RELATIONSHIPS BETWEEN SOIL MORPHOLOGY AND WATER TABLE LEVELS

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Acknowledgements

USEPA National Community Decentralized Wastewater Treatment Demonstration Project
Block Island and Green Hill Pond Watershed, RI
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The BIG HP
National Soil Handbook lists over 30 land uses decisions that are dependent upon the depth to the SHWT

- Agriculture
- Construction
- Wetland delineation
- Onsite wastewater treatment
Summary of the project

The main objective was to develop a better understanding on how the soil features (RMF’s) relate to the depth and duration of the WT.

Focus on:

• How water tables are measured;
• How well soil morphologies relate to WT depth and duration
• Can we model water table durations based on precipitation data;
• How does this all relate to on-site systems.
What should you learn today? (or already know)

• In general, water table levels are dynamic (not static)
• Changes in levels are a function of inputs (precipitation) and outputs (ET and seepage)
• Precipitation varies day to day, month to month, year to year; ET varies seasonally, seepage is essentially depth dependent
• What the WT looks like is depends upon how you measure it
Water table fluctuations monitored every half hour (data logger- one site)

Where do you place the SHWT?
- Weekly data gathering misses peak events
- Water table changes with precipitation events
The **maximum water table recording device**

MWTRD (Gizmo)

- Placed inside a 1 ¼” I.D. slotted PVC well
- A hole in the cap holds the rod
- As the water table rises in the well, the float pushes the magnet up the metal rod
- When the water table and the float decline the magnet remains in place recording the highest level the water table reached
For more details on the Gizmo, visit:

www.nesoil.com

- Materials list
- Construction details
- Photographs
Weekly data refined using template and precipitation data

Logger data

Water Table Depth (cm)

Date

Depth (ft)
The preceding data leads to 3 questions:

1) What is the relationship between soil morphology and water table elevations?

2) What is the relationship between how long the water table is at or above a certain depth and soil morphology?

3) How does this study compare to long-term soil morphology/water table relationships?
Question #1

What is the relationship between soil morphology and water table elevations?
What should you learn today?
(or already know)

• Redoximorphic features (RMFs) form as a function of oxidation and reduction of Fe and Mn, and are used to identify the depth of the SHWT
• The SHWT is dependent upon your definition
• The SHWT does not identify the highest the water table reaches
Redoximorphic Features

Types:
- Concentrations
- Depletions

Abundance Classes:
- Few <2%
- Common 2-20%
- Many >20%
Relationship between depth to the ASHWT and the depth to the first loamy textured horizon with common (or greater) RMFs.

ASHWT: average depth of WT between low and high WT during the spring.

When $r^2 = 1$ indicates data and line are a perfect fit.
Maximum water table height at or above first horizon with common RMFs at each site.
What the previous graph means...

at this site, the WT can be more than 3 feet higher than where common RMF’s were found.
Questions # 2

What is the relationship between how long the water table is above a certain depth and RMFs?
What should you learn today? (or already know)

• In general, the longer a soil is saturated the more RMFs that are present
• Relationships between duration of saturation and RMFs is dependent upon the type of RMFs
• Soil texture is an important soil property to consider when assessing duration of saturation and soil morphology relationships
• Does not identify the highest the water table reaches
% of time soils are saturated at or above common RMF’s
(Loamy textured horizons)

Numbers above boxplots represent mean values.
Letters above boxplots indicate significant difference between means at the 0.05 level.

+/- 20% of time
the WT is at or above common RMF’s

2% 2%
ab

19% 22% 26%
b b

37%
c

Percent of time saturated

No RMFs  Few RMFs  Few dep.w/ com. cons.  Common depletions  Many depletions  Depleted Matrix
% of time soils are saturated at or above common RMF’s (Coarse textured horizons, i.e. sands and loamy sands)

Numbers above boxplots represent mean values

32-45% of time the WT is at or above common RMF’s

- No RMFs: 8%
- Few RMFs: 30%
- Few dep. w/com. cons.: 32%
- Common depletions: 45%
% of time soils are saturated at or above common RMF’s
(Sand dunes and beach sand)

Numbers above boxplots represent mean values

>23 % of time the WT is at or above common RMF’s

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<tr>
<th>Condition</th>
<th>Percent Saturated</th>
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<td>No RMFs</td>
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<td>Few RMFs</td>
<td>30%</td>
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<td>Common cons.</td>
<td>23%</td>
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Question # 3

How do the relationships established during the study period compare to long term RMF-water table relationships?
What should you learn today? (or already know)

• How does significant variations in precipitation over extended periods affect water table levels

• How can you decide if the precipitation patterns are “normal”
Precipitation affects water table levels on the long term

Yearly Precipitation Totals
Block Island, RI

30 year mean
WETS Table Documentation

Natural Resources Conservation Service
Water and Climate Center
Portland, Oregon
May 15, 1995

Table of Contents

- Introduction
- Objective
- Source of Data Used in WETS Table
Link to: Annual Air and Soil Temperature Data From the Remote Soil Temperature Network
Click on a County to link to the WETS Table Text File (not all Counties may have a table, use the adjoining County if not available).

http://nesoil.com/climate/index.htm
### Temperature and Precipitation Data

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<th>min daily</th>
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<th>avg daily</th>
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### Notes
- The data represents monthly average temperature (degrees F) and precipitation (inches) from January 1971 to December 2000.
- The table includes average daily temperatures and precipitation, as well as the percentage chance of having less or more than the average.
Model developed to predict water table fluctuations based on precipitation data

\[ WT_p = WT_{pd-1} + R_{ppt} + D_{ppt} + D_s + M \]

Where:

- \( WT_p \): the daily predicted water table level
- \( WT_{pd-1} \): the previous days predicted water table level
- \( R_{ppt} \): the rise in the water table due to precipitation
- \( D_{ppt} \): the decline in the water table directly following a rise due to precipitation
- \( D_s \): the decline in the water table due to deep seepage
- \( M \): the effect on water table fluctuations due to seasonal factors such as evapotranspiration and the relative depth to the water table during different times of the year
Measured vs modeled hydrograph

- Measured
- Modeled

Depth (cm)

Feb 01  Jun 01  Oct 01  Feb 02  Jun 02
Archived precipitation data were entered into the model for three different periods.

The graphs are a comparison of predicted long-term cumulative saturation to the cumulative saturation measured during the study period. Predicted cumulative saturation for a period of excessive wetness and a period of moderate to severe drought are also shown.
Long-term 1950-1984
Measured 2/01-7/02
2/65-7/66 (dry)

Model 2/01-7/02
2/73-7/74 (wet)

Clayhead 2
Take Home Messages

• The water table is dynamic, changing between seasons and years

• Coarse textured soils are less expressive in regards to abundance of RMF’s

• What is defined as the water table depends on how you measure

• Soils are good at predicting the “average SHWT”

• We should ask: How much of the year is the water table above the SHWT?
Bibliography of Publications and Theses under the Wet Soil Monitoring Project

http://www.uri.edu/ce/wq/NEMO/Publications/index.htm#Soils

A Guide to Monitoring the Depth and Duration of the Seasonal High Water Table in Rhode Island
IRIS Tubes

Indicator of Reduction In Soils

$\text{Fe}^{+3} \rightarrow \text{Fe}^{+2}$

$\text{Mn}^{+4} \rightarrow \text{Mn}^{+2}$
Hydric Soils with Spodic Morphologies
Mesic-Spodic Hydric Soil Indicator: Development and Testing

Based on the hydrology, 25 pedons with spodic morphologies were identified as hydric soils.

Nearly one-half (50%) of the hydric soils reviewed did not meet a hydric soil indicator and suggested the need for the development of an effective indicator for hydric spodic soils.
Plates from Bhsm. Note the mottled appearance that suggests Fe concentrations
Bhsm. Plates and mottled appearance.
Dark surface at least 2” thick and;

1) Layer at least 3” thick starting within 12” of soil surface that is 3/3 or darker and shows evidence of spodic morphology; or

2) A layer 2” or more thick occurring within 12” of the mineral soil surface, having value of 4 or more and chroma of 2 or less, and directly underlain by a layer 3” or more thick having value and chroma of 3 or less and showing evidence of spodic development.
Thanks for your attention!