Where the Water Goes
Hydrology for Inspectors
6 CH

Module 1
Introduction and Hydrologic Cycle
Module 1a

Introduction

Ground Rules

• Keep cell phones off during the training
• Questions and comments are encouraged
• Everyone will have an opportunity to speak and share their thoughts at the appropriate times
• Be supportive of all participants
### Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 – 9:40</td>
<td>Module 1. Introduction/Hydrologic Cycle</td>
</tr>
<tr>
<td>9:40 – 9:50</td>
<td>Break</td>
</tr>
<tr>
<td>9:50 – 10:50</td>
<td>Module 2. Some Principles of Water</td>
</tr>
<tr>
<td>10:50 – 11:00</td>
<td>Break</td>
</tr>
<tr>
<td>11:00 – 11:30</td>
<td>Module 3. Plan reading Skills</td>
</tr>
<tr>
<td>11:30 – 11:45</td>
<td>Module 4. Hydrology and Land Disturbance</td>
</tr>
<tr>
<td>11:45 – 12:45</td>
<td>Lunch</td>
</tr>
<tr>
<td>12:45 – 1:15</td>
<td>Module 4. Continued</td>
</tr>
<tr>
<td>1:15 – 2:00</td>
<td>Module 5. Water and Slopes</td>
</tr>
<tr>
<td>2:00 – 2:15</td>
<td>Break</td>
</tr>
<tr>
<td>2:15 – 3:00</td>
<td>Module 6. Water and Our ESC and Stormwater BMPs</td>
</tr>
<tr>
<td>3:00 – 3:30</td>
<td>Module 7. Inspection issues</td>
</tr>
</tbody>
</table>

### Course Objectives

1. Learn why it is important to know about hydrology
2. Learn some of the basic theory/principles of hydrology
3. Learn inspector basics including:
   1. Compliance assistance
   2. Enforcement
4. Have fun and learn something
Famous Stormwater Quote

HELP, HELP, I’M DROWNING

(Anonymous)

Flooding is a major issue in our country
Our Concern!

In the beginning

Land Disturbance & Construction

Our Concern!

Land Disturbance & Construction

Altering the drainage patterns on a construction site
Our Concern!

Post Construction Stormwater Management

This Course:

Where the water goes (Hydrology for Inspectors)

- What is Hydrology?

- Hydrology is the properties of the earth's water, especially its movement in relation to land.

For us:

- Movement of water in relation to a construction site and a constructed site.
Our Three Legged Stool of Hydrology

- Controlling flow
  - Various ESC measures (during construction)
  - Various Stormwater BMPs (post construction)
- Preventing erosion (pick up of pollutants)
  - Ground cover
  - Slowdown the water
  - Slowdown discharge
- Cleanup dirty water
  - Various ESC measures (during construction)
  - Various Stormwater BMPs (post construction)
An Inspector’s Job

The inspector’s job is two-fold:

1. Ensure the plan is implemented as approved
   a) All controls installed (ESC and SWM)
   b) Per the details and specifications
2. Identify when the plan needs to be changed
   a) Constructability issues
   b) Plan is inadequate

Module 1b

The Hydrologic Cycle
Hydrologic Cycle
Precipitation
- Interception
- Overland flow
- Infiltrated
  - Interflow
  - Groundwater flow

Evaporation
Transpiration
Condensation
Precipitation

Precipitation
- Interception
- Overland flow
- Infiltrated
  - Interflow
  - Groundwater flow

Rain
Snow
Hail
Fog
Dew
**Hydrology, ESC and SW**

- **Precipitation:** Amount, duration, intensity
- **Interception:** Stabilization, Groundcover, MS-1, MS-3, MS-5
- **Overland flow:** Ground cover, imperviousness, ESC, SWM
- **Interflow:** Infiltration, SWM, stream base flow, springs
- **Groundwater flow:** Groundwater recharge

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**Precipitation Measurement**

<table>
<thead>
<tr>
<th>What?</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount</td>
<td>Inches or mm</td>
</tr>
<tr>
<td>Duration</td>
<td>Hours</td>
</tr>
<tr>
<td>Intensity</td>
<td>Inches/hour</td>
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</tbody>
</table>

**What is it?**

- Rain
- Snow
- Hail
- Fog
- Dew

Note: CGP Part II, F.3a(1) and F.4a require that projects that are conducting SWPPP inspections record rainfall data!
Precipitation Measurement

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What is it?

http://hdsc.nws.noaa.gov/hdsc/pfds/

http://hdsc.nws.noaa.gov/hdsc/pfds/

My home in York County
Why is it important?

Rainfall Intensity

1" - 24 hrs.

1" - ½ hr.

Runoff

Infiltration

As small as 1/100"

As slow as 0.05 mph

As fast as 20 mph

Up to 1/3"
When does it occur?

Winter

Thunderstorms (summer/spring)

24-hour storms in Virginia (DEQ offices)

<table>
<thead>
<tr>
<th>Duration</th>
<th>Average recurrence interval (years)</th>
<th>PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Abingdon</td>
<td>24 hr</td>
<td>2.16 (0.2-2.2)</td>
</tr>
<tr>
<td>Roanoke</td>
<td>24 hr</td>
<td>2.05 (0.1-2.1)</td>
</tr>
<tr>
<td>H'burg</td>
<td>24 hr</td>
<td>2.05 (0.1-2.1)</td>
</tr>
<tr>
<td>Woodbr.</td>
<td>24 hr</td>
<td>2.05 (0.1-2.1)</td>
</tr>
<tr>
<td>Insbrook</td>
<td>24 hr</td>
<td>2.05 (0.1-2.1)</td>
</tr>
<tr>
<td>CO</td>
<td>24 hr</td>
<td>2.05 (0.1-2.1)</td>
</tr>
<tr>
<td>VAB</td>
<td>24 hr</td>
<td>2.05 (0.1-2.1)</td>
</tr>
<tr>
<td>Tapp.</td>
<td>24 hr</td>
<td>2.05 (0.1-2.1)</td>
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Crozet, VA
What are design storms?

No!
All our stormwater structures (outlets) are designed to handle certain design storm:

- 2 year
- 10 year
- 100 year

Make sure they are installed according to plan!

What are design storms?

In Stormwater:
- **Bioretention**
  - Overflow ➔ associated with 2 and 10 year design storm
- **Constructed Wetland**
  - Overflow ➔ safely pass the 10 and 100 year storm
- **Dry swale**
  - Convey flow at non-erosive velocity of a 2-year storm event and contain a 10-year storm event within its banks
- **Grass Channel**
  - Convey flow at non-erosive velocity of a 2-year storm event and contain a 10-year storm event within its banks
Precipitation

Measurement

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<td>Inches/hour</td>
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Why?

ESC:

• Inspect every two weeks or within 48 hours of a runoff producing rainfall event

Cover the soil!

Construction Sequence
## Precipitation

### Measurement

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### Why?

SWM: Runoff and Infiltration

- Percolation = Soil permeability
- Infiltration

## Why is it important?

1" - 2 hrs.

- Dry soil
- Infiltration & Percolation (a.k.a. Conductivity)

1" - 2 hrs.

- Moist soil
- Runoff
- Infiltration & Percolation (a.k.a. Conductivity)
Saturated Hydraulic Conductivity

\[ Q = KA \left( h_1 - h_2 \right)/L \]

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Interception

3 Types of Interception

1. **Interception loss** ➔ retained in the vegetation as surface storage and sometimes evaporated.
2. **Throughfall** ➔ drips off leaves and other plant parts
3. **Stem flow** ➔ Runs down leaves to branches to stems and trunks to the surface

In forested areas 35 to 40% of the rain may be intercepted.
In natural grass areas up to 60% of the rain may be intercepted.
In corn and soybeans up to 15% of the rain is intercepted.
Lawn ??
EFFECTIVENESS OF VARIOUS GROUND COVERS IN PREVENTING SOIL EROSION
(this table compares fully established stands of groundcover with bare soil)

<table>
<thead>
<tr>
<th>Type of Ground Cover</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent grass</td>
<td>99</td>
</tr>
<tr>
<td>Perennial ryegrass</td>
<td>95</td>
</tr>
<tr>
<td>Annual ryegrass</td>
<td>90</td>
</tr>
<tr>
<td>Small grains</td>
<td>95</td>
</tr>
<tr>
<td>Millet</td>
<td>95</td>
</tr>
<tr>
<td>Field bromegrass</td>
<td>97</td>
</tr>
<tr>
<td>Grass sod</td>
<td>99</td>
</tr>
<tr>
<td>Hay or straw (@2 tons/acre)</td>
<td>98</td>
</tr>
</tbody>
</table>

Hydrology, ESC and SW

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- Groundwater flow: Groundwater recharge
Overland Flow

- Sheet flow
- Channelized flow
  (Later sections)

Pre- and Post-Development
Figure 18-3  Drainage net of Rock Creek upstream of the District of Columbia–Maryland line in 1913, before modern urbanization and again in 1964. (From U.S. Geological Survey in Dept. Interior 1964.)

Why is that important?
Hydrology, ESC and SW

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**Interflow**

**Important for:**
- Groundwater needed to grow trees and other plants
- Springs
- Base flow or a steady water level in small streams
- Recharge of shallow groundwater wells
Base flow of a stream

Hydrology, ESC and SW

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Groundwater flow

Why it matters
What does it all mean?

Bringing it all back to our past classes.

Land Development

Construction

Road building

Other linear projects
Land Development

- Changes rainfall runoff relationship

Stream Flow Changes as Potential Result of the Changes in Rainfall/Runoff Relationships
Questions?