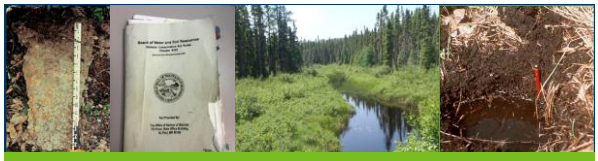


MN Wetland Professional Certification Program Regional Training-Redwood Falls

BOARD OF WATER AND SOIL RESOURCES

Minnesota Wetland Professional Certification Program

1

Remaining MWPCP 2024 Courses

- Regional Training -Redwood Falls– August 27-28
- Introduction to Wetland Delineation & Regulations- Brainerd - September 9-13
- Introduction to Wetland Delineation &Regulations- Arden Hills- September 30-October 4
- Antecedent Precipitation Tool- St Cloud MNDOT Training Center- October 22 (2 sessions)

2

MWPCP Regional Training Agenda

August 27

2024 WCA Statute Changes
- Wetland classification system
- Definitions
- Agricultural Exemption
- Drainage exemption
- De minimis & utility exemptions

WCA Enforcement Short Course
- Assessing WCA impacts
- Reviewing ATF applications

Delineation Field Review Exercise

August 28

Wetland Bank Monitoring Reports
- Wetland Bank plans
- Monitoring reports
- Monitoring methods

Intro to the Enviro Atlas Methods for the new Wetland Functional Assessment Method

Common Wetland Indicators of Hydrogeomorphic Method

Delineation review field exercise (Whittet bank site)

3

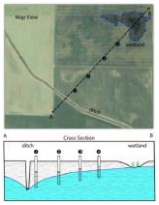
Wetland Bank Monitoring

BOARD OF WATER AND SOIL RESOURCES

4

Overview of Wetland Bank Monitoring

- Monitoring process
  - Construction Certification
  - Duration of monitoring
  - Deposit of Credits
- Maintenance responsibilities
  - Monitoring reports
  - Timeline
  - Reports
- Corrective Actions



- Hydrology Monitoring
  - Performance standards
- Vegetation Monitoring
  - Performance standards

5

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

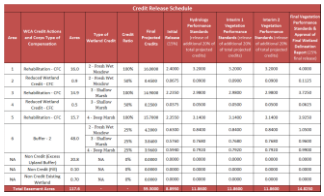
Sponsor/landowner roles:

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

6

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)



Credit Release Schedule

Area	WCA Credit Actions and Corpus Type of Compensation	Acres	Type of Wetland Credit	Credit Ratio	Final Projected Credits	Initial Release (15%)	Hydrology Performance Standards (release of additional 25% of total projected credits)	Interim 1 Vegetative Performance Standards (release of additional 15% of total projected credits)	Interim 2 Vegetative Performance Standards (release of additional 15% of total projected credits)	Final Vegetative Performance Standards & Approval of Final Wetland Delineation Report (15% final release)
1	Rehabilitation - CFC	16.0	2 - Fresh Wet Meadow	100%	16.0000	2.4000	5.2000	5.2000	5.2000	4.0000
2	Reduced Wetland Credit - CFC	0.9	2 - Fresh Wet Meadow	50%	0.4500	0.0675	0.0900	0.0900	0.0900	0.1125
3	Rehabilitation - CFC	16.9	3 - Shallow Marsh	100%	16.9000	2.2350	2.9800	2.9800	2.9800	3.7250
4	Reduced Wetland Credit - CFC	0.5	3 - Shallow Marsh	50%	0.2500	0.0375	0.0500	0.0500	0.0500	0.0625
5	Rehabilitation - CFC	15.7	4 - Deep Marsh	100%	15.7000	2.3550	3.1400	3.1400	3.1400	3.5250
6	Buffer - 2	48.0	2 - Fresh Wet Meadow	25%	4.2000	0.6300	0.8400	0.8400	0.8400	1.0500
			3 - Shallow Marsh	25%	3.6000	0.5400	0.7200	0.7200	0.7200	0.9000
			4 - Deep Marsh	25%	3.5000	0.5250	0.7000	0.7000	0.7000	0.8750
NA	Non-Credit (Excess Upland Buffer)	20.8	NA	0%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NA	Non-Credit (ITC)	0.50	NA	0%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NA	Non-Credit Fee-Ag Buffer	0.70	NA	0%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total Restored Area		117.0			59.9000	8.9900	13.9000	13.9000	13.9000	14.8750

7

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.

Table 2. Hydrology and Vegetation Performance Standards and Credit Release Schedule

Initial Release (15% of total projected credits)	Approval of MBI/Plan, Conservation Easement Recorded, Approval of As-Built plans, and initial seed installation is complete.
Hydrology Performance Standards Release of additional 25% of total projected credits.	Met for ≥2 growing seasons to qualify for credit release **Wet Meadow:** • Water table levels within 12 inches of the surface at a frequency and duration consistent with the off-site reference wetland (within 20% variation of water levels). • Marks/ sides within 12 inches of the surface for ≥28- consecutive days or two periods of ≥14 days during the growing season under normal to wetter than normal conditions. **Shallow Marsh:** • Water table at a frequency and duration consistent with the off-site reference wetland (within 20% of variation in water levels relative to ground surface), or • Inundation up to 6 inches in depth for ≥28 consecutive days during the growing season under normal to wetter than normal conditions. During the growing season, inundation up to 18 inches in depth following the 2-year, 24-hour—or greater—precipitation events is permissible provided that the duration does not exceed 28 consecutive days.
Interim 1 Vegetative Performance Standards Release of additional 15% of total projected credits.	Met for ≥2 growing seasons to qualify for credit release. **Wet Meadow:** • ≥ 50% relative cover by native, non-invasive species composed of at least 8 species • < 50% relative cover of non-native/invasive species • > 50% relative cover by hydrophytes • Bare ground not to exceed 8% and no continuous bare areas > 400 ft² **Shallow Marsh:** • ≥ 40% relative cover by native, non-invasive species composed of at least 4 species • < 60% relative cover of non-native/invasive species • ≥ 70% relative cover by hydrophytes • Areal extent of open un-vegetated water and bare ground not to exceed 30% of community (per basin).
Interim 2 Vegetative Performance Standards Final Vegetative Performance Standards & Approval of Final Wetland Delineation Report (15% final release)	**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 8% and no continuous bare areas > 400 ft²

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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 Reports

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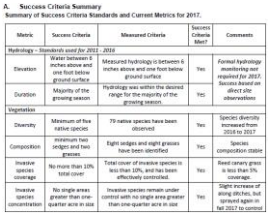
Reviewing Monitoring Reports



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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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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Common Issues in Monitoring Reports

- Insufficient figures/graphs
- Data logger problems
- Performance standards not matching bank plan
- Incorrect monitoring techniques
- Data interpretation concerns

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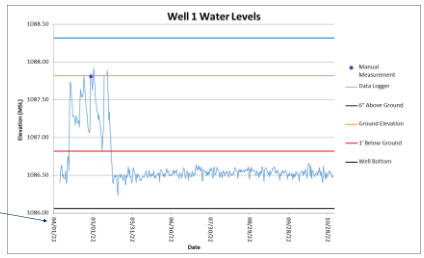
Hydrograph Issues



How do we verify that 28 consecutive days are met?

When does the growing season start?

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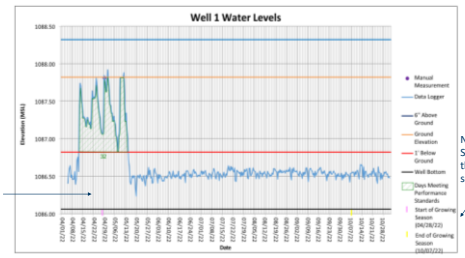
Hydrograph Issues



Lines depicting daily intervals

Now includes Start/End of the growing season

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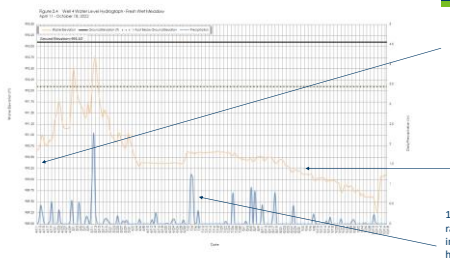
Data Logger Issues



Lacking demarcation of the bottom of the well

Despite multiple rain events, the hydrograph continues to drop

1.25 inches of rain but no spike in the hydrograph

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Veg Standards Excercise

Wetland Bank
Vegetation Monitoring 2022

VEGETATIVE ASSESSMENT DEEP MARSH

Species	Indicator	Native	Invasive	Strata*	Site A Transect 2	Site B Transect 6
Tall manna grass (*Glyceria grandis*)	OBL	Yes	No	H	30	5
Rice cut grass (*Leersia oryzoides*)	OBL	Yes	No	H	5	0
Lake Sedge (*Carex lacustris*)	OBL	Yes	No	H	5	0
Common water plantain (*Alisma subcordatum*)	OBL	Yes	No	H	15	2
Broad-leaf Arrowhead (*Sagittaria latifolia*)	OBL	Yes	No	H	1	1
River Bulrush (*Bolboschoenus fluviatilis*)	OBL	Yes	No	H	5	10
Soft-stem Bulrush (*Schoenoplectus tabernaemontani*)	OBL	Yes	No	H	3	5
American Water Horehound (*Lycopus americanus*)	OBL	Yes	No	H	1	0
Curved Crowfoot (*Ranunculus sceleratus*)	OBL	Yes	No	H	1	0
Canadian horseweed (*Conyza canadensis*)	FACU	Yes	No	H	0	0
Plains Cottonwood (saplings) (*Populus deltoides*)	FAC	Yes	No	H	1	0
Narrow-leaved cattail (*Typha angustifolia*)	**OBL**	**No**	**Yes**	**H**	**3**	1
open water	N/A	N/A	N/A	N/A	30	75
Total					100	101
			% areal cover invasives		3	1
			% areal cover non-invasive natives		67	25
			% areal cover hydrophytes		70	26
			Number Native Non-Invasive Species		10	5

Deep Marsh:

1. **Relative areal cover by Native Non Invasive (NNI) species shall be >60%;**
2. **Relative areal cover by inv. species, including narrow-leaf and hybrid cattails (Typha angustifolia and T. x glauca), shall be <40%;**
3. **Species richness shall consist of > 3 NNI species with at least 2% relative cover;**
4. **Cover by hydrophytes shall be greater than 50%;**

Transect 2 meets performance standards

Should be >60%

Should be >50%

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US Army Corps Monitorting Report Template

US Army Corps of Engineers
St. Paul District

Mitigation Monitoring Report Template
USACE St. Paul District
April 2024 Version 1

Sponsors for compensatory mitigation banks and in-lieu fee sites are required to demonstrate in their monitoring reports whether sites are meeting performance standards or on a trajectory to meeting performance standards. Sponsors must collect accurate and complete data and report that data in their monitoring reports to support their assessment of site conditions relative to the required performance standards.

While sponsors do not have to follow this outline precisely, or present data in tables exactly as illustrated here, the U.S. Army Corps of Engineers St Paul District (Corps) has developed these suggestions in coordination with agencies on the Interagency Review Team (IRT) to aid sponsors in preparing and submitting complete monitoring reports. IRT members will be able to effectively review reports that are prepared by sponsors who implement these suggestions. Efficient agency review of monitoring reports will result in more timely decisions on credit release requests, to include decisions to release credits when warranted or decisions to not release credits and instead provide direction on measures that sponsors should take before submitting another request for a credit release. The Corps will update this template as needed in coordination with IRT members and based on any feedback we receive from sponsors.

The Corps Project Manager (PM) will conduct site inspections, typically during the growing season, to field verify the monitoring and performance documentation before making a decision on credit releases. If sponsors request to request a credit release following monitoring during the growing season, they should consider submitting as much data as possible before the growing season ends and they should request the Corps complete a site inspection before end of the growing season, then, they must submit complete monitoring reports by the due date (usually December 31st or January 31st).

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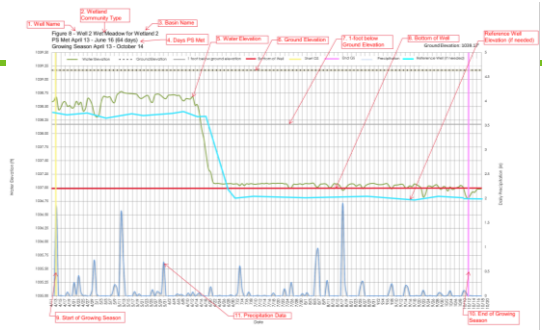

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Hydrology

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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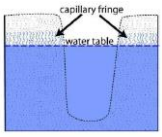
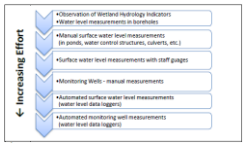
Methods to monitor hydrology

- Observation of indicators
- Staff gauges
- Open boreholes



- Monitoring wells
  - Manual measurements
  - Automated measurements



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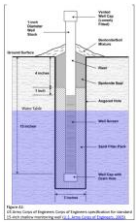
Design and location of monitoring wells

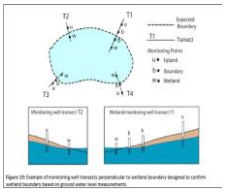


Monitoring wells

- 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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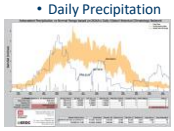
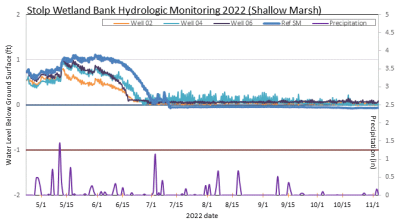
Monitoring Well Data

Hydrograph:

- Growing season
- Normal "envelope"
- 30 day rolling total
- Daily Precipitation





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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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Vegetation

- Methods to monitor vegetation:
  - Floristic Quality Assessment
  - Mapping plant communities
  - Estimating invasive species

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Vegetation

- Interpreting vegetation data
  - Indicator status (% FAC or wetter)
  - Composition (% native species richness)
  - Invasive cover (%)
  - Floristic Quality Assessment (index rating)

Table 1: Summary of Wetland Success Criteria for Phase I

Success Criteria	Phase I		
	Wet Meadow	Hardwood Swamp	Shallow Marsh
Duration			
Growing Seasons	5	4	5
Hydrology			
Hydrology (depth to water table)	Surface to -12"	Surface to -12"	+6" to -12"
Hydroperiod (duration within zone)	Meets duration	Meets duration	Meets duration
Vegetation			
Wetland Indicator (% FAC or wetter)	41/52 = 79%	39/51 = 76%	20/22 = 91%
Species Composition (Native Richness)	39/52 = 75%	39/51 = 76%	19/22 = 86%
Invasive Cover (% non-native)	2%	9%	2%
FQA/WFQA	20.2/26.7	20.0/21.4	16.9/19.7
Tree Coverage (trees per acre)	N/A	*26.48*	N/A

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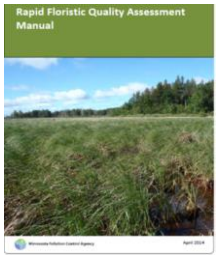
Floristic Quality Assessment

- Vegetation condition assessment to measure the quality of a native plant community
- Developed by the MN Pollution Control Agency
  - 2007, Statewide C-values
  - Efforts to regionalize C-values underway
- Intended to compliment functional assessments such as MNRAM



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FQA Key Concepts

- Key concepts:
  - Species conservatism- tolerance to degradation
    - Coefficients of Conservatism (C-value)
  - Floristic Quality Index
    - Species richness and mean C-values
- Sampling methods
  - Rapid FQA
  - Full Method

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FQA Key Concepts

- Coefficients of Conservatism
  - Numeric rating of an individual species fidelity in relationship to disturbance
  - C-values range from 0-10
    - 0= most tolerant, found in wide variety of plant communities
    - 10= least tolerant, found in narrow range of plant communities
    - Non-native species = 0
      - Reed Canary Grass (introduced) C=0
      - Ostrich Fern (FAC, NCNE) C=5
      - Pink lady slipper C=9

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Sampling Methods Overview

- FQA Sampling Protocol:
  - Map Assessment Area
  - Determine Plant community types
  - Conduct timed meander (rapid) or plot-based sampling
  - Conduct shoreland sampling (if necessary)
  - Make Areal cover estimations
  - Calculations
- Full FQA -Plot-based sampling
- Rapid FQA- Timed meander rules
  - Areal cover in cover classes for each species

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Sampling Methods

- Determining the Assessment Area
- Define plant communities
  - Eggers & Reed
  - MN DNR Native Plant Communities Classification Guide
    - Laurentian Mixed Forest, Eastern Broadleaf Forest, Prairie Parkland and Tallgrass Aspen Parklands

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Metrics

Variables:

- Number of species = Species Richness
- Mean C-value
- Mean C-value (weighted) (wC)
  - $wC = \sum pC$

Floristic Quality Index

- Integral measurement of FQA

$$FQI = \overline{C}\sqrt{S}$$

  - mean C value
  - S= number of species (i.e. species richness)
- Both stand alone indices

Greater the FQI, the closer the condition is to a natural state

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Wetland Hydrology Monitoring - Methods

Minnesota Wetland Professional Certification Program

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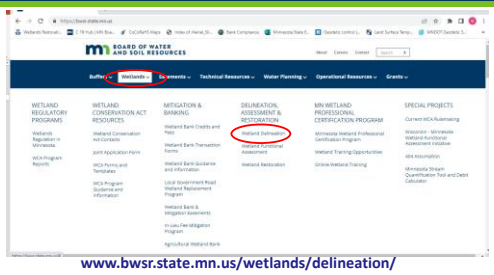
Hydrology



www.bwsr.state.mn.us/wetlands/delineation/

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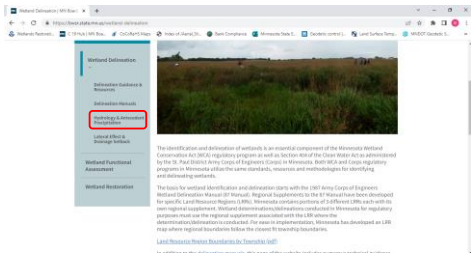
Hydrology



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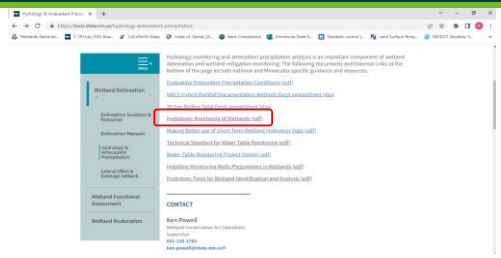
Hydrology



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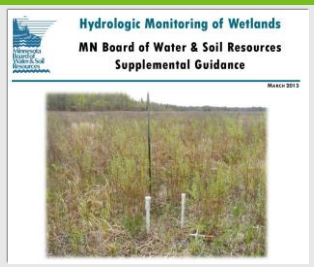
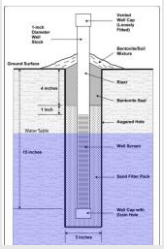
Hydrology





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Monitoring Wetland Hydrology

- Why? Why are we monitoring hydrology?
- How? How are we monitoring hydrology?

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Evaluation over a period of time

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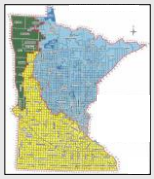
Wetland Hydrology Indicators

Table 9. Wetland hydrology indicators for the Midwest Region.

Indicator	Category	
	Primary	Secondary
Group A – Observation of Surface Water or Saturated Soils		
A1 – Surface water	X	
A2 – High water table	X	
A3 – Saturation	X	
Group B – Evidence of Recent Inundation		
B1 – Water marks	X	
B2 – Sediment deposits	X	
B3 – Drift deposits	X	
B4 – Algal mat or crust	X	
B5 – Iron deposits	X	
B7 – Inundation visible on aerial imagery	X	
B8 – Sparsely vegetated concave surface	X	
B9 – Water-stained leaves	X	
B13 – Aquatic fauna	X	
B14 – True aquatic plants	X	
B6 – Surface soil cracks		X
B10 – Drainage patterns		X
Group C – Evidence of Current or Recent Soil Saturation		
C1 – Hydrogen sulfide odor	X	
C3 – Oxidized rhizospheres along living roots	X	
C4 – Presence of reduced iron	X	
C6 – Recent iron reduction in tilled soils	X	
C7 – Thin muck surface	X	
C2 – Dry-season water table		X
C8 – Crayfish burrows		X
C9 – Saturation visible on aerial imagery		X
Group D – Evidence from Other Site Conditions or Data		
D9 – Gauge or well data	X	
D1 – Stunted or stressed plants		X
D2 – Geomorphic position		X
D5 – FAC-neutral test		X



- Chapter 4 of the regional supplements
- (25 to 29 indicators depending on region)

40

Wetland Hydrology Standard

- On highly disturbed or problematic sites, direct hydrologic monitoring may be needed to determine whether wetland hydrology is present. The U. S. Army Corps of Engineers (2005) provides a technical standard for monitoring hydrology on such sites. This standard requires **14 or more consecutive days of flooding or ponding, or a water table 12 in. (30 cm) or less below the soil surface, during the growing season at a minimum frequency of 5 years in 10 (50 percent or higher probability)** (National Research Council 1995) unless an alternative standard has been established for a particular region or wetland type.

41

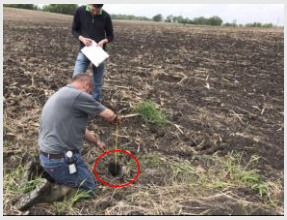
Why Monitor?

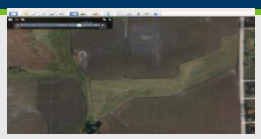
- Is it a wetland? Does the depth and timing of saturation at a location meet the technical criterion for wetland hydrology?

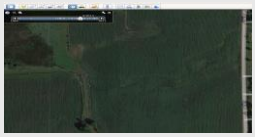
42

Why Monitor?

- Drained wetland, violation?



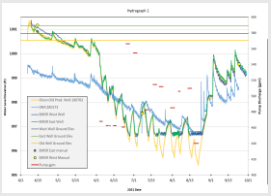




43

Why Monitor?

- Irrigation wells, drainage?



44

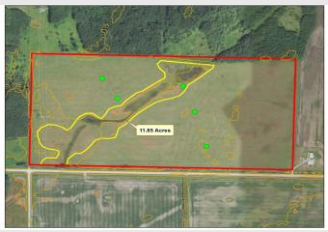
Why Monitor?

- Better define wetland area

45

Why Monitor?

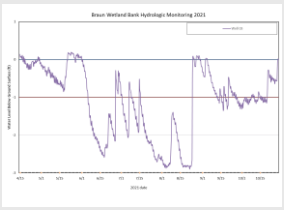
- Better define wetland area



46

Why Monitor?

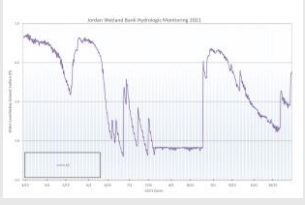
- Monitor wetland restorations and performance standards
- Wet Meadow - Water tables within 12-inches of the surface for 28-consecutive days or two periods of 14-days during the growing season under normal to wetter than normal conditions



47

Why Monitor?

- Monitor wetland restorations and performance standards
- Shallow Marsh - Water table is at the surface or inundation up to 12-inches in depth for at least 28 consecutive days during the growing season under normal to wetter than normal conditions



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Why Monitor?

- Monitor wetland restorations and performance standards
- Deep Marsh - Hydrology shall consist of inundation 6 to 48 inches in depth throughout the growing season with the exception of drought conditions

49

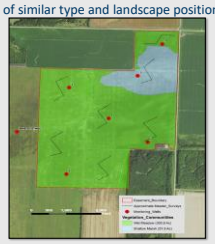
Why Monitor?

- Monitor wetland restorations and performance standards
- Upland Buffer??? No, no hydrology performance standards in the buffer

50

Why Monitor?

- Reference wetland – monitor wetland of similar type and landscape position
- Pre-Project Monitoring…next slide



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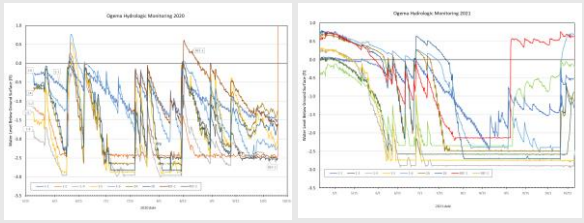
Why Monitor?

- Functional Lift



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Why Monitor?

Reasons to Monitor	Questions to Answer
Wetland identification and determination	• Is the wetland hydrology technical standard met at this point? • What is the hydrologic regime and its associated wetland type?
Wetland boundary determination	• Where does wetland hydrology begin and end on the landscape?
Assessing wetland functions dependent upon hydrologic regime.	• What are the depth, duration, frequency, and seasonality of saturation? • How does this wetland interact with ground water (recharge or discharge)? • How does water flow into or out of the wetland? • What are the hydrologic inputs and outputs?
Assess potential for wetland restoration or creation	• What is the lateral effect of a drain or ditch? • What depth is the current water table? • What are the hydrologic inputs and outputs?
Evaluate hydrologic alteration	• What is the lateral effect of a drain or ditch? • Has a wetland been effectively drained? Or partially drained? • How well is ditch or drain tile functioning?
Determine success of wetland restoration or replacement	• How much has the water table depth changed since a drain was removed? • Has wetland hydrology been restored? • Is the wetland hydrology technical standard met at this point? • Is the restored hydrology adequate to support the planned plant communities
Calcareous fen determination	• Is there localized groundwater discharge to the wetland? • If so, is the discharging ground water cold & alkaline? • What is the direction of ground water flow? • Are there calcareous fen indicator plants there? files.dnr.state.mn.us/natural_resources/water/wetlands/calcareous_fen_fact_sheet_dec_2011.pdf

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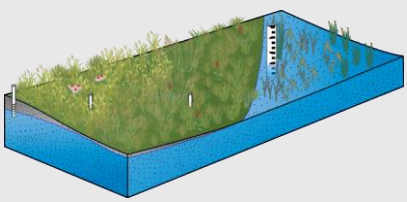
Evaluation over a period of time



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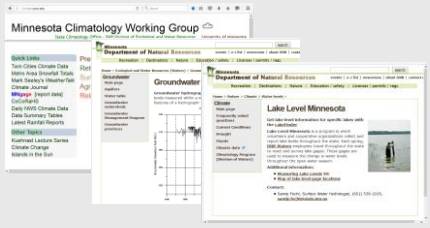
Sources of Hydrologic Monitoring Data

Existing Data



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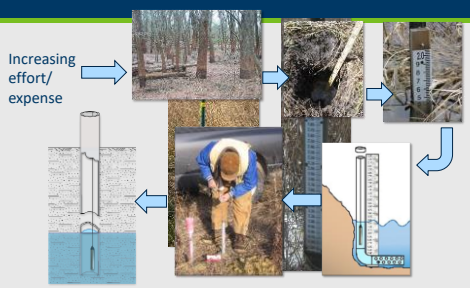
The How of Hydrologic Monitoring



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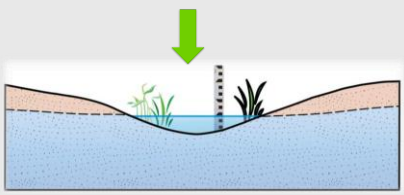
Surface Water Levels



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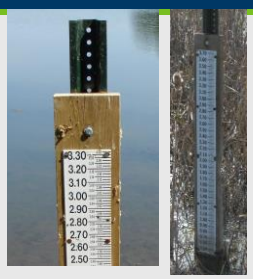
Staff Gauges



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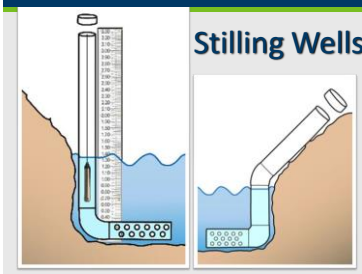
Stilling Wells



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Water Control Structure

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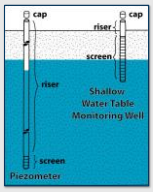
Measuring Ground Water Levels

- Water Table Monitoring Wells
- Piezometers



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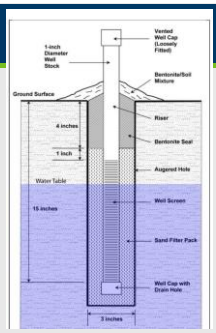
Shallow water table monitoring well



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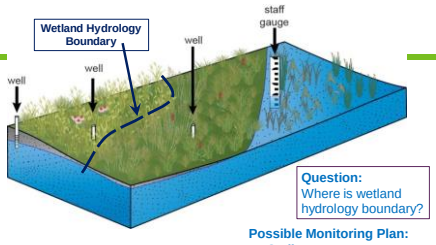

Question:
Where is wetland hydrology boundary?

Setting:
- depressional wetland
- slope from upland to shallow marsh

Possible Monitoring Plan:
- Staff gauge
- Wetland Well
- Upland Well
- Boundary Well

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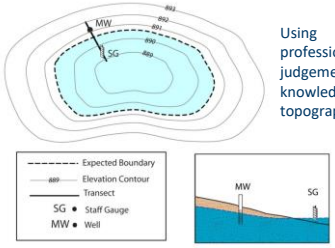

Using professional judgement and knowledge of topography…

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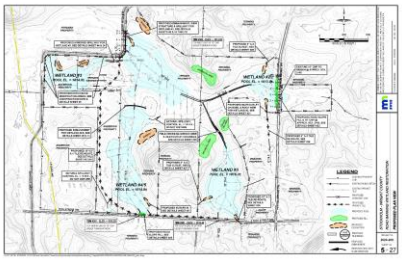
Normal Pool Elevations



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Monitoring Plan

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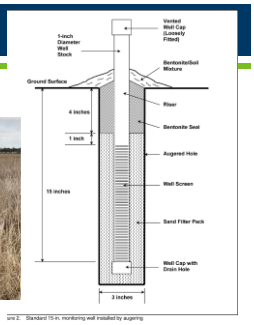
Well installation

How to install a monitoring well…

- Basic components of a casing:
- 1.5" PVC riser and well screen
- Bottom cap (drain hole)
- Vented top cap
- Filter/wrap for screen
- Sand
- Bentonite
- Datalogger



ure 2. Standard 15-in. monitoring well installed by augering

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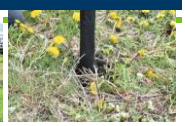
Well installation

1. Auger hole
2. Scrape sides of borehole (clay or loamy soils)
3. Pour 1-2" of sand in the bottom of the borehole
4. Place casing in borehole
5. Backfill remaining void in borehole with sand (to within about 4" of the surface)
6. Fill remaining 4" with bentonite
7. Mound soil/bentonite around base of casing to seal the well
8. Install datalogger
9. Loose cap



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Data loggers

- Solinst/HOBO data loggers
- Levelogger (reads water levels and atmospheric pressure)
- Barologger (reads atmospheric pressure)
- Only one Barologger needed per site, good for a 20-mile radius (two per site is not a bad idea incase one malfunctions)

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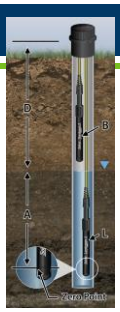
Logger installation

- All **Leveloggers** measure total (absolute) pressure. When submerged, the Levelogger is recording the combination of barometric pressure and water pressure. The actual pressure of just water **(A)** above the sensor is obtained by subtracting barometric pressure **(B)** from the total pressure **(L)**



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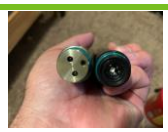
Logger programming

- Program the logger
- USB Connection to computer (Solinst software)
- Bluetooth mobile connection (Solinst app and smartphone)



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Logger programming

- Typically, levelogers are set to take reading every 6 hours
- Barologgers are set to take readings every hour
- Check what your approved monitoring plan says!

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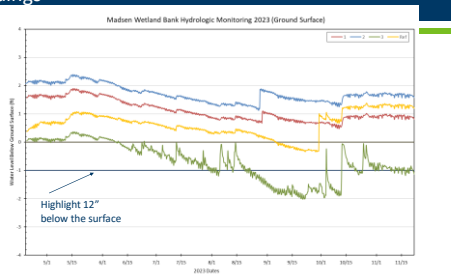
Logger readings

- What to include on the graph



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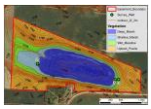
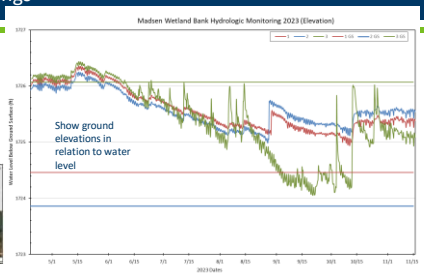
Logger readings

- What to include on the graph





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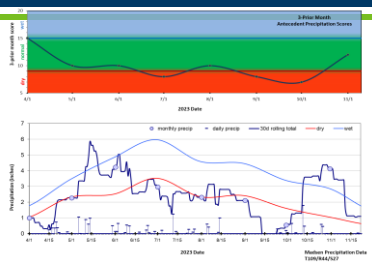
Precipitation



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The performance standard for the wet meadow community required: Water Tables within 12-inches of the surface for 28- consecutive days or two periods of 14-days during the growing season under normal to wetter than normal conditions or, duration of water Table ≤ 12 inches below the soil surface is plus or minus 20 percent of that of the reference wetland.

- **2022 Growing Season:**

✓ Well 1 (WM) showed water within 12-inches of the surface from April 22 (date of installation) to June 13 (53 consecutive days).

✓ Well 3 (WM) showed water within 12-inches of the surface from April 22 (date of installation) to June 2 (42 consecutive days).

✓ Well 5 (WM) showed water within 12-inches of the surface from April 22 (date of installation) to June 16 (56 consecutive days).

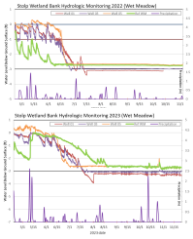
- **2023 Growing Season:**

✓ Well 1 (WM) showed water within 12-inches of the surface from April 19 (date of installation) to June 15 (58 consecutive days).

✓ Well 3 (WM) showed water within 12-inches of the surface from April 19 (date of installation) to June 14 (57 consecutive days).

✓ Well 5 (WM) showed water within 12-inches of the surface from April 19 (date of installation) to June 16 (59 consecutive days).

All three wet meadow wells (1, 3, 5) met the wet meadow performance standards for two consecutive growing seasons.



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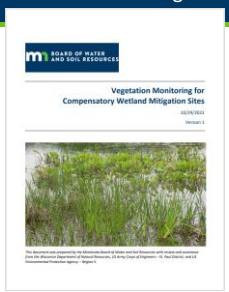
Vegetation Monitoring on Mitigation Sites



Link to Vegetation Monitoring on Mitigation Sites

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Developing Vegetation Monitoring Plan

Areal cover estimates

- Absolute and Relative cover

Species Richness

Non-natives

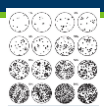

Figure 5. Mapped areas of invasive species on a compensatory mitigation

Figure 3. Formula and example for calculating percent relative cover from absolute cover estimates.

$$\frac{\text{\% Absolute Cover Species A}}{\text{Total Absolute \% Cover All Species}} (100) = \text{\% Relative Cover Species A}$$

Example:

Species	Absolute % Cover
A	30
B	40
C	80
Total	150

30/150 (100) = 20% Relative Cover Species A

40/150 (100) = 27% Relative Cover Species B

80/150 (100) = 53% Relative Cover Species C

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Vegetation Monitoring Sampling Methods

- Sampling Methods
  - Plots
  - Belt transects
  - Point-intercept
  - Meander

Figure 5. The "belt" of a belt transect depicted by the dashed lines. Woody stems meeting certain height and diameter criteria can be tallied by species to estimate stems per unit acre.

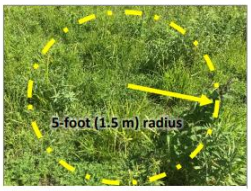

Figure 7. Example of a circular plot for the herbaceous layer.

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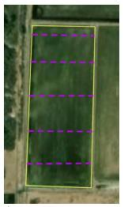
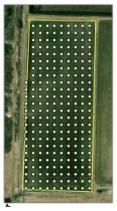
Examples of Transect Layouts

Figure 12. Examples of transect layouts for compensatory wetland mitigation sites.





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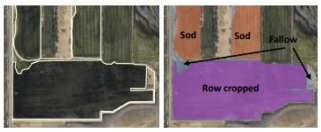
Establishing Monitoring Units

Considerations:

- Land Use
- Hydrology
- Soil Types
- Planting & seeding areas
- Management techniques
- Stressors



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Reporting Monitoring Results

Table 6. Example of summarizing relative areal cover estimates by plant community and plant group.

		% Relative Cover Estimated from Point Intercept Transects (A – F)						
Community	Plant Group	A	B	C	D	E	F	Avg.
Mesic Prairie	Native	70%	95%	100%	60%	100%	60%	81%
	Introduced	30%	5%	0%	40%	0%	40%	19%
Wet Meadow	Native	85%	90%	90%	75%	100%	86%	88%
	Introduced	10%	0%	0%	10%	0%	14%	6%
	Bare/none	5%	10%	10%	15%	0%	0%	6%
Shallow marsh	Native	100%	90%	96%	59%	90%	77%	85%
	Introduced	0%	0%	4%	12%	0%	4%	3%
	Bare/none	0%	10%	0%	29%	10%	19%	12%

Table 7. Example of comparing data on vegetation metrics to previous years and performance standards.

Community	Interim 1 Performance Standards	2018	2019
Mesic Prairie	Native, non-invasive vegetation >50% relative cover	39%	66%
	≥5 native, non-invasive species	18	23
	Non-native and/or invasive species <50% relative cover	61%	34%
	Bare ground <40% absolute cover	4%	0%
Wet Meadow	Native, non-invasive hydrophytic vegetation >50% relative cover	55%	72%
	≥5 native, non-invasive species (≥2% relative cover each)	9	9
	Non-native and/or invasive species <50% relative cover	15%	10%
	Bare ground <40% absolute cover	3%	1%
Shallow Marsh	Native, non-invasive hydrophytic vegetation >30% relative cover	96%	95%
	≥2 native, non-invasive species	24	18
	Non-native and/or invasive species <60% relative cover	3%	3%
	Unvegetated areas <60% absolute cover	16%	10%

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How many plots do I need to do?

Appendix 1. Assessing Sample Adequacy

Plotting Species Accumulation and Performance Curves

Sample Unit (plot)	Cumulative Native Species Richness
1	12
2	14
3	18
4	20
5	21
6	21
7	26
8	28
9	29

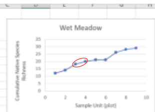

Figure 2. Example of table and resulting native species accumulation curve. The curve has not flattened out, yet the performance standard (18 native species) has been met.

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EnviroAtlas

EnviroAtlas (epa.gov)

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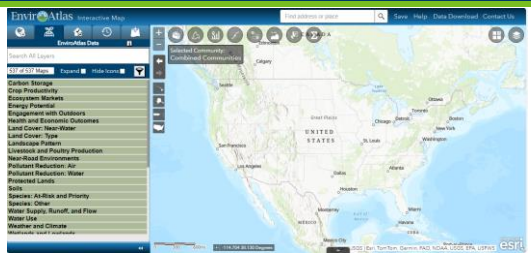
What you can do with



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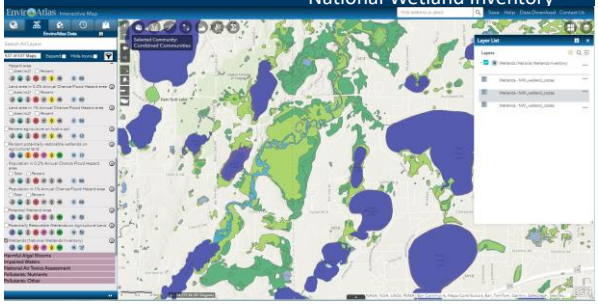
National Wetland Inventory



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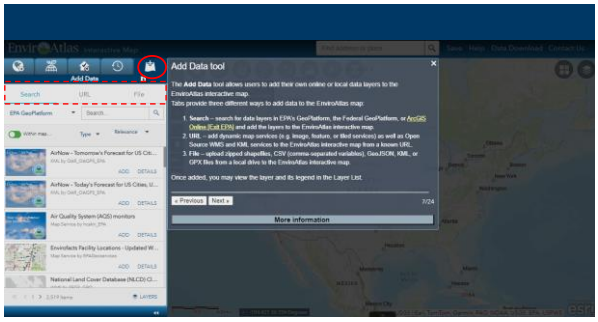

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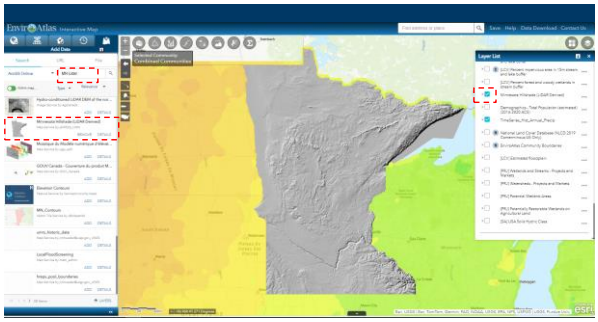

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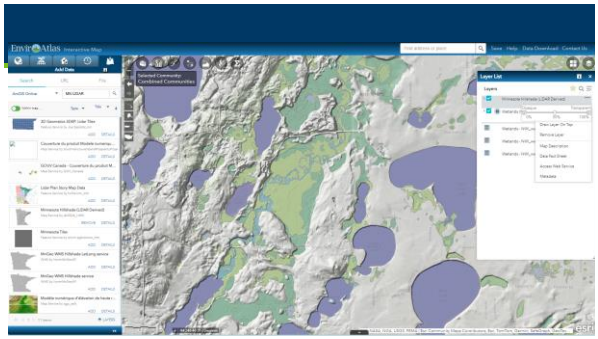

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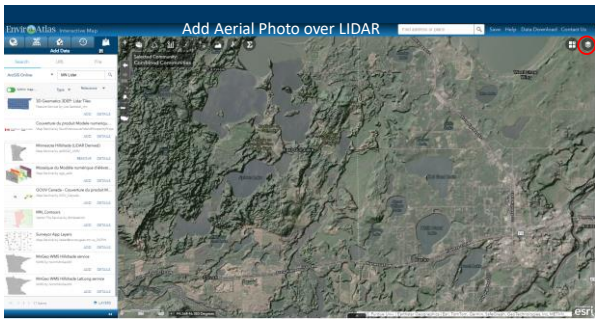

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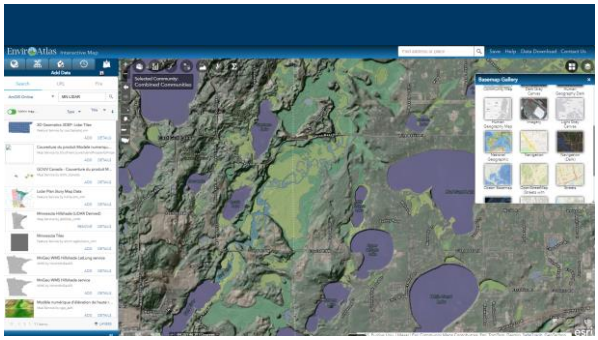

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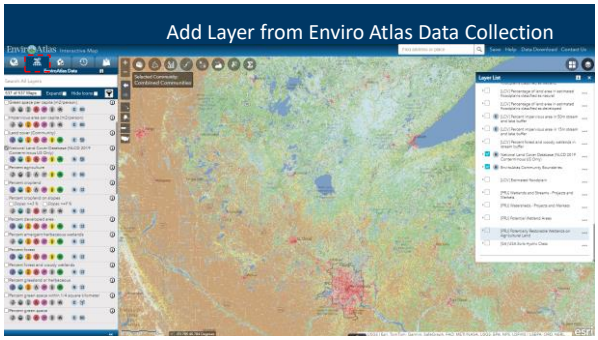
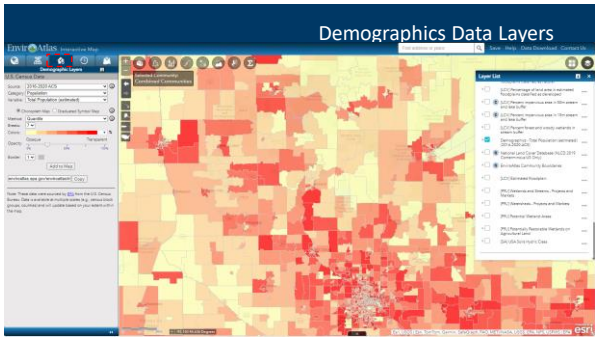
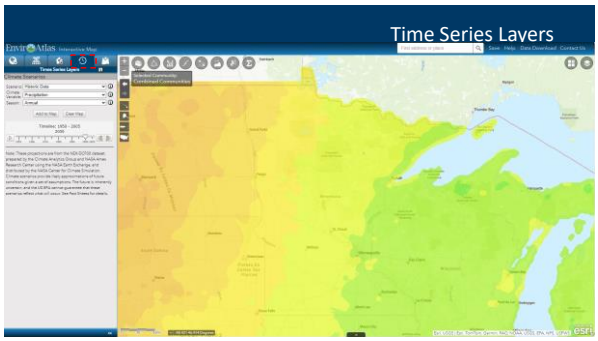

Add Layer from Enviro Atlas Data Collection

92


Demographics Data Layers

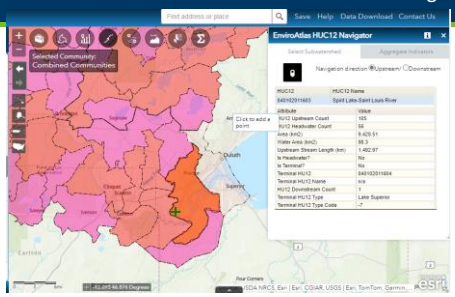
93

Time Series Layers



94

HUC 12 Watershed Navigator



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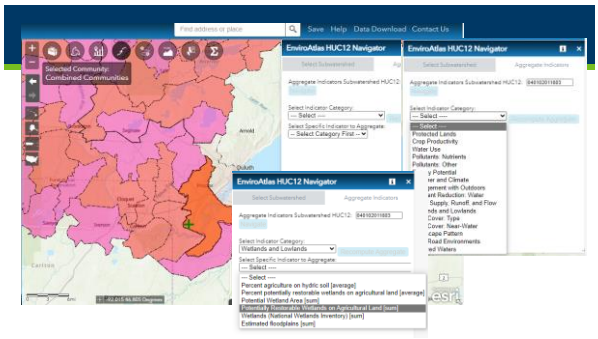
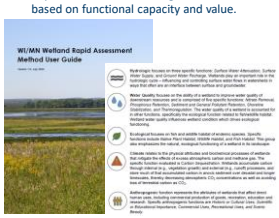


96

WIMN Rapid Functional Assessment Method

- WI/MN Wetland Rapid Assessment Method
  - Rapid method for assessing wetland functions based on functional capacity and value.



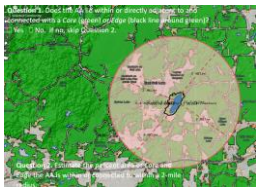
- Link to public notice, tool and user guide: Wisconsin wetlands: assessment methods and tools | | Wisconsin DNR
- Comments due 8/30

97

Functions relevant to functional assessment tool

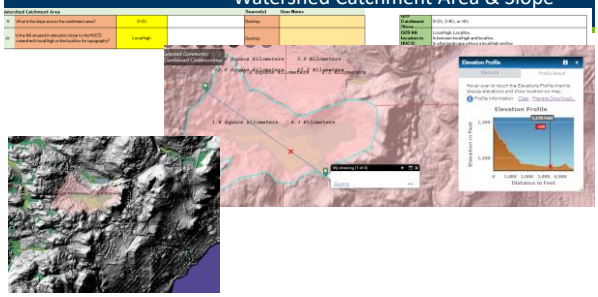
You can use EnviroAtlas to determine:

- Catchment Area
- Catchment Slope
- Land Cover Types in Catchment Area
- Regional Landscape Habitat Connectivity
- Stream and Surface Water Connectivity



98

Watershed Catchment Area & Slope



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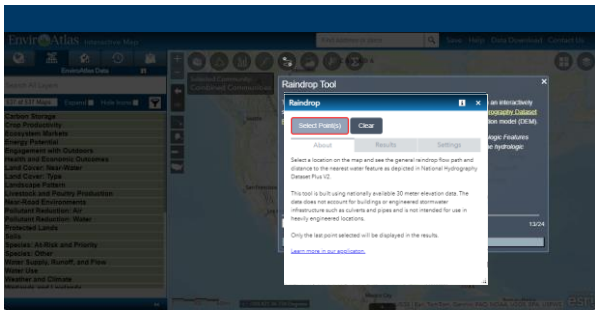
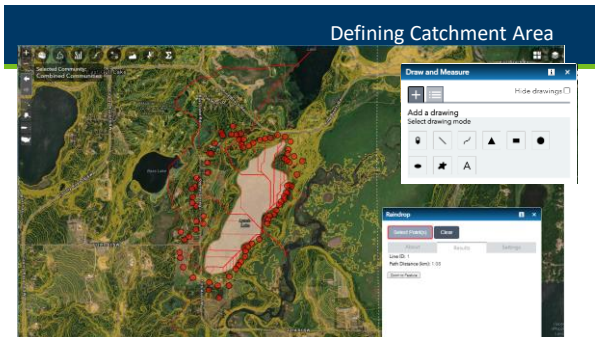
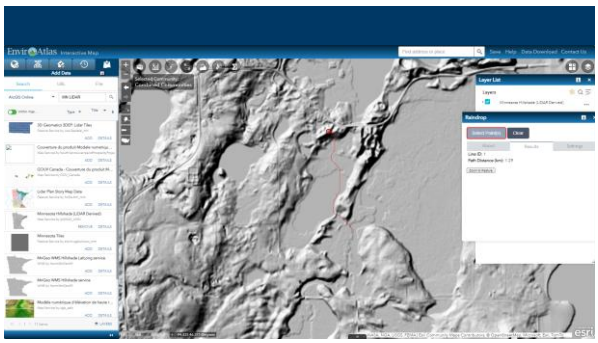

Raindrop Tool
Raindrop
Select Point(s)
Clear

100


Defining Catchment Area
Draw and Measure
Add a drawing
Select drawing mode
Raindrop

101



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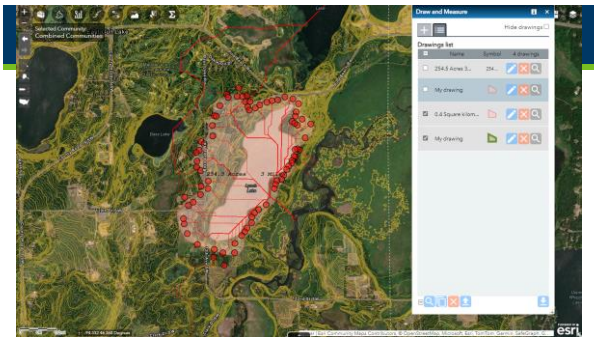
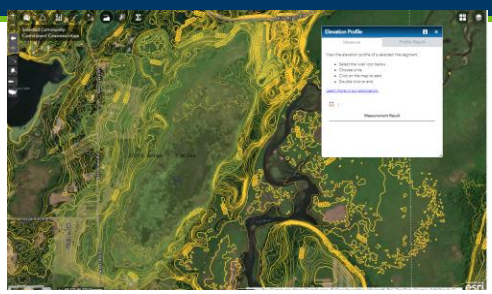


103

104

Determine Catchment Slope



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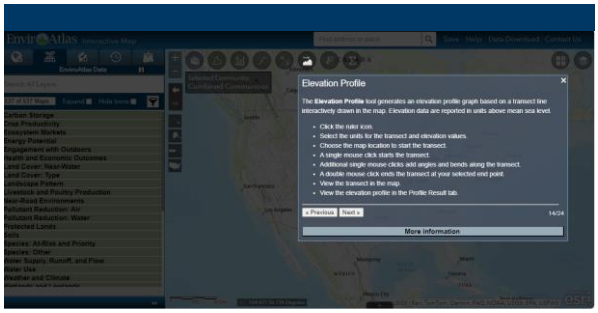

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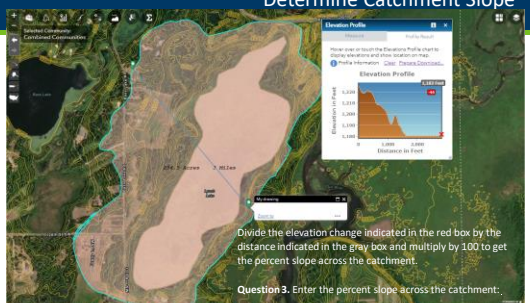
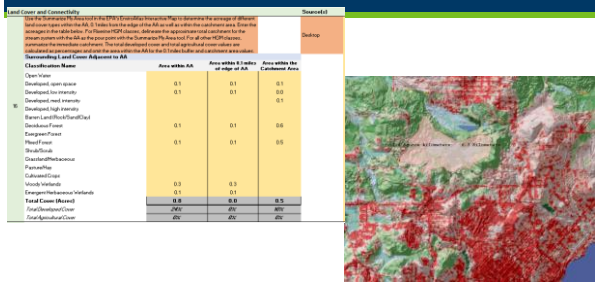
Determine Catchment Slope



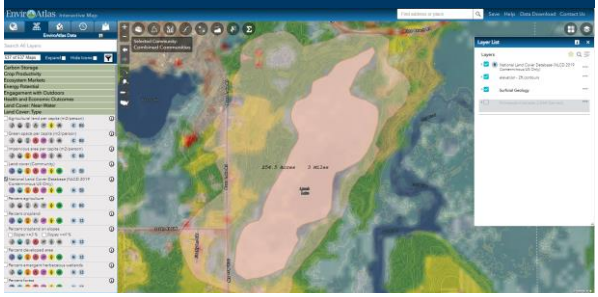
107

Land Cover and Connectivity



108

Determine Land Cover in Catchment Area



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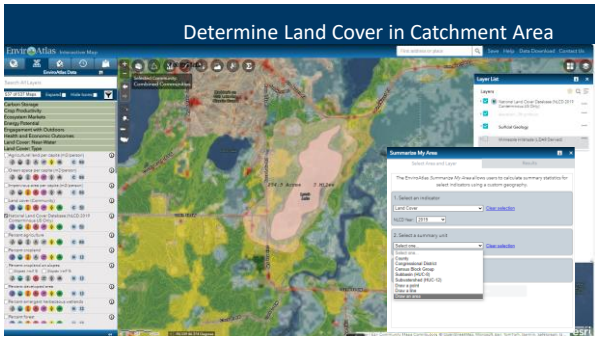
Determine Land Cover in Catchment Area



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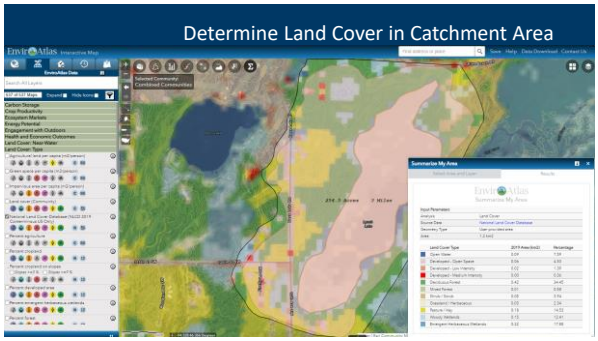
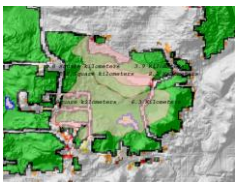
Determine Land Cover in Catchment Area

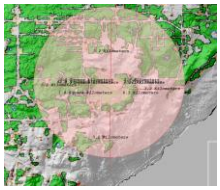


111

Landscape Habitat Connectivity

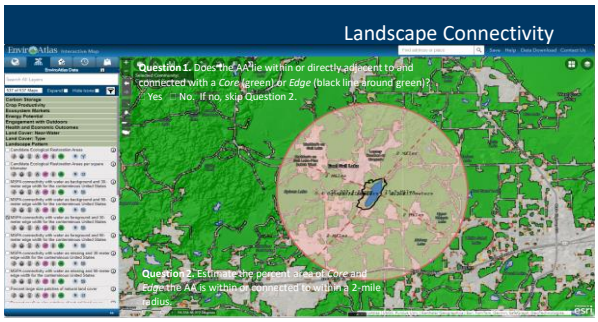
To assess landscape scale habitat and connectivity of the AA, use the *MSPA connectivity with water as background and 30-meter edge width for the conterminous United States* map found in the Landscape Pattern Data Layer() in the EPA's *EnviroAtlas Interactive Map*.				
17	Use EnviroAtlas to assess landscape scale habitat and connectivity of the AA. Is the AA in a core (green symbol) area?	Yes		Desktop
18	Estimate the percent area the core (green) occupies within a 2.0 kilometer (2-mile) radius. If the core containing the AA is connected to other cores as indicated by a bridge(s), include all connected cores in the estimate.	25-75%		Desktop





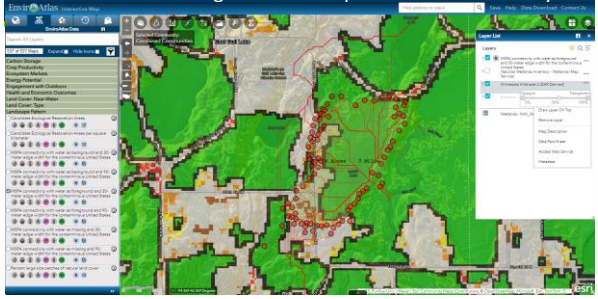
112

Landscape Connectivity



113

Evaluate Regional Landscape Habitat Connectivity



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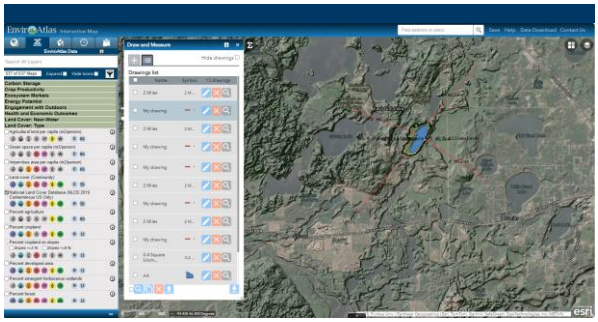

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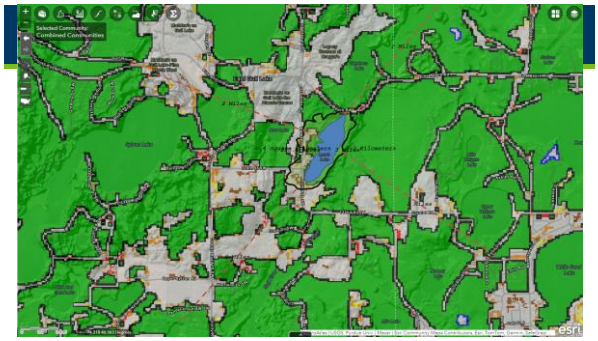

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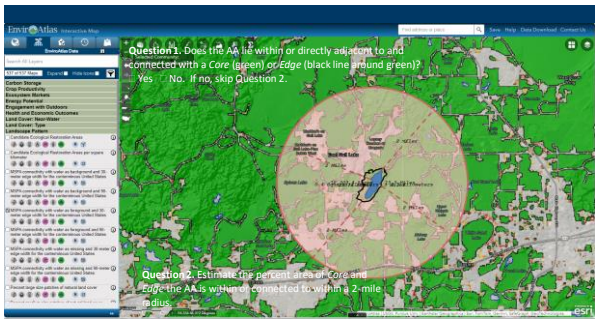
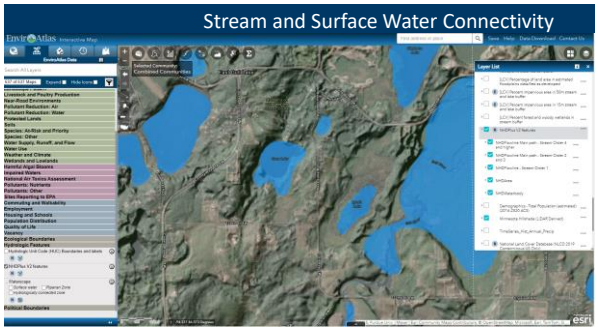

Question 1. Does the AA lie within or directly adjacent to and connected with a *Core* (green) or *Edge* (black line around green)?
Yes No. If no, skip Question 2.
Question 2. Estimate the percent area of *Core* and *Edge* the AA is within or connected to within a 2-mile radius.

117

Stream and Surface Water Connectivity



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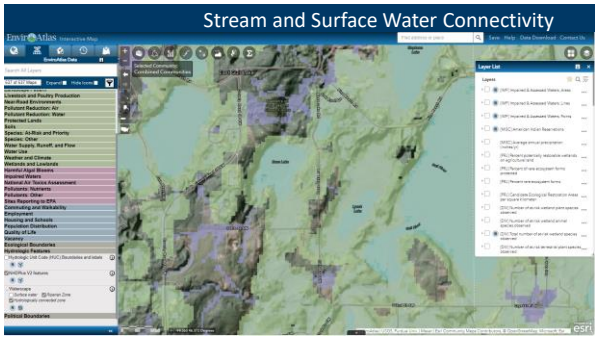
Stream and Surface Water Connectivity



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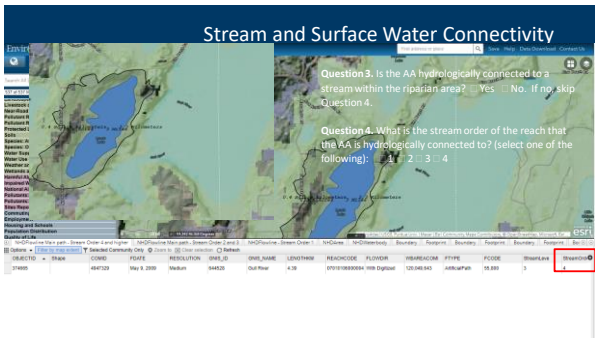
Stream and Surface Water Connectivity



120

Lake Connectivity

121

Common Wetland Indicators of HGM Classes in Minnesota

BOARD OF WATER AND SOIL RESOURCES

Minnesota Wetland Professional Certification Program

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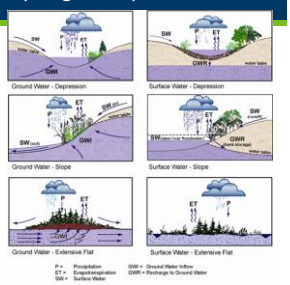
Hydrogeomorphic Method

- 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:

- RIVERINE, DEPRESSIONAL, SLOPE, MINERAL SOIL FLATS, ORGANIC SOIL FLATS, ESTUARINE FRINGE, LACUSTRINE FRINGE



123

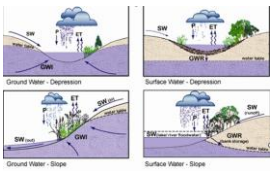
HGM Classes

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

124

HGM Subclasses

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



125

HGM Determination Key from WIMN RAM

Key to the Hydrogeomorphic (HGM) Classes

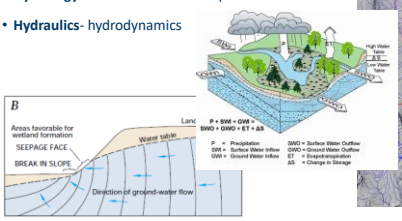
1. Wetland is associated with a perennially flowing stream, floodplain, OR fringing a lake or reservoir 2
2. Wetland is associated with a perennially flowing stream or floodplain 3
3. Stream is designated 1st or 2nd order in the National Hydrography Dataset (NHD). 4
4. Regular overbank flooding occurs (e.g., there is an apparent change in water regime or vegetation close to the channel compared to broader contiguous wetland) ..... **RIVERINE – Upper Perennial**
4. Regular overbank flooding typically does not occur (e.g., no apparent change in water regime or vegetation in broader contiguous wetland) 7
3. Stream is designated 3rd order or higher in NHD and regular overbank flooding occurs 5
5. Wetland lacks a closed topographic contour to retain water following overbank flooding conditions (i.e., the wetland is the floodplain) ..... **RIVERINE – Lower Perennial**
5. Wetland has a closed topographic contour such that floodwater is retained relative to the adjacent floodplain wetland following overbank flooding conditions (i.e., a depression within a broader floodplain) ..**DEPRESSIONAL – Floodplain**
2. Wetland is fringing a lake or reservoir (e.g., named lake in Public Water Inventory, has Limnetic NWI subsystem polygons in the continuous basin) 6
6. Lake water elevation maintains wetland hydrology – surface water flows bi-directionally between the wetland and lake (wetlands with A, C, or F water regimes¹) AND/OR the wetland consists of a floating mat (with a C or D water regime) ..... **LACUSTRINE FRINGE**
6. Wetland elevation above typical high water lake elevation and not consisting of a floating mat (typically wetlands with a D water regime that are not floating) 7

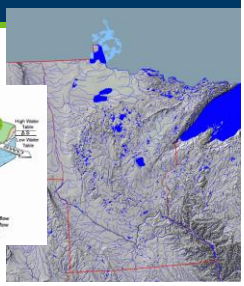
1. Wetland is not associated with a perennially flowing stream channel, floodplain, or fringing a designated lake 7
7. Wetland is within a closed elevation contour that allows for water accumulation (i.e., a depressional basin, includes beaver and manmade impoundments and excavations) ..8
8. Wetland has a predominantly D water regime, is not floating, AND vertical accretion of peat has produced a flat surface. ..... **ORGANIC SOIL FLAT**
8. Wetland has any other predominant water regime or has a D water regime, consists of a floating mat, and does not have significant vertical accretion of peat. ..... **DEPRESSIONAL**
7. Wetland is not within a closed elevation contour. 9
9. Wetland is on a topographic slope (e.g., > 1% percent slope)..... 10
10. Groundwater is the primary water source (e.g., histic epipedon/histosol, groundwater indicator species). ..... **SLOPE – Groundwater**
10. Precipitation is the primary water source (e.g., groundwater indicator species not prevalent)..... **SLOPE – Surface Water**
9. Wetland is topographically flat (e.g., < 1% slope) 11
11. Wetland has predominantly mineral soil (if organic surface layer present, < 20 cm in depth) ..... **MINERAL SOIL FLAT**
11. Wetland has predominantly organic soil (an organic surface layer ≥ 20 cm present²) 12
12. Precipitation is the primary water source. ..... **ORGANIC SOIL FLAT**
12. Groundwater is the primary water source (e.g., groundwater indicator spp. present)..... **SLOPE – Groundwater**

126

Parameters of HGM

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

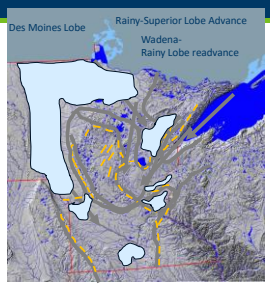




127

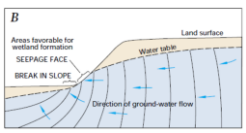
In MN, geomorphology is result of glacial geology

Recent Glacial Geology of MN



128

Hydraulics- how water moves



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

129

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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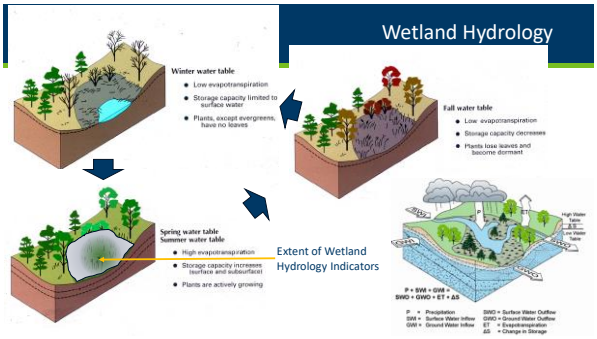
Wetland Hydrology



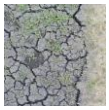
131

Different water levels leave different evidence

132

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.

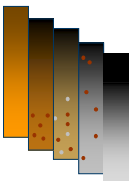
133

Hydric Soil Development

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

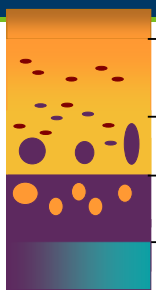
1. **Reduction** and Re-oxidation of Iron
2. **Organic Matter** Accumulation

Foundation of the Field Indicator Manual.



134

Hydric Soil Development and Duration under Aquic Conditions



Never Saturated
Oxidized Matrix

Infrequently Saturated
Oxidized Matrix with few concentrations

Frequently Saturated
Oxidized Matrix with depletions And concentrations

Very Frequently Saturated
Depleted or Reduced Matrix With concentrations

Permanently Saturated - depleted Or reduced matrix

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Hydric Soil Developed in Inundated Conditions


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Hydric Soil Developed in Saturated Conditions



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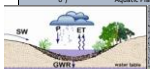
Common Indicators for Depression Wetlands

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, F1- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, F8- Redox Depression, S1- Sandy Mucky Mineral, S5- Sandy Redox
Depression	Saturated	A2- High Water Table, A3- Saturation, B2- Sediment Deposits, C3- Oxidized Rhizospheres 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, F1- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, F8- Redox Depression, S1- Sandy Mucky Mineral, S5- 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- 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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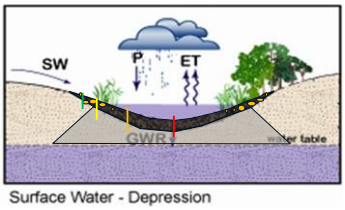
Cross Section of Hydric Soils in Depression Wetlands

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



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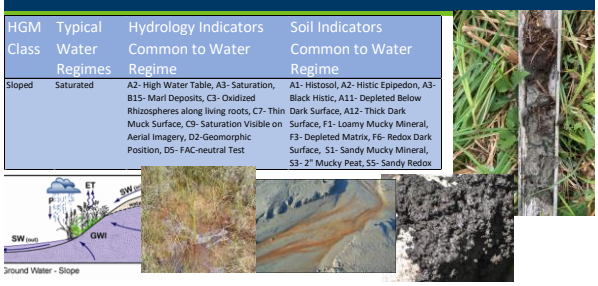
Common Indicators for Sloped Wetlands

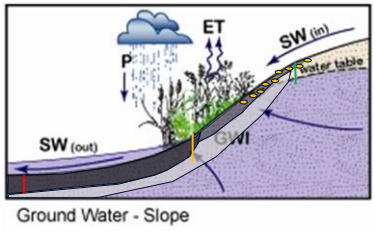
HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
Sloped	Saturated	A2- High Water Table, A3- Saturation, B15- Marl Deposits, C3- Oxidized Rhizospheres along living roots, C7- Thin Muck Surface, C9- Saturation Visible on Aerial Imagery, D2-Geomorphic Position, D5- FAC-neutral Test	A1- Histosol, A2- Histic Epipedon, A3- Black Histic, 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



140

Cross Section of Hydric Soils in Sloped Wetlands

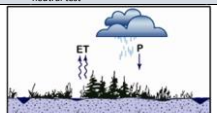
- Histosol
- Depleted below dark surface
- Redox Dark Surface



141

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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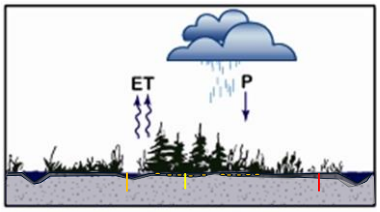
Cross Section of Hydric Soil in Mineral Flat Wetlands

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



Surface Water - Extensive Flat

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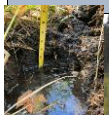
Common Indicators for Organic Flat Wetlands

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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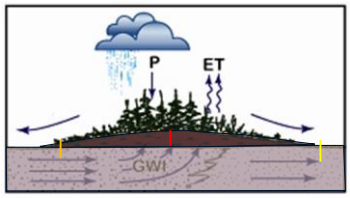
Cross Section of Hydric Soils in Organic Flat Wetland

- Histosol
- Histic Epipedon
- Loamy mucky mineral



Ground Water - Extensive Flat

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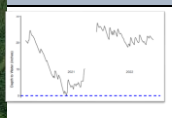
Common Indicators for Lacustrine Fringe Wetlands

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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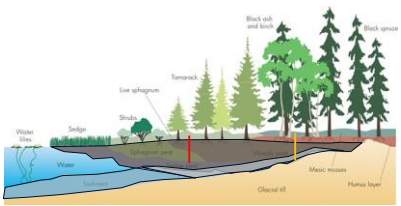
Cross Section of Hydric Soils in Lacustrine Fringe

- Histosol
- Thick Dark Surface



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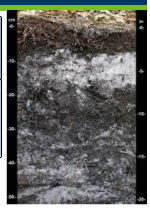
Common Indicators for Riverine Wetlands

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, B8- Sparcely 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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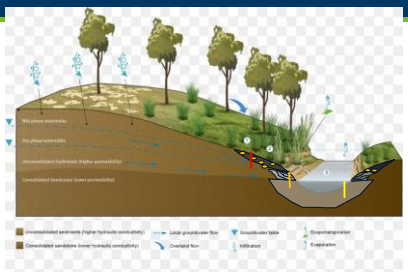
Cross Section of Hydric Soils in Riverine Wetland

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



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What HGM Class?

- Water regime(s)?
- Hydrology Indicators?
- Soil Indicators?
- Plant Community?

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, B8- Sparcely 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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What HGM Class?

- Water regime(s)?
- Hydrology Indicators?
- Soil Indicators?
- Plant Community?

HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
n	Semi permanently flooded (up to 6")	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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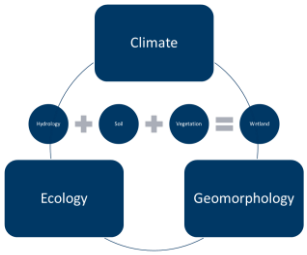
Main points to consider

- 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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