| **Module Title:** | | |
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| Overall objective/point: Watershed structural controls on Baseflow vs. Storm Flow | | |
| **Section** | **Outline** | **Learning Objectives** |
| Introduction | 1. Module Overview<br>a. Summary<br>b. Overall Learning Objectives | |
| Section 1: Baseflow separation | 1. Components of streamflow during a rain event.<br>a. Defining channel interception, overland flow, subsurface flow, baseflow<br>b. Why we can lump the first three into storm flow<br>2. Storm Flow through a hillslope (introduce influence of soil depth or depth to an impeding layer, and partitioning to storage and deeper groundwater).<br>3. The arbitrary nature of baseflow separation but why it's still useful<br>4. Methods of baseflow separation<br>5. Main controls on the degree of baseflow vs. stormflow, reiterate depth to impeding layer, and it's a combo of all these things (i.e. low slope but flashy system). | 1. At the end of this section, the following is expected: Given example hydrographs, the student will be able to distinguish baseflow and stormflow in each. Level 2: Understanding<br>2. Given example separated hydrographs, the student will be able to identify watershed properties that contribute to differences between them. Level 2: Understanding<br>3. Given a description of a landscape, students can describe the type of hydrograph you might expect to see. Level 2: Understanding |
| **Problem** | | |
| Apply knowledge of controls on partitioning between baseflow and stormflow to understand how MTM disturbance has affected storm event hydrographs | | |

**Summary:**
Streamflow can come from a range of water sources. When it is not raining, streams are fed by the slow drainage of groundwater. When a rainstorm occurs, streamflow increases and water can enter the stream more quickly. The rate at which water reaches the stream and the partitioning between groundwater and faster flow pathways is variable across watersheds. It is important to understand how water is partitioned and what controls this partitioning in order to

better predict susceptibility to flooding and if and how groundwater can sustain streamflow in long periods of drought. 1
In this module we will introduce the components of streamflow during a rain event, and how event water moves through a hillslope to reach a stream. We will discuss methods for partitioning a hydrograph between baseflow (groundwater) and storm flow (event water). Finally, we will explore how characteristics of a watershed might lead to more or less water being partitioned into baseflow vs. stormflow. We will test understanding through evaluating data collected from watersheds in West Virginia to determine how mountain top mining, which fundamentally changed the watershed structure, affects baseflow.

Note: While this assessment is written for watersheds in West Virginia, we have designed the course so it is adaptable. Instructors should be able to easily substitute in their own data for the assessment.

**Overall Learning Objectives:**
At the end of this module, students should be able to describe the components of streamflow, the basics of how water moves through a hillslope, and the watershed characteristics that affect partitioning between baseflow and stormflow.

**Assessment:**

1. Initial data exploration
    a. In the geomorphology tab, click on each of the four watersheds in the map on the left to view a 3-D rendering of its topography and read about its characteristics.

*Compare and contrast the watershed structure of the paired watersheds (both large and small). Describe the topography and the slope and soil characteristics.*

    b. Click on the baseflow tab and make sure you have “Flow separation at each site” selected in the choose baseflow data display drop-down menu.

*Describe which line is baseflow and how you would estimate total storm flow for an event.*

    c. Zoom into the storms that occurred between 3 Apr and 19 Apr.

*Compare the overall shape of the hydrographs. Which watersheds have higher peaks? How do the peaks change over successive storms?*

    d. Move your cursor over the hydrographs and look at the values displayed in the top right corner of each graph.

*Determine if the reference or mined watersheds have higher baseflow. Describe how the baseflow changes over time in successive storms.*

2. Synthesis Questions

a. *What do you think is happening in the hillslopes to cause the baseflow to change over time in successive storms?*
b. *Describe how differences in watershed structure might contribute to the differences in baseflow between the mined and unmined watersheds. (Use the findings of Hewlett & Hibbert, section 5 to guide your answer).*
c. Look at the specific conductance tab and look at the mined vs. unmined. *Describe the differences between the two. How do these data support some of your conclusions above?*
d. *What would you expect a hydrograph for a watershed in hawaii (Steep slopes, shallow soils) to look like? Would it have relatively high or low baseflow? What about a watershed in Southern Michigan (low slopes, deep soils)?*

**Rubric:**

| **Criteria** | **Level #1 (Does not meet expectations)** | **Level #2 (Meets expectations)** | **Level #3 (Exceeds Expectations)** |
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| Initial data exploration | | | |
| Short answers to parts a-d | Does not provide answers to all questions | Provides answers to all questions, but only the minimum when asked to describe differences or behavior. | Provides answers to all questions and clear, thorough and thoughtful descriptions. |
| Synthesis Questions | | | |
| a. Successive storm baseflow | Response is incomplete and/or does not provide a reasonable hypothesis of hillslope flow processes | Discusses a hillslope process but does not include how this will change with successive storms | Complete discussion of hillslope processes and baseflow partitioning and how this will change with successive storms |
| b. Watershed structure | Response is incomplete and/or does not provide a reasonable guess of the watershed characteristics affecting partitioning | Discusses only one watershed characteristic that is different between watersheds and how this affects partitioning. | Presentation and discussion of several watershed characteristics that are different between watersheds and how they would affect partitioning |
| c. Specific | Response is | Describes the SC | Describes the SC |

| | | | |
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| Conductance | incomplete and/or does not connect SC data to streamflow data | patterns and relates to baseflow but does not discuss potential mechanisms producing differences in SC. | patterns and relates to baseflow and discusses potential mechanisms producing differences in SC. |
| d. Other locations | Response is incomplete and/or does not demonstrate understanding of how watershed structure influences baseflow partitioning. | Response correctly identifies relative partitioning between baseflow and stormflow in both locations but does not discuss why they drew those conclusions. | Response correctly identifies relative partitioning between baseflow and stormflow in both locations and discusses why the characteristics lead to such partitioning. |