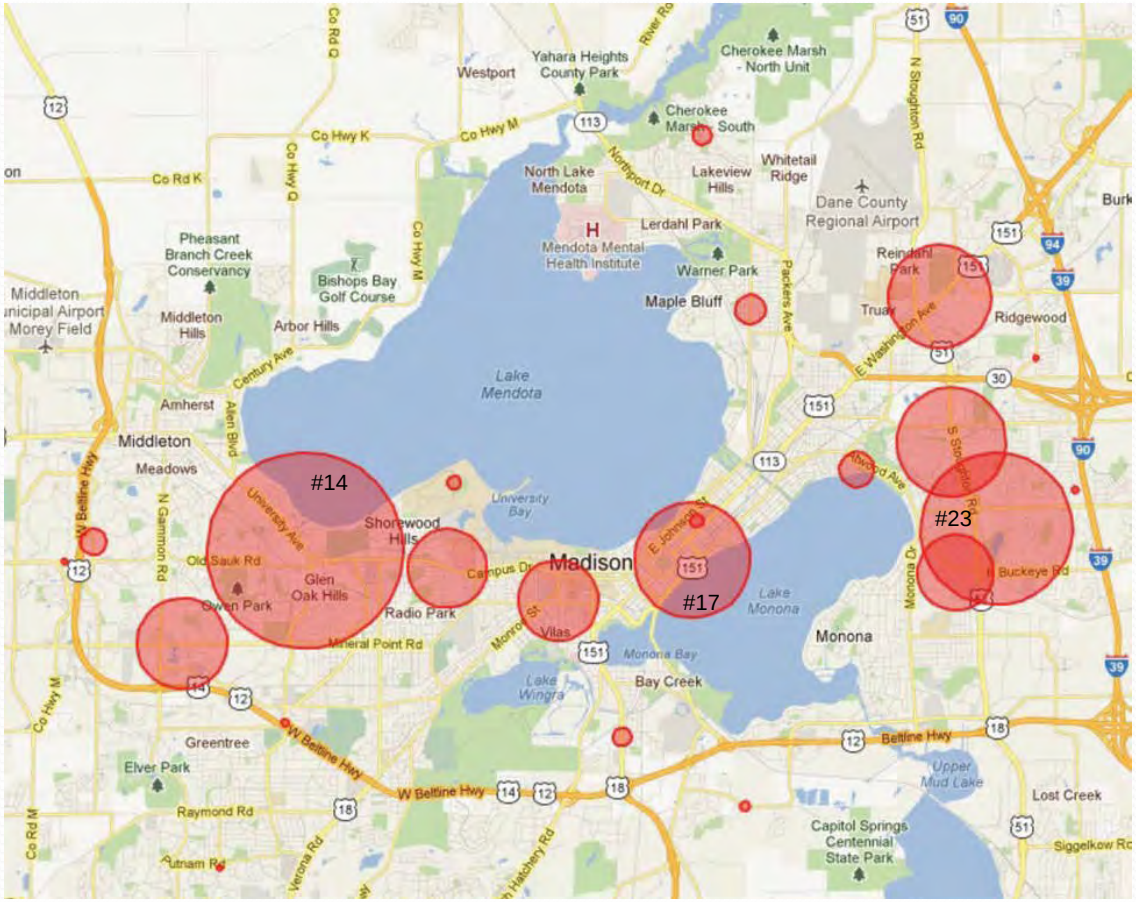


Salt Accumulates in Lakes

Lake Wingra Salt Contributions



Effects on Groundwater



Circle diameter proportional to chloride concentration

How much is enough?

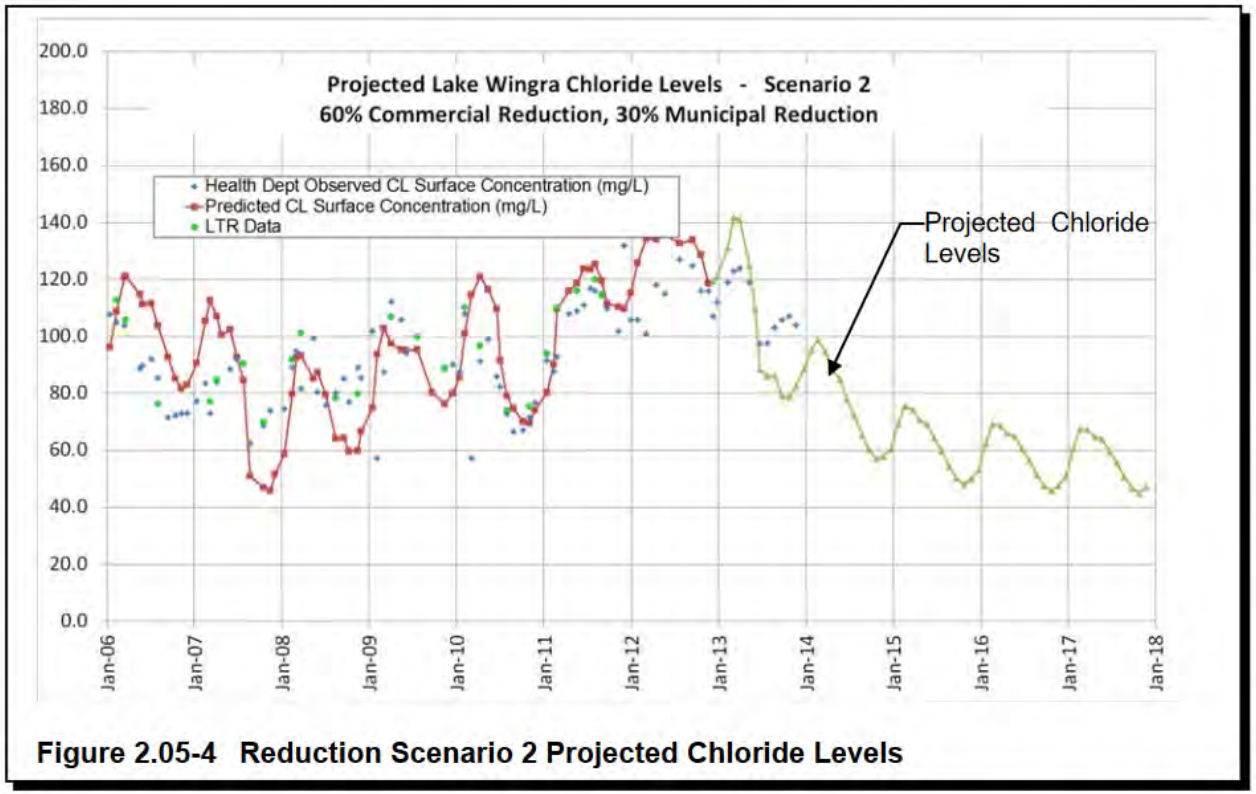


Figure 2.05-4 Reduction Scenario 2 Projected Chloride Levels

Wingra Watershed Plan

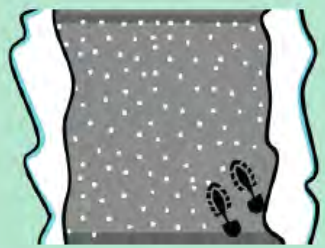
Be Salt WIse!

Once you put salt down, it doesn't go away. It washes off surfaces and accumulates in local lakes, streams and drinking water. You can keep sidewalks and driveways safe this winter while protecting our waters by following these simple steps:

1. Shovel

Clear walkways and other areas before the snow turns to ice. The more snow you remove manually, the less salt you will have to use and the more effective it will be.

2. Scatter



If you apply salt to pavement, aim for a pattern like this, leaving space between salt grains. A coffee mug full of salt is enough for about 60-70 feet of sidewalk. A hand spreader can help create this pattern.

3. Switch

When the pavement temperature is below 15 degrees, salt won't work. Switch to a different ice melter (like a blend) that works at a lower temperature, or use sand for traction.

Brought to you by the WI Salt Wise partnership:

Public Health MADISON & DANE COUNTY

Madison Metropolitan Sewerage District

ENVIRONMENT, HEALTH AND SAFETY DEPARTMENT University of Wisconsin-Madison

Learn more at www.wisaltwise.com.