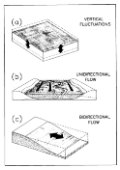
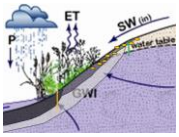





Hydrogeomorphic Classification of Wetlands in MN

BOARD OF WATER AND SOIL RESOURCES

Minnesota Wetland Professional Certification Program

1

Hydrogeomorphic Method

Establishes classes based on geomorphology, hydrology and hydraulic functions of wetlands.

Classification Name	Definition
Lacustrine	Wetland occurs within a topographic depression that has a closed elevation contour that allows the accumulation of surface water and is restricted to the margin of a depressional lake basin.
Riverine	Wetland occurs on a nearly level landform and lies along and is influenced by flooding from a stream, river or flow-through ditch.
Slope	Wetland occurs on a slope (generally >2%) with groundwater discharge as its primary source of hydrology.
Mineral Flat	Wetland occurs on a nearly level landform, is not significantly influenced by flooding from a stream, river or flow-through ditch and has predominately mineral soils.
Organic Flat	Wetland occurs on a nearly level landform, is not significantly influenced by flooding from a stream, river or flow-through ditch and has predominately organic soils.
Depression	Wetland occurs within a topographic depression that has a closed elevation contour that allows the accumulation of surface water and is not associated with the margin of a depressional lake basin.

2

HGM Classes

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

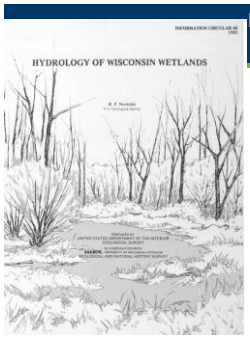
3

Classification System based on Functions

Brinson, M. M. (1993). "A hydrogeomorphic classification for wetlands," Technical Report WRP-DE-4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

4

Hydrology of Wisconsin Wetlands- Novitzki, 1982



A water budget which includes estimates of inflows and outflows was developed for each wetland. The water budget is written as:

$$P + OF + SWI + GWI = ET + SWO + R$$

where:

P = precipitation on the wetland, in inches,
OF = overland flow into the wetland,
SWI = streamflow entering the wetland,
GWI = ground-water inflow to the wetland,
ET = evapotranspiration from the wetland,
SWO = streamflow leaving the wetland, and
R = recharge from the wetland to ground water.

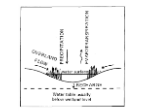
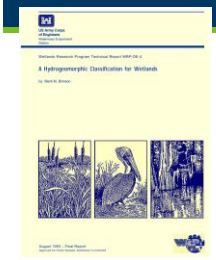
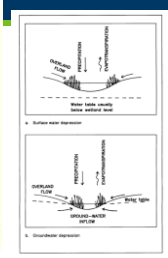


Figure 6. Flow components of ground-water slope wetlands.

5

Brinson- 1993





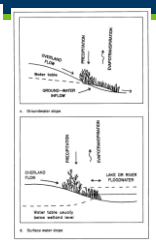


Figure 2. Four major hydrologic types of wetland types in Wisconsin (Continued)

Brinson, M. M. (1993). "A hydrogeomorphic classification for wetlands," Technical Report WRP-DE-4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

6

Connects Geomorphic Setting to Function

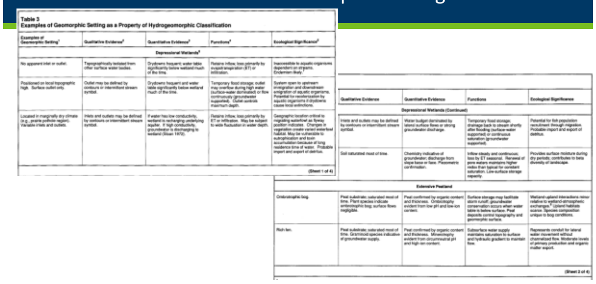


Table 3
Examples of Geomorphic Setting as a Property of Hydrogeomorphic Classification

Examples of Geomorphic Setting[1]	Qualitative Evidence[2]	Quantitative Evidence[3]	Functions[4]	Ecological Significance[5]
Depressional Wetlands[6]				
No apparent inlet or outlet.	Topographically isolated from other surface water bodies.	Drydowns frequent; water table significantly below wetland much of the time.	Retains inflow; loss primarily by evapotranspiration (ET) or infiltration.	Inaccessible to aquatic organisms dependent on streams. Endemism likely.[7]
Positioned on local topographic high. Surface outlet only.	Outlet may be defined by contours or intermittent stream symbol.	Drydowns frequent and water table significantly below wetland much of the time.	Temporary flood storage; outlet may overflow during high water (surface-water dominated) or flow continuously (groundwater supported). Outlet controls maximum depth.	System open to upstream immigration and downstream emigration of aquatic organisms. Potential for recolonization by aquatic organisms if drydowns cause local extinctions.
Located in marginally dry climate (e.g., prairie pothole region). Variable inlets and outlets.	Inlets and outlets may be defined by contours or intermittent stream symbol.	If water has low conductivity, wetland is recharging underlying aquifer. If high conductivity, groundwater is discharging to wetland (Sloan 1972).	Retains inflow; loss primarily by ET or infiltration. May be subject to wide fluctuation in water depth.	Geographic location critical to migrating waterfowl as flyway position indicates. Changes in vegetation create varied waterfowl habitat. May be vulnerable to eutrophication and toxin accumulation because of long residence time of water. Probable import and export of detritus.

(Sheet 1 of 4)

	Qualitative Evidence	Quantitative Evidence	Functions	Ecological Significance
Depressional Wetlands (Continued)				
	Inlets and outlets may be defined by contours or intermittent stream symbol.	Water budget dominated by lateral surface flows or strong groundwater discharge.	Temporary flood storage; drainage back to stream shortly after flooding (surface-water supported) or continuous saturation (groundwater supported).	Potential for fish population recruitment through migration. Probable import and export of detritus.
	Soil saturated most of time.	Chemistry indicative of groundwater; discharge from slope base or face. Piezometric confirmation.	Inflow steady and continuous; loss by ET seasonal. Renewal of pore waters maintains higher redox than typical for constant saturation. Low surface storage capacity.	Provides surface moisture during dry periods; contributes to beta diversity of landscape.
Extensive Peatland				
Ombrotrophic bog.	Peat substrate; saturated most of time. Plant species indicate ombrotrophic bog; surface flows negligible.	Peat confirmed by organic content and thickness. Ombrotrophy evident from low pH and low-ion content.	Surface storage may facilitate storm runoff; groundwater conservation occurs when water table is below surface. Peat deposits control topography and geomorphic surface.	Wetland-upland interactions minor relative to wetland-atmospheric exchanges.[7] Upland habitats scarce. Species composition unique to bog conditions.
Rich fen.	Peat substrate; saturated most of time. Graminoid species indicative of groundwater supply.	Peat confirmed by organic content and thickness. Minerotrophy evident from circumneutral pH and high-ion content.	Subsurface water supply maintains saturation to surface and hydraulic gradient to maintain flow.	Represents conduit for lateral water movement without channelized flow. Moderate levels of primary production and organic matter export.

(Sheet 2 of 4)

7

Early understanding of wetland hydrology input and hydraulics

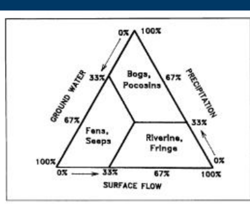
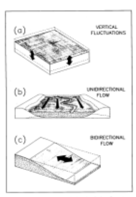


Figure 12. Diagram that allows expression of the relative contribution of three water sources—precipitation, groundwater discharge, and lateral surface flow—to a wetland; location of major wetland types (bog, riverine, etc.) within the triangle show the relative importance of water sources (Brinson 1987)



8

How Water Source Influences Flow on Landscape

Groundwater- Unidirectional- Horizontal

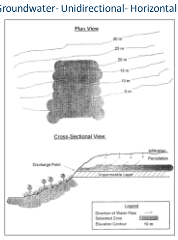


Figure 5. Slope wetland in plan and cross-sectional view

Surface water- Unidirectional- Vertical

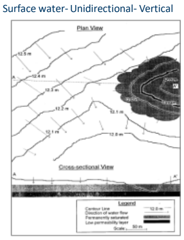
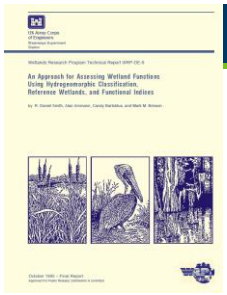


Figure 7. Mineral soil flats wetland in plan and cross-sectional view

9



Smith et a. 1995

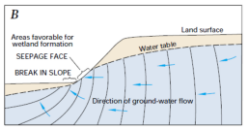
Table 1
Hydrogeomorphic Classes of Wetlands Showing Dominant Water Sources, Hydrodynamics, and Examples of Subclasses

Hydrogeomorphic Class (geomorphic setting)	Water Source (dominant)	Hydrodynamics (dominant)	Examples of Regional Subclass	
			Eastern USA	Western USA and Alaska
Riverine	Overbank flow from channel	Unidirectional and horizontal	Bottomland hardwood forests	Riparian forested wetlands
Depressional	Return flow from groundwater and interflow	Vertical	Prairie pothole marshes	California vernal pools
Slope	Return flow from groundwater	Unidirectional, horizontal	Fens	Avalanche chutes
Mineral soil flats	Precipitation	Vertical	Wet pine flatwoods	Large playas
Organic soil flats	Precipitation	Vertical	Peat bogs; portions of Everglades	Peat bogs
Estuarine fringe	Overbank flow from estuary	Bidirectional, horizontal	Chesapeake Bay marshes	San Francisco Bay
Lacustrine fringe	Overbank flow from lake	Bidirectional, horizontal	Great Lakes marshes	Flathead Lake marshes

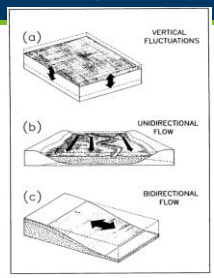
Smith, R. D., Ammann, A., Bartoldus, C., and Brinson, M. M. (1995). "An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices." Technical Report WRP-DE-9, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

10

Hydraulics- how water moves through landscape



- Uni-directional
  - Horizontal or Vertical
- Bi-directional
  - Estuarine and lacustrine fringe



11

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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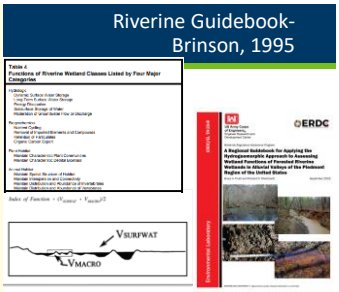
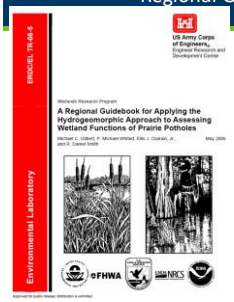
Riverine Guidebook- Brinson, 1995



13

Regional Guidebook for Prairie Potholes- 2006



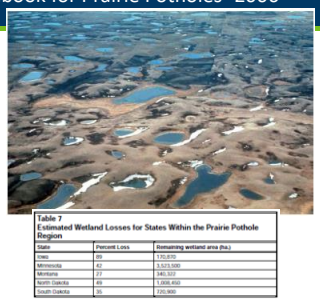
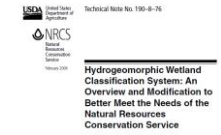


Table 7
Estimated Wetland Losses for States Within the Prairie Pothole Region

State	Percent Loss	Remaining wetland area (ha.)
Iowa	89	170,870
Minnesota	42	3,523,500
Montana	27	340,320
North Dakota	49	1,008,450
South Dakota	35	720,900

14

NRCS Overview of HGM Technical Note- 2008



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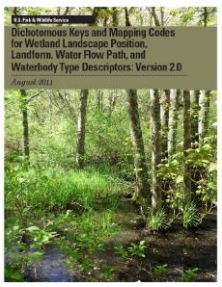
Tiner- 2011



Tiner, R.W. 2011. Dichotomous Keys and Mapping Codes for Wetland Landscape Positio Landform, Water Flow Path, and Waterbody Type Descriptors: Version 2.0. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, MA.

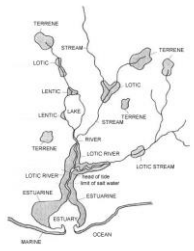


Figure 1. General landscape positions for wetlands, with a few waterbodies shown (ocean,

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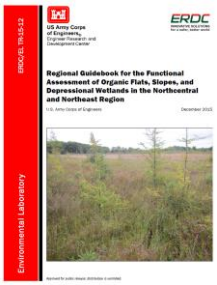
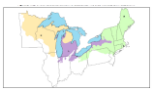
Regional Guidebook for Organic Wetlands- 2015



- Characterizes wetlands based on HGM class in NCNE
- Assessment Variables
- Functions
  - Water Storage
  - Biogeochemical cycling
  - Plant Community
  - Wildlife Habitat
- Assessment Protocol



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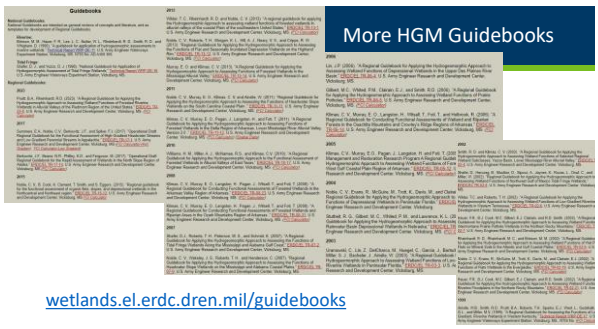
More HGM Guidebooks

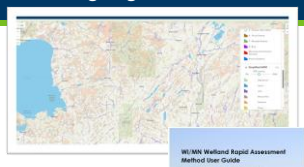


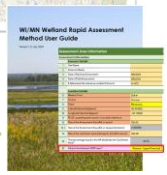
wetlands.el.erdc.dren.mil/guidebooks

18

How is HGM going to be used in MN?

- Wetland Type
- NWI
- Functional Assessment
- Guidance for Submitting Wetland Delineations in MN





Wetland type.

"Wetland type" means a wetland type classified according to *Wetlands of the United States*, United States Fish and Wildlife Service Circular 39 (1971 edition), ~~as summarized in this subdivision~~ or *A Hydrogeomorphic Classification for Wetlands*, United States Army Corps of Engineers (August 1993), including updates, supplementary guidance, and replacements, if any, as determined by the board.

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2024 MN Statute Amendments

Wetland type.

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HGM Class	Circular 39	Eggers & Reed	Cowardin Vegetation Class	Typical Water Regimes
Depression	1	Seasonally Flooded Basin	PEM- Emergent	Seasonally Flooded
Riverine	1	Floodplain Forests	PFO- Forested	Temporary Flooded
Depression	2	Sedge Meadows	PEM- Emergent	Saturated
Depression Organic Flat				
Riverine	2	Fresh (wet) Meadows	PEM- Emergent	Saturated
Depression Mineral Flat				
Depression	2	Wet to Wet-Mesic Prairie	PEM- Emergent	Saturated
Sloped	2	Calcareous Fens	PEM- Emergent	Saturated
Depression Lacustrine Fringe	3	Shallow Marsh	PEM- Emergent	Semi-permanently Flooded (up to 6')
Depression Lacustrine Fringe	4	Deep Marsh	PEM- Emergent PAB-aquatic bed	Semi-permanently to permanently Flooded (6'-10')
Depression Lacustrine Fringe	5	Shallow, Open Water	PEM- Emergent PUB-unconsolidated Bottom	Permanently Flooded (up to 6.2')
Mineral Flat Sloped	6	Shrub Carr	PSS- Scrub-shrub	All regimes except permanently Flooded (Saturated most of growing season)
Mineral Flat Sloped	6	Alder Thicket	PSS- Scrub-shrub	All regimes except permanently Flooded (Saturated most of growing season)
Mineral Flat Sloped	7	Hardwood Swamp	PFO- Forested	All regimes except permanently Flooded (Saturated most of growing season)
Mineral Flat Organic Flat Sloped	7	Coniferous Swamp	PFO- Forested	All regimes except permanently Flooded (Saturated most of growing season)
Organic Flat	8	Open Bog	PML- Moss-lichen	Saturated
Organic Flat	8	Coniferous Bog	PFO- Forested	Saturated

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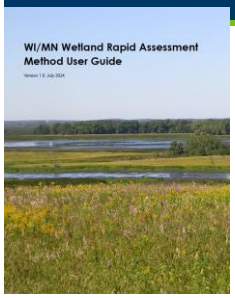
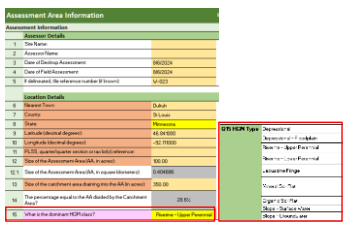
Wetland Rapid Assessment Method





Assessment Area Information		
Assessment Information		
	Assessor Details	
1	Site Name:	
2	Assessor Name:	
3	Date of Desktop Assessment:	09/2024
4	Date of Field Assessment:	09/2024
5	If delineated, file reference number (if known):	M-023
	Location Details	
6	Nearest Town:	Duluth
7	County:	St Louis
8	State:	Minnesota
9	Latitude (decimal degrees):	46.841000
10	Longitude (decimal degrees):	-92.119300
11	PLSS, quarter/quarter section or tax lot(s) reference:	
12	Size of the Assessment Area (AA, in acres):	100.00
12.1	Size of the Assessment Area (AA, in square kilometers):	0.404686
13	Size of the catchment area draining into the AA (in acres):	350.00
14	The percentage equal to the AA divided by the Catchment Area?	28.6%
15	What is the dominant HGM class?	Riverine - Upper Perennial

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Key to HGM Classes

Dichotomous Key to the Hydrogeomorphic (HGM) Classes (water regimes defined below)

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 4th 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 Non-salt/alkaline polygons in the continuous layer).....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 regimes) AND/OR the wetland consists of a floating mat (with a C or D water regimes).....**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., Hotic 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, < 40 cm in depth).....**MINERAL SOIL FLAT**
11. Wetland has predominantly organic soil (an organic surface layer ≥ 20 cm present).....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**

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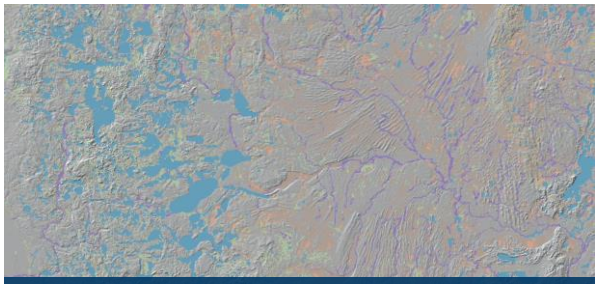

3 Parameters of HGM= Hydrology, Geomophology, Hydraulics

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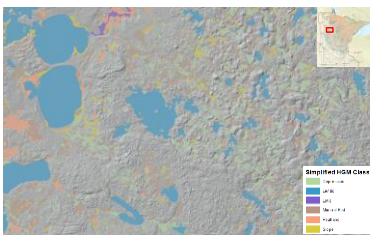
Parameters of HGM

- Geomorphology
  - Where and how a wetland is situated on the landscape
- Hydrology
  - How water enters and leaves the landscape
- Hydraulics
  - How water moves through the landscape

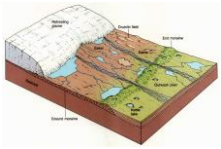


24

Geomorphology

Study of physical features on the surface of the earth and their relation to its geologic structures

- Landscape position
- Parent material
- Surface shape



25

Glacial Geology of MN

Glaciation of the Quaternary period (oldest to youngest):

- Nebraskan
- Kansan
- Illinoian
- Wisconsin
  - Wadena lobe
  - Rainy-Superior lobe
  - Des Moines lobe

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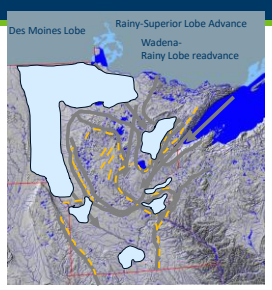
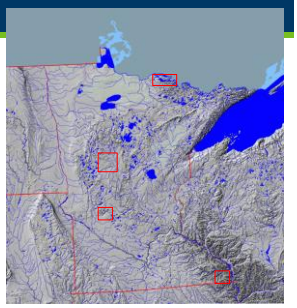
In MN, geomorphology is result of glacial geology



27

Glaciers left different HGM classes of wetlands in MN

- Kettle depressions
  - Depression and lacustrine fringe
- Glacial lakes
  - Organic and mineral flat
- Surficial shape of landscape
  - Mineral flat and sloped
- Fluvial-Lacustrine systems following glacial outwash
  - Riverine, mineral flat, sloped, organic flat



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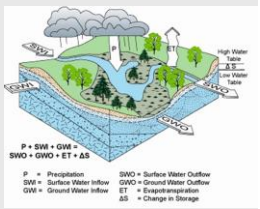
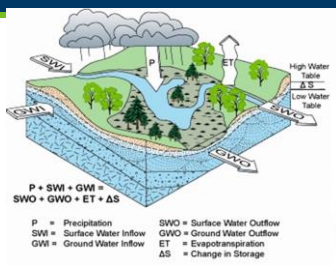
Wetland Hydrology

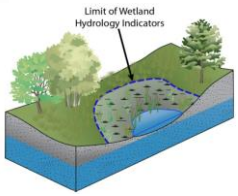


- Inputs
  - Precipitation
  - Surface water inflow
  - Groundwater inflow
- Outputs
  - Surface water outflow
  - Groundwater outflow
  - Evapotranspiration

29

Wetland Hydrology and Indicators





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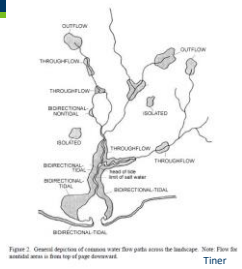
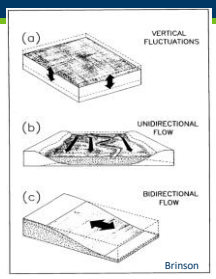
Wetland Hydraulics



Tiner



Brinson

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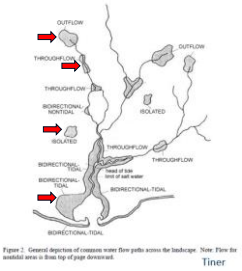
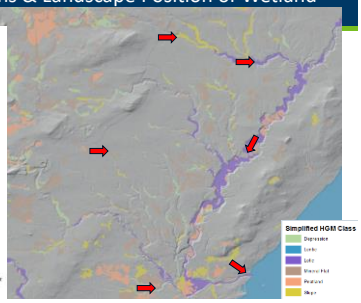
Water Flow Paths & Landscape Position of Wetland



Tiner



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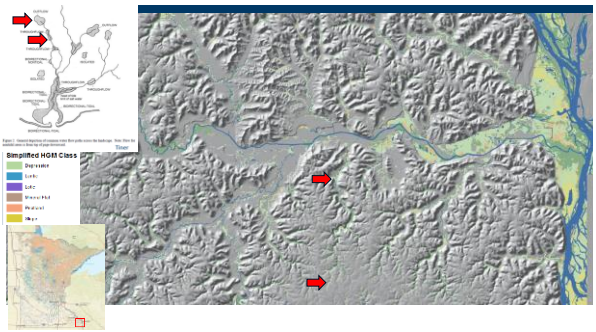

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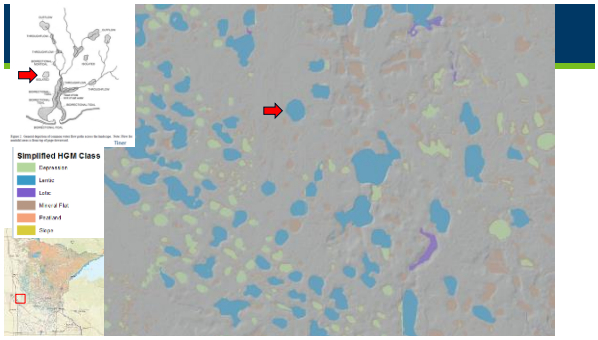

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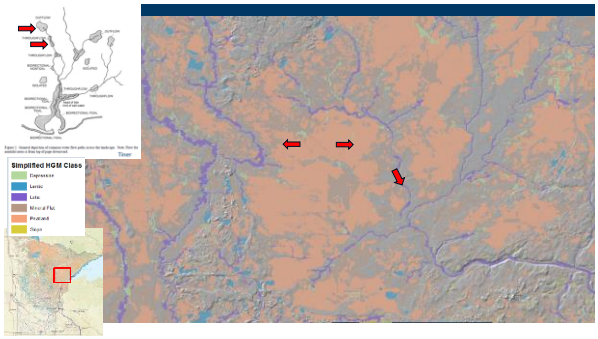

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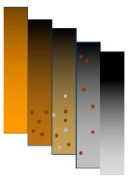
Soil & Hydrology Indicators

Hydrology Regimes

- **Temporarily flooded (A)** – Surface water is present for brief periods (from a few days to a few weeks) during the growing season, but the water table usually lies well below the ground surface for most of the season.
- **Seasonally saturated (B)** – The substrate is saturated at or near the surface for extended periods during the growing season, but unsaturated conditions prevail by the end of the season in most years. Surface water is typically absent but may occur for a few days after heavy rain and upland runoff.
- **Seasonally flooded (C)** – Surface water is present for extended periods (generally for more than a month) during the growing season but is absent by the end of the season in most years. When surface water is absent, the substrate typically remains saturated at or near the surface.
- **Continuously saturated (D)** – The substrate is saturated at or near the surface throughout the year in all, or most, years. Widespread surface inundation is rare, but water may be present in shallow depressions that intersect the groundwater table, particularly on a floating peat mat.
- **Seasonally saturated - Flooded (E)** – Surface water is present for extended periods (generally for more than a month) during the growing season but is absent by the end of the season in most years. When surface water is absent, the substrate typically remains saturated at or near the surface.
- **Semi-permanently flooded (F)** – Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.
- **Intermittently exposed (G)** – Water covers the substrate throughout the year except in years of extreme drought.
- **Permanently flooded (H)** – Water covers the substrate throughout the year in all years.

- Correlates to soils:
  - Long term- organic
  - Seasonal inundation- thick O, dark A
  - Seasonal saturation- thin O
  - Floodplain- thin, stratified layers



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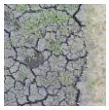
Hydrology Indicator Groups

Group A – direct observation of *water*



Group B – evidence of *flooding/ponding*

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

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

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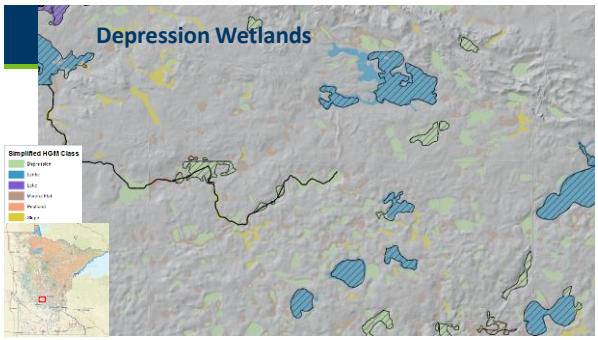
Depression Wetlands



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Common observations with depression wetlands

- Concave surface shape
- Varying water depths
- Multiple plant communities based on water depth
- Organic depth increase deeper in basin
- Can have outflow

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Hydrology of Depression Wetlands

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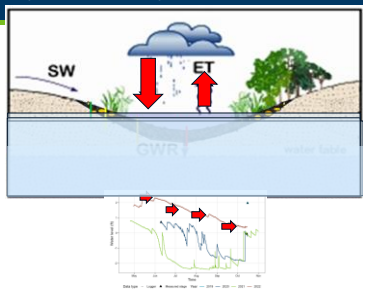
Hydraulics of Depression Wetlands

- Vertical uni-directional
- Evapotransporation
  - Increases and decreases with growing season
- Water table "bounces" with precipitation
- Vertical fluctuations often make hydrology and hydric soils difficult at wetland boundaries



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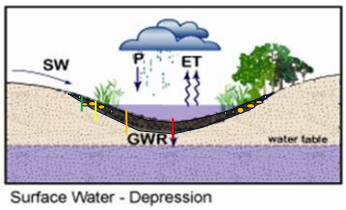
Cross Section of Hydric Soils in Depression Wetlands

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



Surface Water - Depression

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Common Indicators for 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, B8- Sparsely Vegetated Concave Surface, B6- Surface Soil Cracks, C2- Dry-Season Water Table, D2- Geomorphic Position	A11- Depleted Below Dark Surface, A12- Thick Dark Surface, F3- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, F8- Redox Depression, S1- Sandy Mucky Mineral, S5- Sandy Redox
Depression	Saturated	A2- High Water Table, A3- Saturation, C9- Saturation Visible on Aerial Imagery, D2-Geomorphic Position, D5- FAC-neutral Test	A11- Depleted Below Dark Surface, A12- Thick Dark Surface, F3- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, F8- Redox Depression, S1- Sandy Mucky Mineral, 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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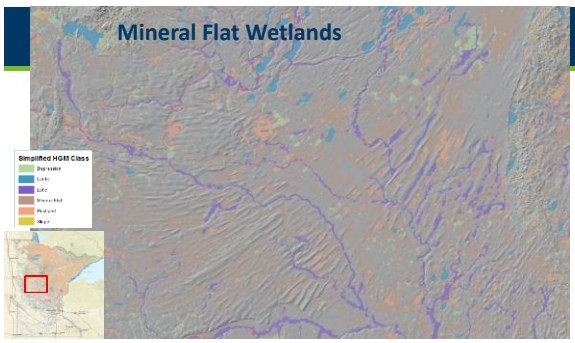
Mineral Flat Wetlands



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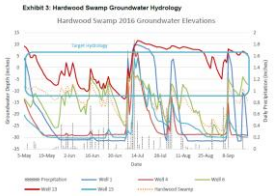
Common Observations

- Relatively flat topography
- Multiple hydrology regimes
- Often intergrade to other HGM classes
- Outflow terrene wetlands
- Both emergent and forested plant communities

45

Hydrology of Mineral Flats



- Precipition primary input
- Responds to precipitation with little lag time otherwise hydrograph descending with season
- Saturated seepage flow
- Microtopography
- Intergrades into organic flats and sloped

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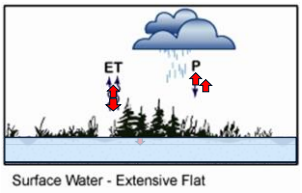
Hydraulics of Mineral Flats

- Vertical uni-directional
- Winter Precipitation
- Overland "seepage flow"
- Evapotransporation
  - Increases and decreases with growing season
- Water table "bounces" with precipitation
- Vertical fluctuations often make hydrology and hydric soils difficult at wetland boundaries



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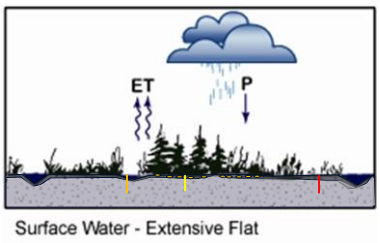
Cross Section of Hydric Soil in Mineral Flat Wetlands

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



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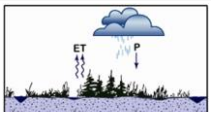
Common Indicators for Mineral Flat Wetlands

HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
Mineral Flat	All regimes except permanently flooded (Saturated most of growing season)	A2- High Water Table, A3- Saturation, C2- Dry-Season Water Table, 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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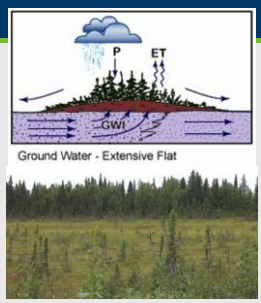
Organic Soil Flats

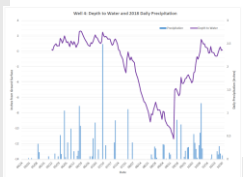


- Landscape position- summit (interfluves- broad "plateau" between drainage systems, depressions filled with organics, vertical accretion of organics
- Hydraulics- precipitation, unidirectional groundwater
- Water source- precipitation, groundwater
- Outputs- saturated overland seepage, evapotranspiration

50

Hydrology of Organic Flats

- Permanently Saturated
  - Water table near the soil surface nearly all year



- Relatively stable hydrology regime
- Water inputs often exceed outputs
  - Water storage is critical function

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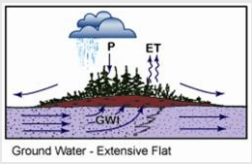
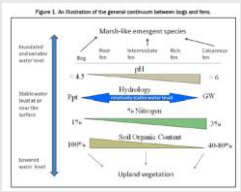
Hydraulics of Organic Flats



Ground Water - Extensive Flat



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Hydric Soil Development in Organic Flat Wetlands

- Microbes use carbon compounds as energy source
- Rate of organic carbon consumed is lower in saturated anerobic environment
- Partially decomposed organic matter accumulates

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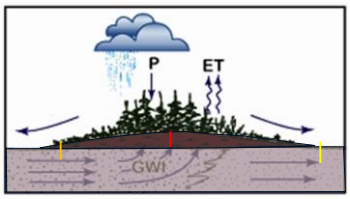
Cross Section of Hydric Soils in Organic Flat Wetland

- Histosol
- Histic Epipedon
- Loamy mucky mineral



Ground Water - Extensive Flat

54

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, B9- Water-Stained Leaves, C2- Dry-Season Water Table, D4- Microtopographic Relief, D1- Stunted or Stressed Plants, 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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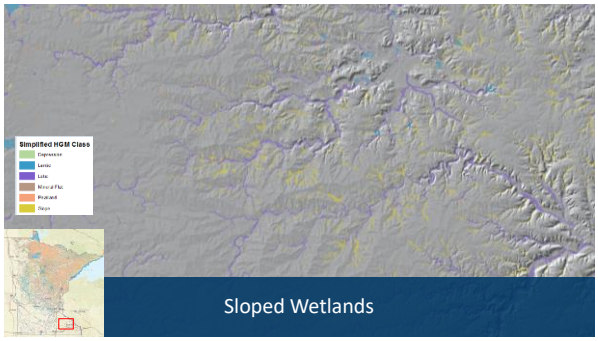

Sloped Wetlands

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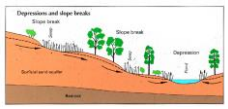
Common Observations

- Open contours
- Stratigraphic and Topographic
- May contain ephemeral drainages
- Intergrade into other HGM classes
- Organic accumulations indicate groundwater sources
- Surface sloped lack primary indicators during dry season



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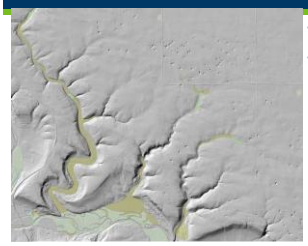
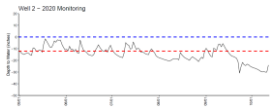
Hydrology of Sloped Wetlands



- Seasonally to continuosly saturated
- Decrease in groundwater input through growing season
  - Shorter duration
  - More abrupt bounce to precip. events



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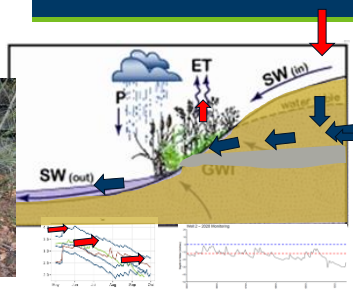
Hydraulics of Sloped Wetlands

- Stratigraphic Sloped
- Differences in permeability
  - Bedrock, soil textures



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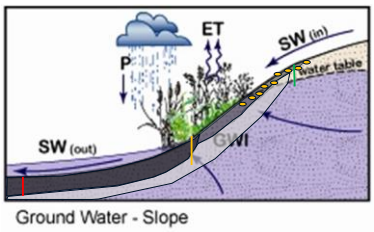
Cross Section of Hydric Soils in Sloped Wetlands

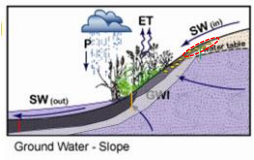
- Histosol
- Depleted below dark surface
- Redox Dark Surface



60

Capillary fringe of fine-grained soils

- Tension-saturated zone
- Water held at tension above water table within pores
- If pore size is small and uniform (i.e. clay or clay loam), capillary action can extend further up the soil profile
- Results in a saturated "fringe" which complicates near wetland boundary
- Esp. in forested wetlands



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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, B10- Drainage Patterns, C7- Thin Muck Surface, D2-Geomorphic Position, D5-FAC-neutral Test	A1- Histosol, A3- Black Histic, F1-Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, F21-Red Parent Material, S1- Sandy Mucky Mineral, S3- 2" Mucky Peat, S5- Sandy Redox

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Riverine

- Landscape position- floodplains and riparian corridors, often intergrade to sloped or depressional
- Hydraulics- unidirectional, surface overbank flow, groundwater, interflow (both surface and ground) from adjacent uplands
- Water source- precipitation, groundwater
- Outputs- overland surface flow (perennial flow not required), evapotranspiration

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Hydraulics of Riverine Wetland

- Active floodplain- Overbank flow from channel
- Passive floodplain- depression

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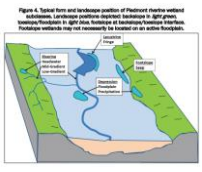
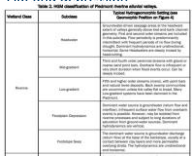
Hydrology of Riverine Wetlands

- Temporary Flooded
- Subclasses- Flat and depression





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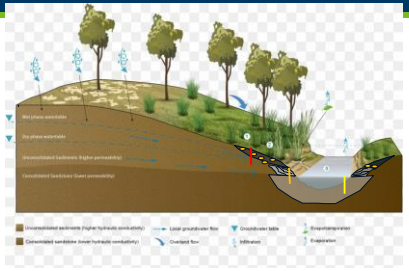
Cross Section of Hydric Soils in Riverine Wetland

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

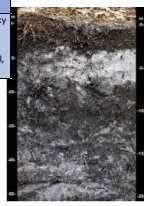


66

Common Indicators for Riverine Wetlands

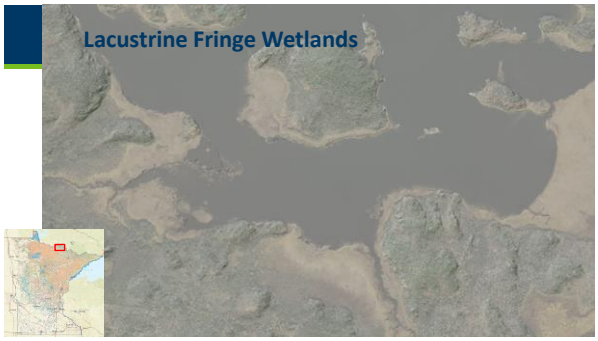
HGM Class	Typical Water Regimes	Hydrology Indicators Common to Water Regime	Soil Indicators Common to Water Regime
Riverine	Temporary Flooded	B1- Water Marks, B2- Sediment Deposits, D3- Drift Deposits, B8- Sparcely Vegetated Concave Surface, B10- Drainage Patterns, C20 Dry Season Water Table, D2- Geomorphic 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



67

Lacustrine Fringe Wetlands



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Lacustrine Fringe

- Landscape position- adjacent to lakes, toe slope, often intergrade to sloped
- Hydraulics- bidirectional (inflow from adjacent uplands and lake)
- Water source- precipitation, groundwater
- Outputs- return flow to lake, saturated surface seepage, evapotranspiration

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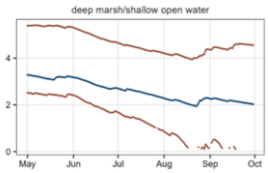
Hydrology of Lacustrine Fringe Wetlands



- Semi-permanently to permanently flooded
- Indundation levels vary with precipitation and evapotransporation
- Baseline flow and surface water input
- Lake levels can control local groundwater
- Surface flow out

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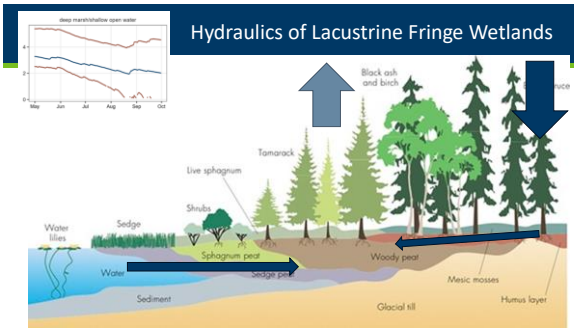
Hydraulics of Lacustrine Fringe Wetlands



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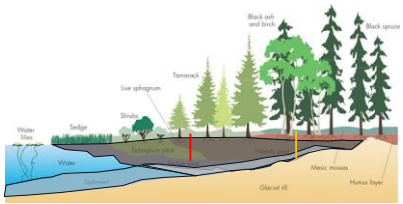
Cross Section of Hydric Soils in Lacustrine Fringe

- Histosol
- Thick Dark Surface



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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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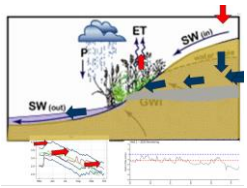
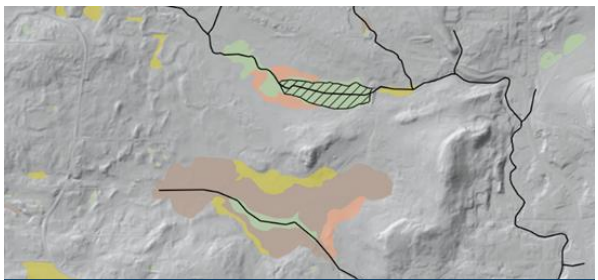
Key Takeaways

- Understand the underlying science behind HGM classes and their parameters:
  - Geomorphology
  - Hydrology
  - Hydraulics
- These parameters are drivers of function
  - And influence development of wetland indicators
- Many wetland functions change based on the water budget
- Evidence of those functions can be observed on the landscape in the form of wetland indicators



74



Field Mapping HGM

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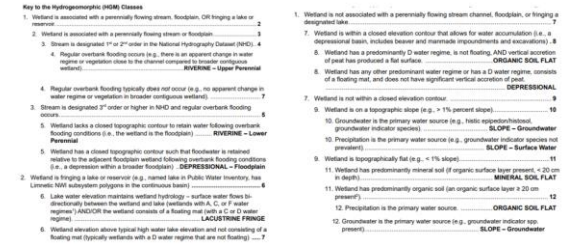
Key to HGM Classes



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 prevalent²) ..... **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 present³) 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**

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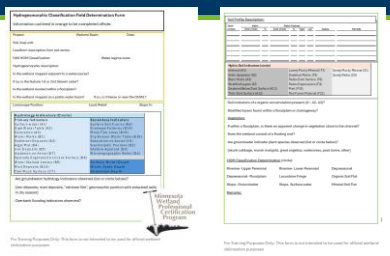
HGM Classification Field Determination Form



- Assume that all wetland parameters have been met
- Form is intended for training purposes only!

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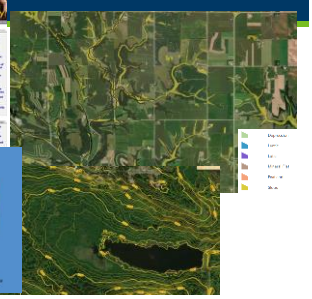
Offsite Resources

- NWI
- MN Topo
- Soil Survey
- EnviroAtlas



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Offsite Review- National Wetland Inventory

- Wetland Finder
- Symbolize:
  - "Simplified HGM"
  - Public watercourses
  - Public waterbasins
- Aerials and hillshade

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Offsite Review- Aerial & topography

- MN Topo
  - imagery & terrain base layers
- Note:
  - Topographic contours
  - Plant communities
  - Water regimes
  - Wetland boundaries
  - Hydrology inputs/outputs
  - Manmade features

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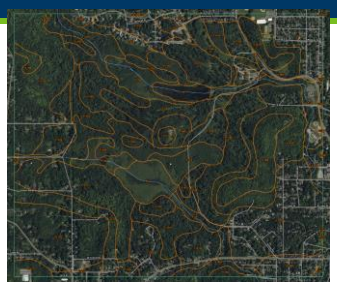
Offsite Review- Web Soil Survey

- Web Soil Survey - Home



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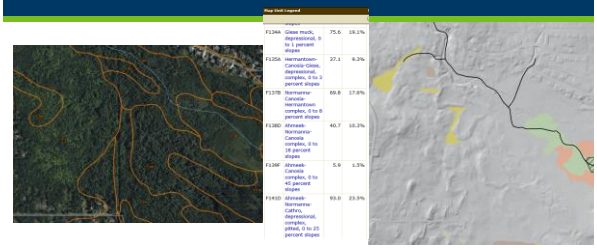
Dominant soil type per Soil Survey



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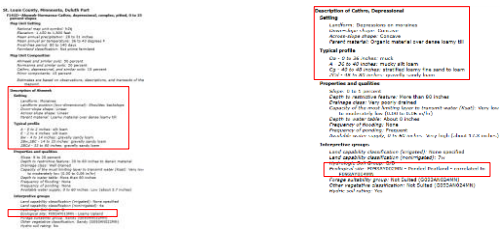
Ecological Site Description



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Wetland Finder Results

- NWI Code- Cowardin Water Regime
- Hydrogeomorphic code- class and hydraulics

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Perennial Stream?

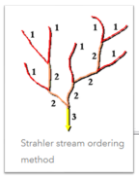
- Mapped as watercourse?

Public Waters Inventory (PWI)	
PWI Basin ID:	No PWI Basins found.
PWI Watercourse ID:	M-059

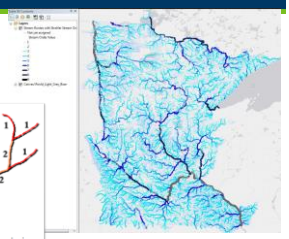
85

Stream Order?

- Upper Perennial = 1st or 2nd Order
- Lower Perennial = 3rd order or higher
- Used in WIMN RAM

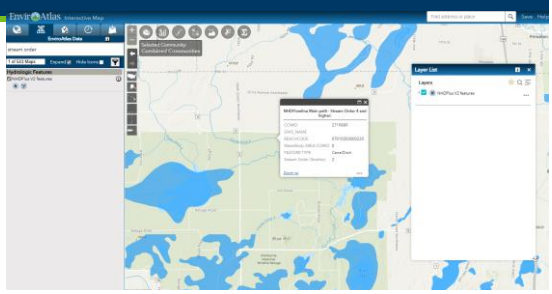


Strahler stream ordering method

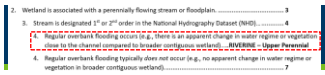


86

Stream Order?



87



Overbank Flooding?

- If wetland is associated with a stream or floodplain, is there an apparent change in water regime or vegetation close to the channel compared to the broader wetland?

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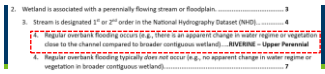

Overbank Flooding?

- Are hydrology indicators of flooding present?
  - Sediment deposits
  - Drift deposits
  - Drainage patterns

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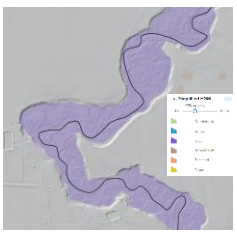
Located within floodplain?

- Use LIDAR to determine floodplain
- Adjust opacity to see more detail in hillshade



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Example of Riverine-Lower Perennial

- adjacent to 4th order stream
- forested vegetation structural class dominated by silver maple and elm
- temporarily flooded water regime and mineral soils
- primary water source for the wetland is overbank flooding from the stream/river

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Depressional- Floodplain

- Located within floodplain
- Concave surface
- Outside of regular overbank flooding
- Will often deeper water regime during high water levels (inundation surrounded by saturation)
- Different plant community

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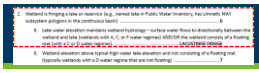
Public Water Basin



- Near Ordinary High Water Level?
- Public Water
- Lentic on NWI?

93

Example of Lacustrine Fringe

- shallow lake has four contiguous wetlands of littoral aquatic bed vegetation structural class
- wetlands have a combination of permanently, semipermanently, seasonally, and temporarily flooded water regimes
- Surface water flows both to and from the lake to the contiguous wetlands (bi-directional flow)

94

Located within Depression?

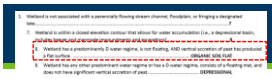
- Closed Contours
- No outlet

95

Example of Depressional

- depressional basin and has been restored by construction of a berm with an outlet in the northwest corner where surface water exits intermittently
- permanently flooded and seasonally flooded water regimes

96



D Water Regime

- **Continuously saturated (D)** - The substrate is saturated at or near the surface throughout the year in all, or most, years. Widespread surface inundation is rare, but water may be present in shallow depressions that intersect the groundwater table, particularly on a floating peat mat.

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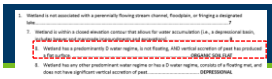

Vertical Accretion of Peat

- Organic Accumulation

98

Organic Surface >20 cm thick

- A1- Histosol
  - 16 inches (40 cm)
- A2- Histic Epipedon
  - 8 inches (20 cm) with low chroma mineral below
- A3 – Black Histic
  - 8 inches (20 cm) peat, mucky peat or muck with low value and chroma

99

Example of Organic Flat

100

Located on Topographic Slope?

101

Ground or surface water?

Groundwater

- Primary hydrology indicators
- Continuosly saturated
- Organic soils
- Indicator plant species

Surface water

- Seasonally saturated
- Secondary indicators in dry months
- Thin muck over mineral soils
- Ephemeral drainage patterns

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Groundwater Indicators?

- Hydrology
  - Springs or Seeps
- Vegetation
  - Groundwater indicator plants
- Soil
  - Muck
  - Organic acculmulation

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, B10- Drainage Patterns, C7- Thin Muck Surface, D2-Geomorphic Position, D5-FAC-neutral Test	A1- Histosol, A3- Black Histic, F1- Loamy Mucky Mineral, F3- Depleted Matrix, F6- Redox Dark Surface, F21- Red Parent Material, S1- Sandy Mucky Mineral, S3- 2" Mucky Peat, S5- Sandy Redox

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Indicators of Groundwater Discharge

Discharge indicators:

- Springs or seeps
- Cold water
- Located near headwater or watershed divide
- Iron or marl deposits in soils
- "rainbow" film on surface water
- Geomorphic position with saturated soils in dry season

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Groundwater Indicator Plants

Groundwater Indicator Plants:

- Skunk cabbage- *Symplocarpos foetidus*
- Marsh Marigold-*Caltha palustris*
- Great angelica- *Anfelica atropurpurea*
- Watercress- *Nasturium officianale*

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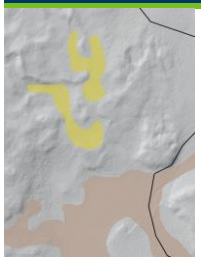
Example of Sloped- Groundwater



106

Ephermal drainage?

- Not mapped as Public Watercourse
- Not flowing during normal dry season
- Channelized drainage
- Drainage patterns
- Often sloped wetlands

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Example of Sloped- surface water

- forested (green and black ash-dominated)
- temporarily flooded water regime
- occurs within a narrow valley forming the headwaters for a 1st order stream
- soil texture is predominately loamy/clayey
- The mineral soil, lack of groundwater species, and headwater position indicate the predominate source of wetland hydrology is from precipitation and surface water from the surrounding watershed, as opposed to groundwater discharge or overbank flooding.
- The wetland also slopes longitudinally, and surface water is not ultimately ponded behind an elevation contour

108

Topographic Flat?

- Soil Description

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Example of Mineral Flat

- Linear, flat surface shape
- Mineral soil with thin muck surface
- Hardwood swamp with shrub fringe
- Hummock microtopography
- Drift deposits and emphemeral drainage pattern at outlet
- Intergrades into sloped wetland

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Field Exercise

- Work in field teams
- Complete offsite review
- Complete onsite field review
  - Document: hydrology indicators, soil indicators, plant communities
  - Determine HGM type(s)
- Draft map showing HGM types

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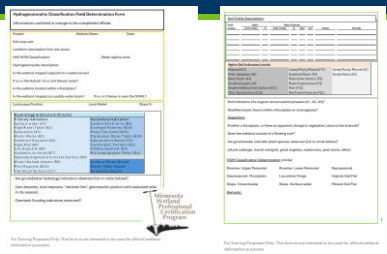
HGM Classification Field Determination Form



- Assume that all wetland parameters have been met
- Form is intended for training purposes only!

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Field Sites

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Questions, comments, thoughts, ridicule…

David Demmer- MN Board of Water & Soil Resources
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