CE 3354 Engineering Hydrology
Exercise Set 7

Exercises

Figure **??** is a Google-Earth image of some watershed. The red boundary defines the watershed; The distance on the image from Rain Gage R-1 to the Rocky Run Branch Gage is 1,500 feet.
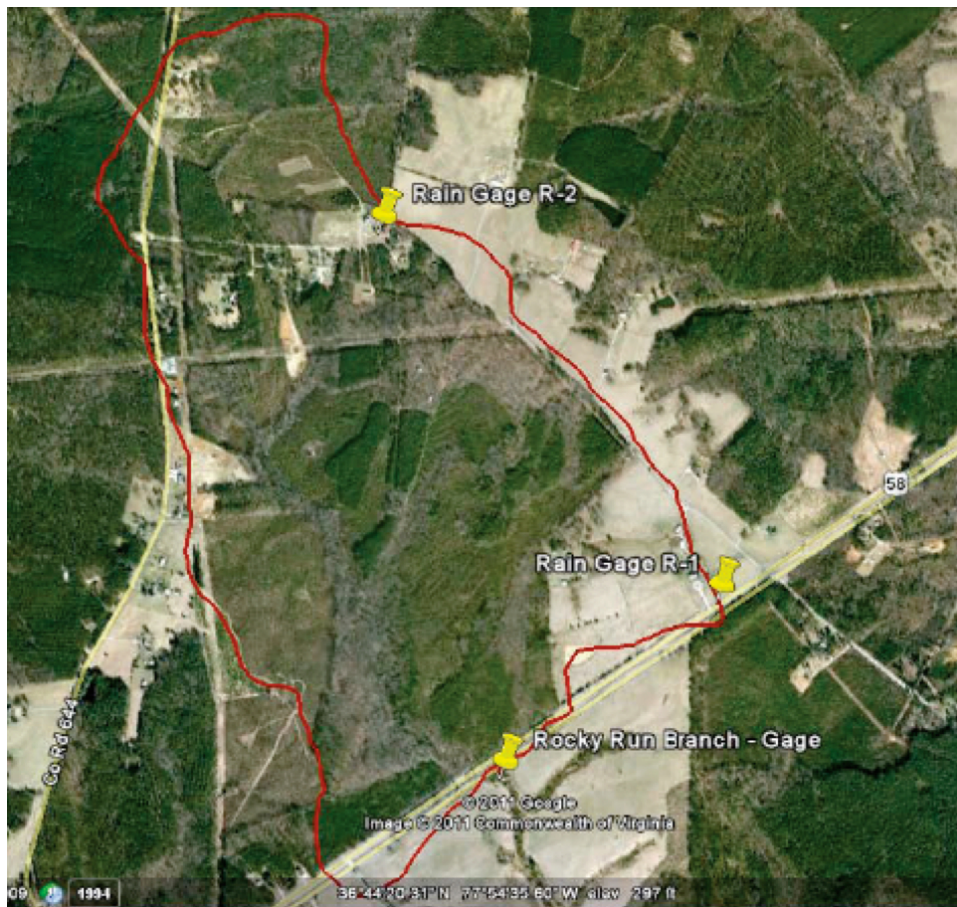

Figure 1: Rocky Run Branch Watershed

1. Estimate the time of concentration using the Kerby-Kirpich method assuming the slope is 0.006 along the main channel (which drains to the outlet). The channel is clearly visible at the gage and running northward to the utility easement about 2/3 up the watershed. Beyond the easement use your judgment as to the channel alignment.

Solution

An annotated Figure **??** is shown below on Figure **??**. The blue line is main channel, it is approximately 4300 feet long using the R1 to Outlet distance as a reference distance. The orange lines are representative overland flow paths. The flow path near R1 to outlet is at least 1500 feet (given), so will use the 1,200 foot maximum length in Kerby-Kirpich method.

The overland slope would be at least equal to channel slope (otherwise incised channel would not form) so use overland slope of 0.006. Quoting from a ChatGPT query:

> In hydrology, when there is evidence of an incised channel, the slopes of overland areas (overland slopes) would generally be larger than the main channel slope.
>
> Here's why:
>
> - Incised channels often indicate that the main channel has cut downward into the landscape, resulting in a deeper and flatter channel profile. The process of incision typically reduces the steepness of the main channel slope compared to surrounding areas.
>
> - Overland slopes are the slopes of the land surface that drain into the channel. These areas tend to be steeper because they represent the natural terrain, which hasn't undergone the same degree of erosion and flattening as the main channel.
>
> - Erosive processes: Overland areas experience more intense surface runoff and erosion, particularly in hilly or mountainous regions, leading to steeper slopes. In contrast, the channel, especially if incised, may have been eroded and widened over time, leading to a reduction in its gradient as it matures.
>
> In summary, with an incised channel, the overland slopes are generally steeper than the main channel slope.

2. Estimate the time of concentration using the NRCS-Upland method assuming the slope is 0.006 along the main channel (which drains to the outlet). The channel is clearly visible at the gage and running northward to the utility easement about 2/3 up the watershed. Beyond the easement use your judgment as to the channel alignment.

3. Research the readings and the internet and select an additional (different) method to estimate the time of concentration – compare the three estimates and select the estimate you would choose and explain why you would make that choice.

4. Assume the utility easment is a barrier to overland flow, and runoff can only cross at a culvert as depicted in Figure **??**. The easement divides the watershed into two smaller

watersheds; the upper watershed whose outlet is the culvert, and the lower watershed with same outlet as before.
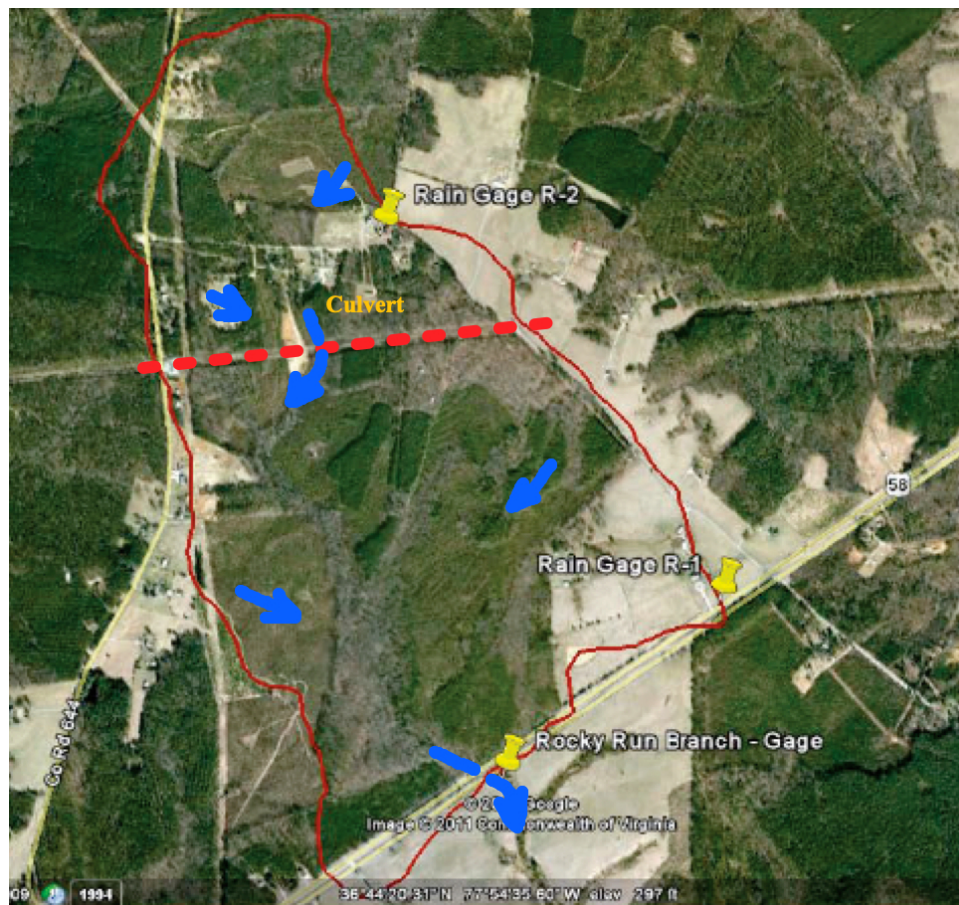

Figure 2: Rocky Run Branch Watershed - Utility Easement as Barrier

Estimate the time of concentration(s) using the three methods in both the upper and lower watershed.[1]

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[1]The SCS Reservoirs in the Hardin Creek project behave similarly in that they divide the watershed into several parts which behave independently with regards to T_C.