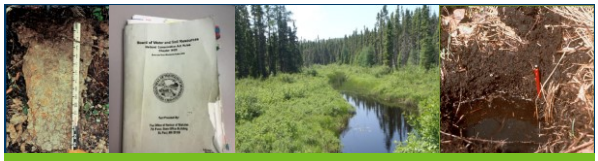


MN Wetland Professional Certification Program Introduction Class- Day 2

BOARD OF WATER AND SOIL RESOURCES

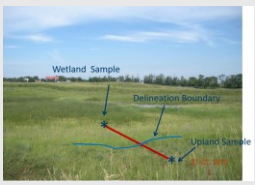
Minnesota Wetland Professional Certification Program

1

Quiz

1) Sampling transects should be?

a) Used when conducting a routine level 1 delineation
b) Representative of wetland-upland transition areas
c) Located systematically using an established grid
d) Randomly located throughout the evaluation area



2

Quiz

2) What is the maximum average water depth for a special aquatic site to be classified as a wetland?

a) 1 foot below the water surface
b) 8.2 feet below the water surface
c) 1 foot above the water surface
d) 3 feet below the water surface

3) Wetland boundaries must be delineated using:

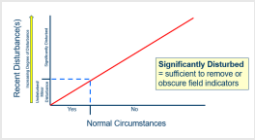
a) Only the US Army Corps of Engineers 1987 manual for identifying and delineating jurisdictional wetlands
b) The hydrogeomorphic method
c) The WCA Rulebook
d) US Army Corps of Engineers 1987 manual & Regional Supplements

3

Quiz

4) A seasonally flooded wetland on agricultural land is normally plowed and planted in most years. For delineation purposes, which of the following conclusions is most likely true?

a) This is not a jurisdictional wetland
b) Normal circumstances are not present
c) Normal circumstances exist
d) A level 2 delineation is required



4

Quiz

5) Explain the concept of a Problem area

- Indicators absent to seasonal, or annual variability; or permanent due to the nature of the soils or species
- Including seasonal wetlands, prairie soils, red parent material etc.

6) Explain the concept of an Atypical Situation

- One or more Indicators absent due to human activity or natural events (beavers, fire, river changing course)

5

7) Which of the following can be used for determining the start of the growing season?

a) Soil temperature at 41 inches below the surface
b) Soil temperature at the soil surface
c) Soil temperature at 18 inches below the surface
d) Soil temperature at 12 inches below the surface

Minnesota Wetland Professional Certification Program

6

8) What classification system uses Systems, Sub-systems and Classes?

a) HGM
b) Eggers and Reed
c) Cowardin
d) Circular 39

9) Which of the following plant communities would be characteristic of a Circular 39 type 6 wetland?

a) Sedge meadow
b) Bog
c) Alder thicket
d) Shallow marsh

7

Quiz

10) Which of the follow is not a parameter of the Hydrogeomorphic Method classification system?:

a) geomorphology
b) plant community
c) hydrology
d) hydraulics

11) A natural process in a wetland that can be scientifically assessed can also be described as a:

a) wetland value
b) routine assessment method
c) exemption
d) wetland function

8

Quiz

12) All wetlands have which of the following hydrology outputs?

a) precipitation
b) groundwater recharge
c) overland flow
d) evapotranspiration

9

Basic Agenda

Monday

- 3 Parameters, Delineation Methods, Wetland Function & Classification Systems, Hydrology Indicators, Critical Definitions, Data Sheet Field Exercise

Tuesday

- Quiz 1, Antecedent Precipitation, Offsite Resources and Hydrology Methods, Soil Concepts, Hydric Soil Indicators, Web Soil Survey, Soil Texture Lab, Soil profile description field exercise

Wednesday

- Quiz 2, Intro to Regulatory Programs, WCA Basic Decision Types, LGU Duties, Technical Evaluation Panel, WCA Application Procedures, Wetland Vegetation, Vegetation Field Plots Exercise

Thursday

- Quiz 3, Small Group delineation Field Exercise, Submitting Delineations, Replacement Plans, Wetland Banks, Monitoring

Friday

- WCA Enforcement, Altered Hydrology and Wetland Restoration, Functional Assessments Methods, Course Summary & Summary Quiz

- MWPCP Professional Exams

10

Antecedent Precipitation Analysis

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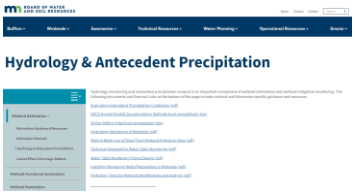
Minnesota Wetland Professional Certification Program

11

Precip

- Hydrology and Antecedent Precipitation



12

When in the process is it needed?

Off-site/Level 1 wetland delineation

On-site/Level 2

- Recommend this be done prior to site visit if possible
- Puts better perspective on site data collection

Other Observations Types

- For interpreting Well or Stage Gauge Data
- Establish baseline conditions for a potential wetland bank/monitoring post construction
- Further defining a wetland boundary/questionable wetland area in difficult/are cases
- May not be needed in advance but will be when interpreting data set.

13

How to do it…

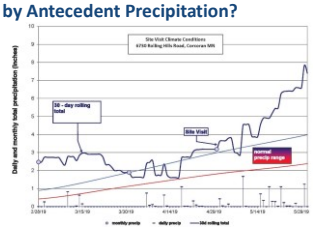
- **Three-Prior Month Method**
  - Using State Climatology Tool
  - Manual Completion
- **Thirty Day Rolling Total**
  - Summing the prior 30-day precipitation totals for each day and plotting this "rolling total" on a daily basis
- **Hybrid Method**
  - Essentially combines above methods

14

Precip.

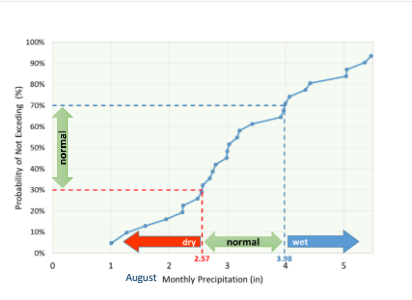
What do we mean by Antecedent Precipitation?

Antecendent: "something that comes before something else"
The prior or preceding precipitation events or conditions, leading up to the site visit or when aerial photography was taken.



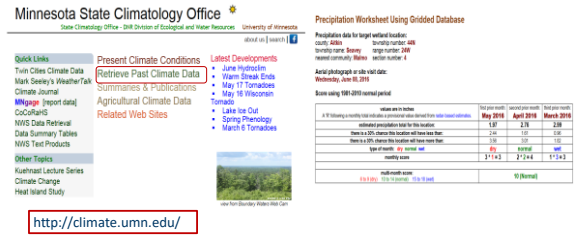
15

What does NORMAL mean? What does WET or DRY mean?



16

With the State Climatology Tool



http://climate.umn.edu/

17

Hybrid Method

30-day rolling total

with

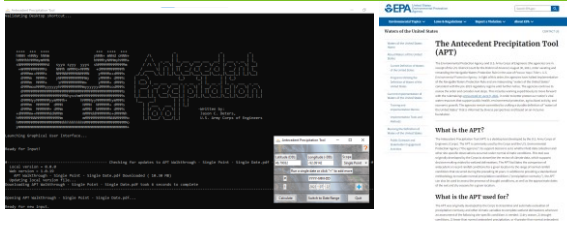
3-prior-month method

18

Precipitation Analysis - Farmington MN 6/15/15

19

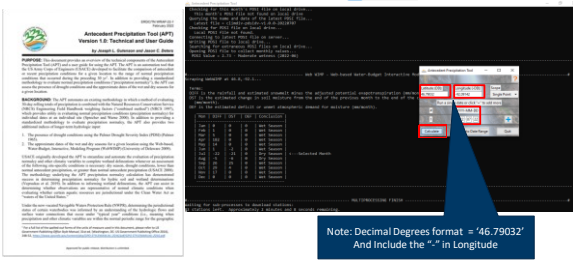
Corps Antecedent Precipitation Tool



https://www.epa.gov/wotus/antecedent-precipitation-tool-apt

20

Enter Lat-Long, Date and Calculate

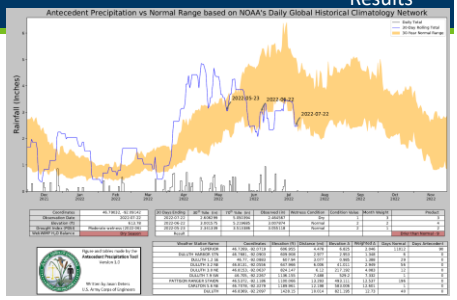


21

Results

- Tool opens pdf in a temporary folder on desktop

- Open pdf to view results:



22

Antecedent Precipitation Evaluation Review

- Important for accurate interpretations/observations
- Done by the delineator
- Included in the report
- Should support your conclusion.
- Not always clear…Best Professional Judgement needed.
- Several methods available, each with certain strengths/weaknesses…

23

Aerial Photo Interpretation and Offsite Methods

BOARD OF WATER AND SOIL RESOURCES

24

Overview

'87 Manual Definitions:
- Normal Circumstances
- Atypical area
- Problem area

Midwest and NC/NE require aerial review per Chapter 5:
- "Agricultural lands"
- "Wetlands that periodically lack indicators of wetland hydrology"

25

Guidance

St. Paul District REGULATORY
US Army Corps of Engineers®

Minnesota Board of Water & Soil Resources

March 4, 2015

Guidance for Submittal of Delineation Reports to the St. Paul District Army Corps of Engineers and Wetland Conservation Act Local Governmental Units in Minnesota, Version 2.0

3.7.6 Using Aerial Imagery to Assess Wetland Hydrology

Procedures have been updated and improved for the assessment of wetland hydrology based on aerial imagery. The interagency approach to off-site wetland determinations on agricultural lands (also referred to as the state ~~"Mapping Conventions"~~) is **required** for CWA and WCA purposes. Refer to the guidance

Guidance for Offsite Hydrology

26

Guidance

US Army Corps of Engineers®
St. Paul District

Minnesota Board of Water & Soil Resources

July 1, 2016

Guidance for Offsite Hydrology/Wetland Determinations

This document replaces all previous Minnesota Board of Water and Soil Resources (BWSR) and St Paul

27

Guidance

- Always use all* imagery in putting the pieces together, and place greatest reliance on more recent years; they tend to best reflect current conditions.

*Use only high quality/good resolution slides. Much better to focus on image quality than normalcy of antecedent conditions.

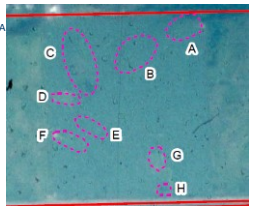
28

Guidance

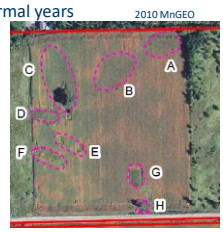
Moving away from FSA images 1979 – 2000

Using more recent and clearer images: 5 normal years

1997 FSA



2010 MnGEO

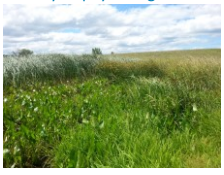


29

Variables

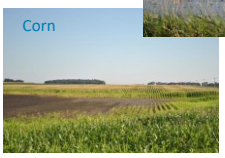
Vegetation Tolerance

Hydrophytic Veg.



Soybeans

Corn



30

Guidance

Vigor and stress responses to wetland conditions

31

Evaluating Images

Signatures:

- CS: Crop stress
- DO: Drowned Out
- NC: Not cropped
- SW: Standing water
- NV: Normal vegetative cover
- NSS: No soil wetness
- AP: Altered pattern
- SS: Soil wetness signature
- CS/DO… (can have multiple, use the /)

Wetland Signatures are a positive "hit"

32

Evaluating Images

Crop Stress (CS)

33

Evaluating Images

Drowned Out (DO)

34

Evaluating Images

NC – not cropped.

35

Evaluating Images

Standing Water (SW)

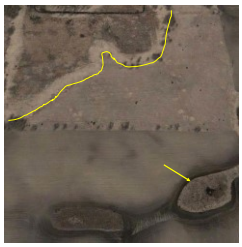
36

AP – altered pattern

37

Evaluating Images

WS – wetland signature.



38

Evaluating Images

Normal Vegetative Cover (NV) or No Soil Wetness (NSS)

39

Evaluating Images

Soil Wetness Signature-SS

- In Bare soil images, dark, or wet-appearing photo tone from early growing season
- May even include some standing water
- Note the drift lines around the edge of the basin

40

What signature(s) do you see?

Crop Stress (CS)	
Drowned Out (DO)	
Not Cropped (NC)	
Standing Water (SW)	
Altered Pattern (AP)	
Wetland Signature (WS)	

41

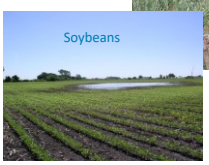
Variables

Stem Density

Alfalfa

Corn

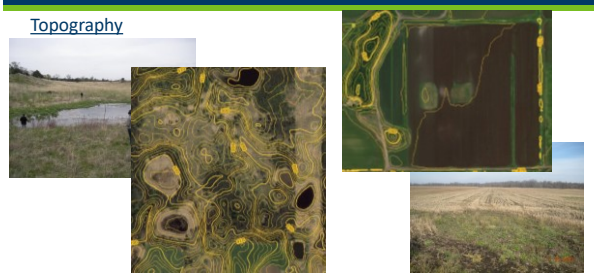
Soybeans



42

Variables

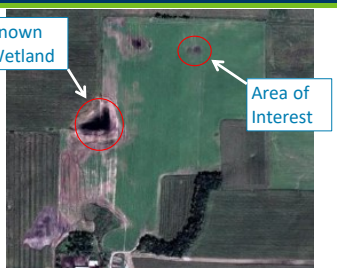
Topography



43

Variables

Reference Areas



44

Variables

Deep Peat Soils

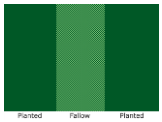
45

Variables

Iron Chlorosis

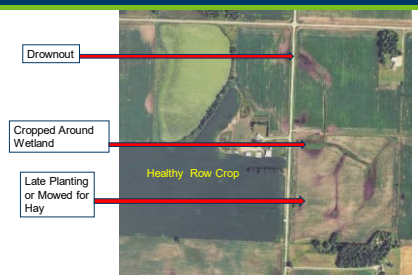
Winter Freeze

Business Decisions



46

Wet Signatures



47

Recording on Data Sheet

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ~~___ Iron Deposits (B5)~~
- X Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ~~___ Crayfish Burrows (C8)~~
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No ____ Depth (inches):
Water Table Present? Yes ____ No ____ Depth (inches):
Saturation Present? (includes capillary fringe) Yes ____ No ____ Depth (inches):

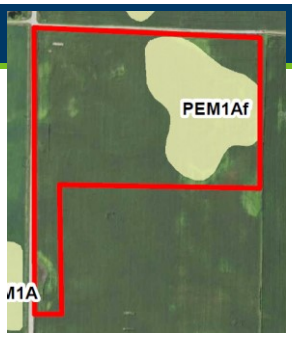
Wetland Hydrology Present? Yes ____ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:
2016 Joint Guidance for Offsite Hydrology was used.

Remarks:

48

Example: AOI NWI



49

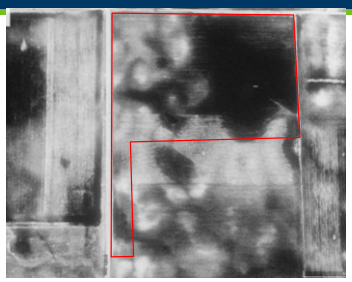
AOI Soils

50

AOI Topography

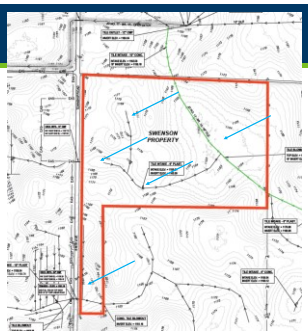
51

Pick wet or current year



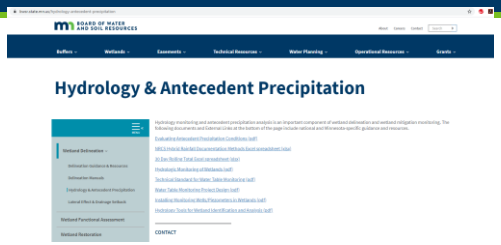
52

AOI Detailed Topo



53

Antecedent Precip



bwsr.state.mn.us/hydrology-antecedent-precipitation

54

2018-Dry

Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017					
2015					
2013					
2012					
2011					
2010					
2008					
2007					
2004					
2003					

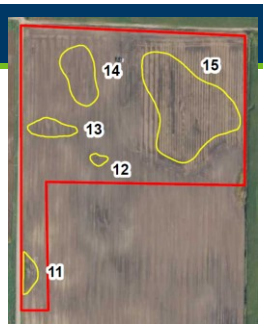
55

2017-Dry

Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015					
2013					
2012					
2011					
2010					
2008					
2007					
2004					
2003					

56

2015-Normal



Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015	SS	NSS	NSS	NSS	AP
2013					
2012					
2011					
2010					
2008					
2007					
2004					
2003					

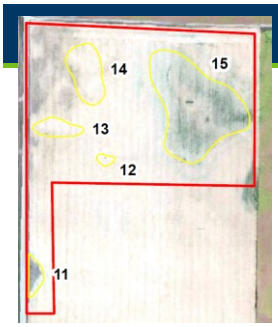
57

2013-Normal

Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015	SS	NSS	NSS	NSS	AP
2013	CS	NV	NV	NV	CS
2012					
2011					
2010					
2008					
2007					
2004					
2003					

58

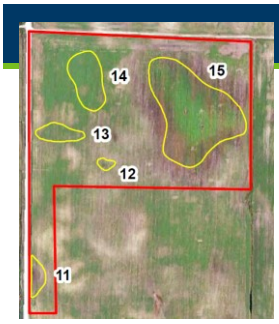
2012-Dry



Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015	SS	NSS	NSS	NSS	AP
2013	CS	NV	NV	NV	CS
2012	DO	NSS	NV	NV	CS
2011					
2010					
2008					
2007					
2004					
2003					

59

2011-Normal



Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015	SS	NSS	NSS	NSS	AP
2013	CS	NV	NV	NV	CS
2012	DO	NSS	NV	NV	CS
2011	DO	CS	NV	NV	CS
2010					
2008					
2007					
2004					
2003					

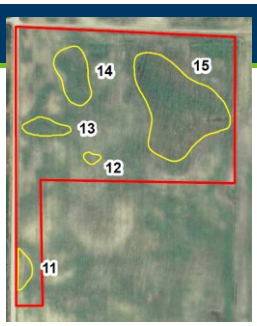
60

2010-Normal

Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015	SS	NSS	NSS	NSS	AP
2013	CS	NV	NV	NV	CS
2012	DO	NSS	NV	NV	CS
2011	DO	CS	NV	NV	CS
2010	DO	CS	NV	NV	CS
2008					
2007					
2004					
2003					

61

2008-Dry



Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015	SS	NSS	NSS	NSS	AP
2013	CS	NV	NV	NV	CS
2012	DO	NSS	NV	NV	CS
2011	DO	CS	NV	NV	CS
2010	DO	CS	NV	NV	CS
2008	NV	NV	NV	NV	NV
2007					
2004					
2003					

62

2007-Wet

Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015	SS	NSS	NSS	NSS	AP
2013	CS	NV	NV	NV	CS
2012	DO	NSS	NV	NV	CS
2011	DO	CS	NV	NV	CS
2010	DO	CS	NV	NV	CS
2008	NV	NV	NV	NV	NV
2007	SS	NV	SS	SS	DO
2004					
2003					

63

2004-Normal

Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015	SS	NSS	NSS	NSS	AP
2013	CS	NV	NV	NV	CS
2012	DO	NSS	NV	NV	CS
2011	DO	CS	NV	NV	CS
2010	DO	CS	NV	NV	CS
2008	NV	NV	NV	NV	NV
2007	SS	NV	SS	SS	DO
2004	CS	NV	NV	NV	NV
2003					

64

2003-Wet

Year	Area 11	Area 12	Area 13	Area 14	Area 15
2018	SS	NV	NSS	NSS	SS
2017	DO	NV	NV	NV	NV
2015	SS	NSS	NSS	NSS	AP
2013	CS	NV	NV	NV	CS
2012	DO	NSS	NV	NV	CS
2011	DO	CS	NV	NV	CS
2010	DO	CS	NV	NV	CS
2008	NV	NV	NV	NV	NV
2007	SS	NV	SS	SS	DO
2004	CS	NV	NV	NV	NV
2003	NV	NV	NV	NV	CS

65

Let's do the math.

Review Summary Table

Image Date (M/D/Y)	Image Source	Climate Condition	Image Interpretation Areas(s)				
			11	12	13	14	15
5/15/2018	County	Dry	SS	NV	NSS	NSS	SS
7/1/2017	FSA	Dry	DO	NV	NV	NV	NV
7/1/2015	FSA	Normal	SS	NSS	NSS	NSS	AP
7/1/2013	FSA	Normal	CS	NV	NV	NV	CS
8/10/2012	County	Dry	DO	NSS	NV	NV	CS
7/1/2011	County	Normal	DO	CS	NV	NV	CS
7/1/2010	FSA	Normal	DO	CS	NV	NV	CS
7/1/2009	FSA	Dry	NV	NV	NV	NV	CS
7/1/2008	FSA	Dry	NV	NV	NV	NV	NV
10/1/2007	County	Wet	SS	NV	SS	SS	DO
7/1/2006	County	Dry	NV	NV	NV	NV	CS
8/1/2004	County	Normal	CS	NV	NV	NV	NV
7/1/2003	FSA	Wet	NV	NV	NV	NV	CS
Number of Normal Years			5	5	5	5	5
Normal Years with Wet Signature			5	2	0	0	4
Percent Normal with Wet Signature			100	40	0	0	80

66

Document

Hydric Soils present[1]	Identified on NWI or other wetland map[2]	Percent with wet signatures from Exhibit 1	Field verification required[3]	Wetland?
Yes	Yes	>50%	No	Yes
Yes	Yes	30-50%	No	Yes
Yes	Yes	<30%	Yes	Yes, if other hydrology indicators present
Yes	No	>50%	No	Yes
Yes	No	30-50%	Yes	Yes, if other hydrology indicators present
Yes	No	<30%	No	No
No	Yes	>50%	No	Yes
No	Yes	30-50%	No	Yes
No	Yes	<30%	No	No
No	No	>50%	Yes	Yes, if other hydrology indicators present
No	No	30-50%	Yes	Yes, if other hydrology indicators present
No	No	<30%	No	No

Area	Hydric Soils Present	Identified on NWI or other wetland map	Percent with wet signatures from Exhibit 1	Other hydrology indicators present:	Wetland?
11	Yes	No	100	NA	Yes
12	Yes	No	40	NA	No
13	Yes	No	0	NA	No
14	Yes	No	0	NA	No
15	Yes	Yes	80	NA	Yes

67

Document

Hydric Soils present[1]	Identified on NWI or other wetland map[2]	Percent with wet signatures from Exhibit 1	Field verification required[3]	Wetland?
Yes	Yes	>50%	No	Yes
Yes	Yes	30-50%	No	Yes
Yes	Yes	<30%	Yes	Yes, if other hydrology indicators present
Yes	No	>50%	No	Yes
Yes	No	30-50%	Yes	Yes, if other hydrology indicators present
Yes	No	<30%	No	No
No	Yes	>50%	No	Yes
No	Yes	30-50%	No	Yes
No	Yes	<30%	No	No
No	No	>50%	Yes	Yes, if other hydrology indicators present
No	No	30-50%	Yes	Yes, if other hydrology indicators present
No	No	<30%	No	No

Area	Hydric Soils Present	Identified on NWI or other wetland map	Percent with wet signatures from Exhibit 1	Other hydrology indicators present:	Wetland?
11	Yes	No	100	NA	Yes
12	Yes	No	40	NA	No
13	Yes	No	0	NA	No
14	Yes	No	0	NA	No
15	Yes	Yes	80	NA	Yes

68

Document

Hydric Soils present[1]	Identified on NWI or other wetland map[2]	Percent with wet signatures from Exhibit 1	Field verification required[3]	Wetland?
Yes	Yes	>50%	No	Yes
Yes	Yes	30-50%	No	Yes
Yes	Yes	<30%	Yes	Yes, if other hydrology indicators present
Yes	No	>50%	No	Yes
Yes	No	30-50%	Yes	Yes, if other hydrology indicators present
Yes	No	<30%	No	No
No	Yes	>50%	No	Yes
No	Yes	30-50%	No	Yes
No	Yes	<30%	No	No
No	No	>50%	Yes	Yes, if other hydrology indicators present
No	No	30-50%	Yes	Yes, if other hydrology indicators present
No	No	<30%	No	No

Area	Hydric Soils Present	Identified on NWI or other wetland map	Percent with wet signatures from Exhibit 1	Other hydrology indicators present:	Wetland?
11	Yes	No	100	NA	Yes
12	Yes	No	40	NA	No
13	Yes	No	0	NA	No
14	Yes	No	0	NA	No
15	Yes	Yes	80	NA	Yes

69

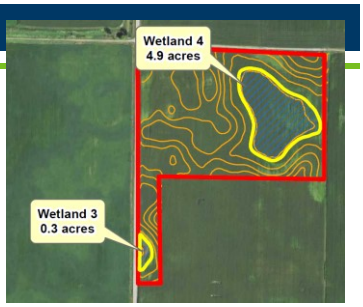
Document

Hydric Soils present[1]	Identified on NWI or other wetland map[2]	Percent with wet signatures from Exhibit 1	Field verification required[3]	Wetland?
Yes	Yes	>50%	No	Yes
Yes	Yes	30-50%	No	Yes
Yes	Yes	<30%	Yes	Yes, if other hydrology indicators present
Yes	No	>50%	No	Yes
Yes	No	30-50%	Yes	Yes, if other hydrology indicators present
Yes	No	<30%	No	No
No	Yes	>50%	No	Yes
No	Yes	30-50%	No	Yes
No	Yes	<30%	No	No
No	No	>50%	Yes	Yes, if other hydrology indicators present
No	No	30-50%	Yes	Yes, if other hydrology indicators present
No	No	<30%	No	No

Area	Hydric Soils Present	Identified on NWI or other wetland map	Percent with wet signatures from Exhibit 1	Other hydrology indicators present:	Wetland?
11	Yes	No	100	NA	Yes
12	Yes	No	40	NA	No
13	Yes	No	0	NA	No
14	Yes	No	0	NA	No
15	Yes	Yes	80	NA	Yes

70

Conclusion: Final Determination



71

Other uses

Level 1 Delineations

Delineation Method	Review of offsite mapping resources	Site Visit	Sampling Approach	Complete Field Data Forms	Field Staking of Wetland Boundaries
Routine Level 1	Yes	Sometimes	Offsite	No	No
Routine Level 2	Yes	Yes	Onsite, qualitative	Yes	Yes
Comprehensive	Yes	Yes	Onsite, quantitative	Yes	Yes

WCA Application Type Examples	*Commonly Used* Delineation Method
Temporary impact under No-Loss	Routine Level 1
Banking application: pre-application scoping	Routine Level 1
Banking application: full application	Routine Level 2
Road Program Wetland Impact Documentation—Road project through a large continuous wetland	Routine Level 1
Road Program Wetland Impact Documentation—Scattered wetlands within construction corridor	Routine Level 2
Replacement plan	Routine Level 2
Enforcement actions	Routine Level 2 or Comprehensive
Wetland boundary approval (no project application)	Routine Level 2
Agricultural exemption determination (8420.0420, Subpart 2A)	Routine Level 1

72

Other uses

Level 1 Delineations

73

Incidental

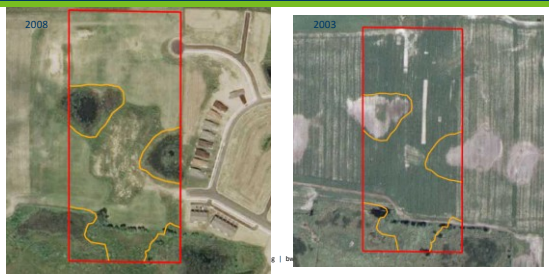
2015

74

Incidental

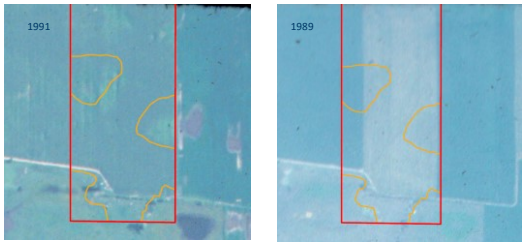
75

Incidental



76

Incidental



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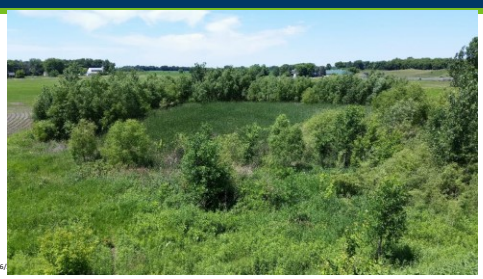
Incidental



78

Final Point

- Except for Level 1 delineations, the results of aerial imagery review are not necessarily the final determination.
- Other data to support conclusions.
- Results do not override site specific data (Level 2, Level 3, Comprehensive).

79

Basic Soil Concepts

BOARD OF WATER AND SOIL RESOURCES

Minnesota Wetland Professional Certification Program

80

Overview

- Basics of Soil
  - Soil formation
  - Landscape position
- Soil Properties
  - Texture
  - Color
- Hydric soil development
- Web Soil Survey
  - Interpreting soil reports
- Hydric soil indicators
  - All
  - Fine
  - Sandy
- Common soil indicators

81

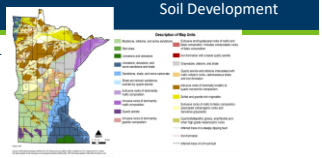
What is Soil?

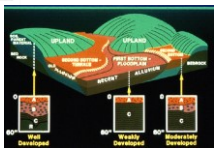
- Natural body that occurs on the land surface, occupies space, and is characterized by one or both of the following:
- Horizons or layers, or
- The ability to support rooted plants in a natural environment
  - Upper limit is air or shallow (>2.5 m) water
  - Lower limit is either bedrock or the limit of biological activity
  - Lower limit for classification set at an arbitrary 2 m

82

Factors That Influence Soil Development

- Climate- weather conditions prevailing over long period of time
- Parent material- geologic material from which soils form
- Topography- landscape position and slope processes
- Organisms- essential role of microbes in the soil, includes humans
- Time- soil doesn't "age", it develops. vegetation, organisms and climate "act on" parent material and topography to develop soil.

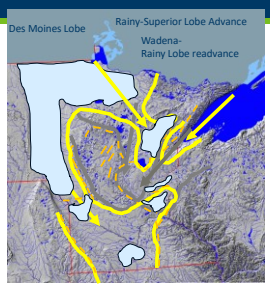




83

Parent Material Relates to Glacial Geology

Recent Glacial Geology of MN



84

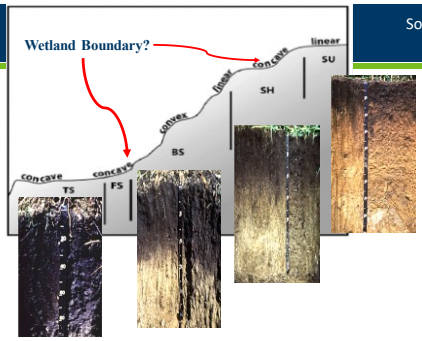
Soil Taxonomy

- 12 orders of soil taxonomy
- Which ones are common in MN

- **Alfisols:** wide range of climate, forest soils, clay in subsoil
- Andisols: volcanic, high nutrient
- Aridisols: desert soils
- **Entisols:** recent deposition, dunes, slopes, floodplains, sandy
- Gelisols: permafrost, high latitudes and/or elevation
- **Histosols:** high organic, most saturated year round
- **Inceptisols**: wide range of climate, moderate weathering
- **Mollisols:** "prairie soils", dark colored, high organic
- Oxisols: highly weathered tropical, stable, low fertility
- **Spodosols:** coarse-textured, acidic, conifer forests
- Ultisols: humid climate, weathered, clay-rich
- **Vertisols**: high content of expanding clays, Red River Valley

85

Soil Catena



86

Two Categories of Soil Material - Mineral Soil/Horizons

Mineral horizons

- Primarily sand, silt, and clay, with varying amounts of organic matter

Organic horizon

- consists of mostly decomposed organic material

87

Organic Matter Decomposition

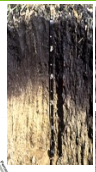
- Fibric (peat)
  - Least decomposed
  - Plant fibers identifiable
  - After rub – >40% of fibers still visible (2/3)
- Hemic (mucky peat)
  - Intermediate decomposition
- Sapric (muck)
  - Most decomposed, <1/3 ID of plant fibers
  - <1/6 of fibers visible after rubbing

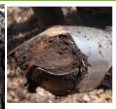
88

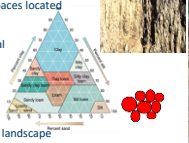
Key Soil Properties

Properties that are important to hydric soil development and recognition:

- Horizons- layer of soil with similar physical, chemical, and biologic properties
- Texture- relative proportion of soil particles (sand, silt, clay)
- Structure- arrangement of solid parts and of the pore spaces located between them
- Permeability- ability of water to move through a material
- Color- hue, value, chroma
- Organic matter- percent, thickness, and level of organic decomposition
- Drainage- presence of natural and human drainage on a landscape







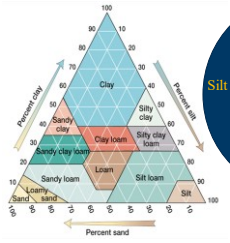
89

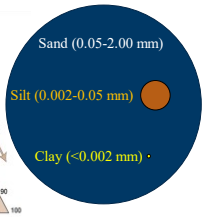
Soil Horizon- layer of soil with similar physical, chemical, and biologic properties

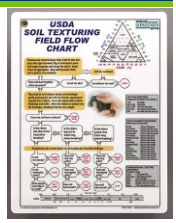
- O horizon- Organic horizon, thickness varies
- A Horizon- Organic accumulation (typically ~10%), ideally granular structure
- E Horizon- Coloring agents (Fe, Organics) removed
- B Horizon- Subsoil accumulation of minerals, organics, and sometimes chemicals, blocky structure
- C Horizon - Similar to parent material, often less developed with little structure
- R Horizon- Parent material

90

Soil Texture- Relative proportion of soil particles



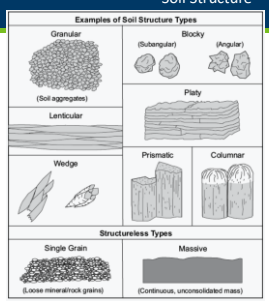




91

Soil Structure

- Soil Structure- arrangement of solid parts and of the pore spaces located between them
- Aggregation- interaction and arrangement of soil particles
- Precipitation of oxides, carbonates and silicates
  - Cementation
- Can decline under cultivation & irrigation



92

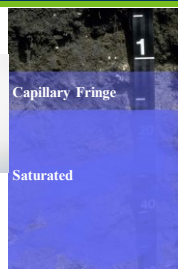
Permeability- ability of water or air to move through the soil profile

- Variables in permeability:
  - Structure- arrangement of soil characterized by size, shape (blocky, columnar, platy, etc.) and grade (weak, strong)
  - Texture- pore space of different particle sizes
- Permeability is "measured" in inches per hour
  - Permeability is an estimated property
- Larger grain sizes= higher permeability

93

Capillary Fringe

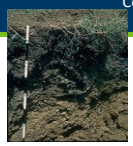
- Based upon permeability
- The zone above the free water table that is effectively saturated
  - Water held at tension
  - Theoretical values much higher than "real life"
  - Difficult to measure

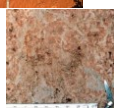


94

Coloring Agents in Soil

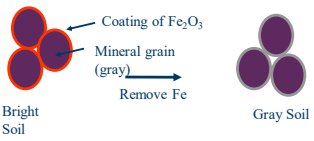
- Organic matter
  - OM will mask all other coloring agents.
- Iron (Fe)
  - brown colors are the result of Fe oxide stains coating individual particles
- Manganese (Mn)
  - resulting in a very dark black or purplish black color
- Calcium
- Lack of coatings
  - Color of the mineral soil grains (stripped)





95

Soil Color



"Bright-colored" soil is bright because the gray-colored mineral grains are coated with a thin layer of "paint" formed by Fe oxides. Stripping the paint off the particles leaves the mineral grains exposed.

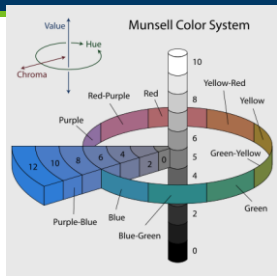
96

Color

- Hue- the spectrum color
- Value- lightness or darkness
- Chroma- "purity" or grayness of color

Hue Value Chroma

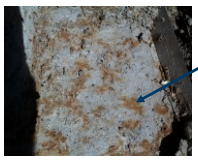
10YR 2/1



97

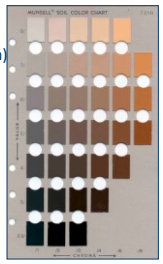
Color

- Matrix (predominant) color
- Color of redoximorphic features (concentration or depletion)
  - Contrast, abundance, location, and size of redox features



What is the percent of redox?

30%



98

Reading Soil Color

- Optimum conditions
  - Natural light
  - Clear, sunny day
  - Midday
  - Light at right angles
  - Soil moist

99

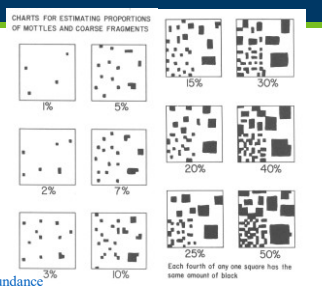
Abundance and Size of Redox

Abundance

- Few -- less than 2%
- Common -- 2 to 20%
- Many -- more than 20%

Size

- Fine -- < 5 mm
- Medium -- 5 to 15 mm
- Coarse -- > 15 mm



Several indicators require at least 2% abundance

100

Contrast

- Contrast refers to the degree of visual distinction between associated colors
  - Faint -- evident only on close examination
  - Distinct -- readily seen at arms length
  - Prominent -- contrast strongly

Contrast Class	Code	Difference in Color Between Matrix and RMF (Δ means "difference between")			
		Hue (h)	Value (v)		*Chroma (c)*
Faint [1]	F	Δh = 0;	Δv ≤ 2	and	Δc ≤ 1
		Δh = 1;	Δv ≤ 1	and	Δc ≤ 1
		Δh = 2;	Δv = 0	and	Δc = 0
Distinct [1]	D	Δh = 0;	Δv ≤ 2	and	Δc > 1 to < 4
			or Δv > 2 to < 4	and	Δc < 4
		Δh = 1;	Δv ≤1	and	Δc > 1 to < 3
			or Δv > 1 to < 3	and	Δc < 3
		Δh = 2;	Δv = 0	and	Δc > 0 to < 2
			or Δv > 0 to < 2	and	Δc < 2
Prominent [1]	P	Δh = 0;	Δv ≥ 4	or	Δc ≥ 4
		Δh = 1;	Δv ≥ 3	or	Δc ≥ 3
		Δh = 2;	Δv ≥ 2	or	Δc ≥ 2
		Δh ≥ 3;			

[1] If compared colors have both a value ≤3 and a chroma of ≤2, the contrast is *Faint*, regardless of hue differences.

Several indicators require distinct or prominent contrast!

101

Definition of a Hydric Soil

- A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding **long enough** during the **growing season** to develop anaerobic conditions in the **upper part**.



102

Landscape and formation of hydric soils

- Landscape position
  - Surface shape (linear, concave, convex)
  - Erosional or depositional
- Hydraulics
  - How water moves
- Hydroperiod- seasonal pattern of water table depth in a wetland
  - Long term- organic
  - Seasonal inundation- thick O, dark A
  - Seasonal saturation- thin O
  - Floodplain- thin, stratified layers

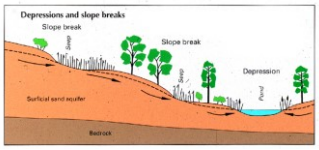
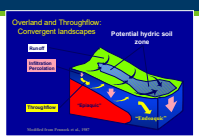


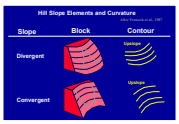
Figure D1. Precipitation analysis for a growing season showing daily precipitation, monthly precipitation, the 30-day rolling sum, and the range of normal conditions.

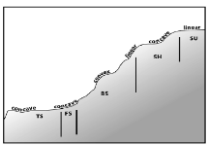
103

Landscape Position

- Location relative to other landforms
- Critically influences water flow and soil formation
- Most wetlands, even groundwater seeps, are on some sort of concave surface







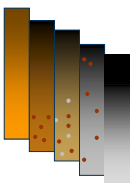
104

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.



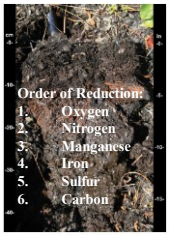
105

Hydric Soil Development

Soil microbes that drive reduction require:

1. Anaerobic conditions i.e. (saturated soil)
2. Organic matter (energy source)
3. Soil temperature warm enough for microbial respiration (>41F)
4. Duration of conditions (Time)

In anaerobic conditions decomposition slows and leads to organic accumulation



106

Conceptual overview of aquic conditions

- Here's what happens when water moves into a soil profile:
  - Downward movement
  - Lateral movement
  - Lose some things
  - Changes in chemical state in others

Think old car left in the elements- chemical reactions leave "rust in the soil"

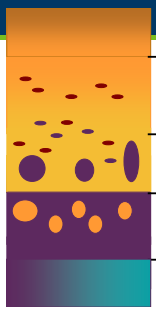
107

Change in the state of iron

- Available O_2, NO_3, and Mn depleted
- $Fe^{3+} \longrightarrow Fe^{2+}$ (Mobile)
- **Bluish Grey** when **reduced**
- **Grey** when **depleted** from soil
- **Orange** or **Red** when **oxidized**

108

Anaerobic process



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

109

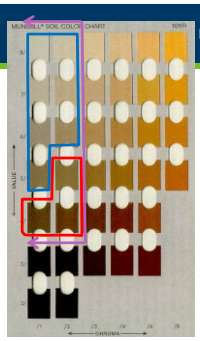
Depleted Matrix

Iron removed or re-organized in profile leaving Grey matrix

- **Value 4 or More**
- **Chroma 2 or Less**

110

Depleted Matrix Requirement



Do Not Need Concentrations

Need Concentrations (2%)

High Value (4 or more)

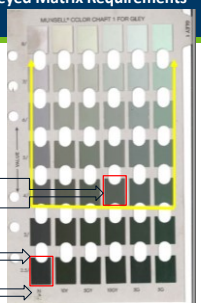
Low Chroma (2 or Less)

111

Gleyed Matrix Requirements

Gleyed Matrix

- **Iron Present, but in reduced state (Fe2+) Gleyed color with value > = 4**



112

Hydric Soil Indicators

BOARD OF WATER AND SOIL RESOURCES

Minnesota Wetland Professional Certification Program

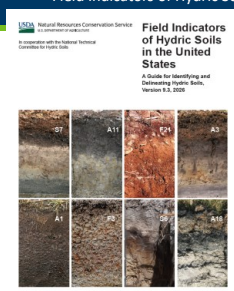
113

Field Indicators of Hydric Soils

Natural Resources Conservation Service

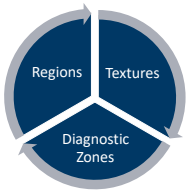
- National Technical Committee for Hydric Soils

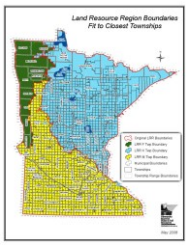
Used for **on-site verification** of hydric soils

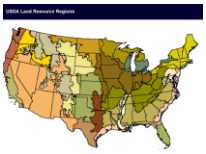


114

Field Indicator Organization- Regions



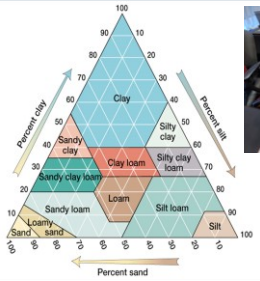


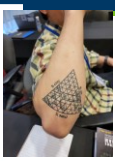


115

Field Indicator Organization- Texture

- Use regardless of texture(s)
  - All Mineral
  - All Organic
- Typically, organic matter influences near the surface
- Includes smell
  - Rotten egg



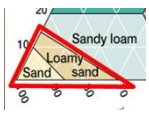


116

Soil Indicator Groups- Texture

Sandy Soil Indicators (S):

- Use when texture is:
  - Loamy Fine Sand or coarser



Fine Grained Soil Indicators (F):

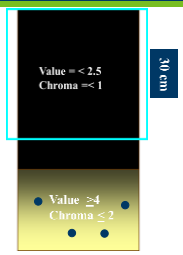
- Use when texture is:
  - Loamy Very Fine Sand or finer

A group- all textures

117

Diagnostic Zones

- Layers with :
  - Certain **Colors**
    - high value and low chroma
    - redoximorphic features
    - organic matter accumulations
  - Specific **Depths** from Surface
  - **Thickness** requirements

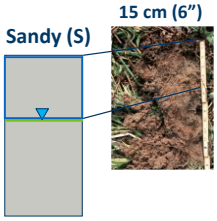


118

Diagnostic Zones for S and F indicator groups

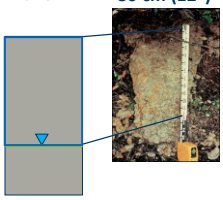
Sandy (S)

Upper 15 cm (6”)



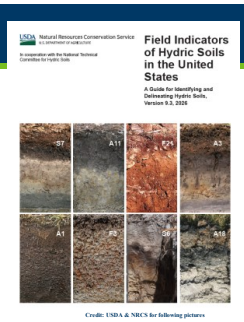
Loamy / Clayey (F)

Upper 30 cm (12”)



119

Key terms to help interpret indicators:

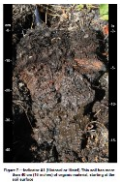


- Aquic- moisture regime, reducing regime virtually free of dissolved oxygen
- Histic- saturated organic horizon
- Epipedon-horizon near the surface
- Depletions- areas of low chroma where oxides have been stripped away
- Concentrations-zones where oxides have accumulated

120

Format of Indicator Descriptions

A1. —Histosol or Histel. For use in all LRRs. Classifies as a Histosol (except Folist) or as a Histel (except Folistel).



User Notes: In a Histosol, organic soil material is typically 40 cm (16 inches) or more of the upper 80 cm (32 inches) (fig. 8). Organic soil materials have organic carbon content (by weight) of 12 percent or more. These materials include muck (sapric soil material), mucky peat (hemic soil material), and peat (fibric soil material). See "Keys to Soil Taxonomy" (Soil Survey Staff, 2022) for a complete definition.

- Alpha-numeric designation
  - A1
- Short name
  - Histosol
- Applicable land resource regions (LRR)
  - Use in all LRRs
- Description of the indicator
- User notes
  - Additional information, explanation and guidance
- Supplement adds regional likelihood, locations

121

A1- Histosol

- **A1. Histosol:** Classifies as a Histosol. A Histosol has a layer of organic matter accumulation of ≥ 16 inches in the upper 32 inches of soil material.
- Use in all LRRs

A1.—Histosol or Histel. For use in all LRRs. Classifies as a Histosol (except Folist) or as a Histel (except Folistel).

User Notes: In a Histosol, organic soil material is typically 40 cm (16 inches) or more of the upper 80 cm (32 inches) (fig. 8). Organic soil materials have organic carbon content (by weight) of 12 percent or more. These materials include muck (sapric soil material), mucky peat (hemic soil material), and peat (fibric soil material). See "Keys to Soil Taxonomy" (Soil Survey Staff, 2022) for a complete definition.

Figure 7.—Indicator A1 (Histosol or Histel). This soil has more than 40 cm (16 inches) of organic material, starting at the soil surface.

122

A2- Histic Epipedon

Histic epipedon- saturated, organic horizons 8 inches or more thick in the upper part

- Applicable land resource regions (LRR)
  - Use in all LRRs

A2.—Histic Epipedon. For use in all LRRs. A histic epipedon underlain by mineral soil material with chroma of 2 or less.

User Notes: Most histic epipedons are composed of surface horizons with organic soil material 20 cm (8 inches) or more thick (fig. 9). Aquic conditions or artificial drainage is required. See "Keys to Soil Taxonomy" (Soil Survey Staff, 2022) for a complete definition.

Figure 9.—Indicators A2 (Histic Epipedon) and A3 (Black Histic). This soil meets the depth criterion of A2 and the color and depth criteria of A3. The black color, a requirement of A3, results from the accumulation of organic matter when the soil is saturated and anaerobic.

123

A3- Black Histic

- A layer of peat, mucky peat, or muck 8 in or more thick that starts at a depth of ≤ 6 in from the soil surface; has hue of 10YR or yellower, value of 3 or less, and chroma of 1 or less; and is underlain by mineral soil material with chroma of 2 or less.
- Applicable land resource regions (LRR)
  - Use in all LRRs

A3.—Black Histic. For use in all LRRs. A layer of peat, mucky peat, or muck 20 cm (8 inches) or more thick starting at a depth of 15 cm (6 inches) or less from the soil surface with a hue of 10YR or yellower, value of 3 or less, and chroma of 1 or less and underlain by mineral soil material with chroma of 2 or less. User Notes: Unlike indicator A2, this indicator does not require proof of aquic conditions or artificial drainage (see fig. 9).

Figure 8.—Indicators A2 (Histic Epipedon) and A3 (Black Histic). This soil meets the depth criterion of A2 and the color and depth criteria of A3. The black color, a requirement of A3, results from the accumulation of organic matter when the soil is saturated and anaerobic.

124

A11- Depleted Below Dark Surface

- Applicable land resource regions (LRR)
  - Use in all MN LRRs

A11.—Depleted Below Dark Surface. For use in all LRRs except for W, X, and Y; for testing in LRRs W, X, and Y. A layer with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less, starting at a depth of 30 cm (12 inches) or less from the soil surface and having a minimum thickness of either

1. 15 cm (6 inches), or
2. 2. 5 cm (2 inches) if the 5 cm consists of fragmental soil material

Organic, loamy, or clayey layer(s) above the depleted or gleyed matrix must have value of 3 or less and chroma of 2 or less starting at a depth of less than 15 cm (6 inches) from the soil surface and extend to the depleted or gleyed matrix. Any loamy fine sand and coarser material above the depleted matrix must have value of 3 or less and chroma of 1 or less starting at a depth of 15 cm (6 inches) or less from the soil surface and extend to the depleted or gleyed matrix. When viewed through a 10x or 15x hand lens, at least 70 percent of the visible sand particles must be masked with organic material.

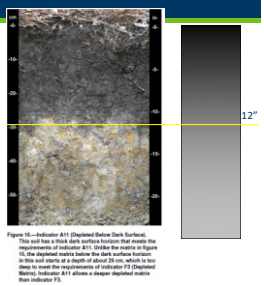


Figure 16.—Indicator A11 (Depleted Below Dark Surface). This soil has a thick dark surface horizon that meets the requirements of indicator A11. Unlike the matrix in figure 15, the depleted matrix below the dark surface horizon in this soil starts at a depth of about 20 cm, which is too deep to meet the requirements of indicator F3 (Depleted Matrix). Indicator A11 allows a deeper depleted matrix than indicator F3.

125

A12- Thick Dark Surface

- Applicable land resource regions (LRR)
  - Use in all LRRs
- User notes
  - Most often associated with overthickened soils in concave landscape positions.

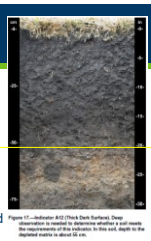
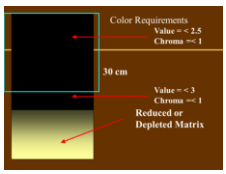


Figure 17.—Indicator A12 (Thick Dark Surface). Deep observation is needed to determine whether a soil meets the requirements of this indicator. In this soil, depth to the depleted matrix is about 50 cm.



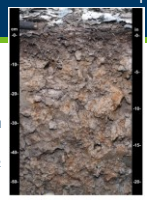
A12.—Thick Dark Surface. For use in all LRRs. A layer 15 cm (6 inches) or more thick with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less starting at a depth of more than 30 cm (12 inches) from the soil surface. The layer(s) above the depleted or gleyed matrix and starting at a depth of less than 15 cm (6 inches) from the soil surface must have value of 2.5 or less and chroma of 1 or less to a depth of 30 cm (12 inches) or more and a value of 3 or less and chroma of 1 or less in any remaining layers above the depleted or gleyed matrix. In any loamy fine sand and coarser material above the depleted or gleyed matrix, at least 70 percent of the particles must be masked with organic material when viewed through a 10x or 15x hand lens.

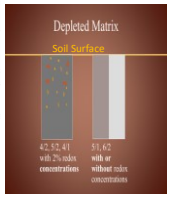
126

F3- Depleted Matrix

- Applicable land resource regions (LRR)
  - Use in all LRRs

F3.—Depleted Matrix. For use in all LRRs, except W, X, and Y; for testing in LRRs W, X, and Y. A layer that has a depleted matrix with 60 percent or more chroma of 2 or less and that has a minimum thickness of either 1. 5 cm (2 inches), starting at a depth of 10 cm (4 inches) or less from the soil surface, or 2. 15 cm (6 inches), starting at a depth of 25 cm (10 inches) or less from the soil surface.





127

F6- Redox Dark Surface

- Applicable land resource regions (LRR)
  - Use in all LRRs

F6.—Redox Dark Surface. For use in all LRRs, except W, X, and Y; for testing in LRRs W, X, and Y. A layer that is 10 cm (4 inches) or more thick, starting at a depth of 20 cm (8 inches) or less from the mineral soil surface, and has 1. matrix value of 3 or less and chroma of 1 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings, or 2. matrix value of 3 or less and chroma of 2 or less and 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings.

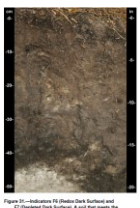
Figure 31.—Indicators F6 (Redox Dark Surface) and F7 (Depleted Dark Surface). A soil that meets the requirements of indicator F7 commonly also meets the requirements of indicator F6. If the dark surface layer has depletions, it most likely also has concentrations.

128

F7- Depleted Dark Surface

- Applicable land resource regions (LRR)
  - Use in all LRRs
- User notes
  - Careful to not mistake an E horizon for depletions!

F7.—Depleted Dark Surface. For use in all LRRs except W, X, and Y; for testing in LRRs W, X, and Y. Redox depletions with value of 5 or more and chroma of 2 or less in a layer that is 10 cm (4 inches) or more thick, starting at a depth of 20 cm (8 inches) or less from the mineral soil surface, and has 1. matrix value of 3 or less and chroma of 1 or less and 10 percent or more redox depletions, or 2. matrix value of 3 or less and chroma of 2 or less and 20 percent or more redox depletions.



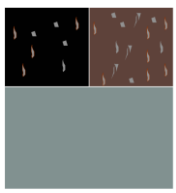


Figure 31.—Indicators F6 (Redox Dark Surface) and F7 (Depleted Dark Surface). A soil that meets the requirements of indicator F7 commonly also meets the requirements of indicator F6. If the dark surface layer has depletions, it most likely also has concentrations.

129

S5- Sandy Redox

- Applicable land resource regions (LRR)
  - Use in all LRRs

S5.—Sandy Redox. For use in all LRRs, except for Q, V, W, X, and Y. A layer starting at a depth of 21Field Indicators of Hydric Soils 15 cm (6 inches) or less from the soil surface that is 10 cm (4 inches) or more thick and has a matrix with 60 percent or more chroma of 2 or less and 2 or more percent distinct or prominent redox concentrations occurring as soft masses and/or pore linings.

Figure 22.—Indic… requirements … of 2 or less … starting at a … meets the … chroma … centrations

130

Data Sheet

Sampling Point: W1-DP2W

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	10yr 2/1	100					Clay Loam	
3-22	10yr 5/2	80	7.5yr 5/6	20	C	M	Loamy clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:
- Histosol (A1)
- Histic Epipedon (A2)
- Black Histic (A3)
- Hydrogen Sulfide (A4)
- Stratified Layers (A5)
- 2 cm Muck (A10)
- Depleted Below Dark Surface (A11)
- Thick Dark Surface (A12)
- Sandy Mucky Mineral (S1)
- 5 cm Mucky Peat or Peat (S3)
- Sandy Gleyed Matrix (S4)
- Sandy Redox (S5)
- Stripped Matrix (S6)
- Loamy Mucky Mineral (F1)
- Loamy Gleyed Matrix (F2)
- Depleted Matrix (F3)
- Redox Dark Surface (F6)
- Depleted Dark Surface (F7)
- Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:
- Coast Prairie Redox (A16)
- Iron-Manganese Masses (F12)
- Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):
Type:
Depth (inches):

Hydric Soil Present? Yes [X] No [ ]

Remarks:

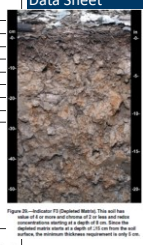


Figure 35.—Indicator F3 (Depleted Matrix). This soil has value of 4 or more and chroma of 2 or less and redox concentrations starting at a depth of 8 cm. Since the depleted matrix starts at a depth of ≥5 cm from the soil surface, the minimum thickness requirement is only 5 cm.

131

Problematic Hydric Soils

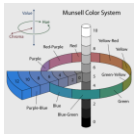
- Covered in Chapter 5 of the regional supplements
- Problematic hydric soils are the norm in some landscapes
  - **Red** Parent Material *(inhibited, or difficult to see redox features)*
  - Active floodplains *(deposition of new material)*
  - Drained systems *(relict hydric indicators)*
  - **High Value** *(bright)* / **Low Chroma** *(grey),*
  - Thick prairie soils
  - Sandy soils

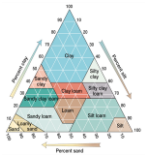
132

Review

- Soil formation
  - Parent material, landscape position, horizons
- Soil Properties
  - Texture
    - Sand, silt, clay
  - Color
    - Hue, value, chroma
- Hydric soil development
  - Anaerobic conditions, reduction, organic accumulation

- Hydric soil indicators
  - All, Fine, Sandy
- Common soil indicators
  - Organic Indicators (A1, A2, A3)
  - Depleted Matrix (A11, A12, F3)
  - Redoximorphic features (F6, S3)





133

Soil Survey Overview

134

Attributes from Soil Survey to help understand Functions

- Geomorphic description
  - Landform
  - Slope shape
  - Parent material
- Typical profile
  - Textures
  - Depths
- Properties and qualities
  - Slope
  - Restrictive layer
  - Drainage class
  - Depth to water table
  - Frequency of flooding/ponding

Description of Normanna

Setting
Landform: Moraines
Landform position (two-dimensional): Summit, backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy material over dense loamy till

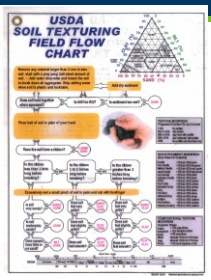
Typical profile
A - 0 to 4 inches: loam
Bw - 4 to 45 inches: gravelly sandy loam
2Bw,BC,2BC - 45 to 48 inches: gravelly sandy loam
2BCd - 48 to 80 inches: gravelly sandy loam

Properties and qualities
Slope: 3 to 8 percent
Depth to restrictive feature: 30 to 60 inches to densic material
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.2 inches)

135

Order of Operation when Describing Soil Profile

1) First order observations
2) Color
3) Texture
4) Apply indicator



136