



# Exercise 3: Surface Analysis

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## Introduction

We will wrap up our use of the Spatial Analyst extension by learning how to create and apply a Hillshade to layers in a map. Then, we will perform a Viewshed analysis in order to determine the visibility of a proposed communications tower.

## Objectives

Upon completion of this exercise, you will be familiar with:

- Creating a Hillshade
- Viewshed Analysis

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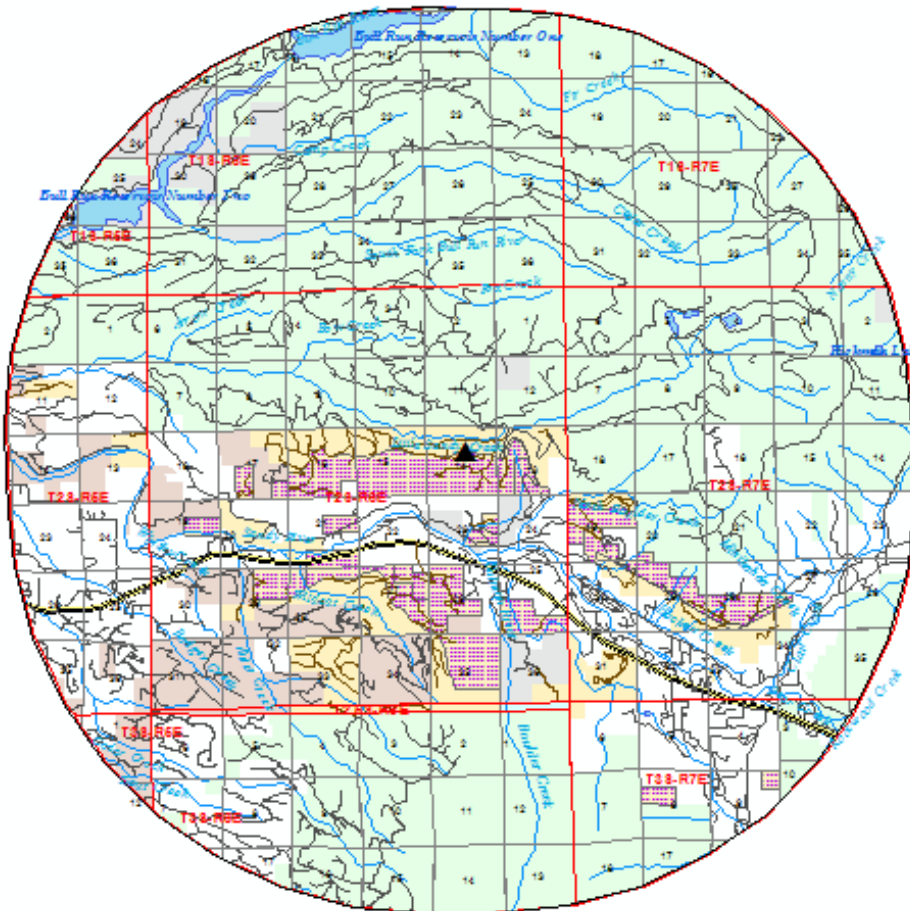


## Part 1: Prepare the Analysis Environment

We will wrap up our use of the Spatial Analyst extension by learning how to create and apply a hillshade to layers in a map. Then, we will perform a Viewshed analysis in order to determine the visibility of a proposed communications tower.

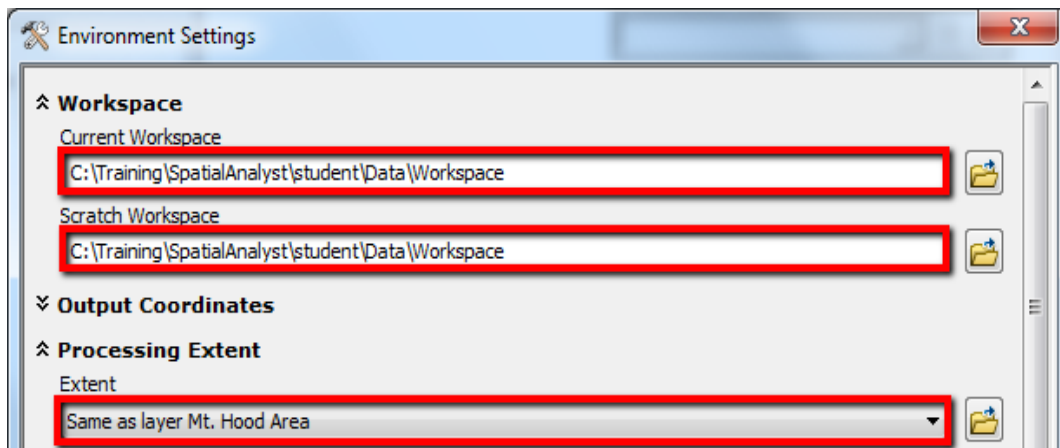
### A. Open the Visibility.mxd in ArcMap.

1. Open ArcMap with the existing map document: **Visibility.mxd** located in the ...\\Data folder. *The map location is southwest of Mount Hood, as Highway 26 follows the Sandy River.*
2. If needed, turn on the **Spatial Analyst** extension.



## B. Set up the Spatial Analysis geoprocessing environment.

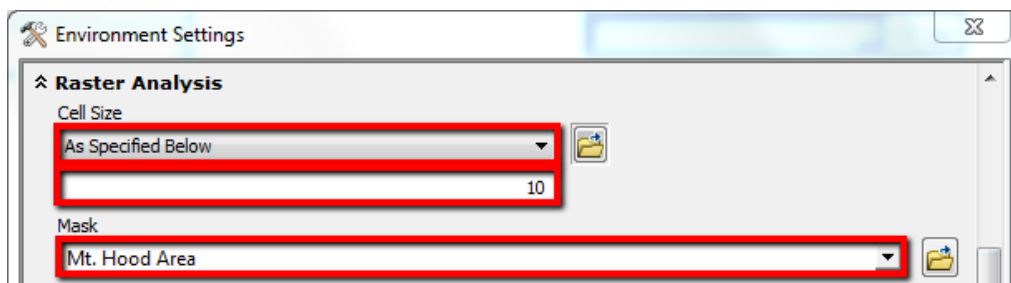
1. From the Geoprocessing menu, choose Environments.
2. Use the following outline to set the analysis environment:
  - i. Change both *Current Workspace* and *Scratch Workspace* to **...Data\Workspace**.
  - ii. *Processing Extent*: Same as layer Mt. Hood Area



iii. Scroll down... Under *Raster Analysis* update:

(a) *Cell Size*: As Specified Below, 10

(b) *Mask*: Mt. Hood Area



3. Click **OK**.

4. **Save** the map document.

## Part 2: Create a Hillshade

Using a hillshade for your map gives the illusion of surface relief. A hillshade can aid you in surface interpretation—giving you a visual sense of hill slope locations.

If you have elevation data, you can create a hillshade layer with the Spatial Analyst extension.

### A. Add Elevation Data to the Map.

1. Click the **Add Data** button, add ...\\Data\\sr\_dem10.

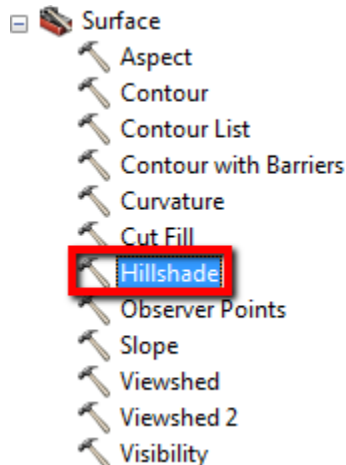
The sr\_dem10 was created by merging two DEMs that each covered a part of this area. DEMs can be merged using the Merge and Filter DEMS tool on the Production Contouring toolbar if you have the Production Mapping Extension turned on.

2. Rename the sr\_dem10 layer **Sandy River Elevation**.

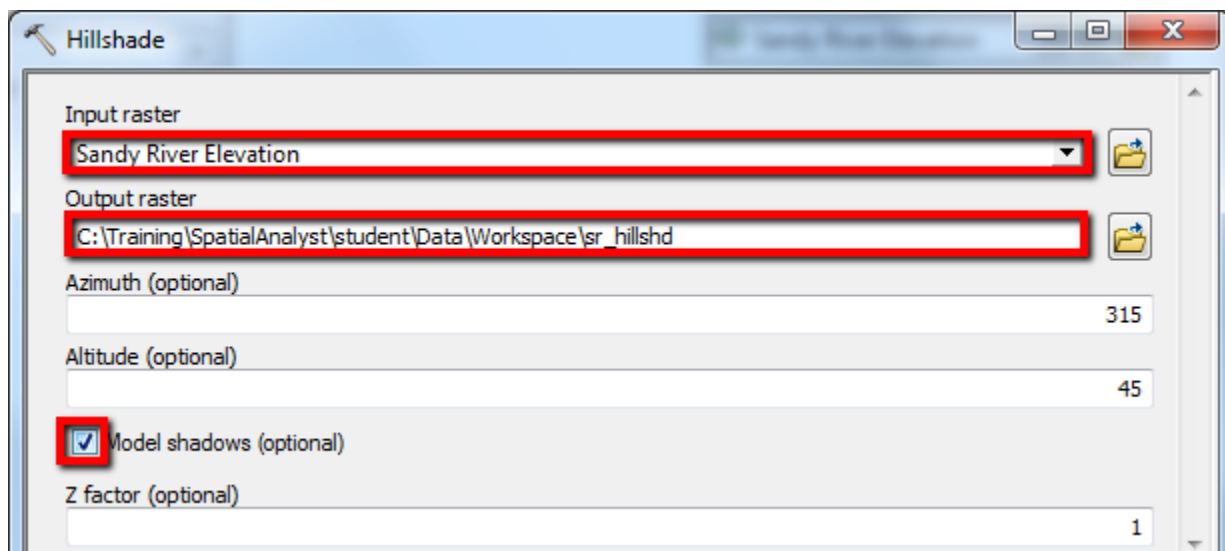


## B. Create a Hillshade of the Sandy River Elevation layer.

1. From *ArcToolbox*, navigate to the **Spatial Analyst | Surface | Hillshade** tool.



2. Set the Input raster to the **Sandy River Elevation** layer.
3. Set the Output raster to **sr\_hillshd**.
4. Use the default values for the **Azimuth**, **Altitude**, and **Z factor** fields.
5. Add a checkmark to “**Model shadows**.”



A hillshade is created by defining an imaginary source of illumination (e.g., the Sun). With the Hillshade tool, you define the light source's angle (azimuth) and altitude. By default, azimuth is in the northwest (315°), with an altitude of 45° (halfway between the horizon and the zenith).

For the hillshade we are about to create, we are using the default settings.

6. Click **OK**.

7. Turn off all layers with the exception of **Sandy River Elevation** and **sr\_hillshd**.

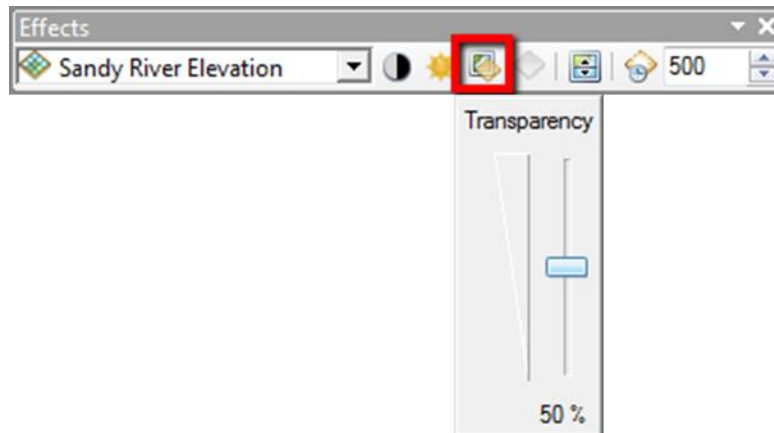


Based on the angle of illumination, you can see which slopes are illuminated and which are not. The change in grayscale creates the illusion of surface relief.

The brightness of the hillshade layer can be visually combined with a raster layer to create a 2.5-D map. Let's combine the brightness of the hillshade layer to the Sandy River Elevation layer.

### C. Use the Effects toolbar to adjust the transparency of Sandy River Elevation.

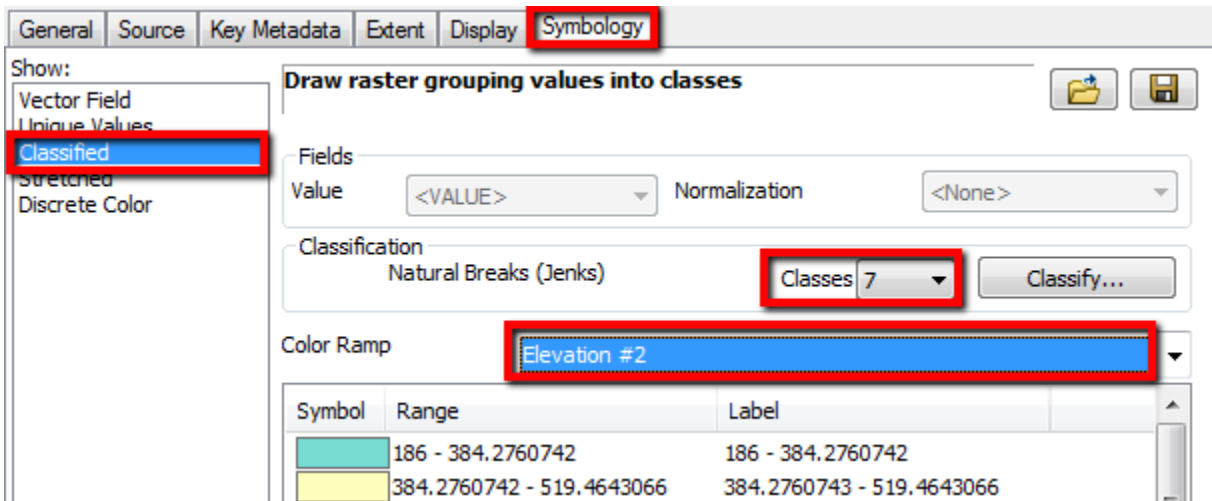
1. Move the **sr\_hillshd** layer to the bottom of the Table of Contents. (The hillshade layer needs to be below the Sandy River DEM.)
2. Turn on the **Effects** toolbar and select **Sandy River Elevation** from the dropdown.
3. Adjust the transparency to **50%**.



The DEM now has a slightly more realistic appearance. Let's see what happens if we add a little color.

#### D. Symbolize the Sandy River Elevation layer.

1. Open the Properties of the Sandy River Elevation layer.
2. Under the **Symbology** tab, change the **Show** option to **Classified**.
3. Select **Yes**, to compute a histogram.
4. Change the *number of classes* to **7**.
5. From the **Color Ramp** drop-down list, choose **Elevation #2**.
  - i. (Hint: If needed the Color Ramp can be switched to text descriptions by right clicking the ramp itself and disabling Graphic View).



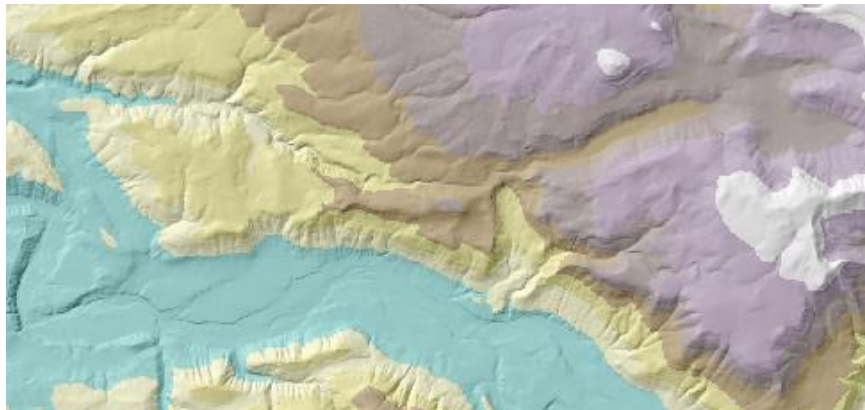
6. Click **OK**.
7. Check that the following layers are ON:
  - Proposed Tower
  - Mt. Hood Corridor SRMA
  - Roads



- Ownership
  - sr\_hillshd
8. Close the **Effects** toolbar.
  9. **Save** the map document.

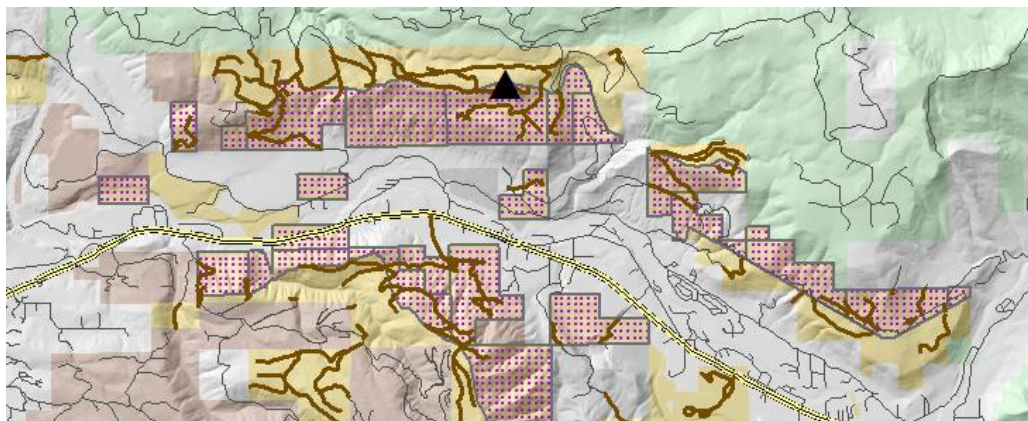
## Part 3: Viewshed Analysis

A company called American Tower is proposing to build a 58 meter (190 ft.) cellular tower on BLM-managed land. Based on current environmental protection plans, if an edifice is built on publicly owned land, and is within an area designated as a visual corridor (VRM Class 1), the edifice must be invisible from public highways.



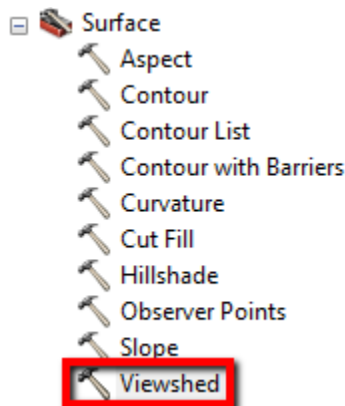
Looking at the map, you can see that the proposed tower (▲) is located on BLM-managed land and within an area designated as a visual corridor (the purple stippling). You can also see that Highway 26 runs just south of the proposed site. Therefore, there is the possibility that the proposed tower could be visible from a public highway.

Based on the information provided in the layers, we can use the Spatial Analyst extension to perform a Viewshed analysis, and see what areas are visible by the proposed tower.



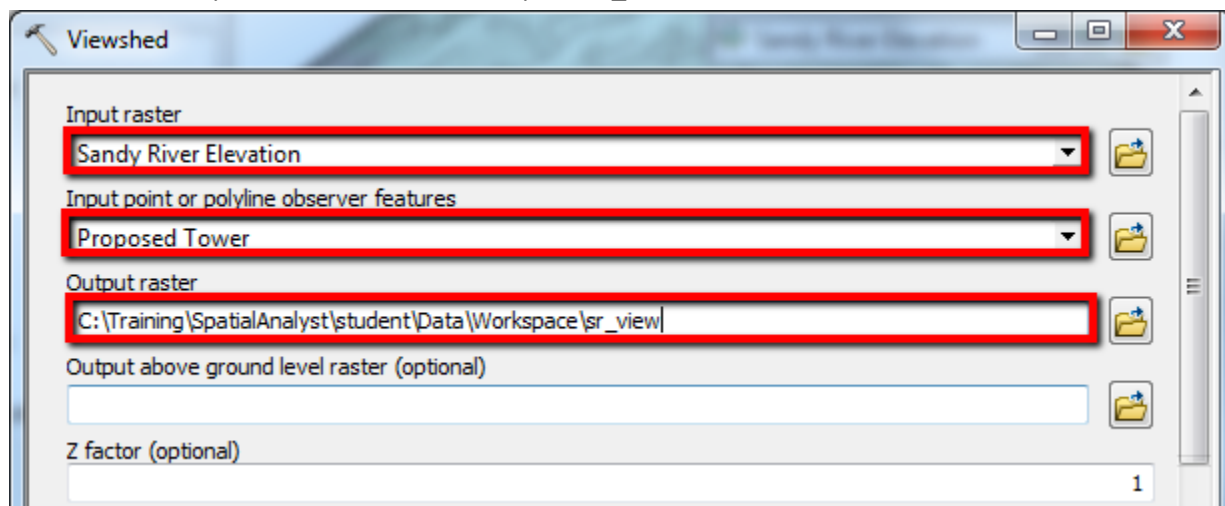
### A. Perform Viewshed Analysis.

1. From *ArcToolbox*, launch the Viewshed tool. (Hint: Spatial Analyst Tools | Surface | Viewshed)



2. In the *Viewshed* window, set the following parameters:

- *Input raster*: Sandy River Elevation
- Input point (observer): **Proposed Tower**
- *Output raster*: ...\\Data\\Workspace\\sr\_view



3. Ensure your parameters match the screen capture on the next page.

### Optional Viewshed settings:

**Z factor** - The z-factor adjusts the units of measure for the z units when they are different from the x, y units of the input surface. The z-values of the input surface are multiplied by the z-factor when calculating the final output surface. For example, if your z units are feet and your x, y units are meters; you would use a z-factor of 0.3048 to convert your z units from feet to meters (1 foot = 0.3048 meter).

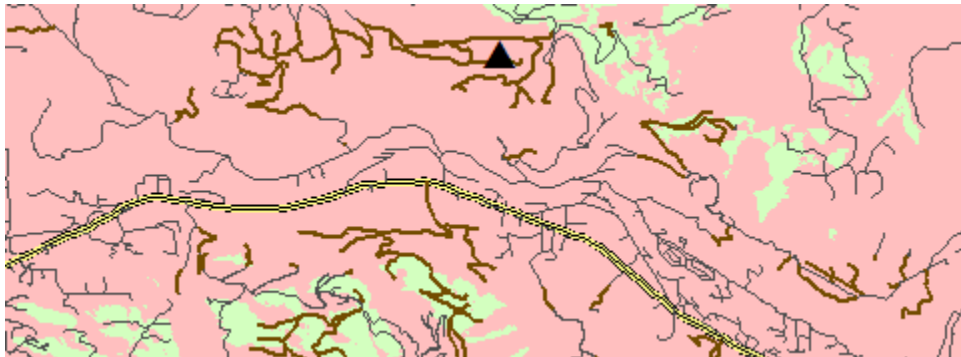
**Use earth curvature corrections** - Allows correction for the earth's curvature. FLAT\_EARTH - No curvature correction will be applied. CURVED\_EARTH - Curvature correction will be applied.



**Refractivity coefficient** - Coefficient of the refraction of visible light in air. The default value is 0.13.

**NOTE:** The Viewshed analysis does not take into account vegetation such as tall conifers that might hide the tower. The analysis assumes that there are no surface obstructions.

4. Click **OK**. After a moment of processing, a new raster layer is added to the Table of Contents. Cells are either coded "Not Visible" (Pink) or "Visible" (Green).
5. If needed, move the **sr\_view** layer below the **Ownership** layer.
6. Turn off the **Ownership** layer.



The proposed tower escapes detection (your results may vary, however the results of this Viewshed analysis do not account for the tower height. It is possible to include the tower's height as an optional Viewshed parameter.

To learn how to incorporate the optional parameters, try the Challenge step.

## Part 4: Challenge: Optional Viewshed Analysis Parameters

As mentioned in the previous step, the Viewshed analysis does not account for the proposed tower's height. In fact, for a more accurate result, the Viewshed analysis should also account for observer's height and viewing angle (e.g., tourists driving in their SUV's along Highway 26 have a certain height and viewing angle). You can control the visibility of the Viewshed analysis by adding optional parameters to the input layers attribute table whose features represent observation points (or observation lines).

### A. Examine the optional parameters you can use.

OPTION	DESCRIPTION
<b>SPOT</b>	Surface elevations for observation points or vertices. Default is Bilinear Interpolation.
<b>OFFSETA</b>	Vertical distance to be added to the Z value of observation point.

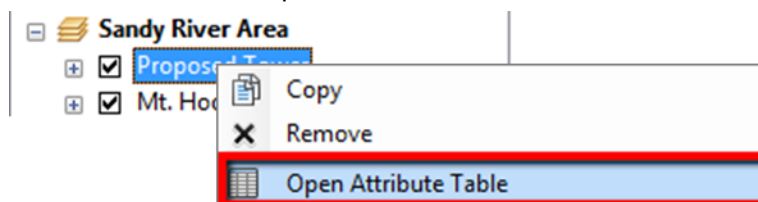
<b>OFFSETB</b>	Vertical distance to be added to the Z value of target mesh points.
<b>AZIMUTH1 &amp; AZIMUTH2</b>	Horizontal angle limits to the analysis. The default settings are for a 360-degree sweep.
<b>VERT1 &amp; VERT2</b>	Vertical angle limits to the scan. The default settings are for everything from directly overhead to directly below (180 degrees).
<b>RADIUS1 &amp; RADIUS2</b>	Limits the search distance from the observation point. The default settings are to infinity.

When the Viewshed analysis is executed, the function checks the layer's attribute table for the optional parameters. If a parameter is found, the values in that field are applied. NOTE: Optional parameters can only be added to a vector dataset (not a raster).

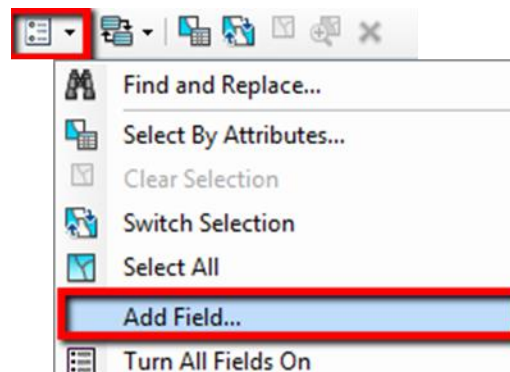
As a challenge, you will add the OFFSETA parameter to the Proposed Tower layer to account for the height of the proposed tower, and then rerun the Viewshed analysis

## B. Include the HEIGHT of the tower as a parameter in the Viewshed Analysis.

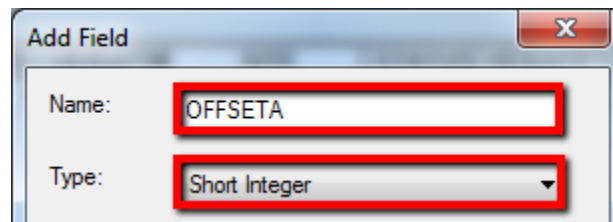
1. Turn off the **sr\_view** layer.
2. Open the Attribute Table for Proposed Tower.



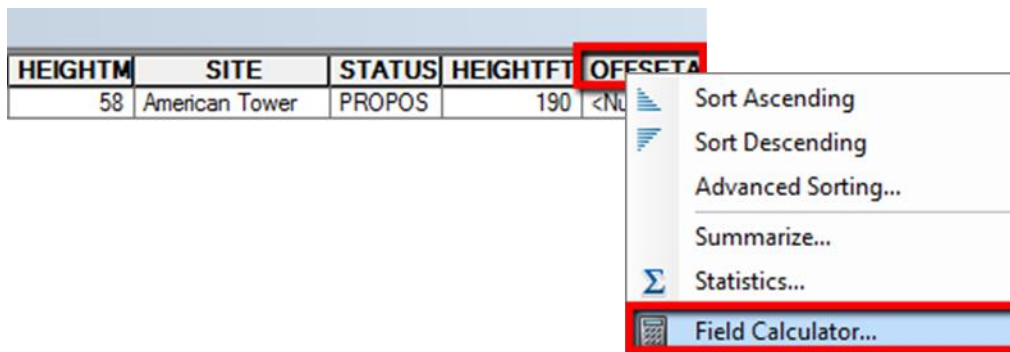
3. Click the **Table Options** button and select **Add Field**.



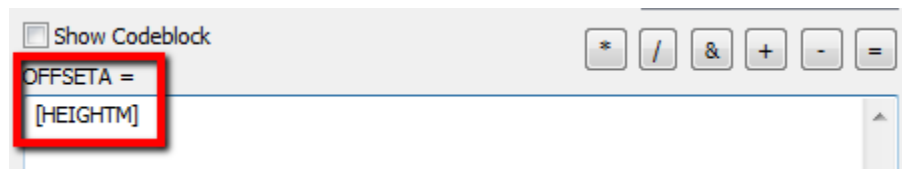
4. In the *Add Field* dialog, enter **OFFSETA** for *Name*. (Note: you must use the exact spelling).
5. The *Type* of the field must be numeric; choose **Short Integer**.



6. Accept the other defaults and click **OK**. The new field is created.
7. *Right-click* the **OFFSETA** field heading and open the **Field Calculator**.



8. Click **Yes** to dismiss the warning. The field calculator appears.
9. Enter the following expression: **OFFSETA = [HEIGHTM]** (FYI: The HEIGHTM field is in meters.)



10. Click **OK**. The height in meters is added to the *OFFSETA* field.

Proposed Tower								
	OBJECTID *	Shape *	ID	HEIGHTM	SITE	STATUS	HEIGHTFT	OFFSETA
	4	Point	4	58	American Tower	PROPOS	190	58

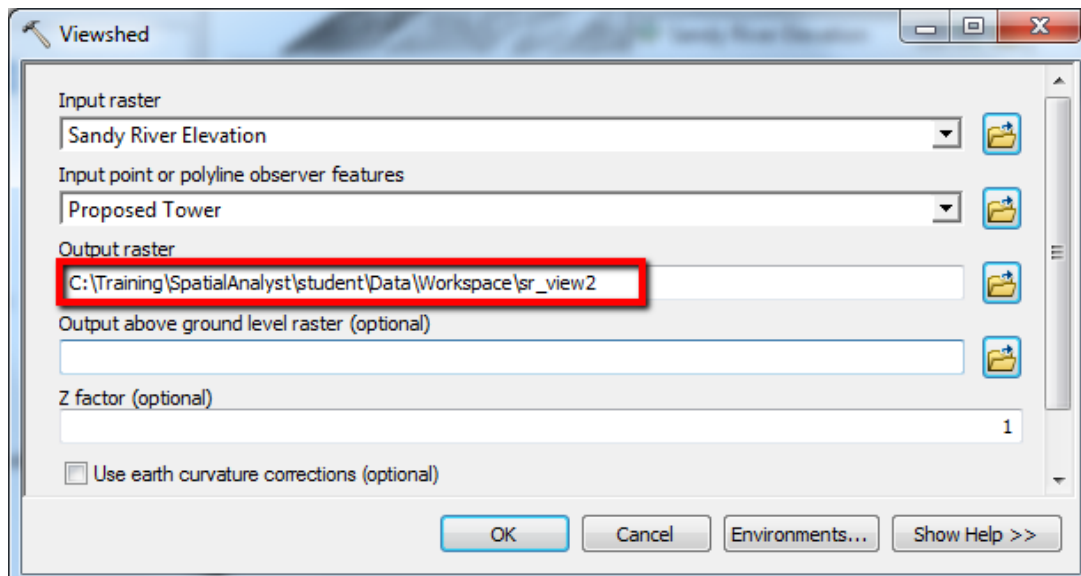
11. **Close** the Attribute Table.

## C. Rerun the Viewshed analysis.

1. From the **Geoprocessing** menu, select **Results**.
2. Expand **Current Session**, then double-click **Viewshed**.



Because the parameters from the previous run of the tool already occupy the window, we only need to update the name of the new output file.



3. Name the output raster **sr\_view2**.
4. Click **OK**.
5. Close the Geoprocessing Results dialog.
6. After the analysis is complete, move the **sr\_view2** layer above the **sr\_view**.



Taking into account the tower height, the results of the second viewshed analysis indicates that the proposed tower is visible from just about any location on Highway 26.

#### D. Save the map and close ArcMap.

1. Save your map document.
2. Exit ArcMap.

*Congratulations! You have completed Exercise 3.*