



## Wetland Restoration

**Technical Training and Certification Program**




BOARD OF WATER AND SOIL RESOURCES | [www.bwsr.state.mn.us/wetlands](http://www.bwsr.state.mn.us/wetlands)

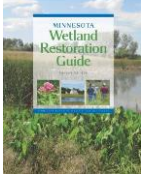
1

## Agenda

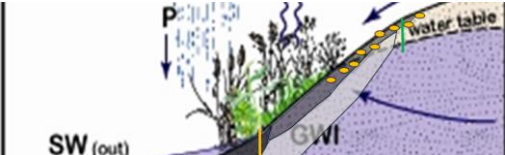
2024 Wetland Restoration - Hutchinson, MN

Day One - May 25, 2024		Speaker
Registration & Housekeeping		
Intro: Wetlands		Demmer
Planning Considerations		Cham
Break		
Site Assessment - Engineering		Peter
Site Assessment - Vegetation		Shaw
Lunch & Travel to Site		
Site Assessment Field Visit		Peter, Shaw, Carlson
End of Day		
Day Two - May 26, 2024		Speaker
Wetland Restoration Design		Cham
Soil Mix Selection, Site Prep, and Seeding		Vogel, Shaw
Break		
Monitoring		Demmer, Meyer, Carlson
Lunch & Travel to Site		
Site Field Visit		Peter, Shaw, Carlson
End of Day		


[MN Wetland Restoration Guide](#)



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## Introduction to the HGM Classes of MN Wetlands





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## What is a Wetland?

Definition: Those areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions.

Hydrology + Vegetation + Soil = Wetland

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### 3 Parameters of a Wetland

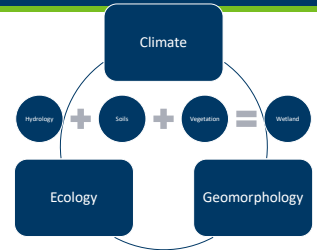
- 3 Parameters of a wetland
- Hydrology- frequency and duration of movement of water through a landscape
- Soil- organic and mineral surfaces which often exhibit characteristics that it has been in saturated conditions
- Vegetation- plant community and prevalence of species that have made adaptations to live in saturated conditions



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### Key factors

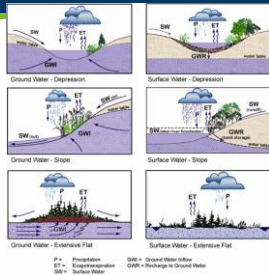
- Climate
- Ecology
- Hydrology
- Geomorphology
- Soil
- Plant Communities
- Wetlands



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### Hydrogeomorphic Method (HGM)

- Assesses functional conditions of a specific wetland referenced to data collected from wetlands across a range of physical conditions
- Established Classes based on geomorphic, hydrology and hydraulic functions of palustrine wetlands



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### HGM Classes



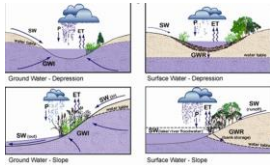
- RIVERINE
- DEPRESSION
- SLOPE
- MINERAL SOIL FLATS
- ORGANIC SOIL FLATS
- ESTUARINE FRINGE
- LACUSTRINE FRINGE



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### HGM Subclasses

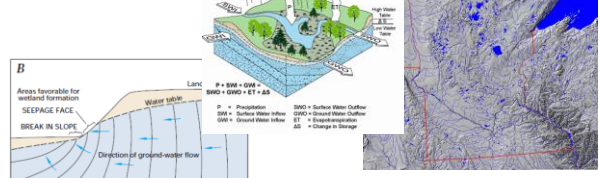
- Determined by:
  - Hydrology Input:
    - Groundwater
    - Surface water
  - Hydrology Output
    - Surface
    - Ground



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### Parameters of HGM

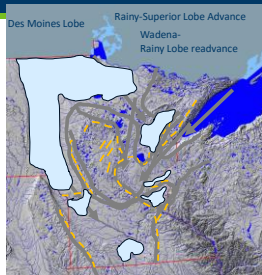
- **Geomorphology**- landscape position, surface shape
- **Hydrology**- water source and output
- **Hydraulics**- hydrodynamics



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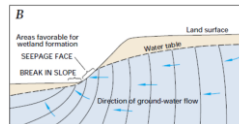
### In MN, geomorphology is result of glacial geology

Recent Glacial Geology of MN



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### Hydraulics- how water moves



- Uni-directional
- Bi-directional
  - Estuarine and lacustrine fringe

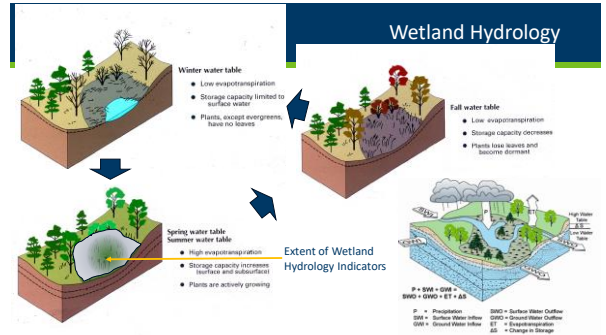


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### Hydrology of HGM Classes

HGM Class (subclass)	Hydrology Inputs	Hydrology Outputs	Hydraulics
RIVERINE	surface flow precipitation groundwater	surface flow evapotranspiration	unidirectional
DEPRESSIONAL- surface	surface flow precipitation	groundwater recharge evapotranspiration	unidirectional
DEPRESSIONAL- ground	groundwater precipitation	intermittent surface flow evapotranspiration groundwater recharge	unidirectional
SLOPED- surface	surface flow precipitation	surface flow evapotranspiration groundwater recharge	unidirectional
SLOPED- ground	groundwater surface water precipitation	surface flow evapotranspiration	unidirectional
MINERAL SOIL FLATS	precipitation intermittent surface flow	evapotranspiration intermittent surface flow	unidirectional
ORGANIC SOIL FLATS	groundwater precipitation	intermittent surface flow Evapotranspiration	unidirectional
ESTUARINE FRINGE	surface flow tidal exchange precipitation	tidal exchange surface flow Evapotranspiration	bidirectional
LACUSTRINE FRINGE	surface flow groundwater precipitation	return flow to lake surface flow evapotranspiration	bidirectional

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### Different water levels leave different evidence



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### Hydrology Indicator Groups

**Group A** – direct observation of water

**Group B** – evidence of flooding/ponding

**Group C** – evidence of current or recent saturation.

**Group D** – Landscape and veg. characteristics that indicate contemporary wetland conditions.

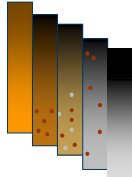
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Hydric Soil Development

Hydric soils indicators develop in **anaerobic** conditions by the process of :

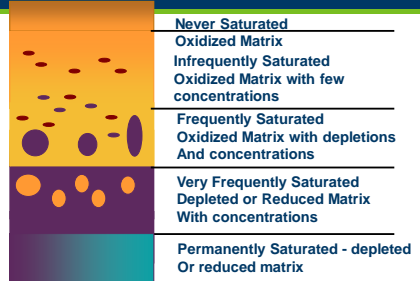
1. **Reduction** and Re-oxidation of Iron
2. **Organic Matter** Accumulation

Foundation of the Field Indicator Manual.



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Hydric Soil Development and Duration under Aquic Conditions



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Hydric Soil Developed in Inundated Conditions



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Hydric Soil Developed in Saturated Conditions



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### Common Indicators for Depression Wetlands

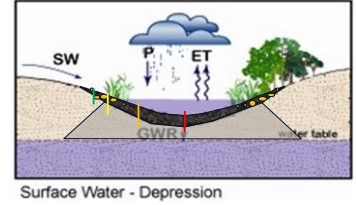
HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
Depression	Seasonally Flooded	A1- Surface Water, B1- Water Marks, B3- Drift Deposits, B8- Sparsely Vegetated Concave Surface, B6- Surface Soil Cracks, C2- Dry-Season Water Table, D2- Geomorphic Position	A11- Depleted Below Dark Surface, A12- Thick Dark Surface, F3- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, F8- Redox Depression, S1- Sandy Mucky Mineral, S2- Sandy Redox
Depression	Saturated	A2- High Water Table, A3- Saturation, B2- Sediment Deposits, C3- Oxidized Rhizosphere along living roots, C7- Thin Muck Surface, C9- Saturation Visible on Aerial Imagery, D2- Geomorphic Position, D5- FAC-neutral Test	A11- Depleted Below Dark Surface, A12- Thick Dark Surface, F3- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, F8- Redox Depression, S1- Sandy Mucky Mineral, S2- Sandy Redox
Depression	Semi permanently flooded (up to 6")	A1- Surface Water, A2- High Water Table, B1- Water Marks, B7- Inundation Visible on Aerial Imagery, B14- Tidal Aquatic Plants, C9- Gauge or well data	A1- Histosol, A2- Histic Epipedon, A5- Black Histic, A11- Depleted Below Dark Surface, A12- Thick Dark Surface



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### Cross Section of Hydric Soils in Depression Wetlands

- Histosol
- Thick dark surface
- Depleted below dark surface
- Redox dark surface



Surface Water - Depression

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### Common Indicators for Sloped Wetlands

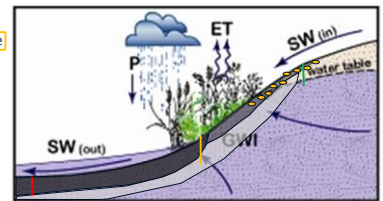
HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
Sloped	Saturated	A2- High Water Table, A3- Saturation, B8- Sparsely Vegetated Concave Surface, B15- Marl Deposits, C7- Thin Muck Surface, C9- Saturation Visible on Aerial Imagery, D2- Geomorphic Position, D5- FAC-neutral Test	A1- Histosol, A2- Histic Epipedon, A3- Black Histic, A12- Depleted Below Dark Surface, A12- Thick Dark Surface, F1- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, S1- Sandy Mucky Mineral, S3- 2" Mucky Peat, S5- Sandy Redox



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### Cross Section of Hydric Soils in Sloped Wetlands

- Histosol
- Depleted below dark surface
- Redox Dark Surface



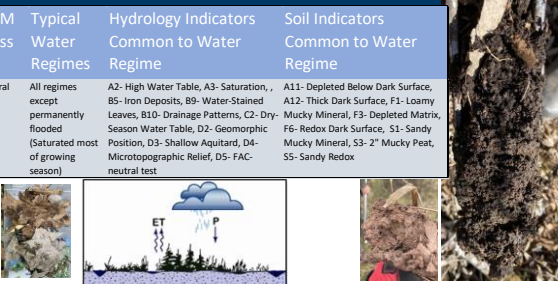
Ground Water - Slope

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### Common Indicators for Mineral Flat Wetlands

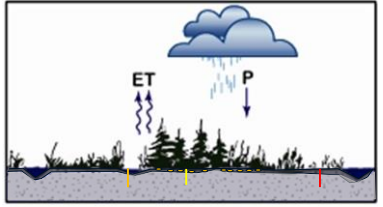
HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
Mineral Flat	All regimes except permanently flooded (Saturated most of growing season)	A2- High Water Table, A3- Saturation, B5- Iron Deposits, B9- Water-Stained Leaves, B10- Drainage Patterns, C2- Dry-Season Water Table, D2- Geomorphic Position, D3- Shallow Aquitard, D4- Microtopographic Relief, D5- FAC-neutral test	A11- Depleted Below Dark Surface, A12- Thick Dark Surface, F1- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, S1- Sandy Mucky Mineral, S3- 2" Mucky Peat, S5- Sandy Redox



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### Cross Section of Hydric Soil in Mineral Flat Wetlands

- Depleted Below dark Surface
- Loamy mucky mineral
- Redox Dark Surface

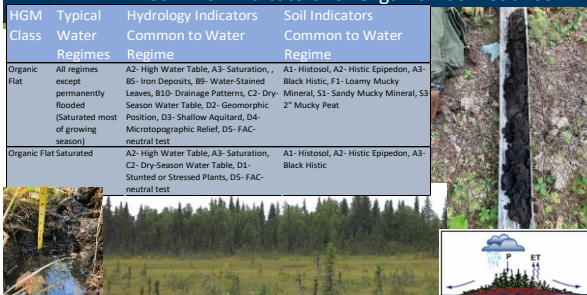


Surface Water - Extensive Flat

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### Common Indicators for Organic Flat Wetlands

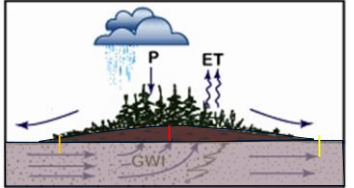
HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
Organic Flat	All regimes except permanently flooded (Saturated most of growing season)	A2- High Water Table, A3- Saturation, B5- Iron Deposits, B9- Water-Stained Leaves, B10- Drainage Patterns, C2- Dry-Season Water Table, D2- Geomorphic Position, D3- Shallow Aquitard, D4- Microtopographic Relief, D5- FAC-neutral test	A1- Histosol, A2- Histic Epipedon, A3- Black Histic, F1- Loamy Mucky Mineral, S1- Sandy Mucky Mineral, S3- 2" Mucky Peat
Organic Flat Saturated		A2- High Water Table, A3- Saturation, C2- Dry-Season Water Table, D1- Stunted or Stressed Plants, D5- FAC-neutral test	A1- Histosol, A2- Histic Epipedon, A3- Black Histic



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### Cross Section of Hydric Soils in Organic Flat Wetland

- Histosol
- Histic Epipedon
- Loamy mucky mineral

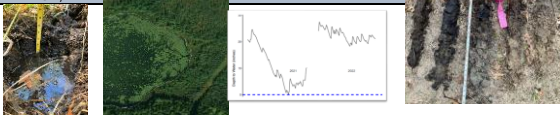


Ground Water - Extensive Flat

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### Common Indicators for Lacustrine Fringe Wetlands

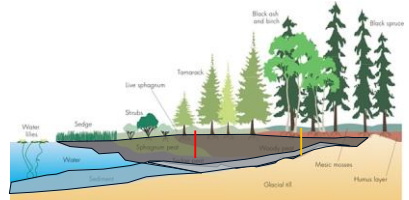
HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
Lacustrine Fringe	Semi permanently to permanently flooded (up to 8.2')	A1- Surface Water, A2- High Water Table, B1- Water Marks, B7- Inundation Visible on Aerial Imagery, B14- True Aquatic Plants, D9- Gauge or Well Data	A1- Histosol, A2- Histic Epipedon, A3- Black Histic, A11- Depleted Below Dark Surface, A12- Thick Dark Surface



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### Cross Section of Hydric Soils in Lacustrine Fringe

- **Histosol**
- **Thick Dark Surface**



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### Common Indicators for Riverine Wetlands

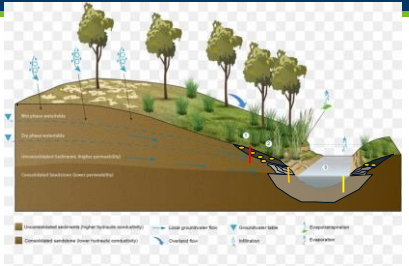
HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
Riverine	Temporary Flooded	B1- Water Marks, B2- Sediment Deposits, D3- Drift Deposits, B6- Sparsely Vegetated Concave Surface, B10- Drainage Patterns, C20 Dry Season Water Table, D2- Geomorphic Position	A5- Stratified Layers, F1- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, F8- Redox Depression, S1- Sandy Mucky Mineral, S5- Sandy Redox



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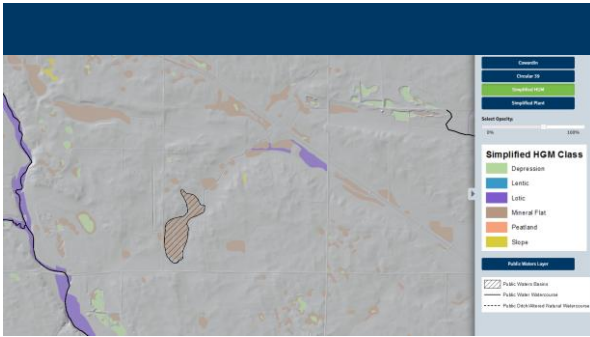
### Cross Section of Hydric Soils in Riverine Wetland

- **Redox dark surface**
- **Stratified Layers**
- **Depleted or Gleyed Matrix**

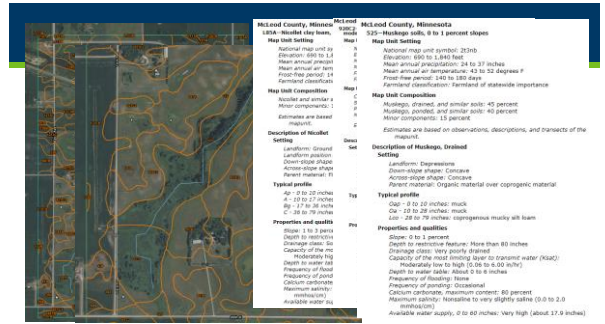


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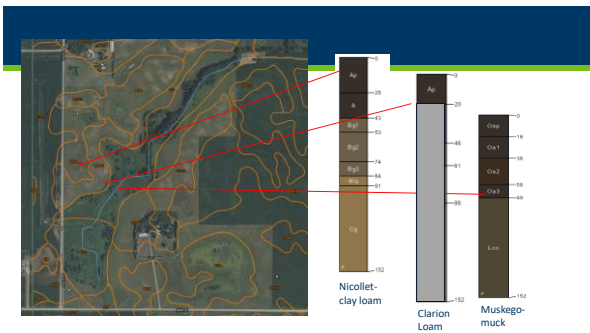




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### Main points to consider

- HGM Class and subclasses are based on geomorphology, hydrology and hydraulics
- Hydrology indicators provide evidence of water regimes
- But...hydrology is the shortest-term evidence of wetland indicators
- Soil indicators correlate with hydrology indicators and provide further evidence of water regimes
- Water regimes correlate with plant communities...

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## Wetland Restoration Overview – Planning Considerations

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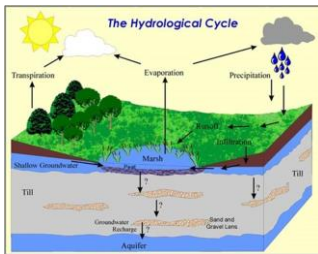
## Wetlands in MN

- Wetlands cover 8.7 million Acres
- 9.7 million acres of Wetlands have been drained or filled

Source: BWSR Wetland Restoration Guide (U. of MN, 1984)

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## Hydrologic Cycle of Typical MN Pothole Wetland



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## Wetland Benefits

- Erosion Control
- Flood Control
- Ground water recharge & Discharge
- Water quality
- Rare Species Habitat
- Recreation
- Wildlife Habitat

Source: BWSR Wetland Restoration Guide (U. of MN, 1984)

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### What does Altered Wetland Mean?

- Decreases the input or increases the output



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### Effectively Drained

- A condition where ground or surface water has been removed



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### Restoration vs Creation vs Enhancement

- Wetland Restoration
- Wetland Creation
- Wetland Enhancement

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### What NRCS Practice Standard Number am I??

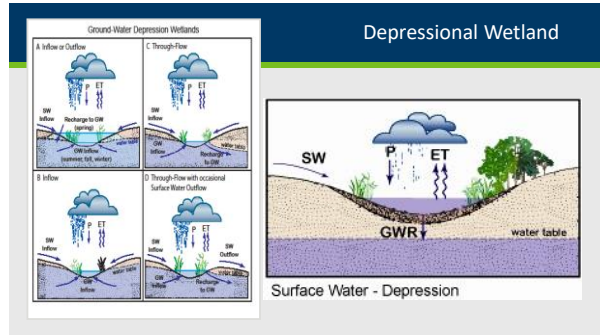
	A. 657	B. 658	C. 659
Wetland Creation	A	B	C
Wetland Enhancement	A	B	C
Wetland Restoration	A	B	C

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What NRCS Practice Standard Number am I??

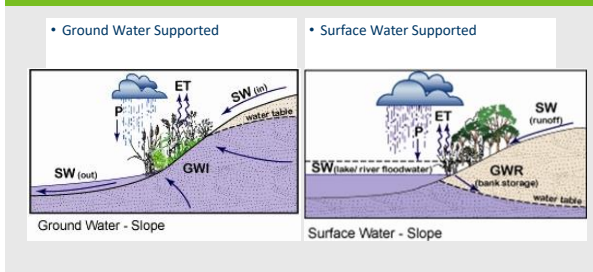
	A. 657	B. 658	C. 659
Wetland Creation	A	<b>B</b>	C
Wetland Enhancement	A	B	<b>C</b>
Wetland Restoration	<b>A</b>	B	C

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Sloped Wetlands



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Why is it important to know the type of Wetland?

- Influences how they were drained
- How to restore them



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Example

- Surface Water Supported Wetland



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Wetlands Farmed Under Natural Conditions

- Hydrology has not been manipulated
- Hydrophytic vegetation has been removed
- Often mapped by NRCS as a "W"



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Wetlands Farmed under Natural Conditions

- Restoration is achieved by re-establishing hydrophytic vegetation



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Drained and Altered Wetlands

- Hydrology has been manipulated
- Often mapped by NRCS as a "FW" and "PC"



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## Drained and Altered Wetlands

- Restoration should address both hydrology and vegetation



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## Common Restoration Strategies

- Tile Blocks
- Outletting Incoming Drainage Tile
- Rerouting Tile and Ditch Systems
- Removing, Relocating, and Installing Drainage Lift Stations
- Sediment/Vegetation Removal
- Ditch Blocks and Fills
- Earthen Embankments
- Wetland Outlets

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## Statewide Wetland Restoration Strategy

- Developed in 2009
- Prioritize Restorations
- Improve coordination
- Design and Produce Better Wetland Restorations

Source: MN Wetland Restoration Guide

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## Project Goals

- Targeted Wildlife
- Improve downstream water quality
- Flood Control
- Groundwater Protection
- Increased Landscape Diversity
- Targeted plant communities
- Specific management objectives

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### Goals & Objectives



Source: MN Wetland Restoration Guide

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### Goals & Objectives



Goals VS Objectives

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### Considerations for Goals & Objectives

- Identify general goals
- Be realistic
- Be consistent with
  - Programs
  - Agencies
  - Sponsoring Organizations



Source: MN Wetland Restoration Guide

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### Restoring to Historic Conditions



Source: MN Wetland Restoration Guide

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Measurable Outcomes		
Goal	Objective(s)	Outcome(s)
Provide high quality wildlife habitat and plant diversity	High interspersed of plant community types achieved by implementing a diverse seeding and management plan Selective shallow scraping to remove sediment and create deeper water regimes	At least 3 different plant community types composed of 12 or more native plant species Scraped areas with normal water depths from 0.5 to 2.5 feet during the growing season At least 3 nesting pair of waterfowl utilize the site each year
Improve flood conditions in downstream lake by attenuating floodwater	Establish dense upland and wetland vegetation to slow and intercept flood waters	At least 90% areal coverage of vegetation and at least 30% coverage by shrubs and trees
Restore seasonally flooded wet meadow	Break drainage tile to restore natural hydrology Establish diverse native vegetation in wetland and upland project areas	Surface water present in 50% of the basin for at least 14 consecutive days from May until June. At least 8 or more dominant native plant species in upland and wetland plant communities
Provide breeding habitat for amphibians	Construct earthen embankment across drainage ditch and install water control structure	At least 6 inches of surface water in 50% of the basin until June 1

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Recap

## Type of Wetland

### Goals

### Objectives

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### Engineering Site Assessments for Wetlands






May 2024

Technical Training and Certification Program

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## MN Wetland Restoration Guide

Restoring Conservation Lands

Wetland Restoration

Wetland Restoration Guide

Vegetation Establishment & Regrowth

Pollinator Habitat

Urban Stormwater Management



Welcome to the "Minnesota Wetland Restoration Guide" web site. This site is designed to provide easy access to the contents of the Guide, whether the user chooses to view it online or print it out as a reference document.

The Minnesota Wetland Restoration Guide is a comprehensive multidisciplinary document that offers sound engineering and ecological principles for restoring and creating functional and productive wetlands in Minnesota.

SECTION

# 3

## Site Assessment and Evaluation

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## First glance

What are the first aspects of a site you should look for?

What has not changed over the years?

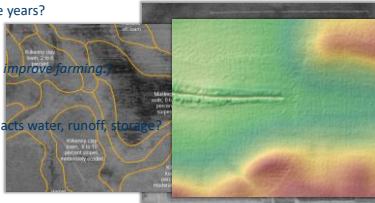
- SOILS

What has changed? (-Likely, to improve farming)

- HYDROLOGY

What else hasn't changed; impacts water, runoff, storage?

- TOPOGRAPHY



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## Investigation role

*You don't have to have all the answers but know what questions to ask.*

The line from site assessment (i.e. what's possible and feasible) to design (what will actually work) is blurry!

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## PROGRAM RULES

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C3softworks games

<https://bravozone.us>

ID: 0097

*You'll need to enter your name  
(first name is fine)*

- *Questions are 30 sec.*

- *Have EFH Fig 14-34 ready*



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Example 1 – Dodge County

5. Jackson Binder.pdf  
9. Franklin Binder.pdf  
1. Dodge Binder.pdf

74

Example 1 – Dodge County

July 27, 2019 photo  
5.4" rain

	0.85
	0.80
	0.47
	2.52
	0.43
	0.30
	0.50
	0.50
	0.30
	0.20
	0

75

Topography

Example 1 – Dodge County

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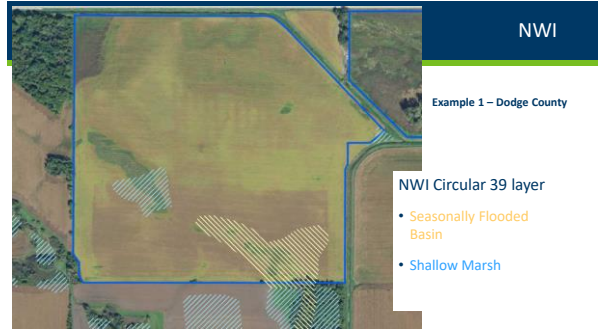
Soils

Engineering Properties Report

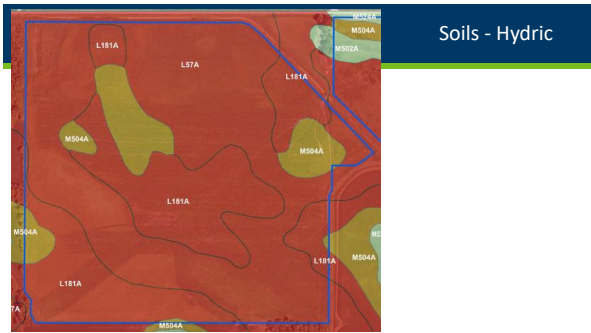
77



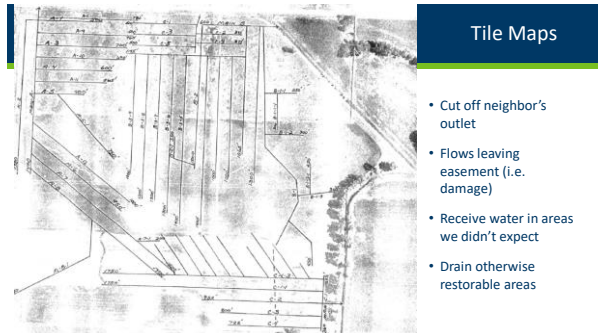
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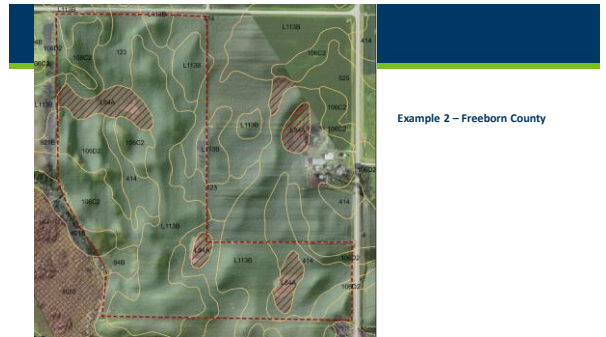
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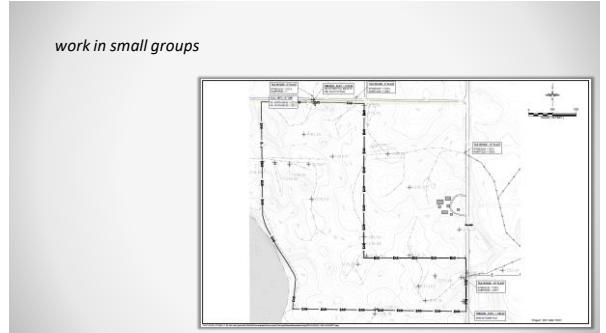




Example 2 – Freeborn County

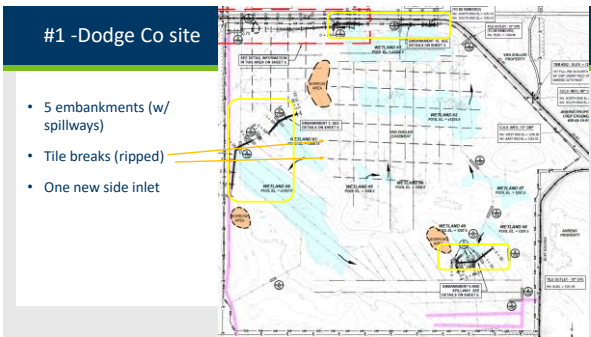
August 1938  
May 1951

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work in small groups

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#1 -Dodge Co site

- 5 embankments (w/ spillways)
- Tile breaks (ripped)
- One new side inlet

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#2 -Freeborn Co site

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#2- Freeborn Co. site

South / East

Design Totals:

- 4 embankments
- 1275 LF tile breaks
- 515 CY scrapes



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Design Example

Example 3 – Jackson County

Site assessment today, design tomorrow

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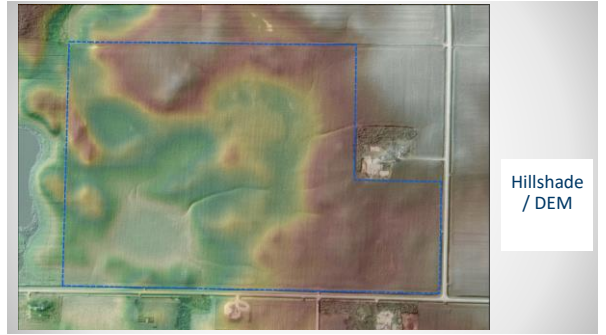
92



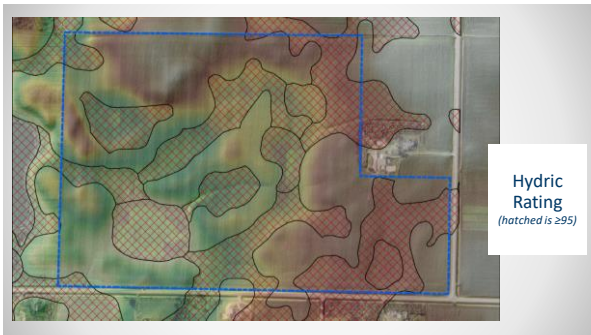
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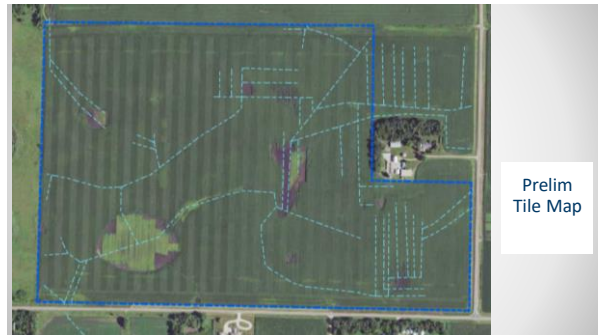
94



95

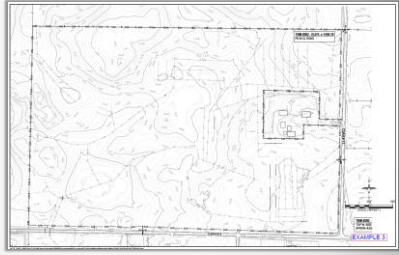


96



97

work on site assessment



98

Identify restoration potential on #3 example



This is a different RIM restoration

99



Wetland Site Assessment - Vegetation  
2024

m BOARD OF WATER AND SOIL RESOURCES

Optimal Taylor Grass (Mn) | see.gov/soilrestoration

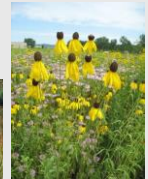
D

100



Vegetation Site Assessment

Goals – an important starting point



D

101

**Vegetation Site Assessment**

Potential Vegetation Goals – Project Scale

D

102

**Vegetation Site Assessment**

Potential Vegetation Goals – Project Scale

- Restore to historic plant communities
- Stabilize soils
- Restore plant diversity
  - Restore a resilient plant community
  - Benefit at-risk wildlife
  - Benefit game species
  - Benefit overall wildlife biodiversity
- Meet mitigation performance standards or other program requirements
- Landowner goals

D

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**Vegetation Site Assessment**



D

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**Site Assessment**

Site Assessment Table

	Site Assessment Table	Comments
Site History	Information for Restoration Plan Development Historical land uses have a big influence on the potential for native seedbank and soil health, as well as the presence of weeds.	
Surrounding Land use and Stressors	Surrounding land uses can cause sedimentation, the introduction of pollutants, nutrients or pesticides, as well as the introduction of aggressive species.	
Hydrology	Site conditions will help determine potential areas of nutrient and pollutant concentrations as well as planting areas, seed rates, and other planting strategies.	
Geology and Soils Information	Geology and soils influence erosion potential as well as nutrient levels, infiltration rates and seedling rates.	
Hydrology	The flow of water, areas of concentrated flow, depth of groundwater influence restoration strategy and appropriate seed mixes and other plant materials.	
Existing Vegetation/Conditions	Existing species or invasive species presence and influence the planning of site preparation, planting and maintenance strategies.	
Unique Natural Resources	Ferns, vernal pools, nesting locations and rock outcrops are all examples of unique natural resources that should be noted as part of the site assessment.	
Wildlife Specific Opportunities	Opportunities such as connections that can be made between habitats and opportunities to restore habitat for specific species should be incorporated into the restoration plan.	
Other Opportunities		

D

105

**Site Assessment**

Site Assessment Table


Site Assessment Table	
Information	Importance for Restoration Plan Development
Site History	Historical landuse can have a big influence on the potential for native seedbank and soil health, as well as the presence of weeds.

D

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**Site History**


- Site History
  - General history (photos, land survey, vegetation)
  - Agriculture (types, duration, and intensity) (Landowner)
  - Hydrology alteration (Landowner/Engineers)
  - Previous restoration (Landowner/Conservation District)
  - Site management (Landowner/Conservation District)



D

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**Site History**



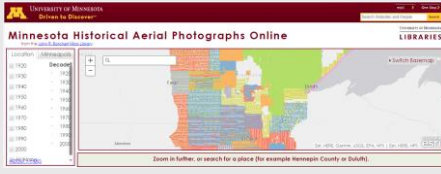
1855 public land survey map overlaying recent aerial imagery

[The Public Land Survey System \(state.mn.us\)](http://state.mn.us)

D

108

**Site History**



[MHAPO \(umn.edu\)](http://mhafo.umn.edu)

109



### Site History

1938 Imagery  
Ditches

1947 Imagery

1953 Imagery  
Additional Ditches

1978 Imagery

D

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### Site History – Field Site

Imagery Date: 9/21/1978

Imagery Date: 10/12/1996

Imagery Date: 12/21/2006

D

111

### Site Assessment

Site Assessment Table

Surrounding Landuse and Stressors	Surrounding landuses can cause sedimentation, the introduction of pollutants, nutrients or pesticides, as well as the introduction of aggressive species.
-----------------------------------	---

D

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### Surrounding Landuse and Stressors

- \*Surrounding Landuse and Stressors
  - Adjacent or nearby Native plant communities
  - Surrounding Agriculture (types, duration, and intensity)
  - Surrounding Industry
  - Surrounding Nutrient Sources
  - \*Chemical use
  - Surrounding Hydrology alteration

D

113

 Surrounding Land use and Stressors



Reviewing aerial images of surrounding areas is valuable

D

114

 Surrounding Land use and Stressors

Potential Site Stressors

- Water Fluctuations
- High Nutrients
- Sediment
- Pollutants
- Invasive Plants
- Herbivores



D

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 Surrounding Land use and Stressors

Potential Site Stressors



D

116

 Surrounding Land use and Stressors

Is reed canary grass present in or around the site?



D

117

**Surrounding Landuse and Stressors**

Are cattails present or a risk?



D

118

**Surrounding Landuse and Stressors**

Surrounding landuse can be positive. Surrounding reference sites can be valuable for understanding restoration potential and as a seed source.



D

119

**Site Assessment**

Site Assessment Table

Topography	Site contours will help determine potential areas of nutrient and pollutant concentrations as well as planting zones, seed mixes, and other planting strategies.
------------	--


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120

**Topography**

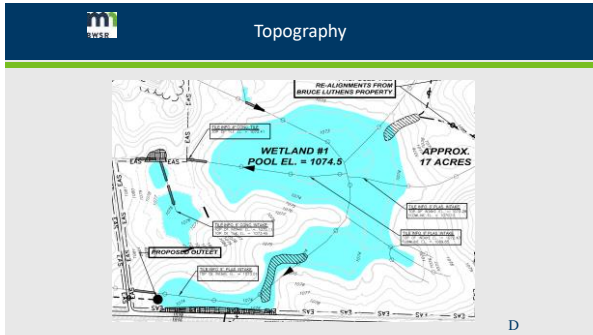
•Topography

Site contours will help determine potential areas of nutrient and pollutant concentrations as well as planting zones, seed mixes, and other planting strategies.



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**Geology and Soils**

Site Assessment Table

Geology and Soils Information	Geology and soils influence erosion potential as well as nutrient levels, infiltration rates and seeding zones.
-------------------------------	---



K

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**Geology and Soils**

NRCS Web Soil Survey

- To begin, navigate to the NRCS Web Soil Survey landing page and click the green "Start WSS" button.

USDA Web Soil Survey

You are here: Web Soil Survey Home

Search: Enter Keyword, All NRCS Sites, Browse by Subject, Soils Home

START WSS

Want To: Start Web Soil Survey (WSS), Know Web Soil Survey, Requirements, Know Web Soil

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**Geology and Soils**

Web Soil Survey

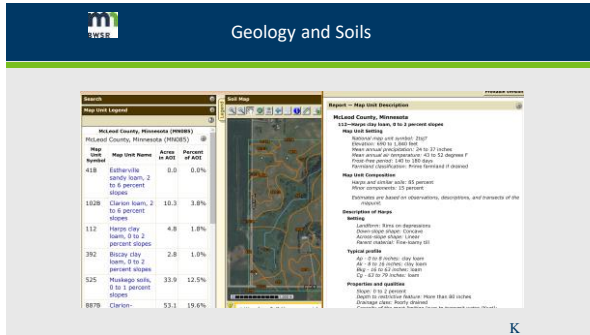
Map of Selected Area

Map Properties

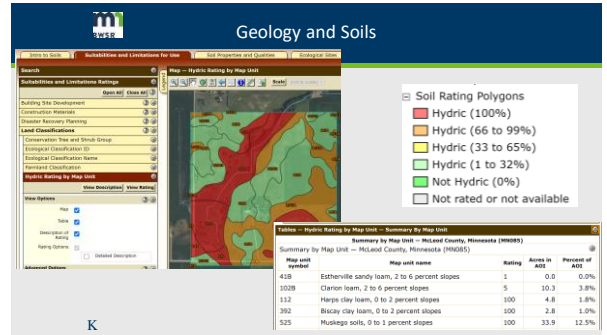
Map Data Available from the Web Soil Survey

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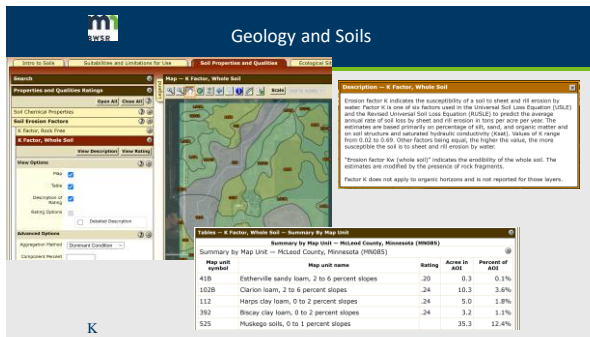
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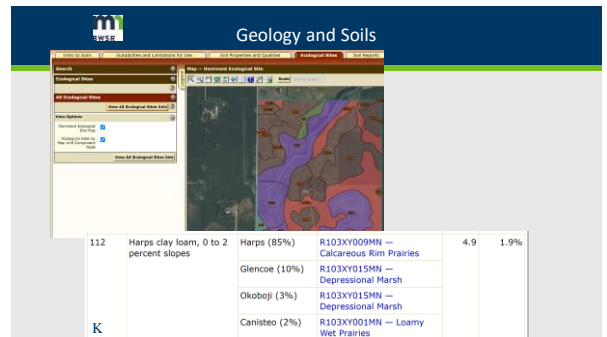
126



127



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**Geology and Soils**

**Ecological site concept**

The Depressional Marsh ecological site is extensive (~190,000 acres) in MRLA 103 and occurs in the central prairie region and the northeastern Big Woods ecoregion. In combination with adjacent sloping ground classifies this site as a **prairie wetland**. Landscape positions include slightly concave (depressions) to near segments. Soils are very poorly drained, frequently ponded, and have a relatively high organic matter content in the surface and near surface horizons. Plant species dominance is influenced by water depth.

**Associated sites**

**Loamy Wet Prairies**  
 #103XY0015MN  
 The Loamy Wet Prairies ecological site is located on inter-depressional linear slopes and slight depressions on 10 plains, moraines, and short lived sediments. Soil parent materials are loamy till and lacustrine materials. The drainage class is poorly drained but the site does not flood or pond.

**Calcareous Rim Prairies**  
 #103XY0016MN  
 The Calcareous Rim Prairies ecological site is characterized by landscape position (rim), calcareous soils, low slope (0-2%), and poorly drained soils. This site is hydrologically connected to adjacent ponded depressions. This site does not pond.

**Glencoe (10%)** R103XY015MN — Depressional Marsh  
**Okoboji (3%)** R103XY015MN — Depressional Marsh

K

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**Geology and Soils**

**Ecological site concept**

The Depressional Marsh ecological site is extensive (~190,000 acres) in MRLA 103 and occurs in the central prairie region and the northeastern Big Woods ecoregion. In combination with adjacent sloping ground classifies this site as a **prairie wetland**. Landscape positions include slightly concave (depressions) to near segments. Soils are very poorly drained, frequently ponded, and have a relatively high organic matter content in the surface and near surface horizons. Plant species dominance is influenced by water depth.

**Classification relationships**

Major Land Resource Area (MLRA): Central Iowa and Minnesota Till Prairies (103) (LRR4 Handbook 294, 2009).  
 USFS Subregions: North Central Glaciated Plains Section (2318), Upper Minnesota River-Des Moines Lobe (2318A) and Southern Des Moines Lobe (2318B) Subregions (Cleveland et al. 2007).

**Associated sites**

**Loamy Wet Prairies**  
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**Glencoe (10%)** R103XY015MN — Depressional Marsh  
**Okoboji (3%)** R103XY015MN — Depressional Marsh

Relationship to Other Established Classifications:  
 The **prairie wetland** classification with Minnesota Department of Natural Resources #103 Prairie Marsh Cattle Marsh.

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**Geology and Soils**

There is a lot to unpack in Web Soil Survey. For a more comprehensive demonstration of the tool, feel free to explore the [Minnesota Technical Training and Certification Program](#) page and the [Minnesota Core Competency Conservation Training \(MNC3\)](#) portal for additional help. A video on WSS demonstration video can be found in Module 2 of the "Introduction to Soils" course: <https://mnc3training.com/course/view.php?id=15>

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**Geology and Soils**

**Soil Map Units**

**Legend**

- 103-103A-103B-103C-103D-103E-103F-103G-103H-103I-103J-103K-103L-103M-103N-103O-103P-103Q-103R-103S-103T-103U-103V-103W-103X-103Y-103Z-103AA-103AB-103AC-103AD-103AE-103AF-103AG-103AH-103AI-103AJ-103AK-103AL-103AM-103AN-103AO-103AP-103AQ-103AR-103AS-103AT-103AU-103AV-103AW-103AX-103AY-103AZ-103BA-103BB-103BC-103BD-103BE-103BF-103BG-103BH-103BI-103BJ-103BK-103BL-103BM-103BN-103BO-103BP-103BQ-103BR-103BS-103BT-103BU-103BV-103BW-103BX-103BY-103BZ-103CA-103CB-103CC-103CD-103CE-103CF-103CG-103CH-103CI-103CJ-103CK-103CL-103CM-103CN-103CO-103CP-103CQ-103CR-103CS-103CT-103CU-103CV-103CW-103CX-103CY-103CZ-103DA-103DB-103DC-103DD-103DE-103DF-103DG-103DH-103DI-103DJ-103DK-103DL-103DM-103DN-103DO-103DP-103DQ-103DR-103DS-103DT-103DU-103DV-103DW-103DX-103DY-103DZ-103EA-103EB-103EC-103ED-103EE-103EF-103EG-103EH-103EI-103EJ-103EK-103EL-103EM-103EN-103EO-103EP-103EQ-103ER-103ES-103ET-103EU-103EV-103EW-103EX-103EY-103EZ-103FA-103FB-103FC-103FD-103FE-103FF-103FG-103FH-103FI-103FJ-103FK-103FL-103FM-103FN-103FO-103FP-103FQ-103FR-103FS-103FT-103FU-103FV-103FW-103FX-103FY-103FZ-103GA-103GB-103GC-103GD-103GE-103GF-103GG-103GH-103GI-103GJ-103GK-103GL-103GM-103GN-103GO-103GP-103GQ-103GR-103GS-103GT-103GU-103GV-103GW-103GX-103GY-103GZ-103HA-103HB-103HC-103HD-103HE-103HF-103HG-103HH-103HI-103HJ-103HK-103HL-103HM-103HN-103HO-103HP-103HQ-103HR-103HS-103HT-103HU-103HV-103HW-103HX-103HY-103HZ-103IA-103IB-103IC-103ID-103IE-103IF-103IG-103IH-103IJ-103IK-103IL-103IM-103IN-103IO-103IP-103IQ-103IR-103IS-103IT-103IU-103IV-103IW-103IX-103IY-103IZ-103JA-103JB-103JC-103JD-103JE-103JF-103JG-103JH-103JI-103JJ-103JK-103JL-103JM-103JN-103JO-103JP-103JQ-103JR-103JS-103JT-103JU-103JV-103JW-103JX-103JY-103JZ-103KA-103KB-103KC-103KD-103KE-103KF-103KG-103KH-103KI-103KJ-103KK-103KL-103KM-103KN-103KO-103KP-103KQ-103KR-103KS-103KT-103KU-103KV-103KW-103KX-103KY-103KZ-103LA-103LB-103LC-103LD-103LE-103LF-103LG-103LH-103LI-103LJ-103LK-103LL-103LM-103LN-103LO-103LP-103LQ-103LR-103LS-103LT-103LU-103LV-103LW-103LX-103LY-103LZ-103MA-103MB-103MC-103MD-103ME-103MF-103MG-103MH-103MI-103MJ-103MK-103ML-103MN-103MO-103MP-103MQ-103MR-103MS-103MT-103MU-103MV-103MW-103MX-103MY-103MZ-103NA-103NB-103NC-103ND-103NE-103NF-103NG-103NH-103NI-103NJ-103NK-103NL-103NM-103NO-103NP-103NQ-103NR-103NS-103NT-103NU-103NV-103NW-103NX-103NY-103NZ-103OA-103OB-103OC-103OD-103OE-103OF-103OG-103OH-103OI-103OJ-103OK-103OL-103OM-103ON-103OO-103OP-103OQ-103OR-103OS-103OT-103OU-103OV-103OW-103OX-103OY-103OZ-103PA-103PB-103PC-103PD-103PE-103PF-103PG-103PH-103PI-103PJ-103PK-103PL-103PM-103PN-103PO-103PP-103PQ-103PR-103PS-103PT-103PU-103PV-103PW-103PX-103PY-103PZ-103QA-103QB-103QC-103QD-103QE-103QF-103QG-103QH-103QI-103QJ-103QK-103QL-103QM-103QN-103QO-103QP-103QQ-103QR-103QS-103QT-103QU-103QV-103QW-103QX-103QY-103QZ-103RA-103RB-103RC-103RD-103RE-103RF-103RG-103RH-103RI-103RJ-103RK-103RL-103RM-103RN-103RO-103RP-103RQ-103RR-103RS-103RT-103RU-103RV-103RW-103RX-103RY-103RZ-103SA-103SB-103SC-103SD-103SE-103SF-103SG-103SH-103SI-103SJ-103SK-103SL-103SM-103SN-103SO-103SP-103SQ-103SR-103SS-103ST-103SU-103SV-103SW-103SX-103SY-103SZ-103TA-103TB-103TC-103TD-103TE-103TF-103TG-103TH-103TI-103TJ-103TK-103TL-103TM-103TN-103TO-103TP-103TQ-103TR-103TS-103TT-103TU-103TV-103TW-103TX-103TY-103TZ-103UA-103UB-103UC-103UD-103UE-103UF-103UG-103UH-103UI-103UJ-103UK-103UL-103UM-103UN-103UO-103UP-103UQ-103UR-103US-103UT-103UU-103UV-103UW-103UX-103UY-103UZ-103VA-103VB-103VC-103VD-103VE-103VF-103VG-103VH-103VI-103VJ-103VK-103VL-103VM-103VN-103VO-103VP-103VQ-103VR-103VS-103VT-103VU-103VV-103VW-103VX-103VY-103VZ-103WA-103WB-103WC-103WD-103WE-103WF-103WG-103WH-103WI-103WJ-103WK-103WL-103WM-103WN-103WO-103WP-103WQ-103WR-103WS-103WT-103WU-103WV-103WW-103WX-103WY-103WZ-103XA-103XB-103XC-103XD-103XE-103XF-103XG-103XH-103XI-103XJ-103XK-103XL-103XM-103XN-103XO-103XP-103XQ-103XR-103XS-103XT-103XU-103XV-103XW-103XX-103XY-103XZ-103YA-103YB-103YC-103YD-103YE-103YF-103YG-103YH-103YI-103YJ-103YK-103YL-103YM-103YN-103YO-103YP-103YQ-103YR-103YS-103YT-103YU-103YV-103YW-103YX-103YY-103YZ-103ZA-103ZB-103ZC-103ZD-103ZE-103ZF-103ZG-103ZH-103ZI-103ZJ-103ZK-103ZL-103ZM-103ZN-103ZO-103ZP-103ZQ-103ZR-103ZS-103ZT-103ZU-103ZV-103ZW-103ZX-103ZY-103ZZ

The site is primarily **fluvial** - saturated, sticky soils that indicate wetlands have long been a part of this site. It is surrounded by **Alluvial** - primarily loamy sands that indicate the area had long been farmed.

K

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**Geology and Soils**

K

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**Hydrology**

Site Assessment Table

Hydrology	The flow of water, areas of concentrated flow, depth to groundwater influence restoration strategies and appropriate seed mixes and other plant materials.
-----------	--

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**Hydrology**

•Hydrology  
The flow of water, areas of concentrated flow, depth to groundwater influence restoration strategies and appropriate seed mixes and other plant materials.

	Upland Prairie	Shallow Marsh	Deep Marsh	Shallow, Open Water
Upland Prairie	Lodge Pole Pine Pine, Other Shrubs Red Spruce Black Spruce Siberian Spruce Siberian Larch			
Shallow Marsh				
Deep Marsh				
Shallow, Open Water				

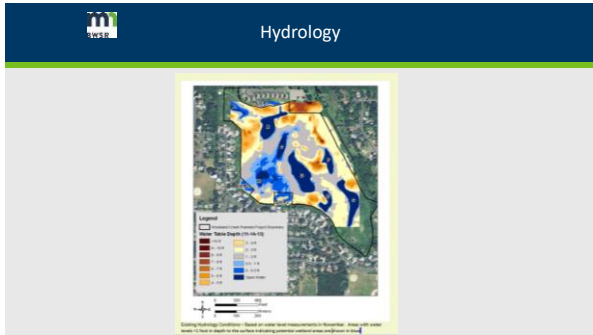
136

**Hydrology**

- Pool elevation - seed a narrow band of emergent mix (10 feet wide) straddling pool elevation. Seed will germinate and plants will grow into emergent zone
- Pool elevation to 1-2 feet in elev. above pool (or saturated soils) - seed wet meadow mix
- Pool elevation plus 1-2 feet and higher - seed an upland mixes

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Existing Vegetation and Seedbank

Site Assessment Table

Existing Vegetation/Seedbank	Existing native or invasive species plants or seed influences the planning of site preparation, planting, and maintenance strategies.
------------------------------	---

A photograph showing a field of green, leafy plants, likely a seedbank or a field of native vegetation. A person is visible in the distance, working in the field.

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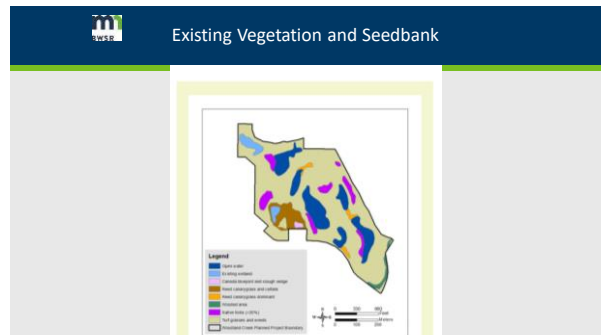
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## Existing Vegetation and Seedbank

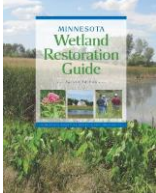


**Benefits:**  
Good method to maximize the Use of local species.

**Limitations:**  
Some species are not common from seedbank. It can be difficult to find seedbank layers where sediment accumulation has occurred.

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## Existing Vegetation and Seedbank



**MN Wetland Restoration Guide - Section 5: Vegetation Establishment** (pdf)

Section 5 - Appendices

- 5.A Technical Guidance Documents - see [Guidance Documents](#)
- 5.B Invasive Species Control (pdf)
- 5.C Process Specifications (pdf)
- 5.D Restoration Quality Observers (pdf)
- **5.E Seedbank Testing Protocol (pdf)**
- 5.F Plant Community Tables (pdf)
- 5.G Vegetation Establishment Tables (pdf)
- 5.H Wetland Vegetation Establishment Research Needs (pdf)
- 5.I Plant Information Links (pdf)
- 5.J Vegetation Plant Inventory (pdf)
- 5.K Checklists (pdf)

Additional Resources

- [MNR Wetland Restoration Plant ID Guide](#) (pdf)
- [Seed Mass](#)

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## Seed Bank Testing Protocol

APPENDIX

SE Seed Bank Testing Protocol

Seed Bank Composition of Wetlands - Seed Emergence Methodology  
*Developed by Jeff Lee of Bari Engineering*

- Field collection of soil samples
- Grow and document seedlings over the course of four months




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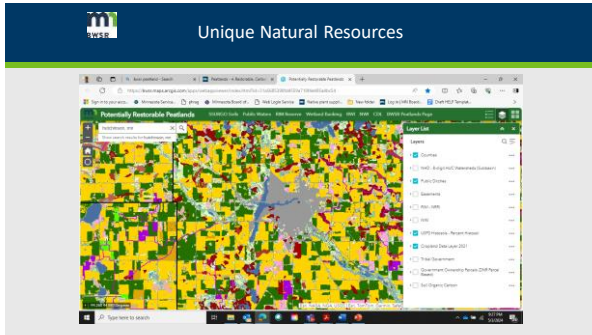
## Unique Natural Resources

Site Assessment Table

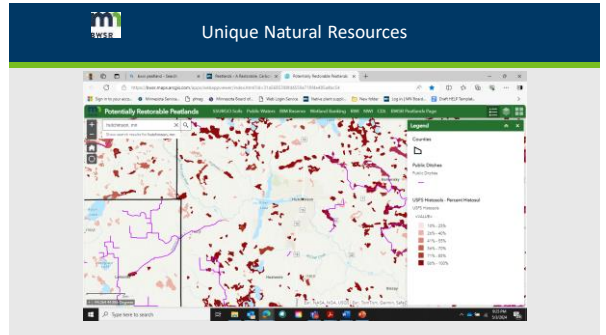
Unique Natural Resources	Fens, seeps, rare species, nesting locations and rock outcrops are all examples of unique natural resources that should be noted as part of the site assessment.
--------------------------	--

[Peatlands - A Restorable, Carbon-Rich Resource | MN Board of Water, Soil Resources \(state.mn.us\)](#)

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**Unique Natural Resources**

**Minnesota Conservation Explorer:**

- To begin, hit the "Explore" button at the top of the page. There is no need to create an account.

Explore the open layer to report on grid areas. Click on the table on the right. Choose from a variety of reports for download. Download your report as a report and create the map title.

**Minnesota Conservation Database:**

- Explore the data. Report on natural resources and their status. There are 140 natural resources and 140 reports.
- Report on the status of natural resources and their status. There are 140 natural resources and 140 reports.

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**Wildlife Specific Opportunities**

Site Assessment Table

Wildlife Specific Opportunities	Opportunities such as connections that can be made between habitats and opportunities to maximize habitat for specific species should be incorporated into the restoration plan.
---------------------------------	--

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**Wildlife Specific Opportunities**

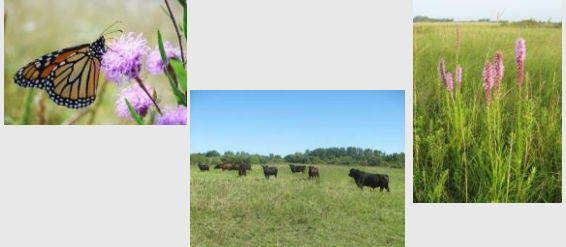
- Wildlife Specific Opportunities

Opportunities such as connections that can be made between habitats and opportunities to maximize habitat for specific species should be incorporated into the restoration plan.



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**Wildlife Specific Opportunities**



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**Other Opportunities**

Site Assessment Table

Other Opportunities	
---------------------	--

Incorporate Landowner Preferences, as able  
Cultural Resources  
Timelines

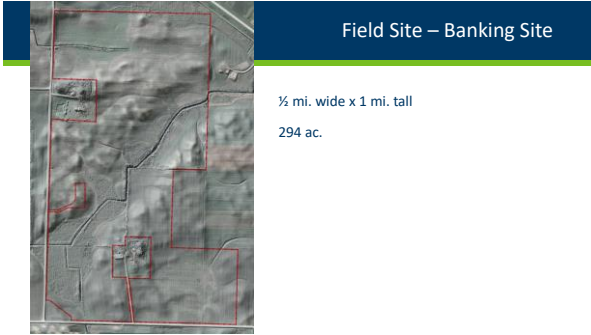
160

**Vegetation Site Assessment**

Questions?



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163



164



165



### Intro to Field Site

Observation	Explanation for Assessment Area	Comments
Site History	Historical evidence on farm 174g indicates the original site usage. Evidence on 174g clearly indicates the presence of agricultural activities in the past.	
Vegetation Condition and Diversity	Vegetation diversity is high and indicates the restoration of a diverse, healthy ecosystem. In 2017, the introduction of aggressive species led to a significant decline in diversity.	
Topography	Topography is relatively flat, which is consistent with the historical use of the site for agriculture. The site is located on a gentle slope.	
Soil Type and Soil Information	Soil type is a loess, which is a common soil type in the region. The soil is relatively fertile and has a high water holding capacity.	
Watering	The field is currently being watered by a center pivot system. The system is efficient and allows for precise water application.	
Fencing	The field is currently fenced with a chain-link fence. The fence is in good condition and provides a clear boundary for the site.	
Soil Sampling/Analysis	Soil sampling was conducted in 2017 and 2021. The results show that the soil is relatively healthy and has a high nutrient content.	
Water Sampling/Analysis	Water sampling was conducted in 2017 and 2021. The results show that the water is relatively clean and has a low nutrient content.	
Water Quality Observations	Water quality observations were conducted in 2017 and 2021. The observations show that the water is relatively clear and has a low nutrient content.	
Other Observations	Other observations include the presence of a small pond and a well. The pond is a natural feature of the site and the well is used for irrigation.	

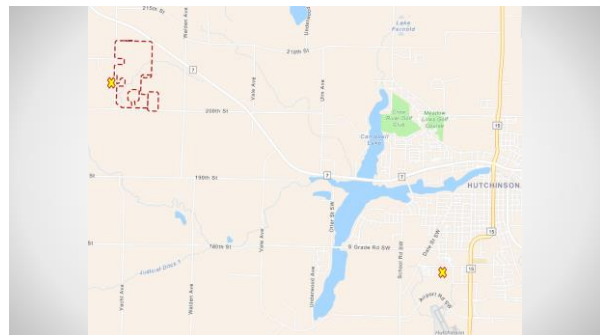
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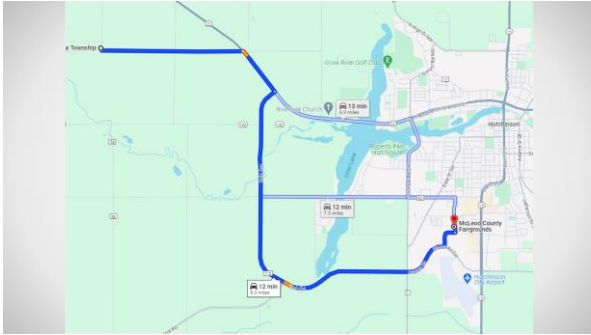
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