Using Wetbud Wizard

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Pocahontas State Park – valley bottom
Wetbud Basic Model uses the “checkbook for a bathtub” approach:

- Old STORAGE + IN – OUT = New STORAGE
- Monthly totals
In the Basic Model, water greater than the “weir depth” is lost from the wetland as outflow each month.

<table>
<thead>
<tr>
<th>Inflows</th>
<th>Outflows</th>
<th>Water depth at end of month without outflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td></td>
<td>Inflows - Outflows</td>
</tr>
<tr>
<td>Groundwater</td>
<td></td>
<td>Water in wetland at start of month</td>
</tr>
<tr>
<td>Runoff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overbank</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evapotranspiration
Groundwater Out

Wetland bottom elevation

Outflow
Weir depth
1. Create Project and Scenario

CLICK: Define a New Project

Enter: Latitude and Longitude

Enter: Wetland Bottom Elevation
Using Wetbud Wizard

2. Select Weather Station

CLICK: Richmond International
Weather Data Requirements

For Wetbud Wizard, Virginia divided into 12 polygons with preloaded data files.
Weather Data Requirements

NOAA (GSOD, GHCN) + NRCS (WETS)
Weather Data Requirements

Precipitation (daily)

Weather (daily):
  Temperature: Min, Max, Ave °F
  Dewpoint

Solar (hourly):
  Extraterrestrial (ETD)
  Surface (MetStatGlo)
Evapotranspiration is computed using Thornthwaite or Penman–Monteith

- **Basic** – Monthly ET removed from the one layer
- **Advanced** – specify layer from which to remove water daily
Using Wetbud Wizard

3. Scenarios Page

<table>
<thead>
<tr>
<th>Enter:</th>
<th>Scenario Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter:</td>
<td>Constructed Wetland Area</td>
</tr>
<tr>
<td>Enter:</td>
<td>Total Area of Wetland Watershed</td>
</tr>
<tr>
<td>Enter:</td>
<td>Curve Number for Wetland Watershed</td>
</tr>
</tbody>
</table>
Runoff (Hillside basin)

Google Earth Pro w/ USGS Topos
Runoff (Hillside basin)

Google Earth Pro w/ USGS Topos

Stream Overbank Flow Basin

Project Wetland Site

Runoff (hillside) Basin
Runoff (Hillside basin)
Google Earth Pro
Runoff (Hillside basin)

Google Earth Pro w/ Soil Web

Need 1 CN for Stream Basin

Project Wetland Site

Need 1 CN for Runoff Basin
Runoff (Hillside basin)

Google Earth Pro w/ Soil Web
Information needed to find Curve Number for Soil Series

- Cover type
- Hydrologic Condition
- Hydrologic Soil Group
- CN Table

Hydraulic and Erosion Ratings

| Wind Erodibility Group         | 3 |
| Wind Erodibility Index        | 86|
| T Erosion Factor              | 3 |
| Runoff                        | Very high |
| Drainage                      | Poorly drained |
| Hydric Rating / Hydrologic Group | Yes (Wooded under natural conditions) [Group D] |
| Parent Material               | clayey granite and gneiss |
| Total Plant Available Water (cm): | 23.8 |

Geomorphology
Using Wetbud Wizard

4. Calculations/Results Page

Click: Run Calculations
Click: Show Results
Display desired pages
Is a specific month W, N, or D?

30%  40%  30%

30 years of precipitation data at representative station

Determined for each month

Data available on a WETS table
Determine WND years w/ WETS tables:

#1: Which years have WET (or DRY or NORM) total ppt?

30-yr record of annual precipitation

<table>
<thead>
<tr>
<th>Year</th>
<th>Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>30.67</td>
</tr>
<tr>
<td>1981</td>
<td>31.74</td>
</tr>
<tr>
<td>1982</td>
<td>32.57</td>
</tr>
<tr>
<td>1983</td>
<td>33.82</td>
</tr>
<tr>
<td>1984</td>
<td>34.99</td>
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<td>1985</td>
<td>35.77</td>
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<td>1986</td>
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<td>1987</td>
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<td>1988</td>
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<td>1989</td>
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<td>1994</td>
<td>38.07</td>
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<tr>
<td>1995</td>
<td>39.57</td>
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<td>1996</td>
<td>39.80</td>
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<tr>
<td>1997</td>
<td>40.23</td>
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<td>1998</td>
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<td>2002</td>
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<td>2004</td>
<td>50.50</td>
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<td>2005</td>
<td>51.02</td>
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<tr>
<td>2006</td>
<td>51.89</td>
</tr>
<tr>
<td>2007</td>
<td>51.97</td>
</tr>
</tbody>
</table>

Select the median value in each split:

- 1988: 35.33"
- 1994: 42.04"
- 1975: WET
Determine WND years w/ WETS tables:

#2: Did 1975 have a WET “spring”?

\[
\begin{align*}
2 & \quad +2 & \quad +3 & \quad +2 & \quad = & \quad 10
\end{align*}
\]

\begin{array}{cccccc}
D & J & F & M & A & M
\end{array}

\begin{array}{cccccc}
N & N & W & W
\end{array}

Score determines if Spring is WND

- 4-6 : DRY
- 7-9 : NORM
- 10-12: WET

A Year is WET if both the Spring and the Annual Precipitation are both WET
Pocahontas State Park – toeslope seeps
Groundwater Considerations

1. Landscape and Geology
2. How and where GW used
3. New calcs: $W_{em}$
Piedmont Wetlands: the interface between uplands, groundwater, and surface water
1. Wetbud was designed for TOESLOPES; use it elsewhere with your eyes open!
Groundwater Considerations

1. Landscape and Geology
2. How and where GW used
3. New calcs: $W_{em}$
Using Wem in Basic Model

1. Input $GW_{in}$ or calculate using $W_{em}$ (well data)

2. Input or calculate $Gw_{out}$
Pocahontas Example Wetland
Groundwater discharge
along toeslope
$GW_{in} = K \ A \ \frac{\Delta h}{\Delta x}$

(for Month B)

Water level in aquifer estimated by $W_{em}$ calc’ns

Ground level at toeslope

$\Delta h/\Delta x$

A: cross-section of uphill end

Soil K
\[ GW_{out} = K \cdot A \cdot \frac{\Delta h}{\Delta x} \]

(for Month B)

Water level at end of Month A

Water level below outlet

A: cross-section of downhill end
In the Basic Model, groundwater is lost to seepage at a constant rate.
Groundwater Considerations

1. Landscape and Geology
2. How and where GW used
3. New calcs: $W_{em}$
4. Example applications
\[ W_{em} = \text{“Effective Monthly Recharge”} \]

\[ W_{mo} = \text{“Monthly Recharge”} = Ppt_{mo} - ET_{mo} \]

Fetter, 1999
Effective Monthly Recharge: $W_{em}$

A time-weighted average recharge value

$$W_{em} = \sum_{a=1}^{N} W_{mo} \times D^{a-1}$$

- $N =$ number of preceding months
- Each month’s recharge ($\text{Ppt} - \text{ET}$)
- Response-decay factor ($D < 1.0$)
To predict the water table in Month A, how many month’s W must you use?

\[ n = 6 \]

\[ W + W + W + W + W + W + W + W = W_{em} \]
How much influence do past months have on water levels in Month A?

\[
\begin{align*}
\text{J} & \quad \text{J} \quad \text{A} \quad \text{S} \quad \text{O} \quad \text{N} \quad \text{D} \quad \text{J} \\
\text{d} = 0.99 & \quad W + W + W + W + W + W + W + W = W_{\text{em}} \\
\text{d} = 0.85 & \quad W + W + W + W + W + W + W + W = W_{\text{em}}
\end{align*}
\]
How much influence do past months have on water levels in Month A?

Must run every combination of N and D to find the best for prediction.
$W_{em}$ vs Measured Head (2003-2005)

Filtered well data
(effects of recent rain removed)

$n = 18$, $d = 0.90$, $I = 0.25$

$R^2 = 0.87$
Matrix of correlation coefficients ($R^2$)

<table>
<thead>
<tr>
<th>$n$: # of antecedent months</th>
<th>0.99</th>
<th>0.9</th>
<th>0.85</th>
<th>0.8</th>
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<td>0.1369</td>
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<tr>
<td>14</td>
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<td>15</td>
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<td>0.6955</td>
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<td>16</td>
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<td>0.824</td>
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<td>0.5597</td>
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<td>17</td>
<td>0.3884</td>
<td>0.8587</td>
<td>0.7356</td>
<td>0.5638</td>
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<td>18</td>
<td>0.3661</td>
<td>0.8711</td>
<td>0.7412</td>
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<td>0.3494</td>
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<tr>
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<td>0.7023</td>
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<td>0.3468</td>
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<tr>
<td>22</td>
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<td>0.5455</td>
<td>0.6768</td>
<td>0.5405</td>
<td>0.3463</td>
</tr>
</tbody>
</table>
Verification of $W_{em}$ Calculations

Whittecar and others (in review)
Verification of $W_{em}$ Calculations

Whittecar and others (in review)
Verification of $W_{em}$ Calculations


USGS Well Record

Estimated by $W_{em}$ Model

Calibration Period

Whittecar and others (in review)
$W_{em} = \text{“Effective Monthly Recharge”}$

$W_{mo} = \text{“Monthly Recharge”} = Ppt_{mo} - ET_{mo}$

Must have at least 6 months of water level measurements from a well just uphill of site

Get readings from the widest possible range of WT levels (dry to wet)

Whittecar and others (in review)
\[ W_{em} = \text{“Effective Monthly Recharge”} \]
\[ W_{mo} = \text{“Monthly Recharge”} = Ppt_{mo} - ET_{mo} \]

Routinely use both Thornthwaite and Penman-Monteith ET methods.

Can reconstruct GW levels using weather data for times with no well data.

\textit{Whittecar and others (in review)}
Groundwater Considerations

1. ...

2. *Drill, baby, drill* (those uphill monitoring wells!)

Questions?