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Zombie Shelter Location

Shanna Carroll

Tyler Lindsay

Hannah Rasmussen

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Background

One common use of GIS is determining ideal locations for projects. This is because GIS makes it very easy to combine and analyze spatial data in a customized way.

In this exercise, assume that there has been a recent zombie outbreak in Utah, USA. To determine the ideal hideout location, data that indicates a safe location must be acquired and combined with geography that is conducive to wilderness survival. Once the data is gathered, spatial analysis using GIS overlay tools must be conducted to determine the ideal location for an anti-zombie hideaway hut. In this exercise, multiple tools will be used in ArcGIS Pro to conduct analysis. A resulting map will be generated showing the most suitable sites.

Problem Statement

The zombie apocalypse is upon us, and you must find a hiding spot that will ensure the best chance of survival. The goal of this exercise is to get as far away from civilization as possible in an attempt to decrease your potential interaction with zombies. Garfield County, Utah was chosen as the area of focus as it has the lowest population density in the state (<http://worldpopulationreview.com/states/utah-population/>).

Presume that you have managed to travel to Garfield, and that you are now analyzing the county based on the following factors: proximity to water, distance to roads, distance from populated areas, average temperature, slope, and visibility of surrounding area. Suitable hiding spots can be determined by reclassifying each layer and combining them in the raster calculator.

Spatial Considerations

For the sake of practicality, you will limit the scope of your analysis to Garfield County, Utah in this exercise. The other factors will be limited as follows:

- Proximity to water: You are to find locations that are ideally within 100 meters from a water source
- Proximity to roads: They should be accessible for supply runs, but not so close as to be dangerous to your safety. They should be within 5 - 10 miles from your hiding location.
- Proximity to populated areas
- Average temperature: Suitable average temperatures should range from about 60 - 80 degrees F
- Slope: Flatter areas are more desirable for a hideout
- Viewshed: There should be no buildings, roads, or other infrastructure within view

Data

The following datasets will be needed for this project. You can either download from the suggested sources or create the data you need to complete this exercise.

- <http://gis.utah.gov/data/boundaries/citycountystate/> Utah Counties Shapefile: You can find a shapefile that represents all the counties from Utah (you will select Garfield County from this dataset). For the County Boundaries section, select the “Links/Download” tab. You should download the “County Boundaries: Shapefile,” which will download in a zipped file.
- <http://gis.utah.gov/data/sgid-transportation/roads-system/> UDOT Highways: You can find a shapefile that represents all the major roads and highways in Utah. For the “Highway Linear Referencing System Routes” section select the “Links/Download” tab. You should download the “UDOT LRS Routes: Shapefile.” This will download in a zipped file.
- <http://gis.utah.gov/datademographic/2010-census-data/> Census District Map Shapefile: You can find a shapefile that represents the 2010 Census data for Utah. For the “2010 U.S. Census Bureau Data” section select the “Links/Download” tab. You should download the “Shapefile: Census Blocks.” This will download in a zipped file.
- <http://gis.utah.gov/data/water-data-services/lakes-rivers-dams/> NHD Streams and NHD Lakes shapefiles for every stream and lake in Utah.
- <http://gis.utah.gov/data/elevation-terrain-data/10-30-meter-elevation-models-usgs-ned/> NED 30: You will need to download the 30 meter NED DEM of Garfield County.
- <http://worldclim.org/version2> Download the average temperature file. You will use the January and July data sets.

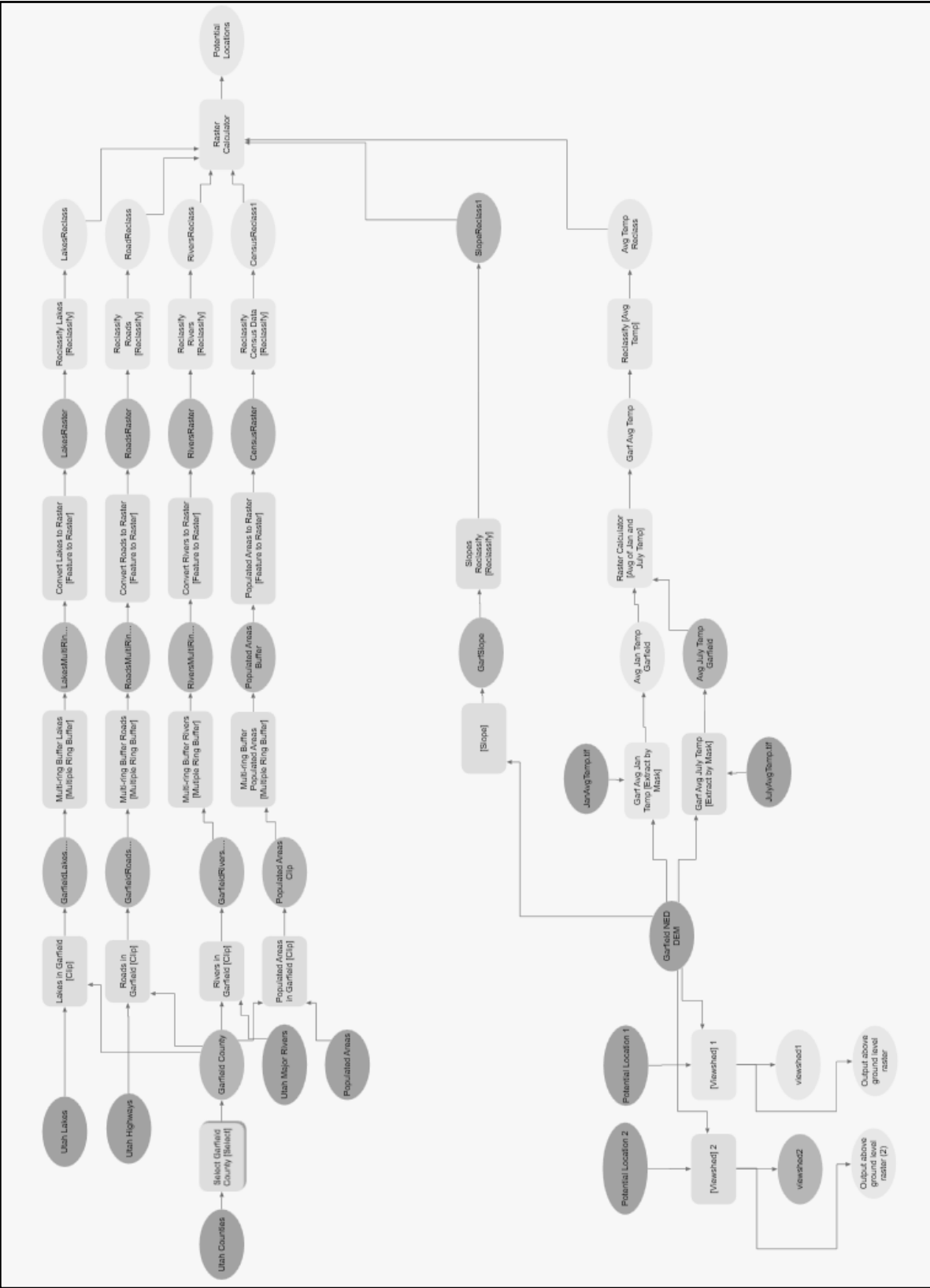
ModelBuilder Tools

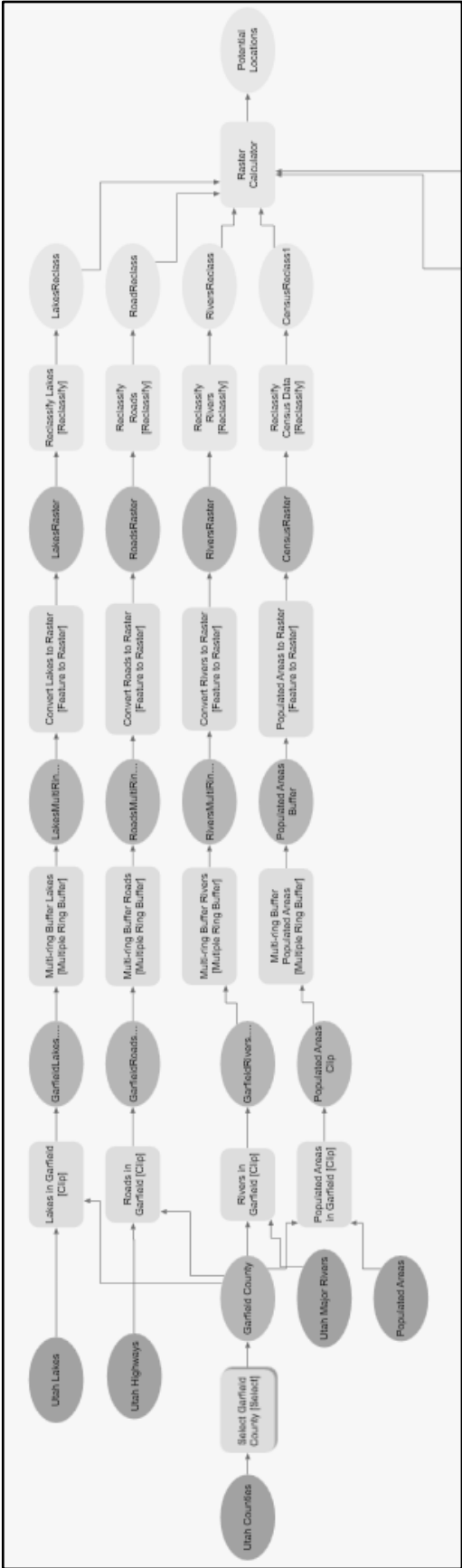
You will be using the ModelBuilder tool to complete this exercise. The following is a list of the necessary tools and their purpose:

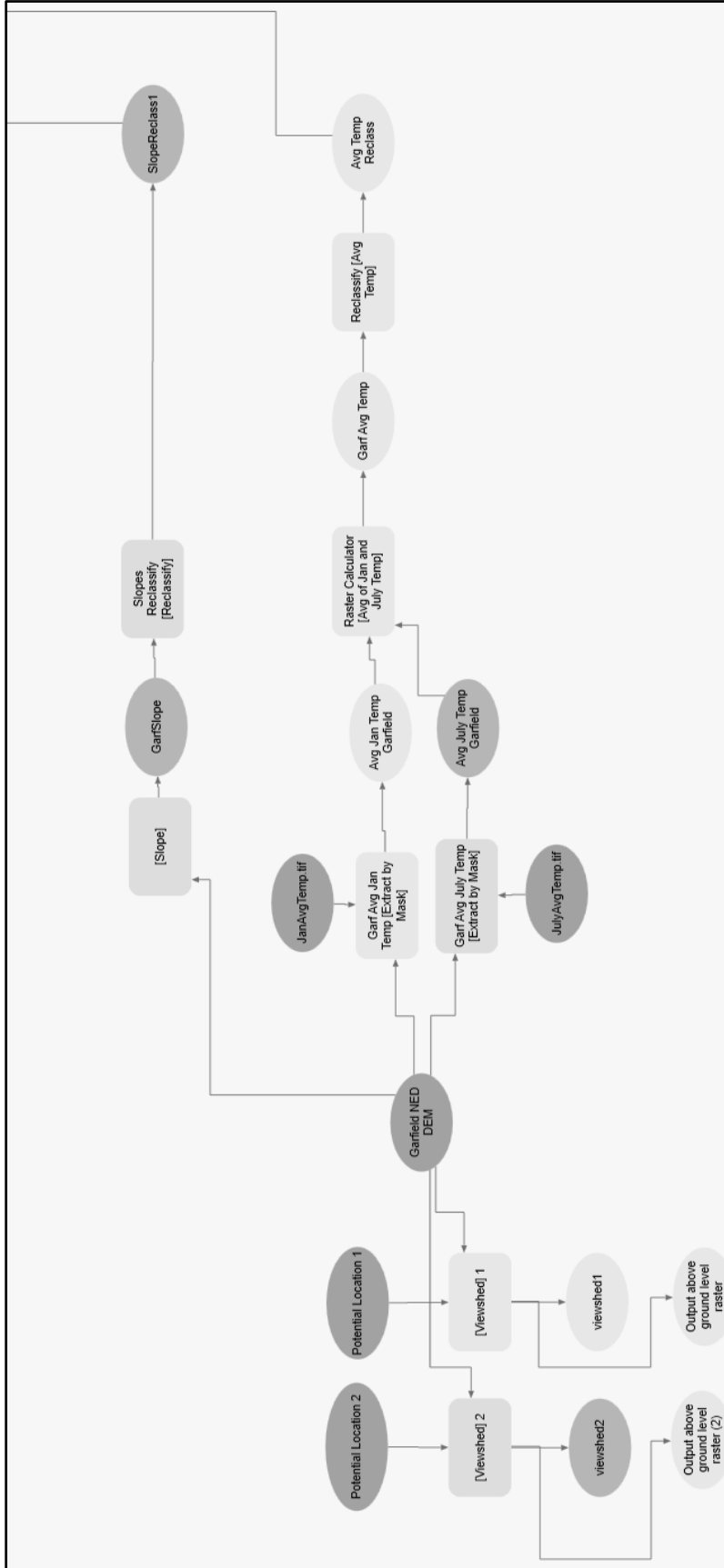
- Select is used to find and select features from your data layers based on attributes from the attribute table. You will first use it to select data necessary for Garfield County.
- Clip is used to cut out a piece of one feature class using one or more of the features in another feature class as a cookie cutter. This is particularly useful for creating a new feature class—also referred to as study area or area of interest.
(<http://pro.arcgis.com/en/pro-app/tool-reference/analysis/clip.htm>)
- Buffer is used to create a polygon ring of a specified distance around the input feature.
- Multiple Ring Buffer creates multiple buffers at specified distances around the input features. These buffers can optionally be merged and dissolved using the buffer distance values to create non-overlapping buffers.

- Feature to Raster turns any feature class (geodatabase, shapefile, or coverage) containing point, line, or polygon features into a raster dataset.
- Reclassify can change the values in a raster. For example, if two ranges are specified, such as reclassifying values 1 to 100 as 100 and values 101 to 200 as 200, an input value less than or equal to 100 will be assigned the value 100 in the output, and an input value that is larger than 100, such as 101, will be assigned to 200.
- Extract by mask is used to extract the cells of a raster that correspond to the areas defined by a mask.
- Slope tool calculates the maximum rate of change between each cell and its neighbors.
- Raster Calculator is used to perform calculations on each cell in a raster. It can also be used to combine multiple rasters.
- Viewshed determines the raster surface locations visible to a set of observer features.

Example Model







Step by Step Solution

For an advanced GIS student, the information up to this point is all you need to complete the assignment and create an output map from the results. Feel free to try conducting the analysis using only the information provided on the previous pages. If you need specific steps, follow the instructions below.

***Note:** Be sure to clearly name each component in your model. Each input, tool, intermediate dataset etc. should have a description that is easily understandable. For example, it is not sufficient to name a tool simply “Select” but should describe what is being selected. “Select Garfield County” would be more appropriate in this case.

Step 1

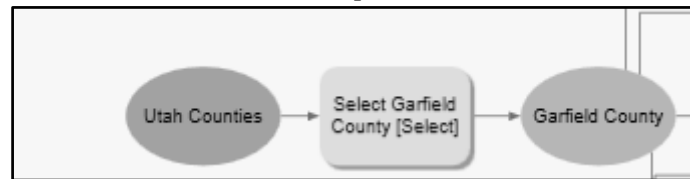


Figure 1 - The Select tool in ModelBuilder.

In your geodatabase in the catalog, create a new toolbox. Right click on this new toolbox and create a new ModelBuilder model. You may want to name it at this point in so you can find it easily later. Within the open model, drag in the data for the Utah Counties. Next, search for the “Select” tool and then drag this in also. Select the Counties shapefile as the input features. The output should be saved in the geodatabase and should be named something descriptive such as “Garfield_County”. Be sure to set **NAME = ‘GARFIELD’** as shown in the figure below.

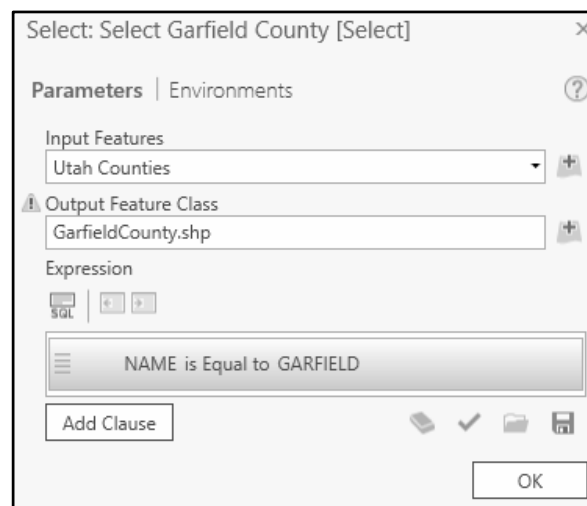


Figure 2 - The Select tool parameters in ModelBuilder.

Step 2

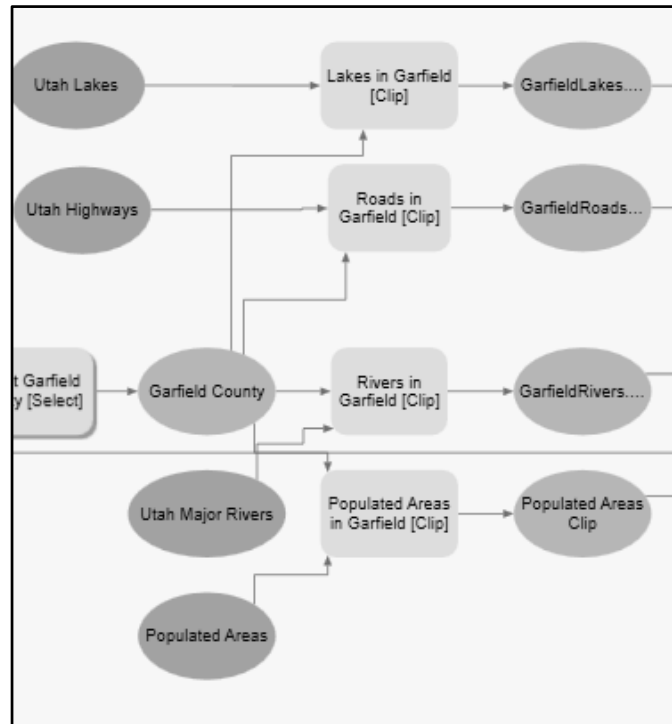


Figure 3 - The Clip tool in ModelBuilder.

Next, you will use the “Clip” tool to create layers containing only data for Garfield County instead of for the entire state. You will do this for rivers, populated areas, highways, and lakes. First, drag in the data for Utah Major Rivers. Using the clip tool, set the Utah Major Rivers as your input, and clip it with the Garfield County output that you obtained in step 1. Repeat this for the datasets Utah lakes, Utah highways, and populated areas. You should end up with four individual datasets that contain only information for Garfield County.

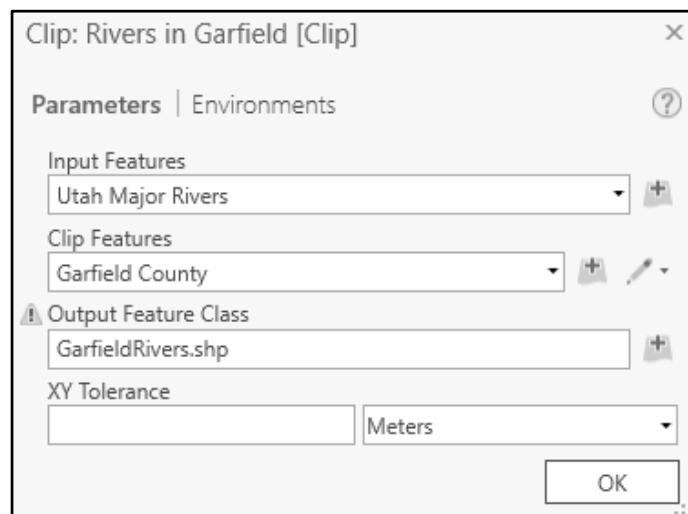


Figure 4 - The Clip tool parameters in ModelBuilder.

Step 3

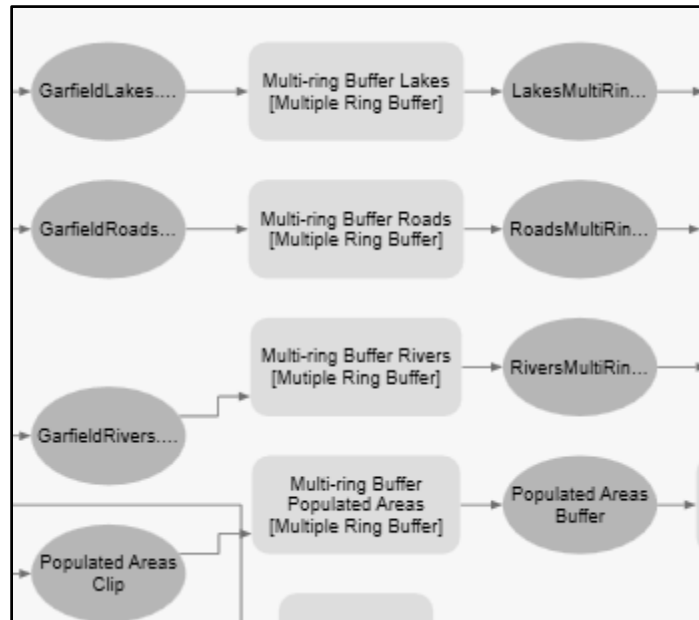


Figure 5 - The Multi-ring Buffer tool in ModelBuilder.

Now you will use the “Multiple-ring Buffer” tool to choose different regions around each feature of interest. Use each data output from the clip tool as your input feature. The units will be in meters and the dissolve option should be set to non-overlapping (rings).

Figure 6 - The Multi-ring Buffer tool parameters in ModelBuilder.

Step 4

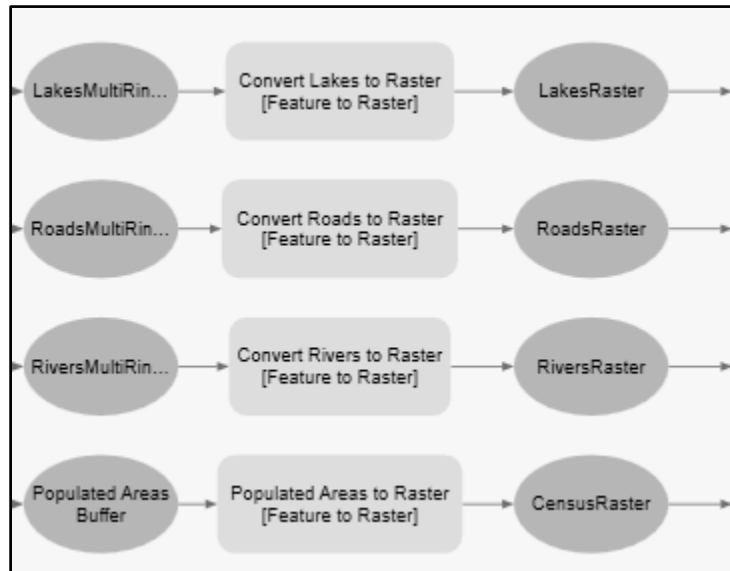


Figure 7 - The Feature to Raster tool in ModelBuilder.

The next tool you will use is the “Feature to Raster” tool. This step is important because it will allow us to enter each feature into the raster calculator later on. You will have to convert four separate features. Your input will be the four multi-ring buffer outputs obtained for lakes, roads, rivers, and population. The output cell size should be 30 meters.

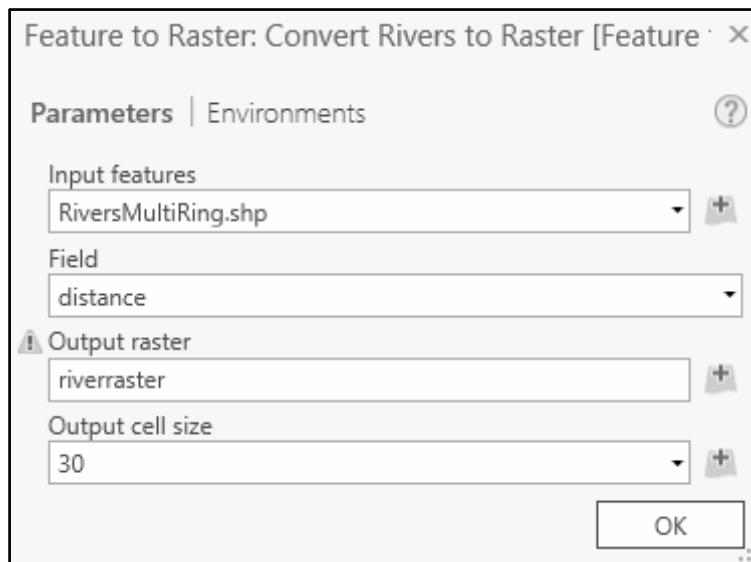


Figure 8 - The Feature to Raster tool parameters in ModelBuilder.

Step 5

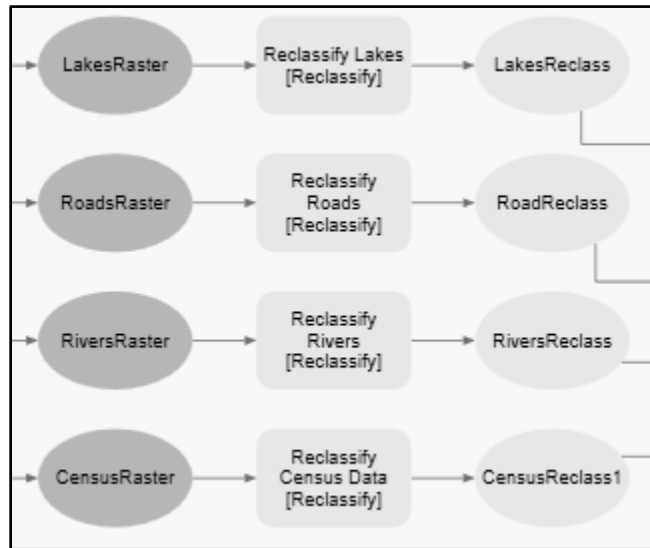


Figure 9 - The Reclassify tool in ModelBuilder.

After all four datasets have been converted to rasters, you will use the “Reclassify” tool to assign a weighted value to each distance. Use “VALUE” for the Reclass Field. Higher values indicate desirable locations, and lower are less desirable. The four reclassified outputs make up four of the six inputs for the final calculation done in the raster calculator. See the figures below for the reclassification values of each feature.

Reverse New Values		
Start	End	New
0	100	5
100	500	3
500	1000	1
NODATA	NODATA	NODATA




Unique Classify   

Figure 10 - The Reclassify tool parameters for Lakes in ModelBuilder.

Reverse New Values		
Start	End	New
0	1	0
1	5	2
5	10	3
10	15	2
15	20	0
NODATA	NODATA	NODATA




Unique Classify   

Figure 11 - The Reclassify tool parameters for Roads in ModelBuilder.

Reverse New Values		
Start	End	New
0	100	5
100	500	3
500	1000	1
NODATA	NODATA	NODATA

Unique Classify

Figure 12 - The Reclassify tool parameters for Rivers in ModelBuilder.

Reverse New Values		
Start	End	New
0	5	0
5	10	1
10	20	3
NODATA	NODATA	NODATA

Unique Classify

Figure 13 - The Reclassify tool parameters for Census Data in ModelBuilder.

Step 6

The last two variables needed for the final raster calculation are average temperature and slope in Garfield County. To find the average temperature, first add the Garfield DEM and temperature data for January and July to your model. Using the “Extract by Mask” tool, create rasters of the average January and July temperatures of only Garfield County.

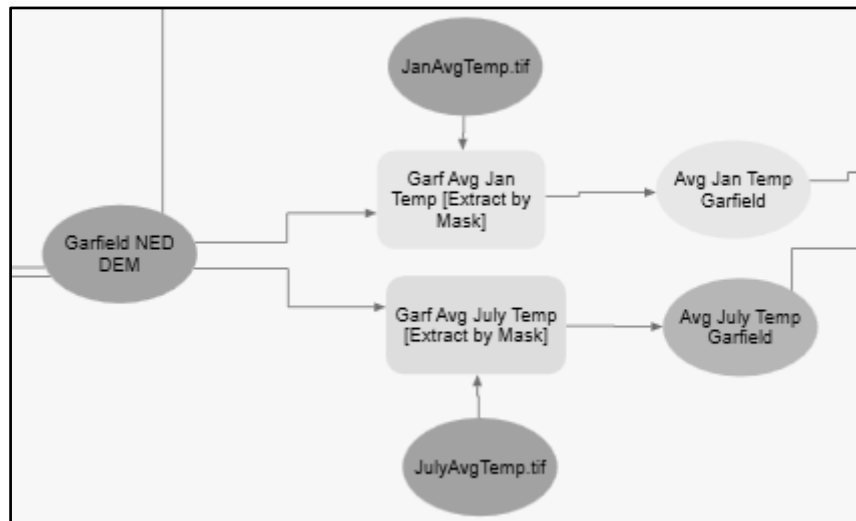


Figure 14 - The Extract by Mask tool in ModelBuilder.

Step 7

Using the “Raster Calculator” find the average of the July and January temperatures for Garfield County. Reclassify the average Garfield County so that values between 60 - 80 degrees F have a value of 2, and all other temperatures falling outside that range have a value of 1.

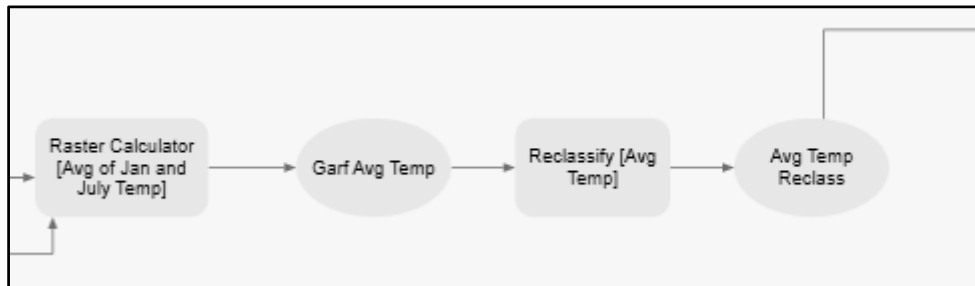


Figure 15 - The Raster Calculator and Reclassify tools in ModelBuilder.

Step 8

The last variable, slope, can be taken directly from the Garfield DEM using the “Slope” tool. It is desirable to have a relatively flat slope, so reclassify the resulting output according to the values below:

Table 1 - Reclassification values for Slope.

Slope	Reclassified Value
0-10	5
10-15	4
15-20	3
20-30	2
30-90	1

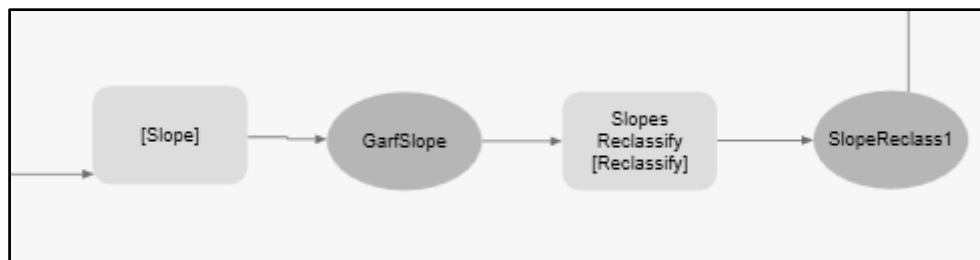


Figure 16 - The Slope and Reclassify tools in ModelBuilder.

Step 9

The final suitable locations will be a combination of the lakes, roads, rivers, census, slope, and temperature rasters. Use the raster calculator to multiply each raster together. The map algebra will look like **lakes*roads*rivers*census*slope*temperature** and will give you your final output raster. The cells with the highest values will be the most desirable locations to build a zombie shelter.

Step 10

As a final safety check, create point shapefiles in the proper projection in areas with the highest values, then use the viewshed tool to check any final locations you are considering. The output will be the range of sight for the input location. Be sure to compare this range to nearby features to ensure there is no possibility of being seen by outsiders. Be aware that the “Output above ground level” rasters are extraneous and not necessary for the purposes of this project. You only need to check the viewshed output.

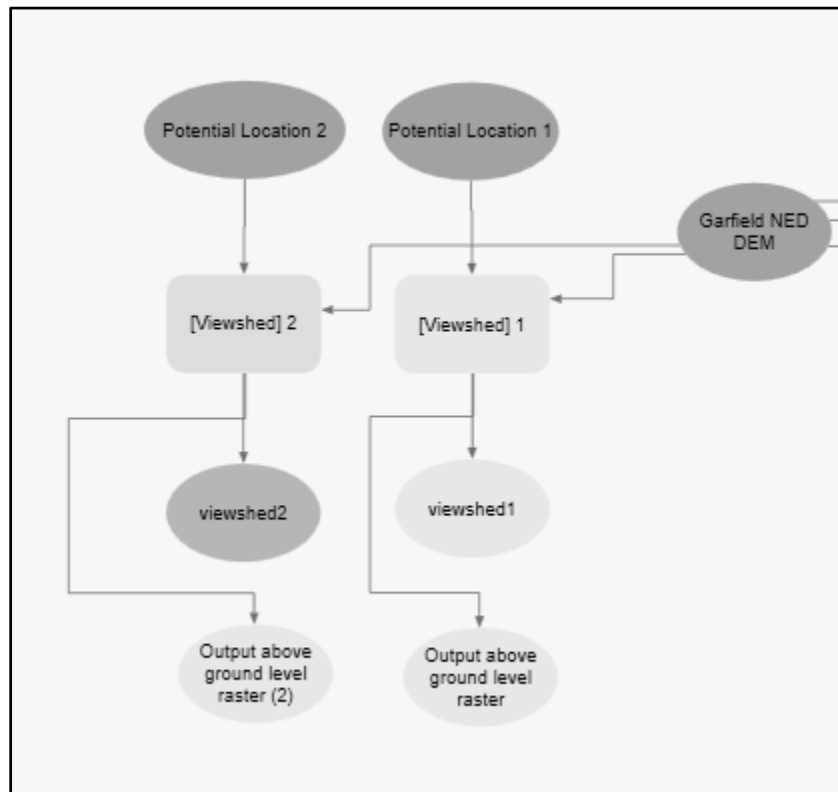


Figure 17 - The Viewshed tool in ModelBuilder.

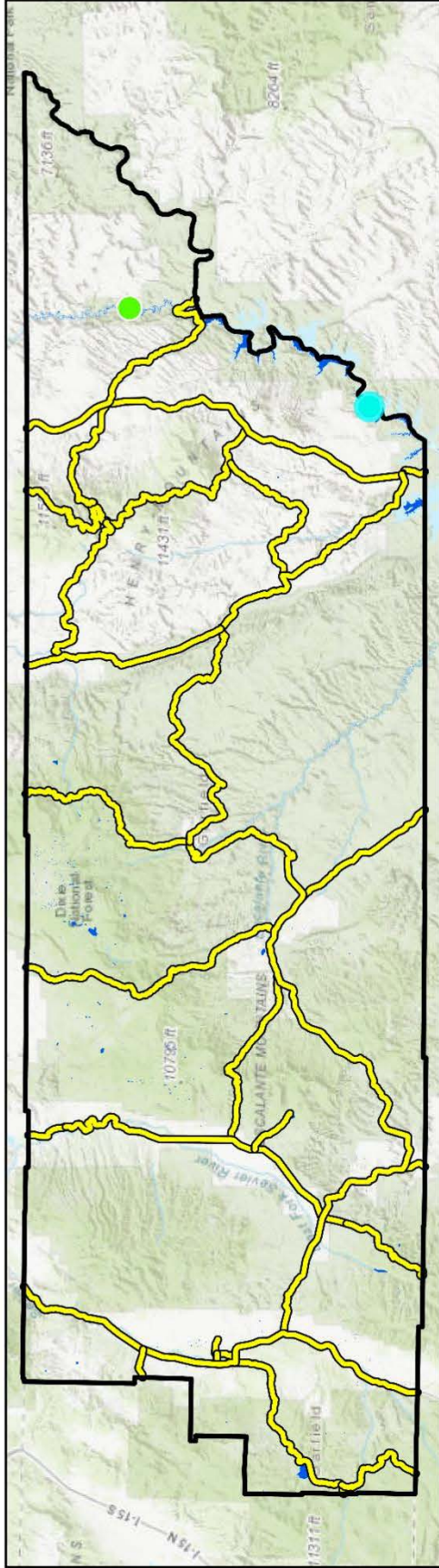
Deliverables

Prepare a report that includes both your final ModelBuilder model and a professional map layout showing possible locations for a zombie shelter in Garfield County. Your map should have frames that show where the locations are in context to the county and a close-up view of the sites. The picture of the model in the report should be legible with a font size of at least 10 pt, and may be broken into segments for increased readability. In your report describe the project requirements, your methods, and explain the reasoning behind your final site selection.

References

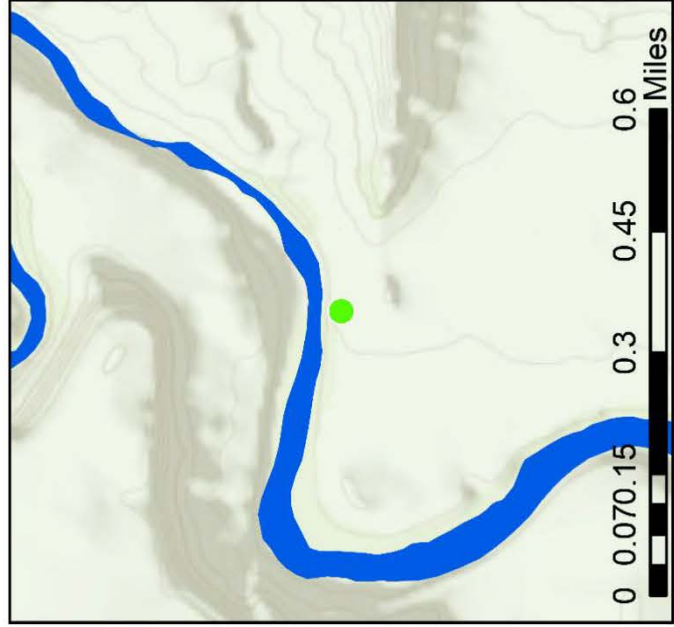
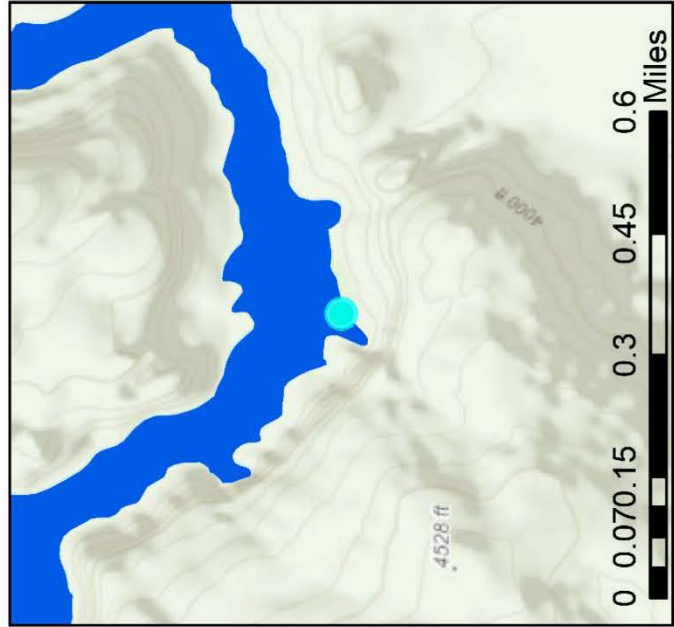
<http://pro.arcgis.com/en/pro-app/tool-reference/>

Zombie Shelter Location



Zombie Outbreak Map
 Date: 12/13/17
 Projection: NAD 1983 UTM
 Zone 12N
 Author: Team Recall

- Potential Location 1
- Potential Location 2
- Garfield County
- Major Roads
- Bodies of Water



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community