Wetland Restoration

Technical Training and Certification Program

USDA United States Department of Agriculture Natural Resources Conservation Service | MASWCD | BWSR

BOARD OF WATER AND SOIL RESOURCES

Minnesota Wetland Professional Certification Program

BWSR Wetland Section | www.bwsr.state.mn.us/wetlands

Technical Training and Certification Program

Minnesota Wetland Professional Certification Program

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Agenda

2024 Wetland Restoration - Hutchinson, MN

Day One - May 15, 2024

Topic	Speaker
Introductions & Housekeeping	
Intro Wetlands	Demmer
Planning Considerations	Deans
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 16, 2024

Wetland Restoration Design	Deans
Sed Mix Selection, Site Prep, and Seeding	Voigt, Shaw
Break	
Monitoring	Demmer, Meyer, Carlson
Lunch & Travel to Site	
Site Field Visit	Peter, Shaw, Carlson
End of Day	

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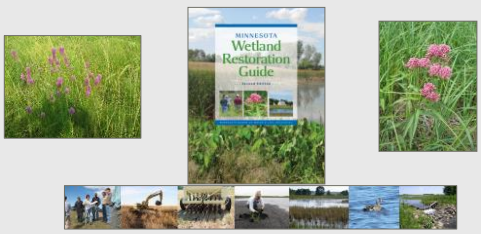
Wetland Restoration Design and Construction

MN Board of Water and Soil Resources
Wetland Restoration Guide



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Wetland Restoration Design and Construction

Natural Resources Conservation Service
CONSERVATION PRACTICE STANDARD
WETLAND RESTORATION
CODE 657
(Ac)

DEFINITION

PURPOSE

CONDITIONS WHERE PRACTICE APPLIES

MN Board of Water and Soil Resources | www.bwsr.state.mn.us

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Wetland Restoration Design and Construction

- Tile Drained Wetlands
- Ditch Drained Wetlands
- Ditch Plugs/Earthen Embankments
- Wetland Excavations
- In-Class Example Project

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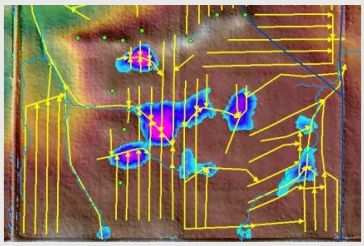
Design and Construction – Restoring Tile Drained Wetlands



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Design and Construction – Restoring Tile Drained Wetlands

A functional design requires gathering enough site information to determine size(s), location(s), depth(s), tile material and tile flow directions.

The design must consider and address the following:

- How and where to disable existing drain tile
- How to best manage expected wetland outflows/discharges
- When to construct and disable tile drainage relative to other work being conducted
- Strategies to protect neighboring properties, especially when they share in the use or benefit of the tile system(s) planned for disablement

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Design and Construction – Restoring Tile Drained Wetlands

Design/Construction Strategies to be Discussed

- Blocking/Plugging Subsurface Drainage Tile
- Outletting (Daylighting) Upstream Drainage Tile
- Rerouting Upstream Drainage Tile

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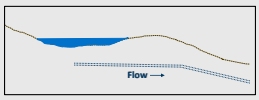
Design and Construction – Restoring Tile Drained Wetlands

Depressional Wetlands

Blocking/Plugging Subsurface Drain Tile



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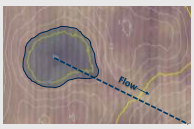
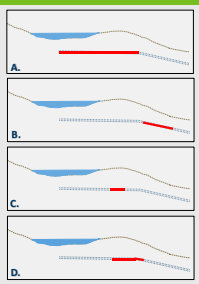
Design and Construction – Restoring Tile Drained Wetlands

Blocking/Plugging Subsurface Drain Tile

Depressional Wetlands



Scale 100 feet



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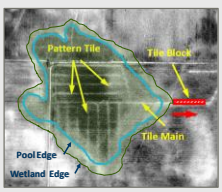
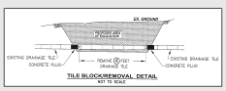
Design and Construction – Restoring Tile Drained Wetlands

Depressional Wetlands

Blocking/Plugging Subsurface Drain Tile



- Locate upstream end of tile block at the downstream edge of the anticipated restored wetland.
- Minimum removal length is 100 feet or calculated lateral effect length from end of downstream tile (if less).
- May want to increase tile block length in sandier soils.



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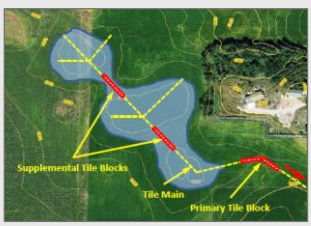
Design and Construction – Restoring Tile Drained Wetlands

Depressional Wetlands

Blocking/Plugging Subsurface Drain Tile

- The primary block at the downstream edge of the wetland should be the lesser of 100 feet or the calculated LE distance.
- Per 657 – supplemental tile blocks within the same wetland basin can be shorter – 40/50 feet minimum.



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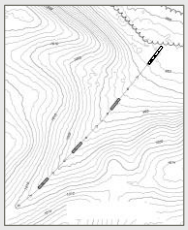
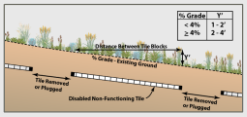
Design and Construction – Restoring Tile Drained Wetlands

Non-Depressional Wetlands

Blocking/Plugging Subsurface Drain Tile



- Multiple tile blocks will likely be needed.
- < 4% land slope - block every 1 to 2 feet in elevation change.
- > 4% land slope - block every 3 to 5 feet in elevation change.
- Lowest elevation block - minimum of 100 feet in length
- Additional upstream blocks 40/50 feet in length.



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Design and Construction – Restoring Tile Drained Wetlands

Non-Depressional Wetlands

Blocking/Plugging Subsurface Drain Tile

- Tile Ripping
- Mild sloping pattern tiled wetlands
- Lowest elevation block - minimum of 100 feet in length

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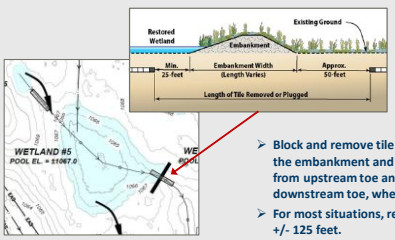
Design and Construction – Restoring Tile Drained Wetlands

Under Embankments

Blocking/Plugging Subsurface Drain Tile



- Block and remove tile the entire area under the embankment and extend out 25 feet from upstream toe and 50 feet from downstream toe, when possible.
- For most situations, removal/plug length is +/- 125 feet.

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Design and Construction – Restoring Tile Drained Wetlands

Blocking/Plugging Subsurface Drain Tile

Construction

- Steps to constructing a typical tile block:
  - Locate the tile
  - Excavate to remove tile
  - Sealing/plugging the exposed tile ends
  - Choosing the backfill material (often same as excavated material)
  - Method of placement and compaction
  - Overbuilding to account for expected settlement

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Design and Construction – Restoring Tile Drained Wetlands

Construction — ***Blocking/Plugging Subsurface Drain Tile***

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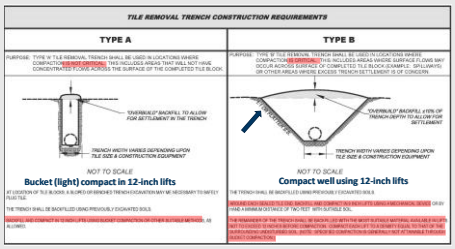
Design and Construction – Restoring Tile Drained Wetlands

Construction — ***Blocking/Plugging Subsurface Drain Tile***



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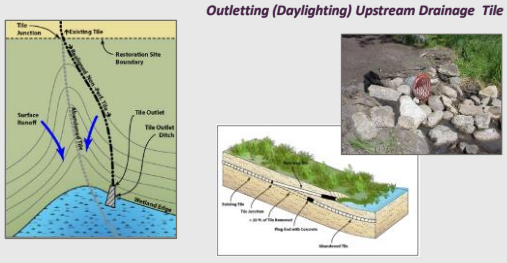
Design and Construction – Restoring Tile Drained Wetlands

Outletting (Daylighting) Upstream Drainage Tile



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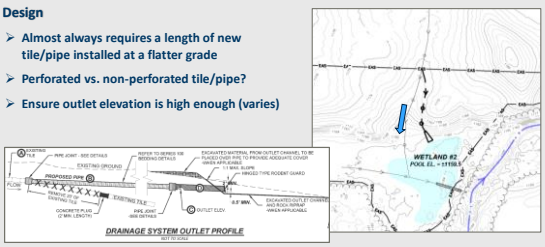
Design and Construction – Restoring Tile Drained Wetlands

Outletting (Daylighting) Upstream Drainage Tile

Design

- Almost always requires a length of new tile/pipe installed at a flatter grade
- Perforated vs. non-perforated tile/pipe?
- Ensure outlet elevation is high enough (varies)



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Design and Construction – Restoring Tile Drained Wetlands

Outletting (Daylighting) Upstream Drainage Tile

Construction

- CMP sleeve and rodent guard needed
- CMP sleeve is often one size larger than tile
- Joint needs to be secure

Table 2. Minimum Length of Outlet Pipe Sections

Pipe Diameter (in.)	Minimum Section Length (ft.)
8 and smaller	10
10 to 12	12
15 to 18	16
Larger than 18	20

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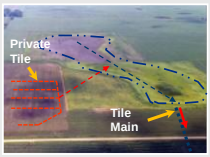
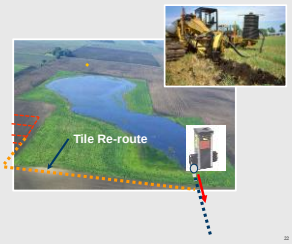
Design and Construction – Restoring Tile Drained Wetlands

Rerouting Upstream Drainage Tile





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Design and Construction – Restoring Tile Drained Wetlands

Rerouting Upstream Drainage Tile

Factors That Will Influence the Design and Construction

- Topography
- Type, size, and depth of tile at junction
- Tile grade upstream of junction
- Land use/cover type in area of new tile (perf. or non-perf)
- Cost (feasibility)

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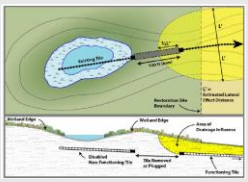
Design and Construction – Restoring Tile Drained Wetlands

Summary

- The minimum length of tile block allowed per PS 657 and EFH 13 is 40 feet, unless at bottom of a non-depressional wetland or outlet of a depressional wetland, then its the lesser of 100 feet or lateral effect distance from anticipated wetland edge to downstream tile/outlet.



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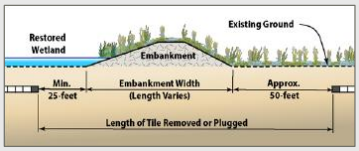
Design and Construction – Restoring Tile Drained Wetlands

Summary

- If located under an embankment, remove the entire length of tile under the embankment along with an additional 25 feet upstream of embankment and 50 feet downstream of embankment, when possible.



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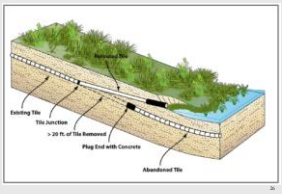
Design and Construction – Restoring Tile Drained Wetlands

Summary

- If upstream drain tile enters a planned restoration site, the options to address this situation include:
  - Manipulate the incoming tile and daylight it into site
  - If feasible, reroute the incoming tile around/away from site/planned wetland(s)
  - Do nothing – leave tile as is and consider wetland unrestorable



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Design and Construction – Restoring Ditch Drained Wetlands

Design/Construction Strategies to be Discussed

- Filling Drainage Ditches
- Plugging Drainage Ditches

- Design and Construction of Ditch Plugs, Earthen Embankments and Berms

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Design and Construction – Restoring Ditch Drained Wetlands

Ditch Fill

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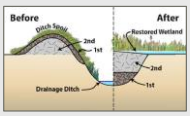
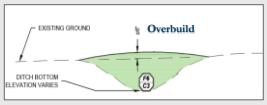
Design and Construction – Restoring Ditch Drained Wetlands

Ditch Fill

Design/Construction Considerations

- **Process/sequencing (see figure).**
- **Location of supplemental borrow sources if ditch spoil has subsided and/or no longer exists?**
- **Upwards of 30% or more settlement can occur depending on soils used and methods of construction. Could be an issue in a sloped setting – overbuild needed.**





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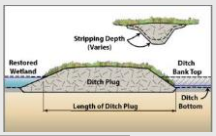
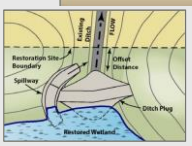
Design and Construction – Restoring Ditch Drained Wetlands

Ditch Plug





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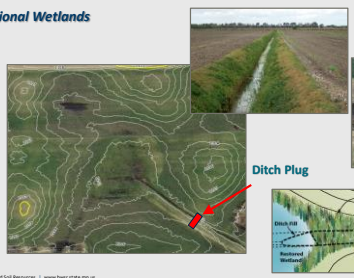
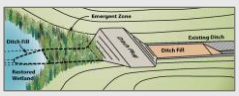
Design and Construction – Restoring Ditch Drained Wetlands

Depressional Wetlands



Ditch Plug



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Design and Construction – Sediment Removal/Other Wetland Excavations

Sediment / Vegetation Removal


Before


During


After


2 Weeks Later

Photos Curtesy of US Fish & Wildlife Service – Register WPA

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Design and Construction – Sediment Removal/Other Wetland Excavations

Restoration of the natural or historic wetland type

- Removing soils that have been placed in shallow wetlands
- Removing sediment that has accumulated over time due to erosion of adjoining upland areas




Design and Construction – Sediment Removal/Other Wetland Excavations

Improve wetland function or enhance vegetation diversity

- Removing monolithic stands of hybrid cattail, reed canary grass, or other undesired vegetation
- Removing topsoil that is laden with nutrients and pesticide




Now What??

Structural Outlet Options

Flow Capacity

- Hook into existing tile system
- Vegetated spillway
- Principle spillway pipe
- Rock weir
- Sheetpile weir

Highest

On-site work (varies!)

- Soil borings
  - Verify mapped soils (for borrow area, embankment foundation)
  - Check sediment accumulation in scrape areas
- Survey key elevations
  - Property lines
  - Existing outlets
  - Culverts

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Design Example

Example 2 – Jackson County

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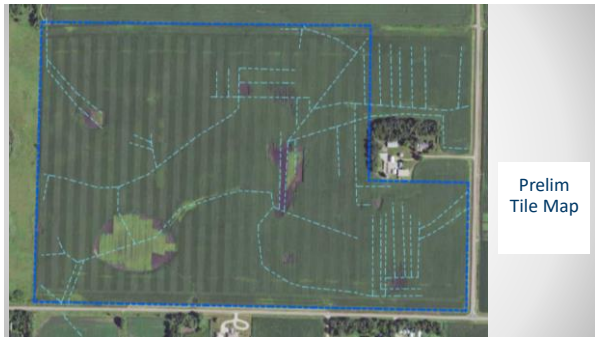

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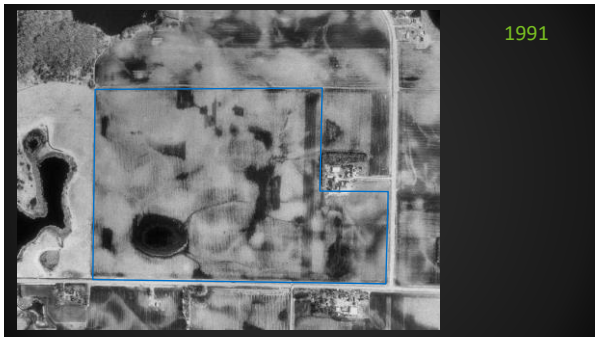

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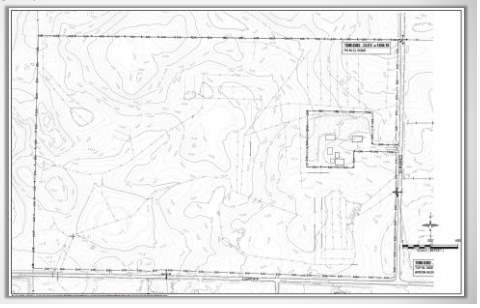
work in small groups



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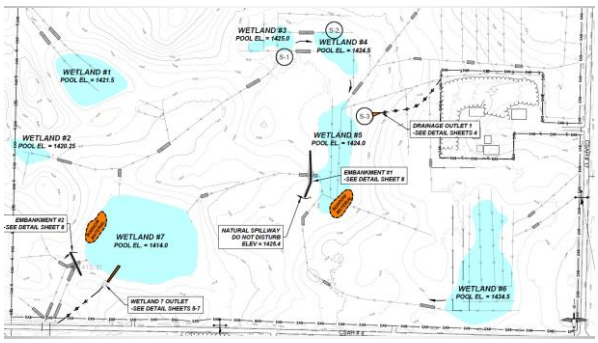

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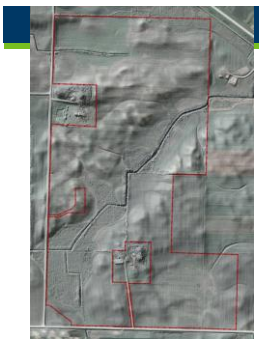

Field Site – Banking Site

- 26 bid items (engineering plans)
- Construction: ~ $140,000

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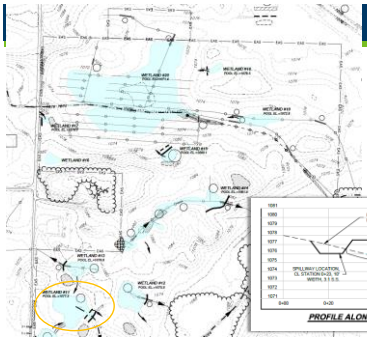
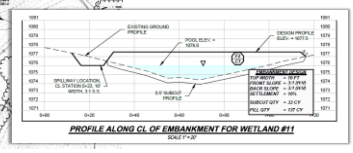


Final Design

North Half

- Pool #20 (11 ac.)
- Numerous small scrapes / pools



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South Half

- Pool #1 (18 ac.)
- Numerous small scrapes / pools

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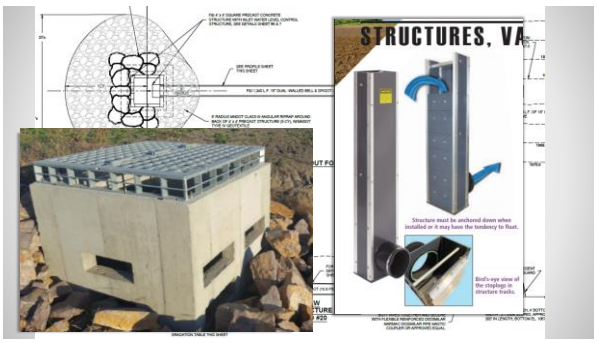

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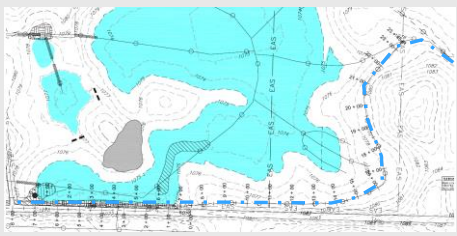
Exsted Pool Outlet



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Vegetation Establishment

May 16, 2024

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Vegetation Establishment

- Seed Mix Selection/Design
- Site Preparation
- Seeding Timing and Method
  - Wet Areas
  - Upland
  - (Buffer) Areas
- Post Establishment Activities (Operation

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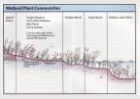
Minnesota Wetland Restoration Guide



http://www.bwsr.state.mn.us/publications/restoration_guide.html

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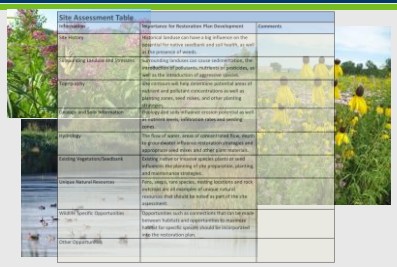
Project Goals and Site Assessment



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Vegetation Establishment

- **Seed Mix Selection/Design**
- Site Preparation
- Seeding Timing and Method
  - Wet Areas
  - Upland (Buffer) Areas
- Post Establishment Activities (Operation and Maintenance)

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Seed Mix Selection

Even small differences in elevation can create major differences in suitability for species

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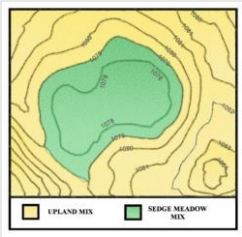
Seed Mix Selection

It is important to consider elevation when planning seed zones



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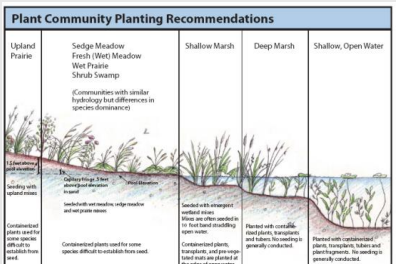
Seed Mix Selection



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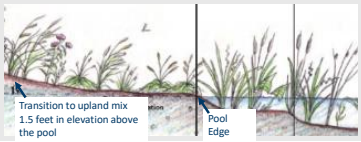
Seed Mix Selection

- In some cases a narrow band of emergent mix (10 feet wide) is seeded 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 upland mixes



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Seed Mix Selection

When to use separate wetland seed mixes

Wet meadow/Wet Prairie - When a distinct wet meadow/ wet prairie zone is present and a low contribution from the seedbank

Emergent Wetland – When a seed mix is needed to provide diversity for emergent areas and compete with cattails

Deep Marsh – When a mix is needed to stabilize large areas of deep marsh to establish diversity and compete with cattails

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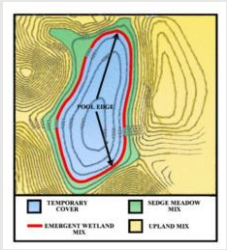
Seed Mix Selection

Swales, seeps and slopes are also considerations



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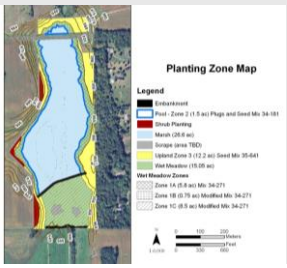
Seed Mix Selection



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Seed Mix Design

Seed Mix Design Considerations for Wetlands:

-Project Goals
-Site Stressors
-Plant Guilds
-Cost
-Diversity
-Pollinator Benefits

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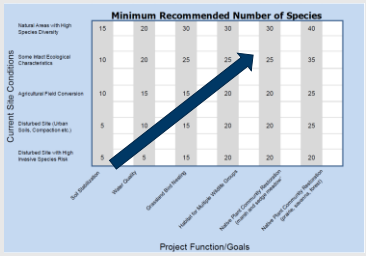
Seed Mix Design



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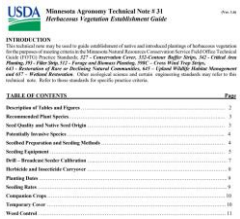
Seed Mix Design



Minnesota Agronomy Technical Note # 31
Herbaceous Vegetation Establishment Guide

INTRODUCTION

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Wetland Restoration: Page 35

https://www.nrcs.usda.gov/wps/cmis_proxy/https/ecm.nrcs.usda.gov%3a443/fncmis/resources/WEBP/ContentStream/idd_70A4A371-0000-CD31-961B-36A05E49CE33/0/MN+Herbaceous_Veg_Est_Guide+FINAL-1.6.pdf

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Seed Mix Design

Seed Planting Density - Wetland seed mixes shall provide seed densities ranging from 110 to 200 seeds/ft². Wet/sedge meadow seed mixes shall contain 20-30 species. Shallow emergent marsh communities may be seeded with mixes of 10-20 species. Refer to Table 21 for recommended species and optional seeding calculator on the MN NRCS Home Page at Technical Resources/Seeding Tools. Higher diversity mixes will help support pollinators and other invertebrates that play a key role in the health of wetland habitats. Recommended composition of mixes, based on seeds/ft²:

EMERGENT FRINGE		SEDGE MEADOW		WET MEADOW	
Grasses	20 – 65%	Grasses	20 – 50%	Grasses	20 – 60%
Sedges - Rushes	20 – 65%	Sedges - Rushes	40 – 70%	Sedges - Rushes	15 – 60%
Forbs	15 – 30%	Forbs	15 – 35%	Forbs	15 – 35%

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Seed Mix Design

Practice Standards

CRP Practice	State of MN Requirements for Vegetation Establishment
CP-23	**657 Standard (native species only)** Minimum - Adjacent Upland: Herbaceous Upland: 327 – Conservation Cover, Native Grasses, Forbs and Legumes Forested Upland: 612 - Tree/Shrub Establishment Minimum - Wetland: Refer to Technical Note #31: 657 - Wetland Restoration

CRP Practice	State of MN Requirements for Vegetation Establishment
CP-23a	**657 Standard (native species only)** Minimum - Adjacent Upland: 643 - Tallgrass Prairie Specifications Preferred - Adjacent Upland: Refer to NRCS/BWSR Guidelines for seed mixtures benefitting monarchs and beneficial insects. Minimum - Wetland: Refer to Technical Note #31: 657 - Wetland Restoration

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Seed Mix Design

Plant Guilds

-Warm Season Grasses
-Cool-season Grasses
-Sedges
-Rushes
-Forbs

Milkweeds
Asters
Goldenrods
Lobelia
Native Loosestrife
etc.

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Seed Mix Design

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Seed Mix Design

State
wetland
seed mixes

https://bwsr.state.mn.us/seed-mixes

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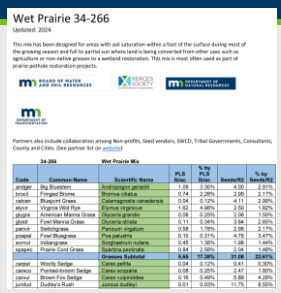
Seed Mix Design

State wetland seed mixes

https://bwsr.state.mn.us/seed-mixes


Wet Prairie 34-266

Updated: 2024

This mix has been designed for areas with soil saturation within a foot of the surface during most of the growing season and full to partial sun where land is being converted from other uses such as agriculture or non-native grasses to a wetland restoration. This mix is most often used as part of prairie pothole restoration projects.

Partners also include collaboration among Non-profits, Seed vendors, SWCD, Tribal Governments, Consultants, County and Cities. (See partner list on website)

34-266 Wet Prairie Mix

Code	Common Name	Scientific Name	PLS lb/ac	% by PLS lb/ac	Seeds/ft2	% by Seeds/ft2
andger	Big Bluestem	Andropogon gerardii	1.09	3.35%	4.00	2.91%
brocil	Fringed Brome	Bromus ciliatus	0.74	2.28%	2.99	2.17%
calcan	Bluejoint Grass	Calamagrostis canadensis	0.04	0.12%	4.11	2.99%
elyvir	Virginia Wild Rye	Elymus virginicus	1.62	4.98%	2.50	1.82%
glygra	American Manna Grass	Glyceria grandis	0.08	0.25%	2.06	1.50%
glystr	Fowl Manna Grass	Glyceria striata	0.11	0.34%	3.64	2.65%
panvir	Switchgrass	Panicum virgatum	0.58	1.78%	2.98	2.17%
poapal	Fowl Bluegrass	Poa palustris	0.10	0.31%	4.78	3.47%
sornut	Indiangrass	Sorghastrum nutans	0.45	1.38%	1.98	1.44%
spepec	Prairie Cord Grass	Spartina pectinata	0.84	2.58%	2.04	1.48%
		Grasses Subtotal	**5.64**	**17.34%**	**31.66**	**22.93%**
carpal	Woolly Sedge	Carex pellita	0.04	0.12%	0.41	0.30%
carsco	Pointed-broom Sedge	Carex scoparia	0.08	0.25%	2.47	1.80%
carvul	Brown Fox Sedge	Carex vulpinoidea	0.16	0.49%	5.88	4.28%
junbuf	Dudley's Rush	Juncus dudleyi	0.01	0.03%	11.75	8.55%

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Seed Mix Design

State wetland seed mixes

https://bwsr.state.mn.us/seed-mixes


Wet Prairie 34-266 Seed Mix Guidance

Seed mix name: Wet Prairie 34-266 (Previously 34-265, 34-262)

Geographic area: Southern and Western Minnesota

Year of development: 2009

Year/s of update:

Status (Standard or Pilot mix): Standard

Primary and Secondary Functions:

Primary – Wildlife habitat, restoration of wetland functions, and water management

Secondary – Carbon Sequestration, emission reductions, pollinator habitat, songbird habitat

Similar State Mixes: Wet Meadow Northeast 34-372, Wet Meadow South and West 34-272

Compatible NRCS Practice Standards: NA

Compatible Minnesota CRP Practices: NA

Suitable Site Conditions: Areas with soil saturation within a foot of the surface during a majority of the growing season and full to partial sun where land is being converted from other uses such as agriculture or non-native grasses to a wetland restoration. This mix is most often used as part of prairie pothole restoration projects. The mix is similar to wet meadow mixes but includes an increased percentage of prairie species such as prairie cordgrass, big bluestem and some prairie forbs.

How to Modify for Site Conditions and Goals: This mix includes a list of additional species that can be considered to add species diversity. Site conditions such as sunlight, soils, hydrology and existing vegetation along with functional goals for the project such as carbon sequestration, pollinator habitat, and benefit to bird species can all have an influence on species selection and the modification of seed mixes. Additional plant species can also be added from containerized plants. It is also common that seed substitutions (see list) are used for wetland seed mixes when other species are not available.

Site Preparation: Primary goals for site preparation tend to focus on controlling weed species and providing ideal growing conditions for seed or plants to be installed. Site preparation methods vary depending on past uses of the site and the weed species that are present. The protection of microorganism populations and native seedbanks, preventing soil erosion, and managing weed

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Seed Mix Design

Harps (85%) — R103XY009MN — Calcareous Rim Prairies

The reference state shares similarities to Minnesota Department of Natural Resources WPs54b Southern Wet Prairie

System Summaries & NPC Factsheets

Upland Forests and Woodlands

Wetland Forests

Upland Grasslands, Shrublands, and Sparse Vegetation

Wetland Grasslands, Shrublands, and Marshes

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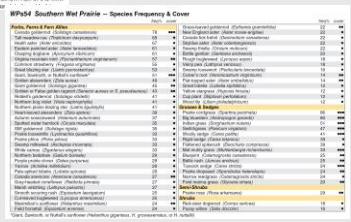
Seed Mix Design

★ **WPs54b Wet Prairie (Southern)**

Grass-dominated, forb-rich herbaceous communities. Big bluestem and prairie cordgrass are the usual dominant species, either together or separately. Switchgrass and Indian grass are frequently present and often are major components. Woodly sedge (*Carex pellita*) and mat muhly grass are often common. The forb component of WPs54b is species rich. Canada goldenrod is usually present and often abundant. Other common forbs are tall meadow-rue, eastern panicled aster, Virginia mountain mint, clasping dogbane, heath aster, great blazing star, golden alexanders, giant, sawtooth, or Nuttall's sunflower, and giant goldenrod. Documented in the southern half of the MIM and throughout the CGP. Description is based on summary of vegetation


WPs54 Southern Wet Prairie -- Species Frequency & Cover

Forbs, Ferns & Fern Allies	freq%	cover%	Grasses/sedges	freq%	cover%
Canada goldenrod (Solidago canadensis)	78	▪▪▪	Grass-leaved goldenrod (Euthamia graminifolia)	22	▪▪
Tall meadow-rue (Thalictrum dasycarpum)	69	▪	New England aster (Aster novae-angliae)	20	▪
Heath aster (Aster ericoides)	67	▪	Canada fox tail (Devenodium canadense)	20	▪
Eastern panicled aster (Aster lanceolatus)	61	▪	Fowl manna grass (Glyceria striata)	22	▪
Clasping dogbane (Apocynum sibiricum)	61	▪	Bottle gentian (Gentiana andrewsii)	22	▪
Virginia mountain mint (Pycnanthemum virginianum)	61	▪	Fowl bluegrass (Poa palustris)	20	▪
Common strawberry (Fragaria virginiana)	59	▪	Hairy sedge (Carex hirtifolia)	18	▪
Great blazing star (Liatris pycnostachya)	53	▪	Swamp horsetail (Pedicularis lanceolata)	18	▪
Giant, Sawtooth, or Nuttall's sunflower*	51	▪▪	Cooke's rush (Necastocanthus nigricuspis)	16	▪▪
Golden alexanders (Zizia aurea)	49	▪	Flat-topped aster (Aster umbellatus)	14	▪▪
Giant goldenrod (Solidago gigantea)	47	▪	Prairie cordgrass (Spartina pectinata)	14	▪▪
Golden or False golden ragwort (Senecio aureus or S. pseudaureus)	43	▪▪	Yellow stargrass (Hypoxis hirsuta)	12	▪
Riddell's goldenrod (Solidago riddellii)	41	▪	Cup plant (Silphium perfoliatum)	12	▪
Northern bog violet (Viola nephrophylla)	41	▪	Woodly (Carex pellita/lanuginosa)	12	▪
Northern prairie dock or slim (Lactis ligulistylis)	39	▪	**Grasses & Sedges**		
Prairie cordgrass (Spartina pectinata)	39	▪	Prairie cordgrass (Spartina pectinata)	69	▪▪▪
Autumn bittersweet (Helenium autumnale)	37	▪	Big bluestem (Andropogon gerardii)	65	▪▪▪
Spotted water hemlock (Cicuta maculata)	35	▪	Indian grass (Sorghastrum nutans)	51	▪▪▪
Mat muhly (Muhlenbergia richardsonis)	33	▪	Switchgrass (Panicum virgatum)	49	▪▪▪
Prairie bonesetts (Lysimachia quadriflora)	33	▪	Woolly sedge (Carex pellita)	41	▪▪
Prairie phlox (Phlox pilosa)	33	▪	Rigid sedge (Carex tetanica)	39	▪
Swamp milkweed (Asclepias incarnata)	33	▪	Fibrous sedge (Carex lasiocarpa)	39	▪
White vervain (Verbena stricta)	33	▪	Wet muhly grass (Muhlenbergia richardsonis)	35	▪▪▪
Wild bergamot (Monarda fistulosa)	31	▪	Porcupine sedge (Carex hystericina)	33	▪▪
Prairie smoke (Geum triflorum)	29	▪	Tussock sedge (Carex stricta)	25	▪▪
Various (Actaea rubra/alba)	29	▪	Canada wild rye (Elymus canadensis)	24	▪▪
Canada anemone (Anemone canadensis)	27	▪	Nodding wild rye (Elymus hystrix ssp. elymoides)	24	▪▪
Tall meadow-rue (Thalictrum dasycarpum)	27	▪	Fowl manna grass (Glyceria striata)	22	▪▪
Grey-headed coneflower (Ratibida pinnata)	27	▪	**Semi-Shrubs**		
Marsh vervain (Ludwigia palustris)	27	▪	Prairie rose (Rosa arkansana)	29	▪▪
Smooth aster/grass (Symphyotrichum laeve/Calamagrostis stricta)	25	▪	**Trees**		
Meadowsweet (Spiraea alba)	25	▪	Red-osier dogwood (Cornus sericea)	18	▪
Maximilian's sunflower (Helianthus maximiliani)	24	▪	Peach willow (Salix discolor)	18	▪
Field horsetail (Equisetum arvense)	24	▪			

*Giant, Sawtooth, or Nuttall's sunflower (Helianthus giganteus, H. grosseserratus, or H. nuttallii)

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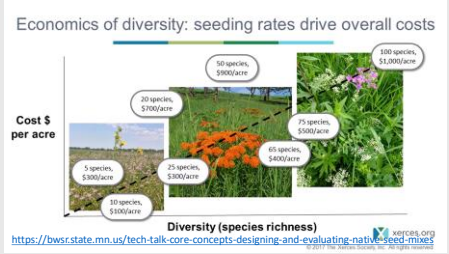
Seed Mix Design



https://bwsr.state.mn.us/tech-talk-core-concepts-designing-and-evaluating-native-seed-mixes

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Vegetation Establishment

- Seed Mix Selection/Design
- **Site Preparation**
- Seeding Timing and Method
  - Wet Areas
  - Upland (Buffer) Areas
- Post Establishment Activities (Operation and Maintenance)

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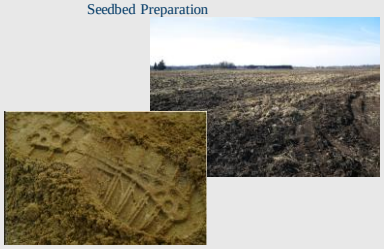
Site Preparation Considerations

Seedbed Preparation



Benefits:
Necessary step in preparation of seeding

Limitations:
The right seedbed preparation strategy must be selected for the seeding equipment to be used.

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Site Preparation Considerations

Crop Production

Benefits:
Can produce a relatively clean seedbed with few other steps needed before seeding.

Limitations:
Can disturb soil micro-organisms, may not remove all perennial weeds such as Canada thistle.

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Site Preparation Considerations

Perennial Vegetation Removal

Benefits:
Generally necessary to establish native vegetation

Limitations:
Usually requires herbicide treatment and may take a season or longer.

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Site Preparation Considerations

Scraping

Benefits:
Can remove invasive species roots/rhizomes and seed, may expose native seedbank

Limitations:
May remove needed topsoil, can cause compaction

Sediment excavation as a wetland restoration technique had early effects on the developing vegetation community

https://www.fws.gov/Midwest/Planning/r3ssd/main.html?knutson_restoring_wetlands

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Site Preparation Considerations

Tilling for Weed Control

Benefits:
Can minimize herbicide use and aid in seedbed preparation

Limitations:
Can disturb soil structure and lead to compaction and erosion, herbicide usually also needed for perennial weed control

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Vegetation Establishment

- Seed Mix Selection/Design
- Site Preparation
- **Seeding Timing and Method**
  - **- Wet Areas**
  - **- Upland (Buffer) Areas**
- Post Establishment Activities (Operation and Maintenance)

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Seeding Timing

- Fall installation
  - Seed is stratified naturally over winter and will germinate in spring
  - Best timing for forb species
- Spring installation – Best timing for grass species
- Mid-summer installation – not recommended

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Seeding timing

Most wetland seed needs a period of cold stratification, so fall dormant seeding is commonly conducted

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Seeding Timing

Recommended Seeding Dates for Restoration Projects

Recommended Dates / Vegetation Type

Vegetation Type	Spring/Early Summer	Mid-Summer	Early Fall	Late Fall (Dormant Seeding)	Snow Seeding
Prairie Grasses	Apr 15 - Jun 30	*	Aug 1 - Oct 1	Oct 15 - Frozen Soil	Feb 15 - April 7
Prairie Sedges and Forbs	Apr 1 - Jun 30	*	Aug 1 - Oct 1	Oct 15 - Frozen Soil	Feb 15 - April 7
Wetland Grasses	Apr 1 - Jun 30	*	Aug 1 - Oct 1	Oct 15 - Frozen Soil	Feb 15 - April 7
Wetland Sedges and Forbs	Apr 1 - Jun 30	*	Aug 1 - Oct 1	Oct 15 - Frozen Soil	Feb 15 - April 7
Native Construction Mix	Apr 1 - Jun 30	*	Aug 1 - Oct 1	Oct 15 - Frozen Soil	Feb 15 - April 7
Oats Cover	Apr 1 - Jun 30	*	-	Oct 15 - Frozen Soil	Feb 15 - April 7
Winter Wheat Cover	-	*	Aug 1 - Oct 1	Oct 15 - Frozen Soil	Feb 15 - April 7

Success Rates:

High Success Rates
Medium Success Rates
Low Success Rates
* Not Recommended Without Watering
** Not Recommended

Note: Planting dates will vary from northern to southern Minnesota.

Notes about success rates: Success is less predictable for optional vegetation types and seeding dates, so use the recommended dates for each vegetation type unless construction sequencing or other factors make that impossible. For example, if the state of Minnesota "Native Construction" mix is used in early fall, watering is recommended to aid establishment.

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Seeding Considerations

- Wetland species – Often broadcast as most species require light to germinate and seeds are very small. They cannot be buried.
- Upland species – May be drilled or broadcast. Generally, forbs should be broadcast and grasses drilled or broadcast (1/4 inch deep)

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Wetland Seeding Considerations

Wetland Planting Strategies:

Utilizing Existing Native Seedbank
Managing Hydrology
Broadcast Seeding
Hydroseeding Wetlands
Stabilizing Upland Erosion
Wetland Containerized Plants and Rootstock
Wetland Trees and Shrubs
Mulching Wetlands
Peatland Restoration

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Wetland Seeding – Utilizing Existing Native Seedbank

Sediment Removal

Benefits:
Can expose native seedbank

Limitations:
Can cause compaction, may be difficult to find native seedbank

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Wetland Seeding

Managing Hydrology

Benefits:
Water level control can be very helpful to ensure that young plants have sufficient hydrology.

Limitations:
control structures add cost and require adjustment.

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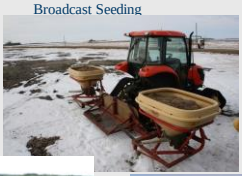
Wetland Seeding

Broadcast Seeding



Benefits:
Can be conducted without smooth seedbed, seed may not require as much processing, can be conducted on frozen ground in some cases

Limitations:
May require more seed

Agronomy Technical Note #31 requires 1.5 x the amount of seed for broadcast seeding

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Wetland Seeding

Hydroseeding

Benefits:
Can be used where equipment access is limited
Provides some moisture retention for germination
Visibility of seeded area

Limitations:
Expensive for very large areas

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Wetland Planting

Wetland Containerized Plants and Rootstock

Benefits:
Good method to add species that do not do well from seed, and to add species along the edge of open water where seedlings may not do well.

Limitations:
Changing water levels may influence survival.

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Wetland Seeding Considerations

0.5 cm of sediment will reduce 90 percent of wetland seed emergence *

- ✓-Stabilize uplands first if needed
- ✓-Use temporary covers or mulch
- ✓-Pay attention to water level control
- ✓-The smaller the seed, the greater the impact of sediment

* Gleason, Robert A. 2003. Effects of Sediment Load on Emergence of Aquatic Invertebrates and Plants From Wetland Soil egg and Seed Banks, Wetlands, Vol. 23, No. 1, pp 26-34

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Wetland Seeding Considerations

Different options can stabilize wetlands prior to installing expensive seed mixes

Temporary cover crops - (allow time for late summer or fall seeding)

Establishing uplands first - (allow time for seeding in fall or the next year)

Oats have worked well as a cover

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Upland Seeding or Planting

Upland Planting Strategies:

Broadcast Seeding
Seed Drills
Containerized Plants and Rootstock
Upland Trees and Shrubs
Bacterial and Mycorrhizal Inoculum

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Upland Seeding

Seed Drills

Benefits:
Ensures good placement of grass seed, no-till versions available.

Limitations:
Specialized equipment and good seedbed preparation needed

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Upland Seeding

Inoculating Legumes

Benefits:
Increases long term success of legume species

Limitations:
Inoculum needs to be species matched, not all species have an inoculum available
Requires special handling

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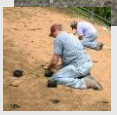
Upland Planting

Containerized Plants and Rootstock



Benefits:
Good method to add species that may not establish well from seed.

Limitations:
Watering and weed control often needed.

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General Seeding Considerations

Seeding before or after construction

- Common to seed after construction in later fall (using temporary covers if needed)
- Want to avoid projects getting too wet for seeding equipment
- Sometimes delay seeding fringe mixes until June if water levels will bounce in early spring

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General Seeding Considerations

Temporary Cover Crops

Benefits:
Can allow time for weed management and can be disked To provide mulch

Limitations:
Can add cost (though may be able to harvest vegetation)

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Vegetation Establishment

- Seed Mix Selection/Design
- Site Preparation
- Seeding Timing and Method
  - Wet Areas
  - Upland (Buffer) Areas
- **Post Establishment Activities (Operation and Maintenance)**

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Post-planting/Maintenance

Maintenance Strategies:

Herbivore Control
Mowing
Prescribed Burning
Tree and Shrub Care
Haying
Grazing
Biological Control
Herbicide Application
Hand Weeding
Hydrology Control
Supplemental Planting
Supplemental Watering

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Post-planting/Maintenance Considerations

Mowing

Benefits:
Mowing is essential for the establishment of prairie and can aid control of species such as Canada thistle.

Limitations:
Mowing may be limited by hydrology or steep slopes.

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Post-planting/Maintenance Considerations

Prescribed Burning

Benefits:
Burning invigorates prairies and can aid the control of woody plants.

Limitations:
Burning in wet meadow restorations can lead to spread of thistle and reed canary grass depending on timing.

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Post-planting/Maintenance Considerations

Haying

Benefits:
Aid the removal of thatch and woody seedlings. Allows light to reach lower growing species.

Limitations:
May be a temporary solution and limited by hydrology.

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Post-planting/Maintenance Considerations

Biological Control

Benefits:
Effective for species such as purple loosestrife and leafy spurge.

Limitations:
Less effective for scattered plants and bio-control may be lost due To flooding or fire.

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Post-planting/Maintenance Considerations

Herbicide Application
-Spot Treatment

Benefits:
Can decrease invasive species before they have a chance to spread.

Limitations:
Repeated visits may be needed and care must be taken to ensure proper use of herbicides.

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Post-planting/Maintenance Considerations

Hydrology Control

Benefits:
Allows lowering of water levels for access of equipment.

Limitations:
Careful control of water levels is needed as multiple wildlife species can be influenced

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Post-planting/Maintenance Considerations

Supplemental Planting

Benefits:
Ensures that weeds will not become dominant in areas of poor establishment.

Limitations:
Requires access that could cause more disturbance.

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Watonwan County

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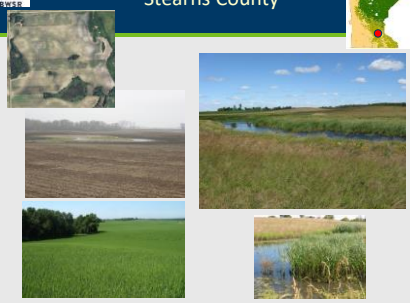
Stearns County



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Planning Considerations

Site Kanabec County – Mowed 1st Year

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Planning Considerations

Site Kanabec Co. – 2nd Yr Emergent Zone Spring

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Planning Considerations

Site Kanabec Co. – 2nd Yr Saturated Zone Spring

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Planning Considerations

Site Kanabec Co. – 2nd Yr Emergent Zone Late Summer

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Planning Considerations

Wetland Restoration Guide
www.bwsr.state.mn.us/publications/restoration_guide.html
-Minnesota Wetland Plant ID Guide
www.mn.nrcs.usda.gov/programs/wrp/plantid/about.html
-State Seed Mixes
www.bwsr.state.mn.us/wetlands/vegetation/index.html
-Grassland Inter-seeding Guidelines
www.bwsr.state.mn.us/grantscostshare/native-buffer.html
-Conservation/Restoration "What's Working" Information
www.bwsr.state.mn.us/grants/WhatsWorking.html

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Wetland Bank Monitoring

BOARD OF WATER AND SOIL RESOURCES

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General Monitoring roles once wetland bank is approved

LGU/Corps roles:

- certify construction
- certify credits for deposit
- review monitoring reports
- may require corrective actions as needed

Sponsor/landowner roles:

- Sponsor responsible for maintenance
- Submitting as-built documentation
- Submitting wetland credit deposit transaction form(s)
- Submitting monitoring reports
- Paying administrative fees

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Construction Certification

- LGU must certify the initial construction
  - Documentation:
    - as-built drawing
    - surveyed map
    - Delineation
    - seed tags
    - construction photos
- Site Visit with TEP
  - Recommend TEP Findings of Fact

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Performance Standards

- Performance standard: observable or measurable physical (including hydrological), chemical and/or biological attributes that are used to determine if a compensatory mitigation project meets its objectives.

Examples:

- Vegetation
  - *"85% of the site is vegetated by planted species and/or regenerated species as per approved plan by end of 5th complete growing season."*
- Hydrology
  - *"Hydrology must meet wetland definition of 1987 Corps of Engineers Manual with saturation to the surface of the soil for at least 31 days of the growing season."*

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Performance Standards

Common hydrology metrics*

- Meet standard for 2 full growing seasons
- Reference site (± 20%)
- Water table/inundation timing and duration measurements
- Expect wells with daily readings

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Performance Standards

Common vegetation metrics:

- Interim 1 met for 2 consecutive seasons
- Interim 1 NNI relative cover ≥ 50%
- Final NNI relative cover ≥ 70% - 90%
- Species richness of 5, 10, and 15 NNI species for most communities
- > 50% hydrophytes for wetland communities
- Maximum bare ground/open water area
- Multi-strata communities may have metrics in each stratum

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Monitoring Reports


Hydrologic Monitoring of Wetlands
MN Board of Water & Soil Resources
Supplemental Guidance
April 2013
BOARD OF WATER AND SOIL RESOURCES
Vegetation Monitoring for Compensatory Wetland Mitigation Sites
10/29/2021
Version 1
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Monitoring Report

- Submitted following the first full growing season no later than 12/31
- Then submitted as per approved bank plan
- May include Transaction Form to Deposit Credits


Transaction Form to Deposit Credits
Minnesota Wetland Bank Program

Contents of the report:

- Project location map
- Description of performance standards
- Activities completed and planned
- Hydrology measurements
- Plant communities map
- Color photographs
- Other information specified from approved plan

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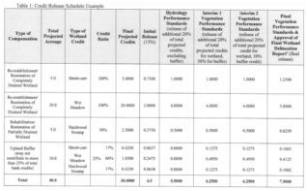
Monitoring Schedule

- Monitoring must begin no later than first full growing season after construction certification
- Must continue for at least 5 full growing seasons
- If unsuccessful, the LGU may extend the monitoring period (<5 additional years)
- Actual monitoring schedule may vary for different bank types (restoration vs preservation)



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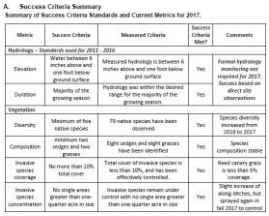
Reviewing Monitoring Reports


A. Success Criteria Summary
Summary of Success Criteria Standards and Current Metrics for 2017.

Metric	Success Criteria	Measured Criteria	Success Criteria Met?	Comments
Hydrology – *Standards used for 2011 - 2016*				
Elevation	Water between 6 inches above and one foot below ground surface	Measured hydrology is between 6 inches above and one foot below ground surface	Yes	*Formal hydrology monitoring not required for 2017. Success based on direct site observations*
Duration	Majority of the growing season	Hydrology was within the desired range for the majority of the growing season.	Yes	
Vegetation				
Diversity	Minimum of five native species	79 native species have been observed	Yes	Species diversity increased from 2016 to 2017
Composition	minimum two sedges and two grasses	Eight sedges and eight grasses have been identified	Yes	Species composition stable
Invasive species coverage	No more than 10% total cover	Total cover of invasive species is less than 10%, and has been effectively controlled.	Yes	Reed canary grass is less than 5% coverage.
Invasive species concentration	No single areas greater than one-quarter acre in size	Invasive species remain under control with no single area greater than one-quarter acre in size	Yes	Slight increase of along ditches, but sprayed again in fall 2017 to control

- Know performance standards
- Interpret data to determine whether the site meets those standards
- If not, document with data what is not meeting standard
- Consult with TEP & Corps
- Then corrective actions should be recommended

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Credit Deposits

- Up to 15% of the credits are eligible for deposit after the certification of construction
- Remaining credits are eligible for deposit based on the credit release schedule and performance standards in the approved bank plan
- Subject to review by the LGU & TEP
- After certifying the credit for deposit, the LGU must forward to BWSR banking adminstrator


Transaction Form to Deposit Credits
Minnesota Wetland Bank Program

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Credit Release Schedule

Determines "when" credits can be released and in what proportion

Typical release schedule*

- Initial (≤15%)
- Hydrology (0 - 45%)
- Interim 1 (variable)
- Interim 2 (variable)
- Final (≥ 20%)
- Performance standards and credit release guidance

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Credit Release Schedule

Common release schedule elements*

- Hydrology release approved before vegetation releases occur
- Buffer credits released at same time and rate as wetland credits
- Final release requires 1 growing season after Interim 2 approved
- Final release should not be approved before annual monitoring has ended
- Wetland delineation conducted prior to final release

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Corrective Actions

- If, during the monitoring period, the LGU/Corps or TEP determine that a bank site does not meet the approved plan's specifications, the LGU must require corrective actions
- BWSR can freeze accounts by restricting deposits, withdrawals, transfers until the LGU determines the site is in compliance
- Noncompliance of bank sites is subject to enforcement procedures

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Hydrology Monitoring

Considerations in planning hydrologic monitoring project:

- What is the question?
- What is the performance criteria?
  - Precision?
- Site characteristics
  - Landscape position, hydrology setting, soil, vegetation, drainage features
- Pre-existing data
- Timeline and available resources

- BWSR Hydrology Guidance documents

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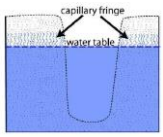
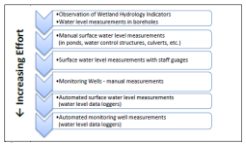
Methods to monitor hydrology

- Observation of indicators
- Staff gauges
- Open boreholes



- Monitoring wells
  - Manual measurements
  - Automated measurements



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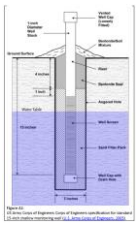
Design and location of monitoring wells

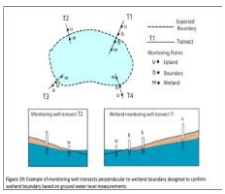


Monitoring wells

- Screen, Riser, Sand Pack, Bentonite seal

Well location

- Depends on the question:
  - Single well will tell if hydrology is present
  - Complex sites require transects based on landscape position, etc.
    - Professional judgement



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Monitoring Data for Exsted

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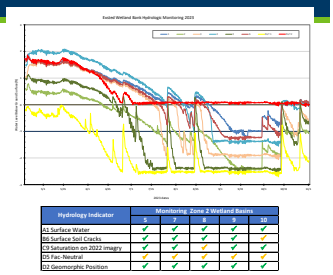
Interpreting Hydrology



Hydrology Indicator	Monitoring Zone 2 Wetland Basin				
	5	7	8	9	10
A1 Surface Water	✓	✓	✓	✓	✓
B6 Surface Soil Cracks	✓	✓	✓	✓	✓
C9 Saturation on 2022 imagry	✓	✓	✓	✓	✓
D5 Fac-Neutral	✓	✓	✓	✓	✓
D2 Geomorphic Position	✓	✓	✓	✓	✓

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Vegetation

- Methods to monitor vegetation:
  - FQA
  - Mapping plant communities
  - Estimating invasive species
- Interpreting vegetation data
  - Indicator status (% FAC or wetter)
  - Composition (% native species richness)
  - Invasive cover (%)
  - Floristic Quality Assessment (index rating)

	Each performance standard met for ≥2 consecutive growing seasons to qualify for credit release
Interim 1 Vegetation Performance Standards release of additional 15% of total projected credits for wetland, 35% for buffer	**Wet Meadow:** • ≥ 50% relative cover by native non-invasive species composed of at least 5 species, with at least 2% cover each • ≤ 50% relative cover of non-native/invasive species • ≥ 50% relative cover by hydrophytes • bare ground not to exceed 40% absolute cover **Shallow/Deep Marsh:** • ≥ 40% relative cover by native species composed of at least 3 species • ≤ 60% relative cover of non-native/invasive species • ≥ 40% relative cover by hydrophytes • open un-vegetated water not to exceed 40% absolute cover **Upland Prairie*:** • ≥ 50% relative cover by native, non-invasive species composed of at least 6 species • ≤ 50% relative cover of non-native/invasive species • bare ground not to exceed 35% absolute cover

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Interpreting Vegetation

- Vegetation measurements to consider:
  - Percent absolute cover of bare ground/open water
  - % relative cover of native, non-invasives
  - % relative cover of non-native, invasives
  - % relative cover of hydrophytes
  - Plant species richnesss

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Interpreting Hydrology

Wet Meadow Community (installed 5/19/2022)	Reference 2	Well 1-1		Well 1-2		Well 1-3		Well 1-4	
A) Duration of water table < 12-inches below the surface is at least 80 percent of the wet meadow reference duration on Ogema Springs WMA; OR	111 Days	145 Days (130%)	✓	66 Days (60%)	✗	Logger Failed*	✓	130 Days (117%)	✓
B) Water table < 12-inches below the surface from the beginning of the growing season until at least July 1, except for drought conditions (Drought Severity Classification D0 to D4).	September 7	October 11	✓	July 24	✓	Logger Failed*	✓	Sept. 26	✓

Marsh Community (installed 5/19/2022)	Reference 1	Well 1-5		Well 1-6		Well 2A*		Well 2B	
A) Duration of shallow inundation and water table < 12-inches below the surface is at least 80 percent of the shallow marsh reference duration on Ogema Springs WMA; OR	71 Days	133 Days (187%)	✓	151 Days (213%)	✓	81 Days (114 %)	✓	138 Days (194%)	✓
B) Inundation up to 10-inches for ≥ 28 consecutive days during the growing season, except for drought conditions (Drought Severity Classification D0-D4).	71	133	✓	151	✓	81	✓	138	✓

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Interpreting Vegetation

Community	Plant Group	% Relative Cover					
		1a	1b	1e	2e	2b	Ave
Marsh	Native	54	89	89	75	71	76
	Hydrophytes	100	100	100	100	100	100
		% Absolute Cover					
	Bare/Open Water	42	0	0	18	42	20

Community	Interim 1 Performance Standards (3 consecutive growing seasons)	Method	2021 Monitoring Results	2022 Monitoring Results	Standard Met (2 of 2 yrs)
Wet Meadow	≥ 90% relative cover by native non-invasive species	Step-point Transects (average)	86%	68%	✓
	≥ 5 native non-invasive species present	Meanders (average)	14	11	✓
	≥ 90% relative cover by hydrophytes	Step-point Transect (average)	75%	82%	✓
	No bare ground* areas >1000 ft²	Meanders	0	0	✓
Shallow Marsh	≥ 90% relative cover by native non-invasive species	Step-point Transects (average)	62%	78%	✓
	≥ 5 native non-invasive species present	Meanders (average)	10	9	✓
	≥ 90% relative cover by hydrophytes	Step-point Transect (average)	98%	100%	✓
	≥ 90% vegetative canopy cover in majority of area	Meanders	>90%	>90%	✓
	No bare ground* areas >1000 ft²	Meanders	0	0	✓
Upland Prairie	≥ 90% relative cover by native non-invasive species	Step-point Transect	41%	37%	✗
	≥ 6 native non-invasive species present	Meanders	6	7	✓
	No bare ground* areas >1000 ft²	Meanders	0	0	✓

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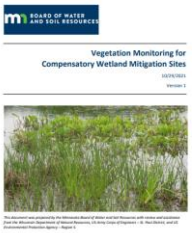
Vegetation Monitoring for Wetland Bank Sites

Vegetation Monitoring for Compensatory Wetland Mitigation Sites

- Developing a vegetation monitoring plan
- Sampling methods
- Where and when to monitor
- Monitoring plan considerations
- Reporting monitoring results



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Review

- General considerations for successful restoration
  - Restoration over creation, degraded sites, adjacent land uses , soil conditions, water quality, other drainage features, landownership
- Restoring natural hydrology
  - Understand the landscape position, hydrology, hydraulics
- Establishing vegetation
  - Strategic site preparation, landscape connections, match plant communities to site, plant diversity, work with ecological variability, species tolerance, manage Invasive species
- Restoration techniques
  - Filling ditches, removing drain tile, rerouting & pump removal
- Performance Standards
  - Measurable attributes to determine if restoration goals are met
- Monitoring Reports
  - Hydrology monitoring
    - Monitoring wells
    - Interpreting data
  - Vegetation monitoring
    - Interpreting data
- Use available technical guidance!

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