GREEN INFRASTRUCTURE PLANTING PLANS

Conservation Design Forum

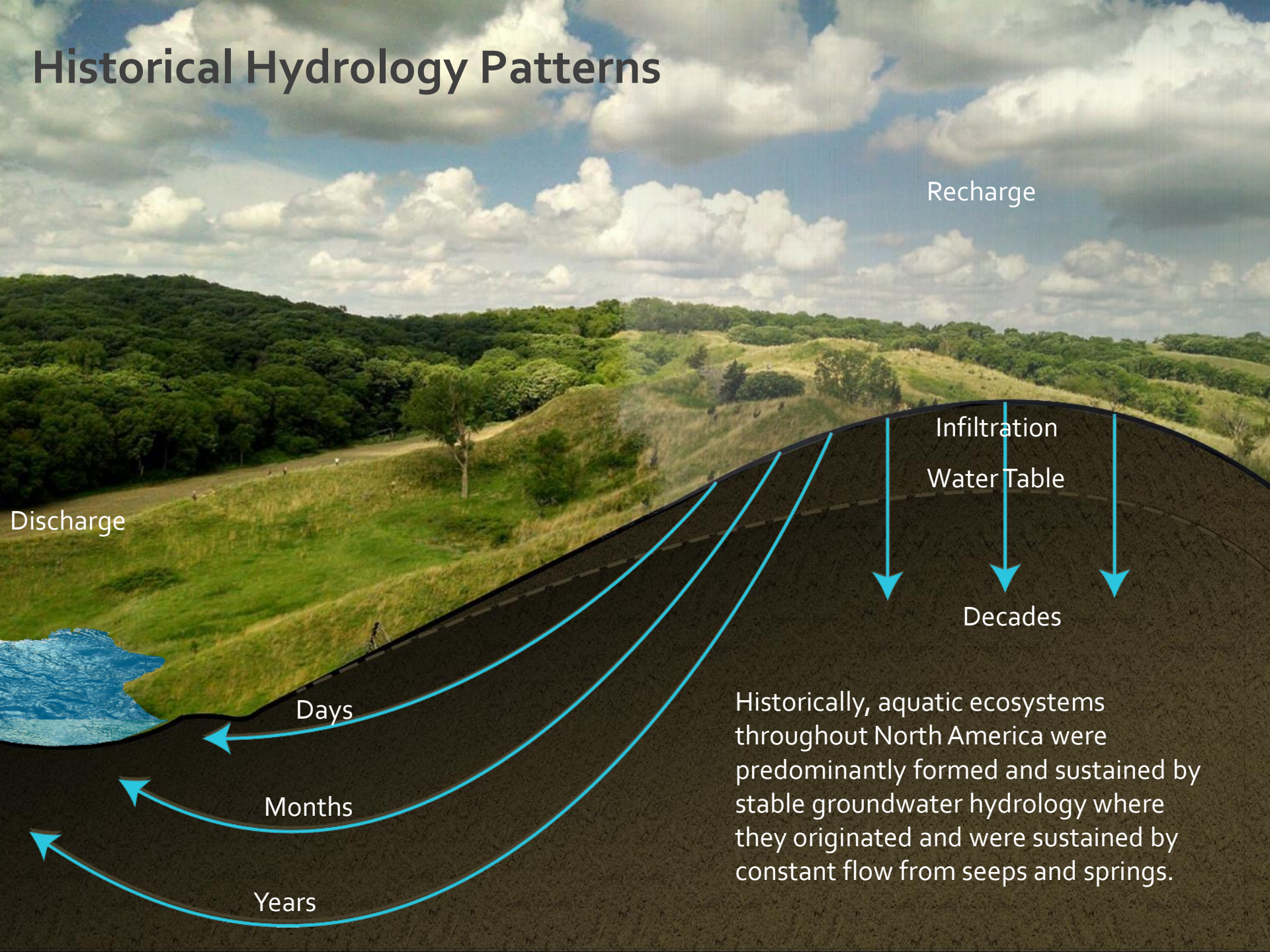
MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

FRESH COAST GUARDIANS

GREEN INFRASTRUCTURE PLANTING PLANS

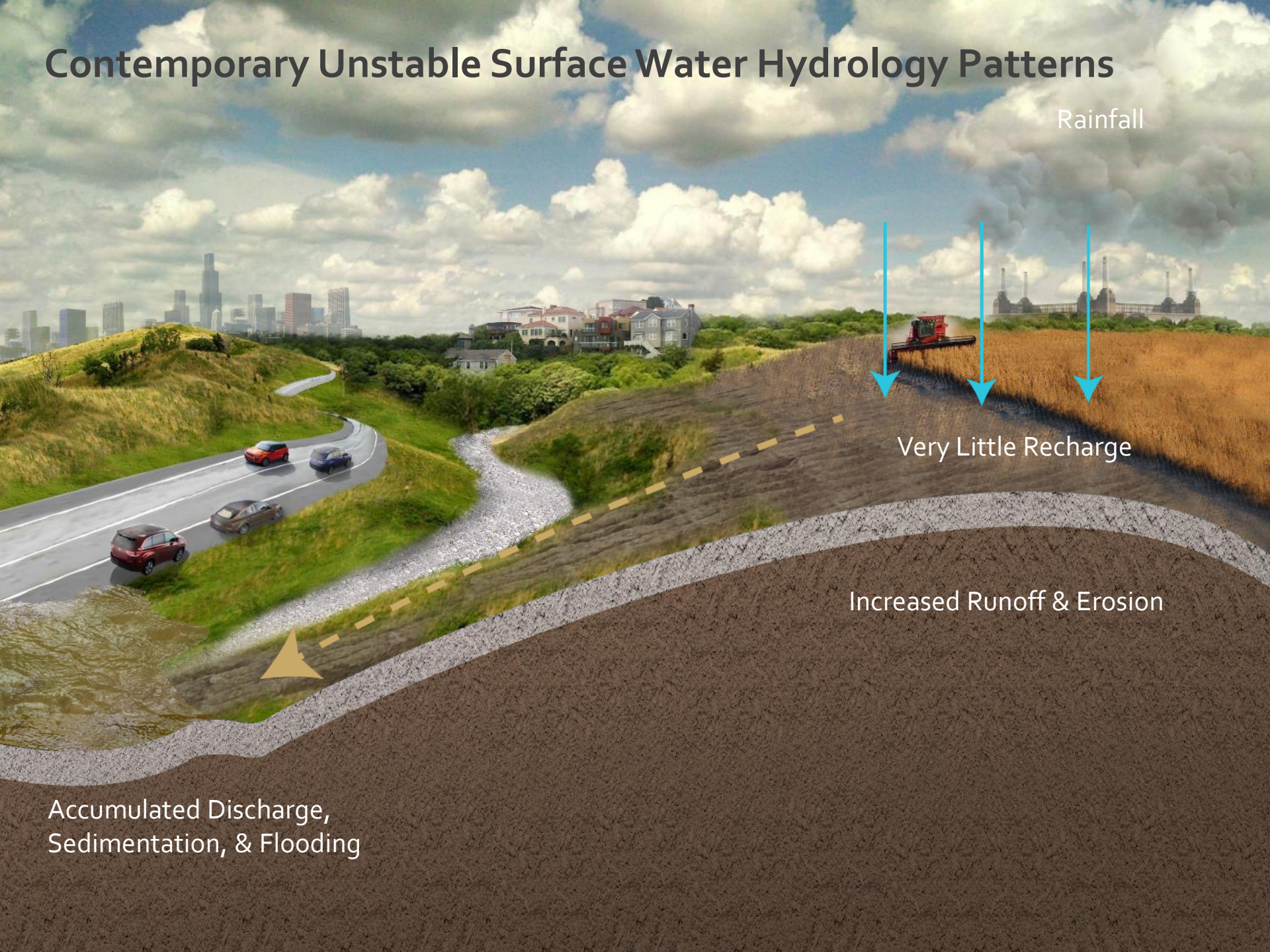
- UNDERLYING STORMWATER PROBLEMS
- BENEFITS OF VEGETATED GREEN INFRASTRUCTURE
- CHALLENGES OF USING PLANT MATERIAL
- PLANT SELECTION TOOL

Historical Hydrology Patterns



Historically, aquatic ecosystems throughout North America were predominantly formed and sustained by stable groundwater hydrology where they originated and were sustained by constant flow from seeps and springs.

Contemporary Unstable Surface Water Hydrology Patterns



WHY MANAGE STORMWATER?

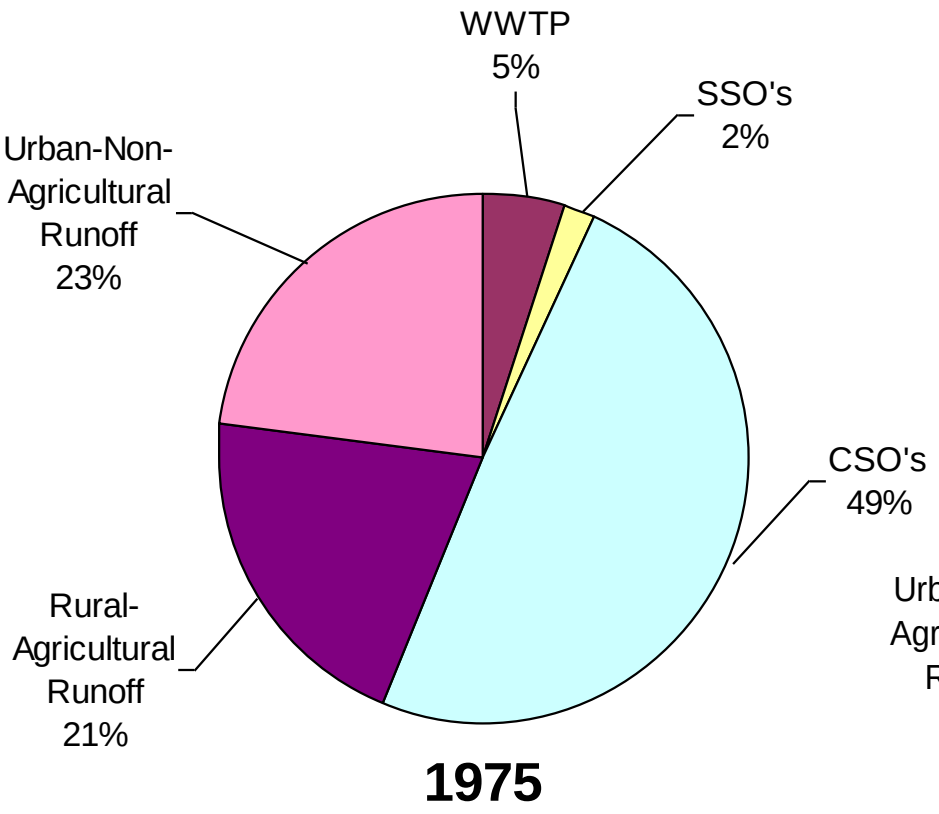
PUBLIC HEALTH (CSO'S)

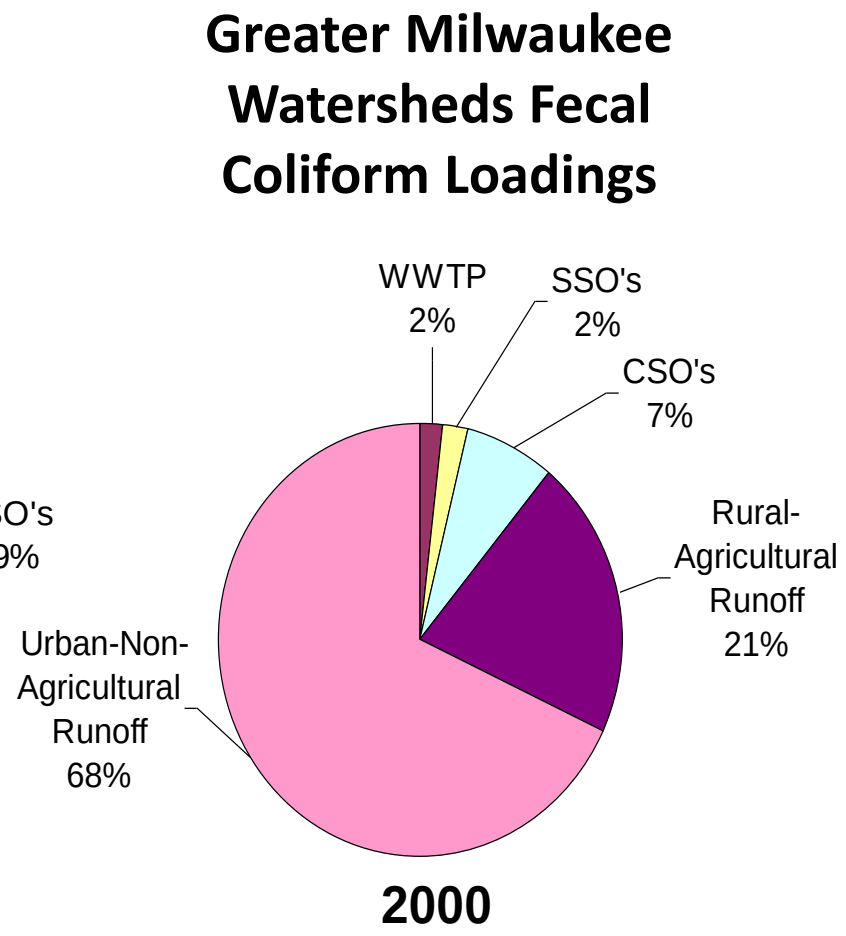
SOIL CONSERVATION

FLOODING / BASEMENT BACKUPS

AQUATIC ECOSYSTEMS

SOURCES OF POLLUTION





Estimated Pollutant Reduction over 25-Year Period About 50 Percent

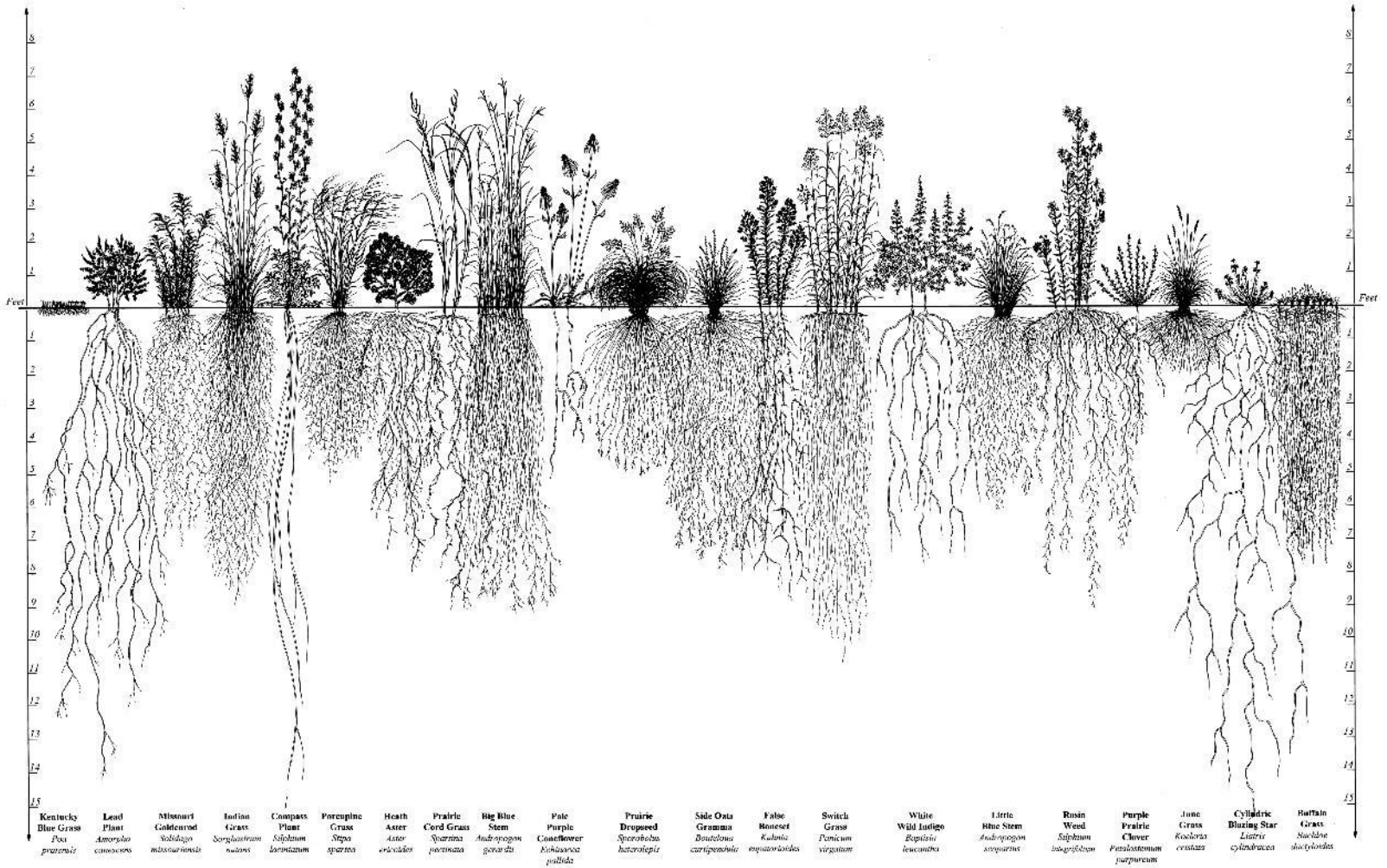
CONCLUSION: FOCUS ON ABATING STORMWATER RUNOFF POLLUTION

VEGETATED GREEN INFRASTRUCTURE

- HABITAT
- NUTRIENT REMOVAL
- EVAPOTRANSPIRATION
- INFILTRATION AND AQUIFER RECHARGE

ROLE OF HERBACEOUS PLANTS

- SOIL HEALTH
- DISPERSED ROOT SYSTEMS
- EROSION CONTROL



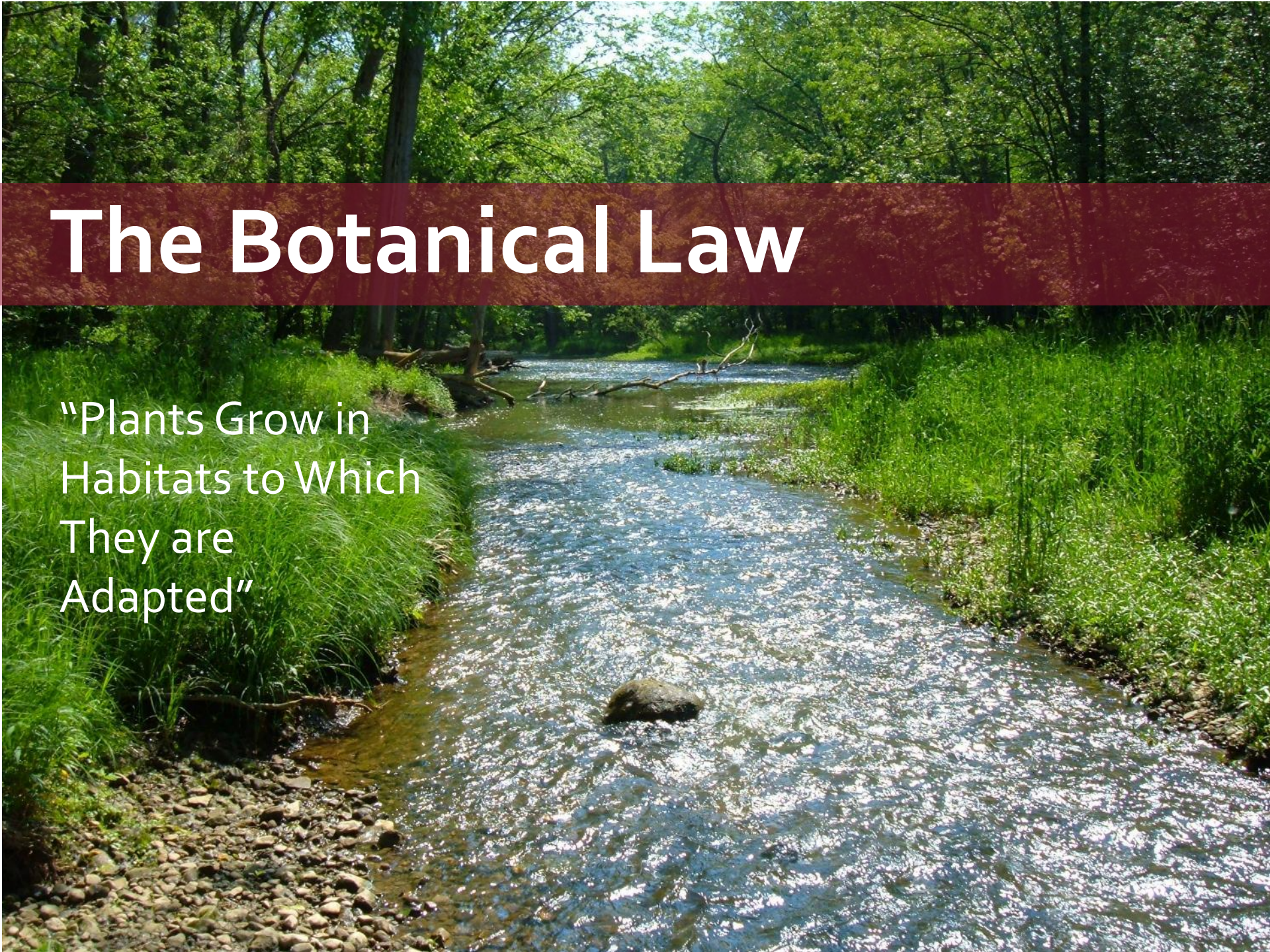
VEGETATED GREEN INFRASTRUCTURE

RAIN GARDENS

GREEN ROOFS

NATURALIZED PLANTINGS

BIORETENTION



The Botanical Law

"Plants Grow in Habitats to Which They are Adapted"

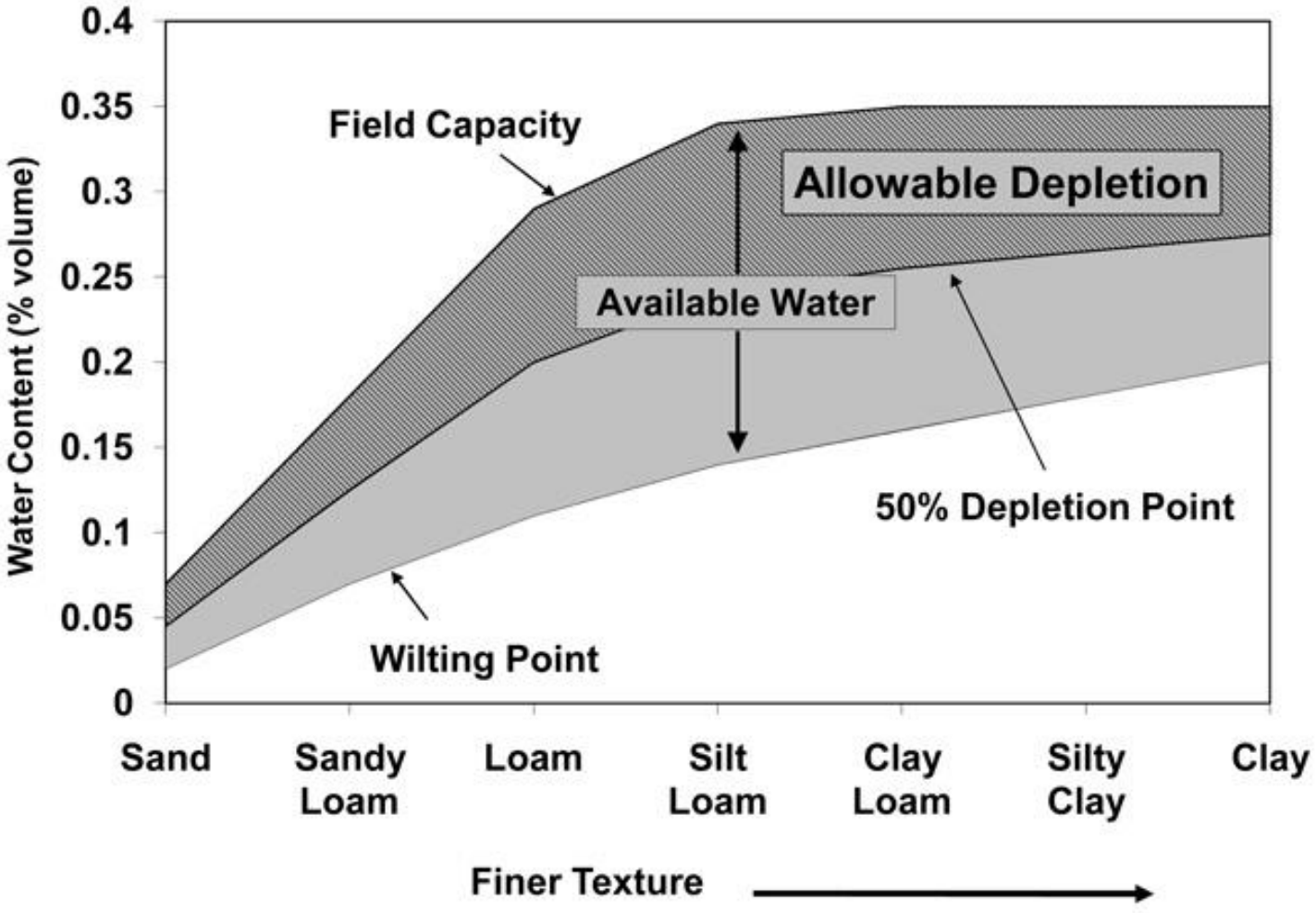
Habitat Considerations

- Flood Duration
- Soil Moisture (complete saturation to wilting point)
- Temperature
- pH
- Nutrients
- Sun exposure
- Weed competition / Beneficial associations
- Soil Health

Flood Duration

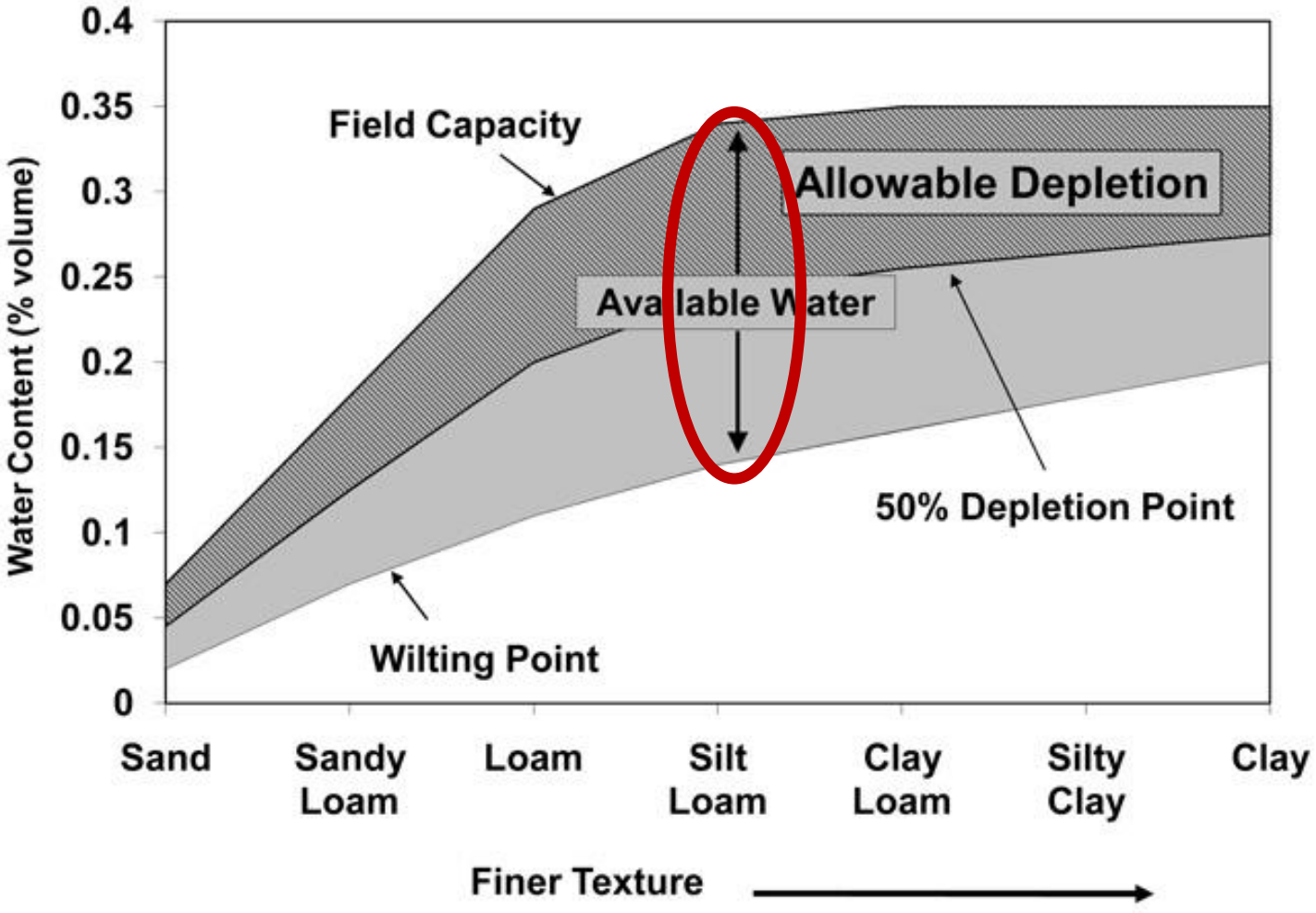
- Flooded soils have limited oxygen
- Impeded respiration leads to a build up of carbon dixide, methane, and nitrogen gasses
- Toxic compounds such as ethanol and hydrogen sulphide build up

Soil Moisture



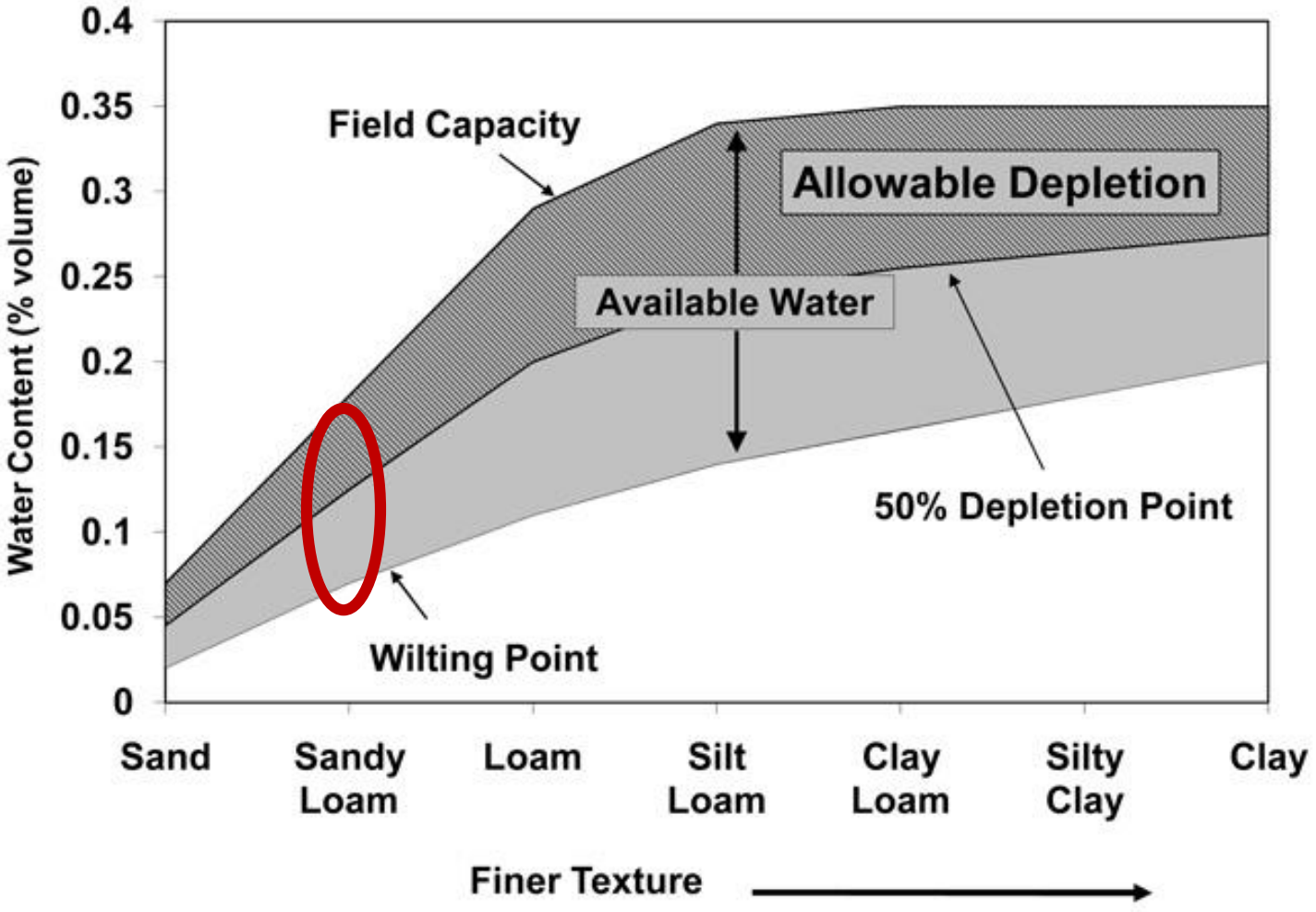
(Source: Utah State University)

Soil Moisture



(Source: Utah State University)

Soil Moisture



(Source: Utah State University)

Temperature

Soil bacteria die

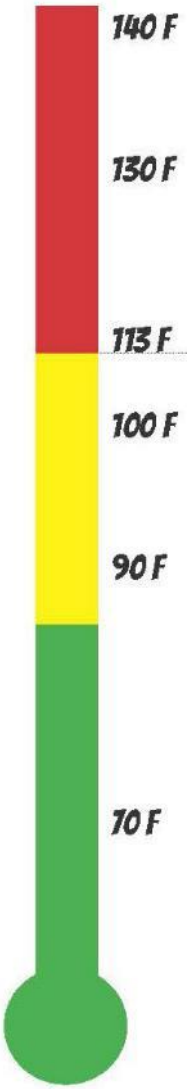
100% moisture is lost through evaporation or transpiration

Some bacteria species start dying

15% moisture used for growth, 85% moisture lost through evaporation and transpiration

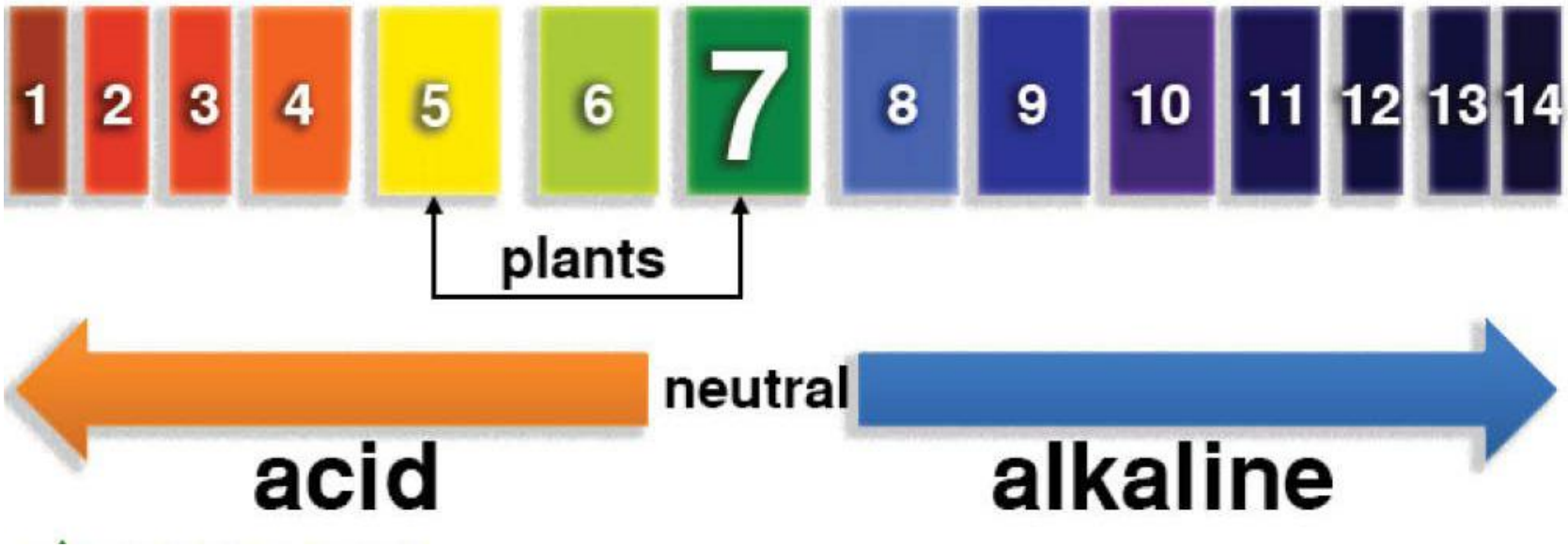
Plant growth slows

100% moisture is used for plant growth



Source: NRCS

pH



- Most cultivated plants prefer a pH of 6.2 to 7.0
- Many native Illinois plant communities prefer more alkaline conditions

Source: Mississippi State University

Nutrients

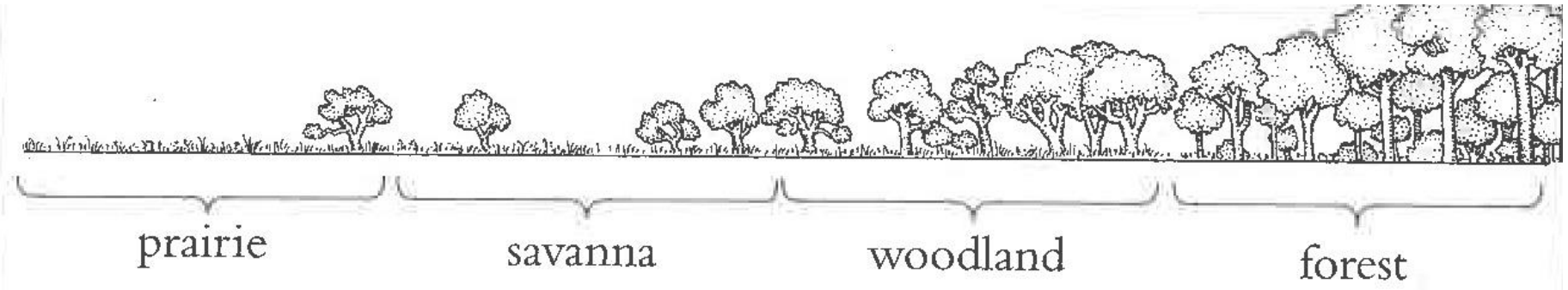
- Major Nutrients
  - Nitrogen (N)
  - Phosphorus (P)
  - Potassium (K)
- Trace Elements
  - Iron
  - Manganese
  - Zinc
  - Copper
  - Boron
  - Molybdenum

Nutrients

Nutrients

NUTRIENTS ARE NOT PLANT FOOD

Sun Exposure



FULL SUN
6 or more hours
of direct sunlight

PART SUN
4-6 hours of
direct sunlight

FULL SHADE
Less than 4 hours
of direct sunlight

(Source: "The Tallgrass Restoration Handbook," 1994)

Weed Competition

REED CANARY GRASS

Phalaris arundinacea

COMMON REED

Phragmites australis

BUCKTHORN

Rhamnus spp.

BULL THISTLE

Cirsium vulgare

Beneficial Associations

- Grasses – Soil builders and thermal regulators
- Mycorrhizal Fungi – often symbiotic relationship – assist plants with obtaining water, phosphorus and other micronutrients
- Rhizobacteria – release plant growth compounds
- Animal associates – forage and pollination

Soil Health - Rhizosphere

VEGETATED GREEN INFRASTRUCTURE - SUCCESSES

RAIN GARDENS

GREEN ROOFS

NATURALIZED PLANTINGS

BIORETENTION

VEGETATED GREEN INFRASTRUCTURE - FAILS

RAIN GARDENS

GREEN ROOFS

NATURALIZED PLANTINGS

BIORETENTION

Cultural Practices

Owners have expectations with Vegetation:

"It's a strange phenomon: People pay so little attention to the appearance of concrete or asphalt, but when these impervious surfaces are removed and plants are installed, everyone has an opinion as to how they should look and be managed" - T. Liptan

(Source: "Sustainable Stormwater Management," 2017)

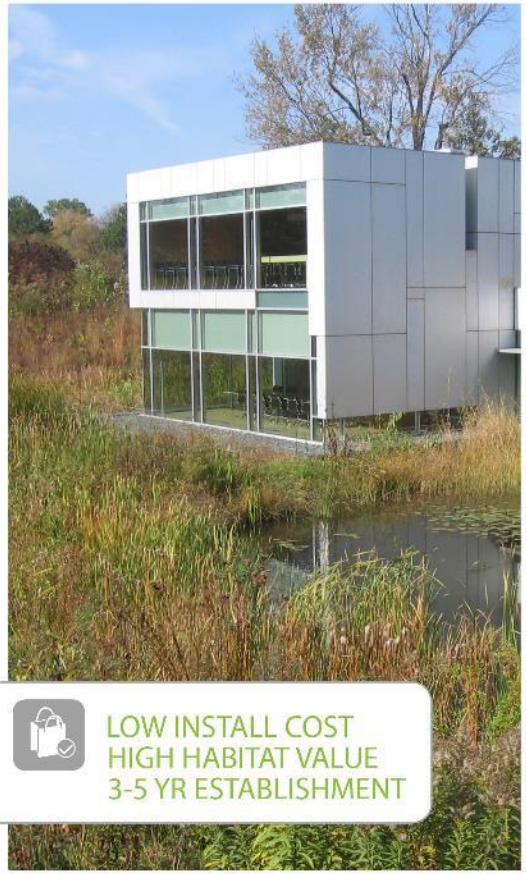
Cultural Practices

". . . naturalistic landscapes require the least oversight and upkeep of any vegetative system because informal planting designs allow for variation in arrangement" - T. Liptan

(Source: "Sustainable Stormwater Management," 2017)

Planting Approaches

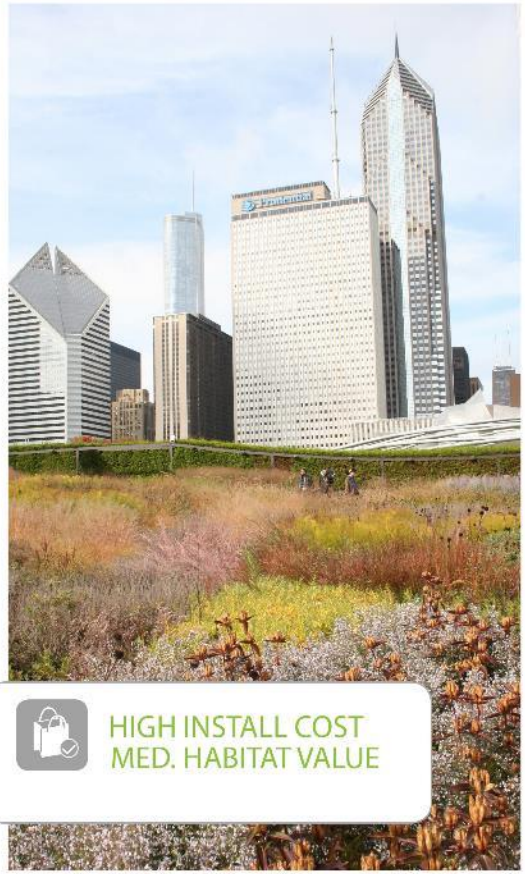
NATURALIZED



LOW INSTALL COST
HIGH HABITAT VALUE
3-5 YR ESTABLISHMENT

KRESGE FOUNDATION HQ

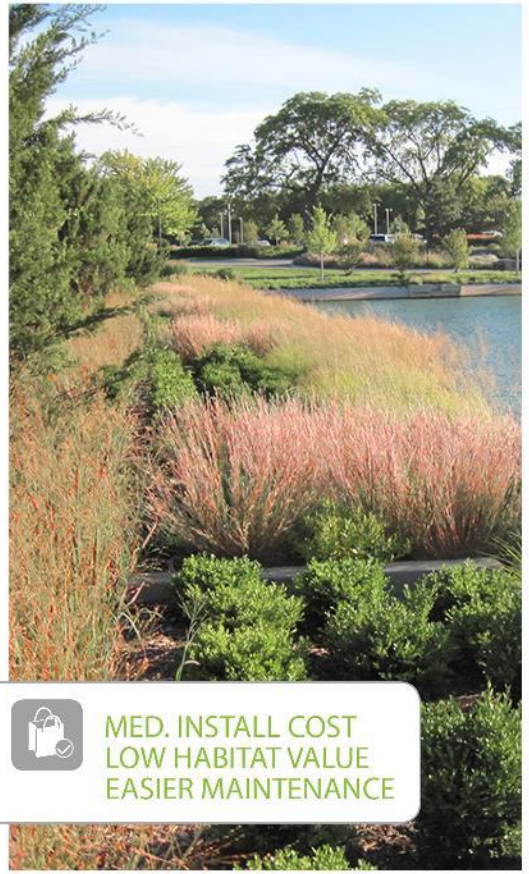
DRIFT



HIGH INSTALL COST
MED. HABITAT VALUE

LURIE GARDEN

FORMAL/BLOCK

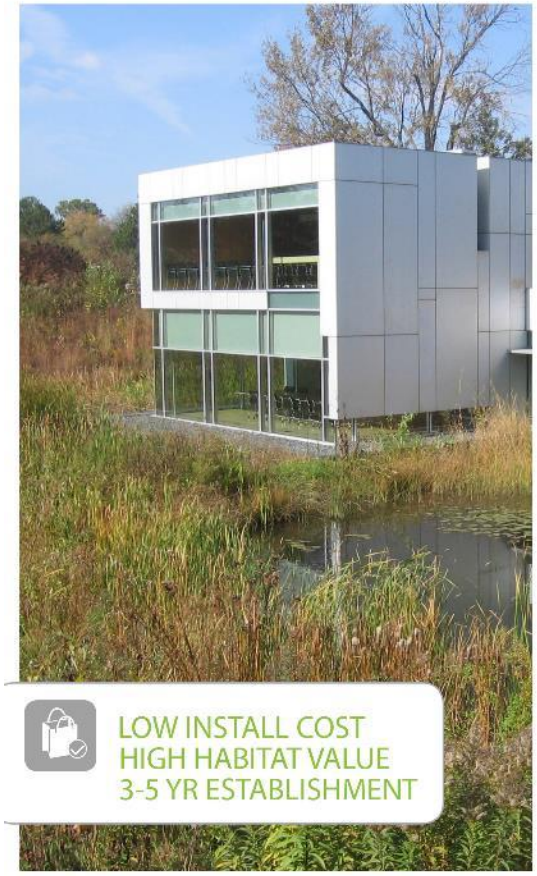


MED. INSTALL COST
LOW HABITAT VALUE
EASIER MAINTENANCE

JOHNSON CONTROLS HQ

Planting Approaches

NATURALIZED



KRESGE FOUNDATION HQ

PROS
- High habitat value, soil health
- Long-term maintenance savings
- Lower inputs of water, fertilizer
- Resistant to pests/diseases
- Sustainable, Self-renewing

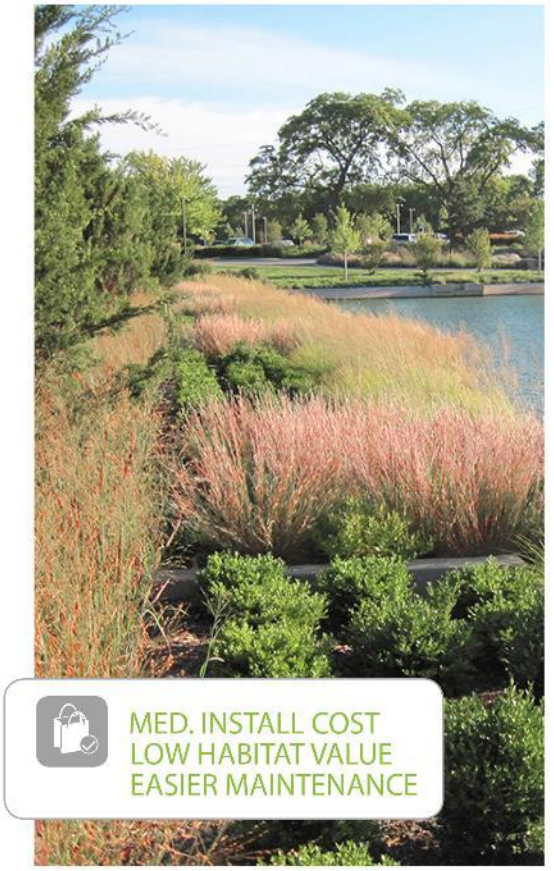
CONS
- Works better with larger, contiguous plantings
- Higher, specialized establishment cost in year 1 through 5
- Weed competition
- Aesthetic is not for everyone

Planting Approaches

PROS
- Beauty
- Stable, consistent maintenance cost
- Easier to weed
- Easier to maintain in smaller, fragmented spaces
- Immediate establishment

CONS
- Lower habitat value
- Larger, long-term maintenance cost
- More inputs of water and fertilizer
- Less resistant to pests/diseases
- Must be replaced every 8 to 15 years

FORMAL/BLOCK



JOHNSON CONTROLS HQ

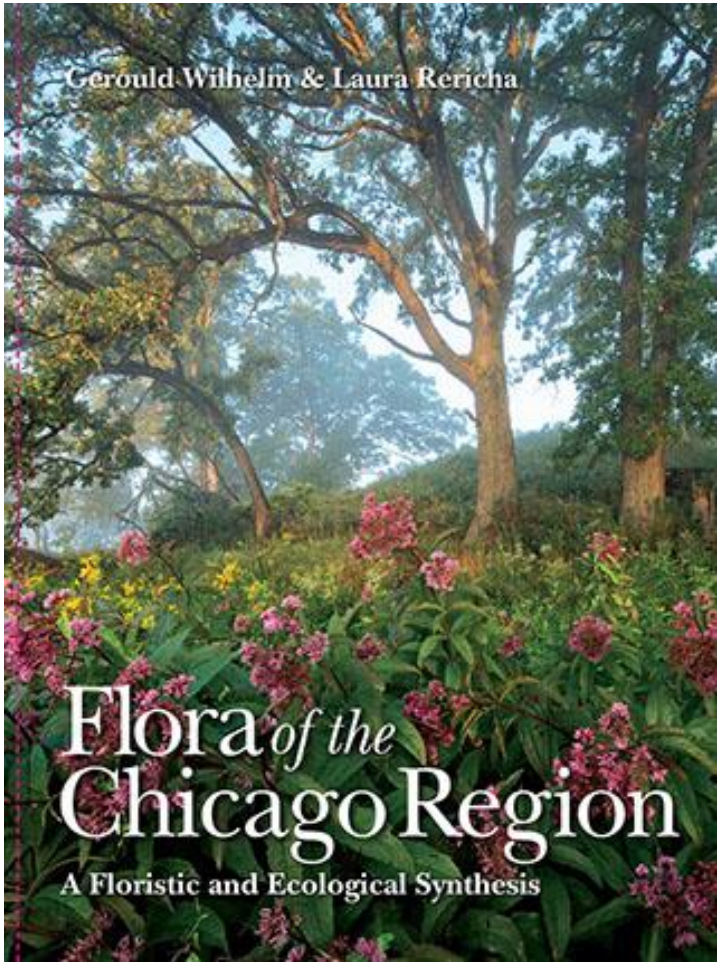
Cultural and Ecological Conditions

- Green Infrastructure Conditions
- Planting Approach (cultural expectations)
- Site Context
- Soil Depth
- Flood Duration
- Soil Moisture
- Soil Temperature
- pH
- Nutrients
- Sun exposure
- Weed competition / Beneficial associations
- Soil Health

Plant Selection

- At least 3,149 naturally occurring vascular plants in the Chicago region

- Several thousand more cultivated plants available from nurseries



Green Infrastructure Sizing Calculator

Milwaukee Metropolitan Sewerage District

Disclaimer

Green infrastructure sizing calculator is specific to MMSD service area, results are not for final design, and not all MMSD green infrastructure strategies are included in the calculator. Refer to MMSD Chapter 13 Rules and Regulations for additional information.

Note: Please provide requested project information in blue boxes.

Project Drainage Area	
1.00	Drainage Area (acres)
1.00	Impervious Drainage Area (acres)
C	Land Use (C = Commercial, I =Industrial, R = Residential)

Project Site Dimensions	
290	Available Project Area Length (feet)
15	Available Project Area Width (feet)
19	:1 Length to Width Ratio
4,350	Available Project Area (ft^2)

Project Specific Questions

Yes	No	
☐	☑	Is the project area for the green infrastructure strategy within the right-of-way?
☑	☐	Are the topographic slopes adjacent to the green infrastructure strategy greater than 12%?
☐	☑	Is the depth to bedrock less than 6 feet?
☐	☑	Is the depth to groundwater less than 6 feet?
☐	☑	Is the project area within 10 feet horizontally of building foundations?
☐	☑	Is the project area within 10 feet laterally from underground sanitary sewer infrastructure or other utilities?

Note: After providing requested project information, green infrastructure strategies which are not recommended based on characteristics for the specific project will not be selectable. Please select an appropriate green infrastructure strategy to begin design and develop costs and quantities.

Green Infrastructure Strategies

Bioswale / Bioretention

Porous Pavement

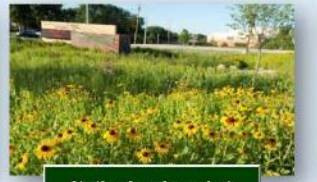
Rain Garden

(max imp. DA = 0.086 ac, max footprint = 300 sf)

Note: If none of the green infrastructure strategies displayed above can be selected based on the specific site-suitability parameters, other green infrastructure strategies may be viable and should be considered, including stormwater trees, native landscaping, and soil amendments. See below for links to typical details and specifications.

Additional Green Infrastructure Strategies (Not Included in Sizing Calculator)

Stormwater Tree



Native Landscaping

Soil Amendments

Stormwater Runoff Capture Goal

Stormwater Runoff Generated from Impervious Surfaces During a 0.5-Inch Rainfall Event **13,600** gallons

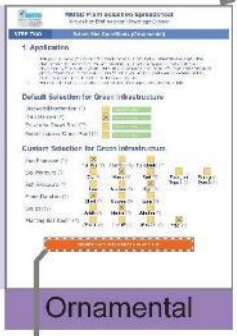
MMSD Plant Selection Spreadsheet Flowchart

DRAFT - SEPTEMBER 20, 2018

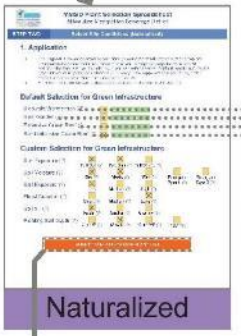
STEP 1:
Introduction/
Choose Design
Approach

Pros/Cons of Ornamental and Naturalized

STEP 2:
Select Site
Conditions



Ornamental



Naturalized

Costs of Ornamental and Naturalized

Patterns

STEP 3:
Plant List

Ornamental

Naturalized

Print Sheets

Print Sheets

Specifications

Direct Links
Supplemental Links
Hyper Links

Inclusion Criteria

- Hardy in Milwaukee Climate
- Generally long-lived
- Suitable for Large-scale Landscape Applications
- Not known to be invasive
- Not overly aggressive, especially if not native
- Commercially available

Planting Groupings

Deciduous Trees

Evergreen Shrubs

Grasses, Sedges, Rushes

Conifer Trees

Broadleaf Evergreens

Bulbs

Ornamental Trees

Vines

Ferns

Deciduous Shrubs

Flowering Perennials

Green Infrastructure Plant Selection Spreadsheet
Milwaukee Metropolitan Sewerage District

Conservation Design Forum

Introduction

Disclaimer

i. This tool is intended to be a starting point for the successful use of plants in green infrastructure applications. It is the responsibility of the local municipality or designer to understand the conditions specific to their site and the requirements for planting. It is recommended that planting plans be developed and/or reviewed by a licensed landscape architect, landscape designer, or qualified tradesperson.

1. Application

i. The Milwaukee Metropolitan Sewerage District (District) has created this tool to help project partners and interested residents with the selection of plants for green infrastructure applications.

ii. Green infrastructure is one piece of the multi-tiered approach to meeting the District's 2035 Vision for zero basement backups, zero overflows, and improved water quality. Widespread green infrastructure plays an important part in achieving the Vision by capturing stormwater. This infrastructure allows stormwater to soak into the ground or be absorbed by plants, and prevents it from entering sewers and contributing to sewer overflows and basement backups.

iii. The District recognizes the important role that plants play in this infrastructure, but also understands that the conditions the plants must survive in can be challenging. This tool allows users to select those conditions and narrow down a master list of plants to reveal the ones most suited to their particular site.

2. Steps to Complete

i. Orange buttons will move you to the next step.

ii. Next, fill in information about your project with the yellow buttons to create a customized plant list.

iii. Green buttons will provide supplemental information.

Step One — Choose Planting Style

1. Ornamental or Naturalized

i. The first choice this tool requires you to make, is to select the type of planting approach that will be used. The two choices offered are, ornamental or naturalized.

ii. An ornamental landscape is one that most people are familiar with. It has been the typical planting approach in the U.S. for the last half century. Ornamental landscapes rely on the use of plants whose traits are carefully selected by growers to be durable, long-lived, and produce bold leaves or flower displays. These plants are typically not native to one specific region having been originally imported from all over the world. Because each selection of plant tends to possess identical genes, these landscapes can be unproductive with plants producing few, if any, offspring. The arrangement of ornamental plantings usually uses plants in blocks or groupings. The simple collection of these large masses of individual plants is what many people think of when they imagine a garden.

iii. Naturalized landscapes are beginning to gain popularity. The naturalized approach utilizes local native plants in arrangements that attempt to mimic a common regional plant community like a prairie. The placement of these plants is more dense and diverse than in an ornamental landscape. Unlike the typical cultivated approach, the naturalized landscape is designed to self-replicate through natural reproduction.

Choose Planting Style

Ornamental

Naturalized

Choose Planting Style

Ornamental

- Ornamental Pros/Cons
- Cost Considerations

Naturalized

- Naturalized Pros/Cons
- Cost Considerations

Green Infrastructure Plant Selection Spreadsheet
Milwaukee Metropolitan Sewerage District

Conservation Design Foru

Step Two — Select Site Conditions (Ornamental)

1. Application

i. This page will allow you to enter the conditions on your site that will determine the appropriate plant material to choose from. You can customize your settings by going directly to #3 and choosing from a range of conditions, or you can select a series of default conditions for typical green infrastructure practices under #2. Once you are happy with your selections, hit the "Submit Data and Create Plant List" button under #4.

ii. For more information on standard green infrastructure practices visit www.freshcoastguardians.com.

2. Default Selection for Green Infrastructure

(?) Bio-Swale	☐	Standard Detail
(?) Rain Garden	☐	Standard Detail
(?) Extensive Green Roof	☐	Standard Detail
(?) Semi-Intensive Green Roof	☐	Standard Detail

3. Custom Selection for Green Infrastructure (?)

(?) Sun Exposure	☐ (?) FULL SUN	☐ (?) PART SUN	☐ (?) FULL SHADE			
(?) Soil Moisture	☐ (?) DRY	☐ (?) MESIC	☐ (?) WET	☐ (?) EMERGENT TYPE 1	☐ (?) EMERGENT TYPE 2	
(?) Salt Exposure	☐ (?) LOW	☐ (?) MEDIUM	☐ (?) HIGH			
(?) Flood Duration	☐ (?) SHORT	☐ (?) MEDIUM	☐ (?) LONG			
(?) Soil pH	☐ (?) MILDLY ACIDIC	☐ (?) NEUTRAL	☐ (?) MILDLY ALKALINE			
(?) Planting Soil Depth	☐ (?) 3" TO 5"	☐ (?) 6" TO 17"	☐ (?) 18" TO 29"	☐ (?) ≥30"		

Clear Selection ☐ Select All ☐

4. SUBMIT DATA AND CREATE PLANT LIST

BACK TO STEP ONE

2. Default Selection for Green Infrastructure

(?) Bio-Swale	☐	Standard Detail
(?) Rain Garden	☐	Standard Detail
(?) Extensive Green Roof	☐	Standard Detail
(?) Semi-Intensive Green Roof	☐	Standard Detail

3. Custom Selection for Green Infrastructure (?)

(?) Sun Exposure	☐ (?) FULL SUN	☐ (?) PART SUN	☐ (?) FULL SHADE		
(?) Soil Moisture	☐ (?) DRY	☐ (?) MESIC	☐ (?) WET	☐ (?) EMERGENT TYPE 1	☐ (?) EMERGENT TYPE 2
(?) Salt Exposure	☐ (?) LOW	☐ (?) MEDIUM	☐ (?) HIGH		
(?) Flood Duration	☐ (?) SHORT	☐ (?) MEDIUM	☐ (?) LONG		
(?) Soil pH	☐ (?) MILDLY ACIDIC	☐ (?) NEUTRAL	☐ (?) MILDLY ALKALINE		
(?) Planting Soil Depth	☐ (?) 3" TO 5"	☐ (?) 6" TO 17"	☐ (?) 18" TO 29"	☐ (?) ≥30"	

Clear Selection ☐ Select All ☐

4. SUBMIT DATA AND CREATE PLANT LIST

Green Infrastructure Plant Selection Spreadsheet

Milwaukee Metropolitan Sewerage District

Conservation Design Forum
Landscape Architecture • Ecological Services
Civil / Water Resources Engineering • Planning

STEP THREE YOUR CUSTOMIZED ORNAMENTAL PLANT LIST

NATIVE RANGE | TOLERANCE TO

* Midwest is defined as the states of Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana, Michigan, and Ohio.
** See green vendor's list for plant suppliers.

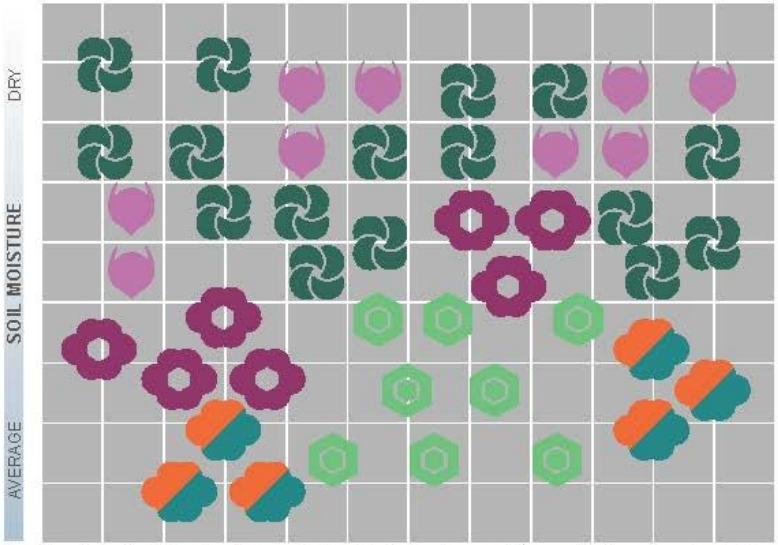
Recommended Street Tree
High performance plants

		Symbol	Scientific Name	Common Name	Spacing	Comments	NOT NATIVE	MID-WEST*	SOUTH WISC.	DEER	RABBIT
Deciduous Trees											
		AC SA	Acer saccharum	Sugar Maple	NA	Tolerates heavy shade, great fall color, likes uncompacted understory		X	X		
		AC SG	Acer saccharum 'Green Mountain'	Green Mountain Sugar Maple	NA	A sugar maple variety more tolerant of urban conditions.		X	X		
		AC AR	Acer x freemanii 'Armstrong'	Armstrong Fastigate Red Maple	NA	Narrow Maple (15'Wx60'T) for wetter soils, hardy hubrid between rubru		X	X		
		AC FR	Acer x freemanii 'Jeffersred' AUTUMN BLAZE	Autumn Blaze Maple	NA	Maple for wetter soils, hardy hybrid between rubrum and saccharinum,		X	X		
		AC RU	Acer rubrum 'Franksred' RED SUNSET	Red Sunset Red Maple	NA	The best red maple cultivar with outstanding red fall color,		X	X		
		BE NI	Betula nigra 'Cully' HERITAGE	Heritage River Birch	NA	Multi-stem for preferred, salmon-cream exfoliating bark, prefers moist a		X	X	X	
		CE OC	Celtis occidentalis 'Prairie Pride'	Prairie Pride Hackberry	NA	Tolerates urban conditions, dimpled bark,		X	X		
		OS VI	Ostrya virginiana	Hop-hornbeam	NA	Spring dig only, small tree for urban conditions		X	X	X	
		PO TR	Populus tremuloides	Quaking Aspen	NA	Multi-stem form preferred, Short-lived, but will sucker clones, full sun w		X	X		
		PR SE	Prunus serotina	Black Cherry	NA	Has tap root - transplant young		X	X		
		QU AL	Quercus alba	White Oak	NA	Spring dig only, beautiful oak - state tree of Illinois, Can be difficult to tr		X	X		
		QU BI	Quercus bicolor	Swamp White Oak	NA	Spring dig only, tolerates wet soils, can be difficult to transplant		X	X		
		QU MA	Quercus macrocarpa	Bur Oak	NA	Spring dig only. Can be difficult to transplant larger plant. very large/wid		X	X		
		QU RU	Quercus rubra	Red Oak	NA	Spring dig only, transplants easier than most oaks		X	X		
		TI AM	Tilia americana 'Redmond'	American Basswood	NA	Pyramidal variety,		X	X		
		ULAM	Ulmus americana x 'Princeton' & 'Valley Forge'	Hybrid American Elm	NA	Excellent resistance to dutch elm disease and elm leaf beatle, but susc		X	X		
Conifer Trees											
		ME GL	Metasequoia glyptostroboides	Dawn Redwood	NA	Needs moist to wet soils, deciduous conifer, very large tree	X			X	
		TA DI	Taxodium distichum	Common Bald cypress	NA	Prefers moist, acidic, sandy soil		X		X	
		TH ON	Thuja occidentalis 'Nigra'	Nigra Arborvitae	NA	Conical form, (5'wx25'h), good dark green color year-round		X	X		
		TH OC	Thuja occidentalis 'Techny'	Techny Arborvitae	NA	Intolerant of dry conditions, avoid exposed sites, (8'wx18'h)		X	X		
Ornamental Trees											
		AM LA	Amelanchier laevis	Allegheny Serviceberry	NA	Multi-stem form preferred. Tolerant of wide range of soils, edible fruit.		X	X		
Deciduous Shrubs											
		CP OC	Cephalanthus occidentalis	Buttonbush	6' O.C.	Interesting ball-shaped flowers, tolerant of wet soils.		X	X		
		CO SE	Cornus sericea 'Flaviramea'	Flaviramea Redosier Dogwood	5' O.C.	Bright yellow stems in winter, shortish at 6' tall		X	X	X	
		CO IS	Cornus sericea 'Isanti'	Isanti Redosier Dogwood	5' O.C.	Bright red stems in winter, more compact than species to 5' tall,		X	X	X	
		CO AM	Corylus americana	American filbert	6' O.C.	Very large shrub to 15' tall, edible nuts, will spread		X	X		
		HY FR	Hypericum frondosum 'Sunburst'	Sunburst Golden St. Johnswort	3' O.C.	Larger flowers on smaller (3' tall) plant than species, showy yellow flow		X			
		IL VE	Ilex verticillata	Common Winterberry	5' O.C.	Showy red berries in winter, tolerates wet soil		X	X		
		IT VL	Itea virginica 'Little Henry'	Little Henry Sweetspire	3' O.C.	Compact form (3'-4' tall) with red-purple fall color,		X			
		IT VH	Itea virginica 'Henry's Garnet'	Henry's Garnet Sweetspire	4' O.C.	Long flowers up to 6", brilliant reddish purple fall color, grows to 5' high		X			
		PH OP	Physocarpus opulifolius 'Diablo'	Diablo Purpleleaf Ninebark	6' O.C.	Purple leaved ninebark for contrast, drought tolerant, tough shrub		X	X		
		PO FR	Potentilla fruticosa (Dasiphora fruticosa)	Shrubby Cinquefoil	30" O.C.	Versatile, long-blooming shrub		X	X	X	X
		PO MT	Potentilla fruticosa 'Uman' MANGO TANGO (D. fruticos	Mango Tango Potentilla	30" O.C.	Orangy-yellow flower		X	X	X	X

Plant Arrangement

BIOSWALE - ADVANCED

9' x 12' PLOT (108 S.F.) • 39-46 PLANTS • 15" TO 18" SPACING
FULL SUN



Remarks: The plants in this mix offer a variety of leaf structure and flower displays throughout the year. Cape Breeze Switchgrass provides the backbone to the display with an upright and compact form. The Sideoats Grama is distinct for its arrangement of oak-like seed spikes which hang from one side of the stem. The three flowering perennials in the mix will ensure that something is always in bloom from May through August.

QTY	PERENNIALS
7	*PENSTEMON DIGITALIS 'HUSKER'S RED'* FOXGLOVE BEARDTONGUE • (15% OF MIX)
9	*NEPETA X FAASSENII 'JUNIOR WALKER'* WALKER'S LOW CATMINT • (20% OF MIX)
6	*HELIOPSIS HELIANTHOIDES 'PRAIRIE SUNSET'* FALSE SUNFLOWER • (13% OF MIX)
	GRASSES
16	*BOUTELOUA CURTIPENDULA* SIDEOATS GRAMA • (35% OF MIX)
8	*PANICUM VIRGATUM 'CAPE BREEZE'* CAPE BREEZE SWITCHGRASS • (17% OF MIX)





GREEN INFRASTRUCTURE PLANTING PLANS

www.freshcoastguardians.com

Conservation Design Forum

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

FRESH COAST GUARDIANS