Spatial Data Science MOOC

Exercise

Create a suitability model

Section 3 Exercise 1

03/2020

THE SCIENCE OF WHERE™

Create a suitability model

Time to complete
120 minutes

Introduction

Suitability modeling is one of the most foundational approaches to solving spatial problems—where are the best, or most suitable, locations for something. Whether you are trying to identify the most suitable location for a store or conservation area, you will follow the same basic steps.

1. **Define the problem:** Defining the problem will help you identify a specific and measurable goal for the suitability analysis.
2. **Identify the criteria:** The subject of your suitability model will respond to different phenomena, referred to as criteria (for example, slope). The criteria should support the defined goal of the suitability model.
3. **Derive the criteria:** If you do not have data that represents each criteria, you can derive the criteria from a base dataset (for example, a slope criterion is derived from an elevation base dataset).
4. **Transform criteria values:** Criteria values are measured using different scales, so you must transform these values to a common scale so that they can be compared and combined.
5. **Weight and combine criteria:** Some criteria may be more significant than others. You can weight the criteria relative to one another before combining them to create a single suitability layer.
6. **Locate the site:** The suitability layer reflects the characteristics of a location. In this step, you integrate the spatial requirements of the subject of your suitability model and use these spatial requirements to identify the best locations from the suitability layer.
7. **Analyze the results:** Analyze the results to confirm that the selected site meets the requirements and ensure that you achieve the goals of the analysis.

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Exercise scenario

A global company wants to identify the best location for its carbon neutral headquarters. The owner would like the headquarters located in the state of Vermont.

In this exercise, you will complete each step of suitability modeling to locate the best, or most suitable, location for the company's carbon neutral headquarters.

Step 1: Define the goal

a. Before you begin your analysis, define the goal of the suitability model.

b. **Goal:** Choose a location for a corporate headquarters that has a minimal carbon footprint. This location should be situated and designed in a way that is attractive to prospective employees.

You will use this goal to define the criteria used to create your suitability model and to evaluate the model to ensure that it is successful.

Step 2: Identify the criteria

Based on the goal of this suitability, and a discussion with corporate leaders, the criteria were identified. You will organize this criteria into four different objectives to clarify how the criteria relate to each other.

- Building site: a location that reduces construction cost and is easily accessible by employees
- Energy independence: an optimal location to incorporate renewable energy devices
- Access to amenities: a location that is accessible to various amenities
- Environmental concerns: a location that will minimally disrupt critical environmental areas and corridors

The following tables list the criteria for each objective and the required data. Each of these objectives will become submodels for the overarching suitability model. You will create the building site submodel in this exercise.

Submodel: Building site

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Criteria	Required data
Wetlands and high-density areas are less preferred	Land use layer
Steep slopes are less preferred	Slope layer
Closer to major roads is preferred	Distance from major roads layer
Visibility from major roads is less preferred	Viewshed layer

Submodel: Energy independence

Criteria	Required data
Higher solar radiation potential is preferred	Solar radiation potential layer
Closer to electric lines (to connect solar energy to the utility grid) is preferred	Electric distributions layer
South-facing angles are more preferred	Aspect layer

Submodel: Access to amenities

Criteria	Required data
Closer to the airport and the city of Burlington is preferred	Airport locations layer
Closer to recreational areas is preferred	Recreation layer
Closer to residential areas is preferred	Residential density layer

Submodel: Environmental concerns

Criteria	Required data
Farther from protected areas is preferred	Protected areas layer
Farther from biological areas is preferred	Biological areas layer
Farther from wetlands is preferred	Wetlands layer
Farther from streams is preferred	Streams layer

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Note: These criteria have been chosen for the purpose of this exercise and are not intended to be an exhaustive list of the criteria used in this type of suitability model.

Step 3: Download the exercise data files

In this step, you will download the exercise data files.

a. Open a new web browser tab or window.

b. Go to https://bit.ly/2RKBpQx and download the exercise data ZIP file.

Note: The complete URL to the exercise data file is https://www.arcgis.com/home/item.html?id=1c3f12e136d54def91eb944eee55f5fe.

c. Extract the files to a folder on your local computer, saving them in a location that you will remember.

Step 4: Open an ArcGIS Pro project

a. Start ArcGIS Pro.

b. If necessary, sign in using the provided course ArcGIS account.

c. Click Open Another Project.

d. In the Open Project dialog box, browse to the Suitability folder that you saved on your computer.

e. Select the Headquarters_Siting.aprx project and click OK.

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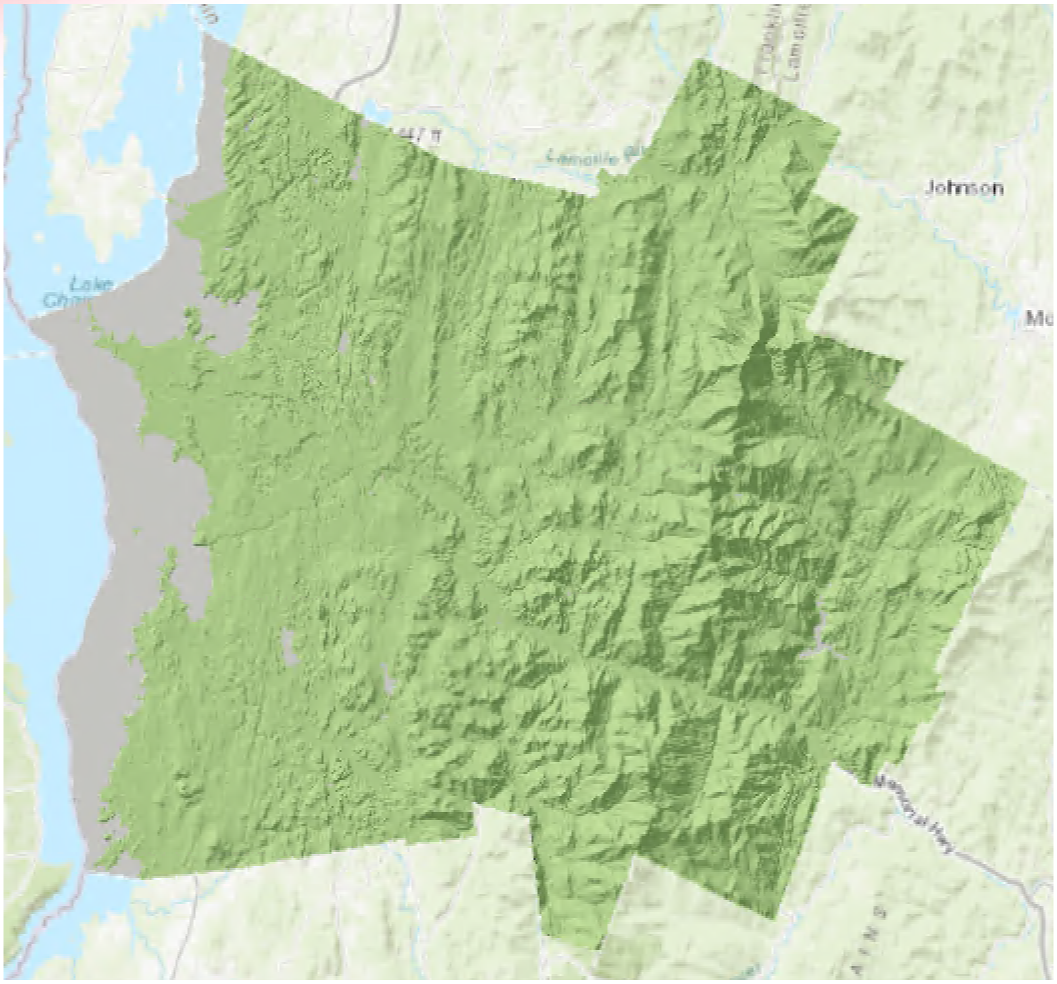

Your ArcGIS Pro project includes a map of Vermont with a layer that outlines the area of interest, or study area, for this suitability model. This study area spans across several counties in Vermont, including the cities of Burlington, Hinesburg, and Stowe. The map includes additional layers that represent the other datasets required to create the Building Site submodel.

A mountain range, called Green Mountains, runs north to south in the eastern part of the study area. You can continue turning on and off layers to familiarize yourself with the study area.

f In the Contents pane, turn off the Hillshade layer.

Step 5: Review model properties

a In the Catalog pane, expand Toolboxes, and then expand Headquarters_Siting.tbx.

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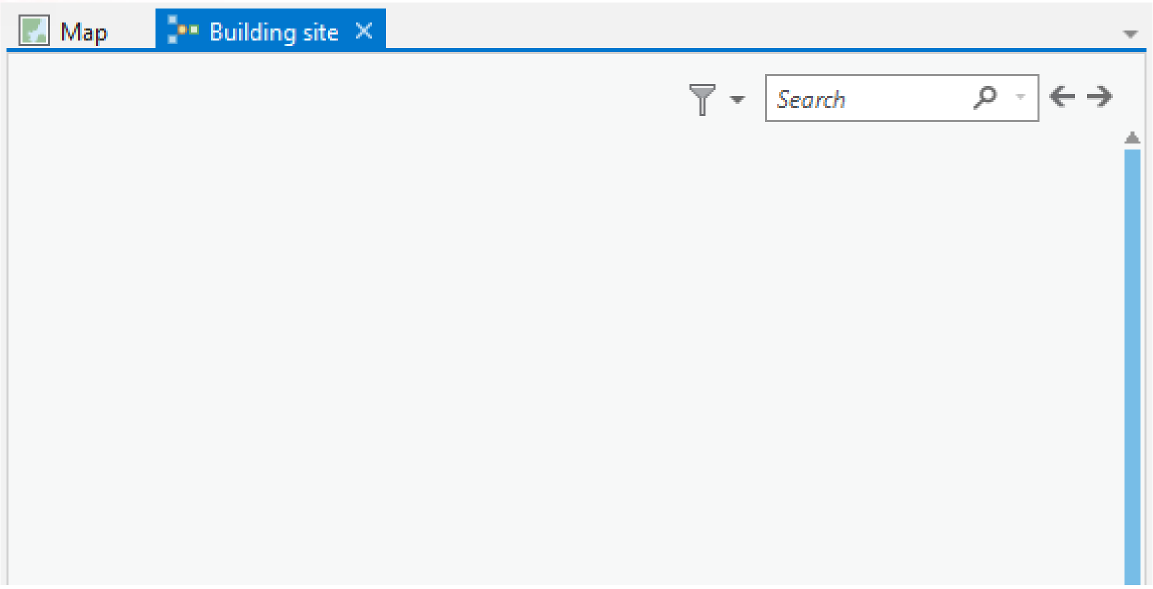
b Right-click Building Site and choose Edit.



A new ModelBuilder tab appears at the top of your project with an empty model.

You will use ModelBuilder to create the Building Site submodel. ModelBuilder allows you to visualize and record a series of analyses, or model. It uses shape, color, text, and symbols to visually communicate information about the model. ModelBuilder can help you organize, document, and share your analysis with others.

c From the ModelBuilder tab, in the Model group, click Environments.

The model environments define specific analysis settings that will apply to the output of all tools used in the model. The environments for this model include a specified area as the extent, a mask, and a raster cell size. The extent defines the minimum boundary rectangle within which the analysis will occur. The mask identifies which cells to process within the extent. The cell size defines the resolution of the resulting output rasters. For more information about geoprocessing environments, see ArcGIS Pro Help: What is a geoprocessing environment setting?

d Close the Environments dialog box.

Step 6: Add base data to the model

Each criterion in a suitability model begins with a base dataset. The base dataset can be used as the criterion dataset, or it can be used to derive the required criterion dataset. In this step, you will add the base data associated with the building site criteria to the model.

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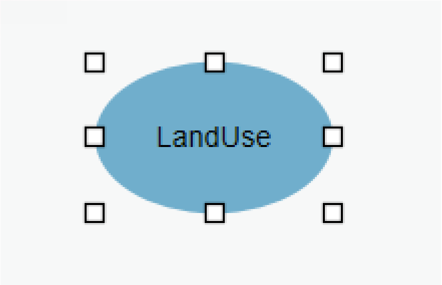
a In the Contents pane, click LandUse and drag it into the model.



A blue circle appears, indicating that LandUse is a dataset that will be the input into a geoprocessing tool. The LandUse base dataset will be used for the land use criteria.

b Repeat the previous step for the following datasets:

- Elevation_30
- GreenMTRidge
- Views
- MajorRoads

c From the ModelBuilder tab, in the View group, click Auto Layout.

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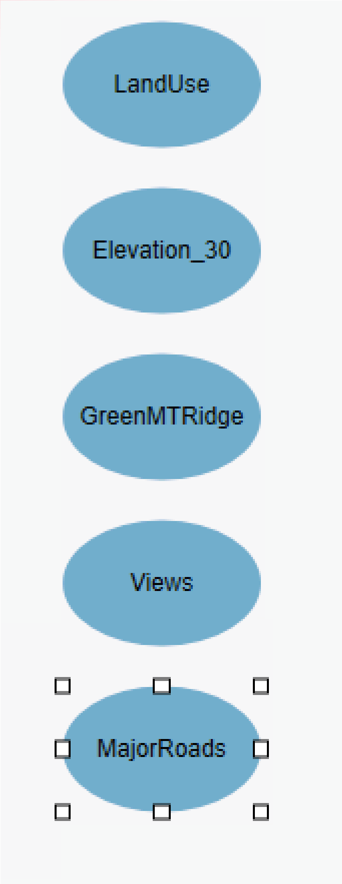

The input datasets are automatically realigned. The GreenMTRidge and the other MajorRoads base datasets will be used to derive the proximity to the major roads criterion. The Elevation_30 base dataset will be used to derive the slope criterion. Views will be used to derive the visibility from the roads criterion.

d From the ModelBuilder tab, in the Model group, click Save.

You have saved the edits made to this model. Saving the model does not save the project, nor does saving the project save the model. To save the project, click the Save button near the top of the ArcGIS Pro ribbon.

Step 7: Derive a criterion

a From the Analysis tab, in the Geoprocessing group, click Tools.

b In the Geoprocessing pane, in the search field, type **slope**.

c Click and drag the Slope (Spatial Analyst Tools) tool into the model.

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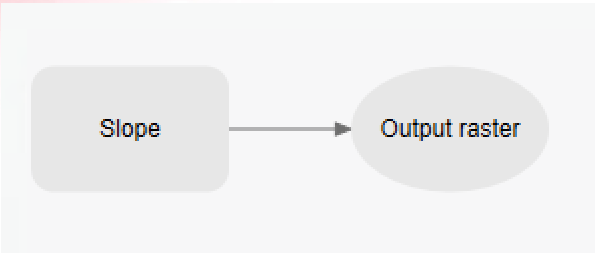
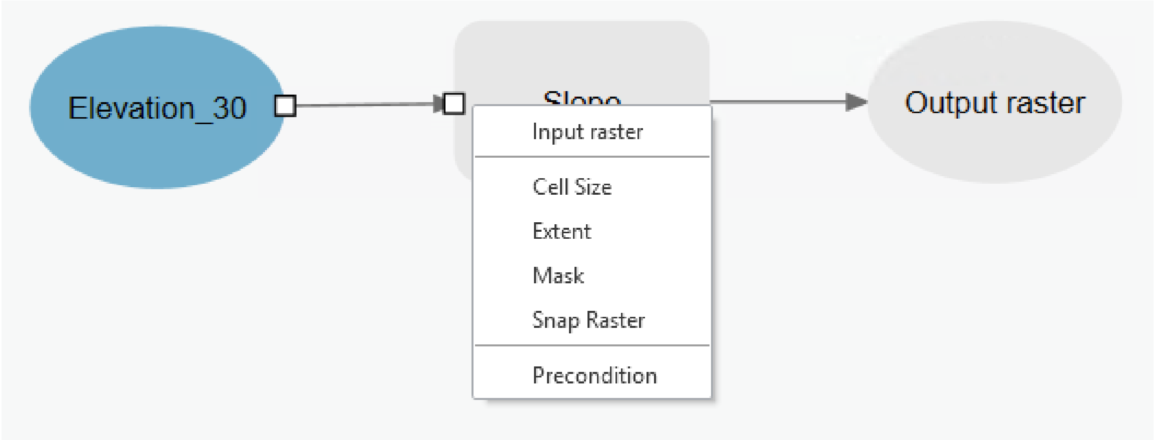


A gray square and a gray circle are added to the model. The square indicates the geoprocessing tool that will be run, and the circle indicates the output from the tool. They are both gray to indicate that the tool is not ready to run and requires an input dataset.

d. In the model, click Elevation_30 and, while holding the mouse button, drag it to Slope.

e. Release the mouse button.



When you drag Elevation_30 to Slope, an arrow appears. The arrow indicates that Elevation_30 will be an input parameter to the Slope geoprocessing tool. When you release the arrow, a list of compatible parameters appears based on the type of input. You will specify which parameter Elevation_30 represents.

f. From the list of parameters, choose Input Raster.

g. Double-click Slope.

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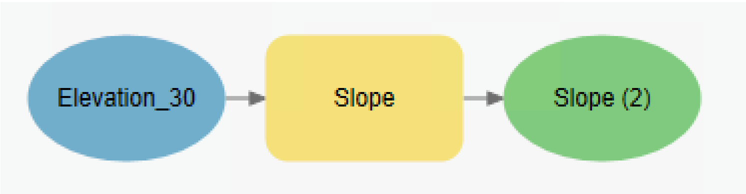
The Slope dialog box opens, and the Input Raster parameter was automatically updated to Elevation_30.

h In the Slope dialog box, enter the remaining parameters:

- Output Raster: **Slope**
- Z Factor: **0.3048**

i Click OK.

j From the ModelBuilder tab, click Auto Layout.



The square and circle change colors to indicate that they are ready to run. This tool will derive the slope, or gradient, for each cell in the Elevation_30 base data. Slope is calculated as rise over run. Because the run is in meters and the rise (elevation values) is in feet, you used a 0.3048 Z Factor to convert the output to meters.

k Right-click Slope and choose Run.

l In the Building Site window, check the box for Close On Completion.

m Close the Building Site window.

The square and circle are shaded to indicate that this tool in the model has run and that the output has been generated.

n Right-click Slope (2) and choose Add To Display.

o Next to the Building Site view tab, click the Map view tab.

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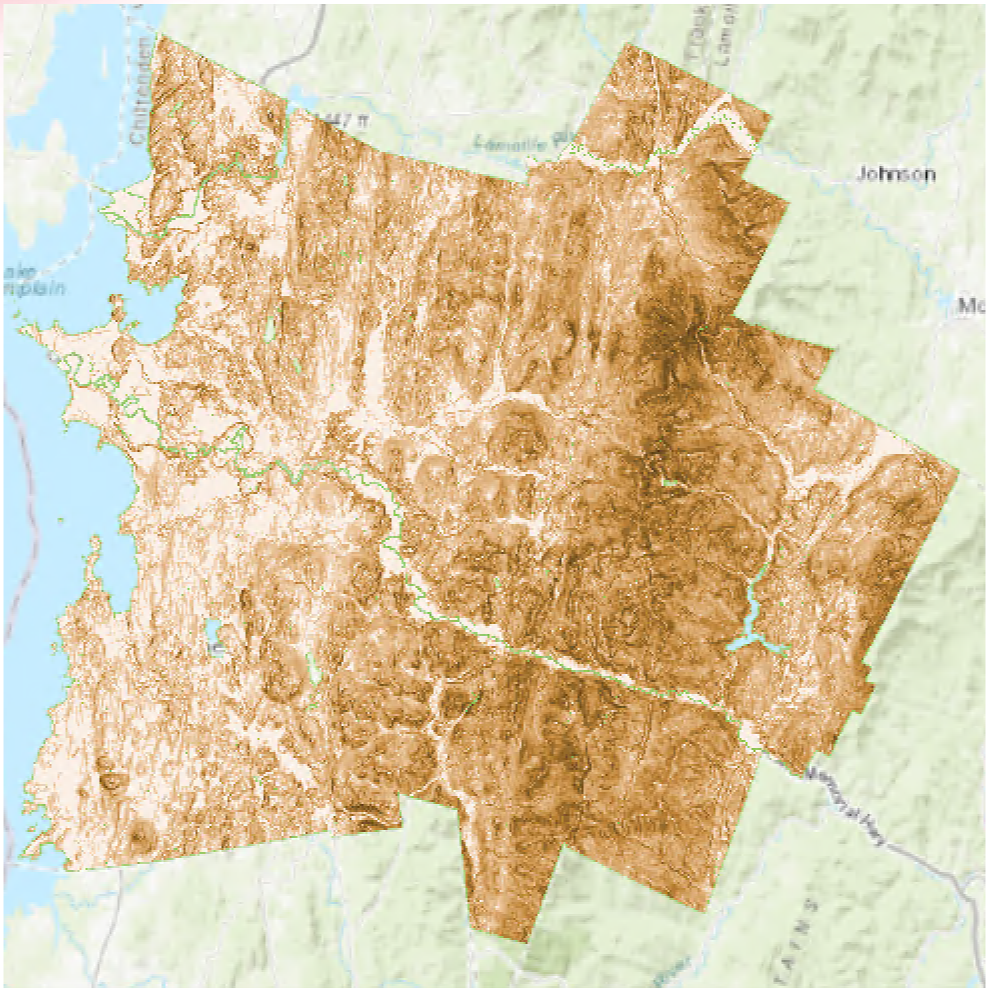

The output layer, Slope (2), is added to the map. The cells in this raster are symbolized in colors ranging from a light tan, indicating gentler slopes, to a dark brown, indicating steeper slopes. To learn more about the Slope tool, see ArcGIS Pro Help: How Slope works.

Step 8: Derive the remaining criteria

Next, you will derive the remaining criteria for the building site model.

a. Click the Building Site view tab to return to the model view.

b. In the Geoprocessing pane, search for **distance accumulation**.

c. Add the Distance Accumulation (Spatial Analyst Tools) tool to the model.

d. In the model, click and drag MajorRoads to Distance Accumulation.

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- (e) From the list of parameters, choose Input Raster Or Feature Source Data.
- (f) Click and drag GreenMTRidge to Distance Accumulation.
- (g) From the list of parameters, choose Input Barrier Raster Or Feature Data.
- (h) Double-click the Distance Accumulation tool.
- (i) In the Distance Accumulation dialog box, for Output Distance Accumulation Raster, type **Dist_MRoads**.
- (j) Click OK.
- (k) Right-click Distance Accumulation and choose Run.
- (l) Right-click Dist_MRoads and choose Add To Display.
- (m) Click the Map view tab.

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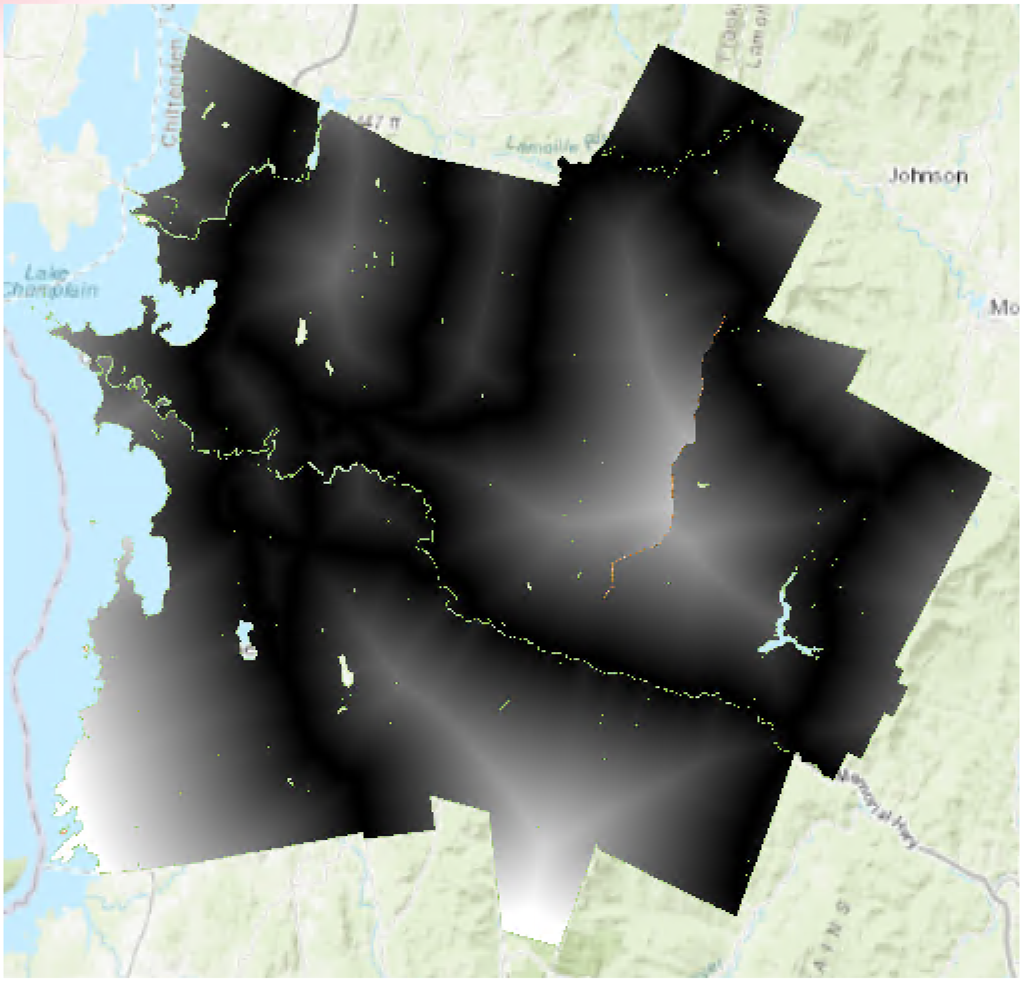

The tool calculates the straight-line, or Euclidean, distance from the major roads. The study area for this analysis includes the Green Mountain Ridge. Cars must drive around the ridge, which you have indicated by adding it as a barrier. The resulting layer illustrates the accumulated distance from major roads, where black indicates shorter distances and white indicates further distances. Areas around the ridge may be relatively close (straight-line distance) to a major road. However, the Distance Accumulation tool indicates that these areas are far from major roads because you would have to drive around the ridge. To learn more about the Distance Accumulation tool, see ArcGIS Pro: Distance Accumulation (Spatial Analyst).

n In the Contents pane, turn on the following layers:

- Views
- MajorRoads

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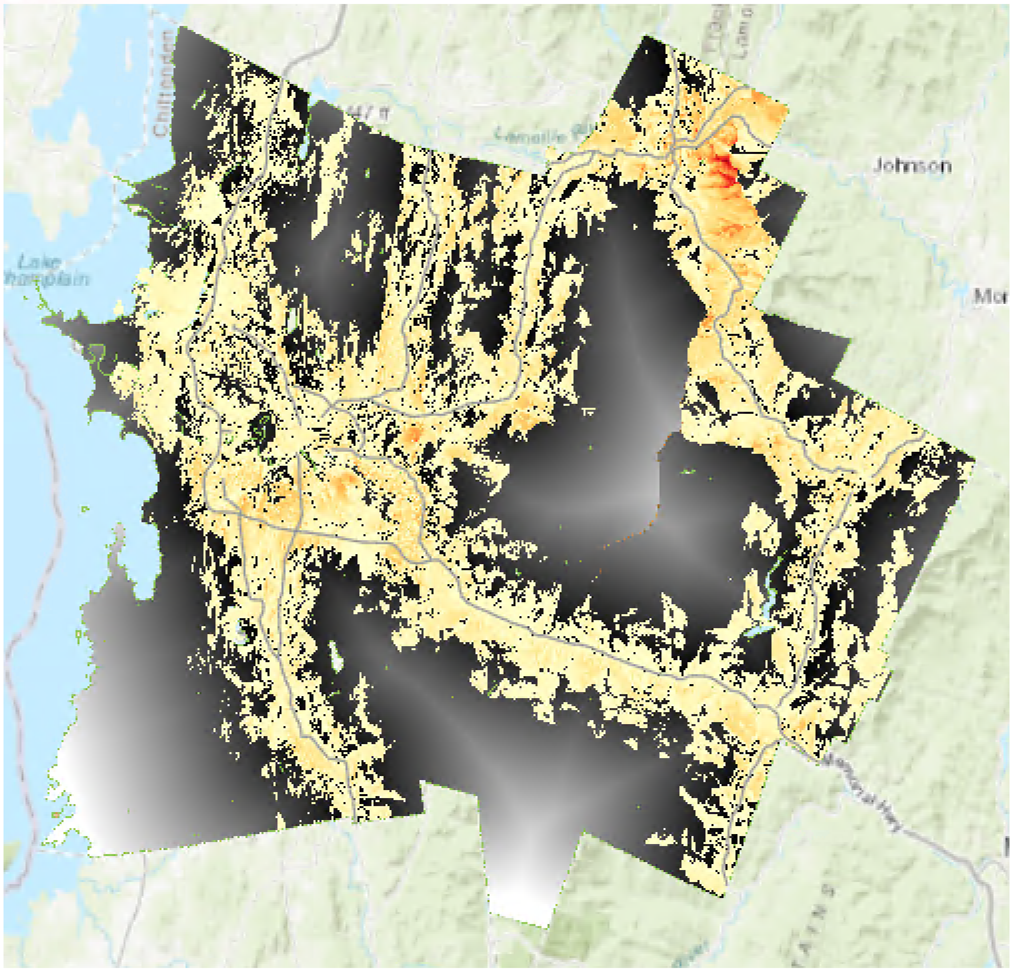
o In the Contents pane, drag the Views layer above the Dist_MRoads layer.



To save time, the Views layer was created for you using the Viewshed 2 geoprocessing tool with the Elevation_30 and MajorRoads layers as the input parameters. The tool identifies the number of times that a location is seen from a given point or line. In this example, it identifies areas within a 5-kilometer radius that are visible from the major roads. Each cell in the output raster is assigned the number of times that it can be seen from the major roads. Areas that are not visible are not assigned a value and are considered NoData cells. To learn more about the Viewshed 2 tool, see ArcGIS Pro Help: How Viewshed 2 works.

Any time a cell is assigned NoData, the cell will not be considered available for locating the headquarters. Because you want to include these areas in this suitability analysis, you will convert NoData cells to cells with a value of zero.

p Click the Building Site view tab to return to the model view.

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q. Add the Raster Calculator (Spatial Analyst Tools) tool to the model.

r. Drag Views to Raster Calculator.

s. From the list of parameters, choose Map Algebra Expression.

t. Double-click Raster Calculator.

u. In the Raster Calculator dialog box, under Map Algebra Expression, type **Con(IsNull("%Views%"), 0, "%Views%")**.

This expression uses a conditional statement where cells assigned NoData (null) are evaluated as "True" and are assigned a cell value of zero. All other cells are evaluated as "False" and maintain their original value.

v. For Output Raster, type **Views_Zero**.

w. Click OK, and then click Auto Layout.

x. Run the tool, and then add the analysis output to the map.

y. In the Contents pane, turn off Views.

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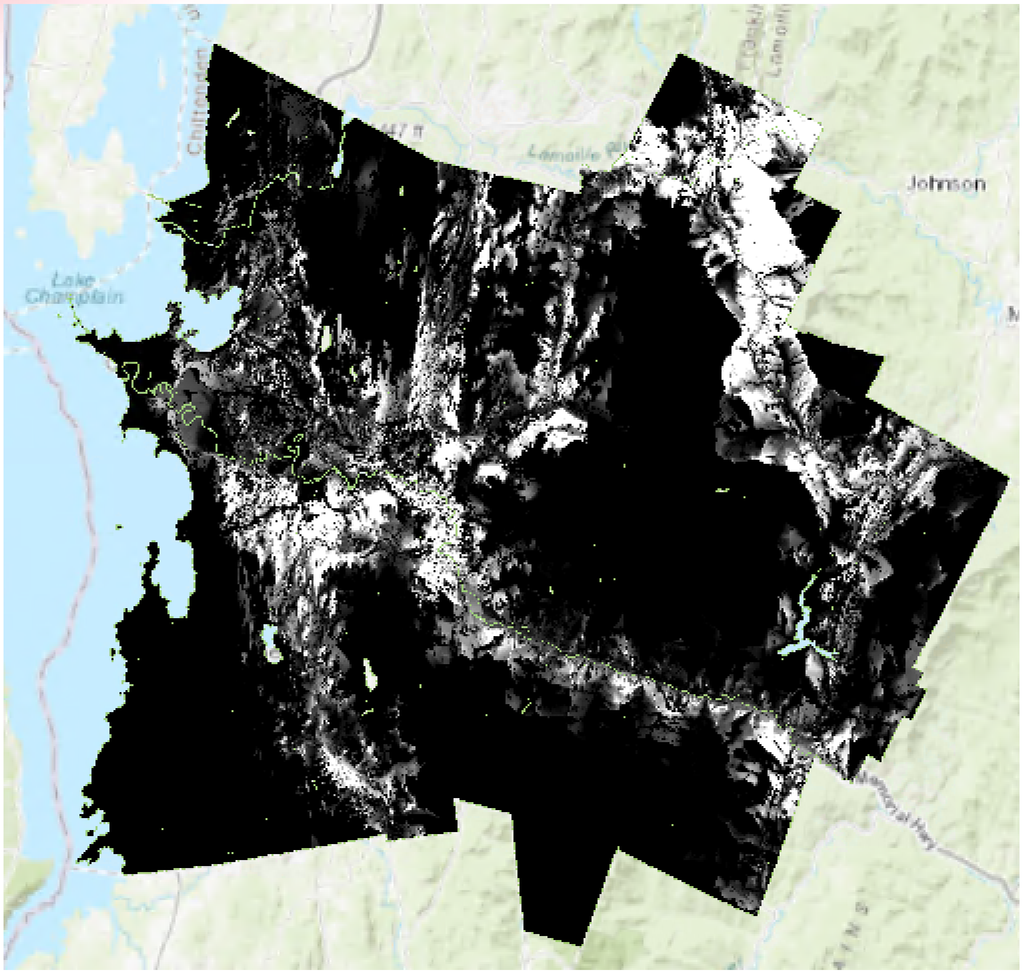

NoData cells have been reassigned to a cell value of zero, which is represented using black. As the cell value increases, the symbology lightens to gray and eventually white. The white areas are the most visible from the major roads, making them the least preferable areas.

z Return to the model view, and then from the ModelBuilder tab, click Save.

The LandUse dataset can be used directly as the criterion, so no geoprocessing tool was necessary to derive criterion from this base data.

Step 9: Transform criteria values using reclassify

The values of the criteria datasets are relative to the criteria that they represent. Land use uses categorical values, such as open water, whereas slope uses continuous values ranging from 0 through 90. Before you can weight these criteria relative to each other, you need to transform their values to a common scale.

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a. Add the Reclassify (Spatial Analyst Tools) tool to the model.

b. Drag LandUse to Reclassify.

c. From the parameter list, choose Input Raster.

d. In the Reclassify dialog box, for Reclass Field, choose Category, if necessary.

e. Under the Reclassification table, click Unique.

f. Complete the Reclassification table using the following New values:

Value	New
Open Water	**1**
Developed, Open Space	**5**
Developed, Low Intensity	**4**
Developed, Medium Intensity	**3**
Developed, High Intensity	**1**
Barren Land	**8**
Deciduous Forest	**8**
Evergreen Forest	**7**
Mixed Forest	**8**
Shrub/Scrub	**9**
Herbaceous	**7**
Hay/Pasture	**10**
Cultivated Crops	**9**
Woody Wetlands	**1**
Emergent Herbaceous	**5**
NODATA	NODATA

The Reclassification table defines the preference scale for each category, where 1 is not preferable and 10 is very preferable.

g. For Output Raster, type **Trans_LandUse** and click OK.

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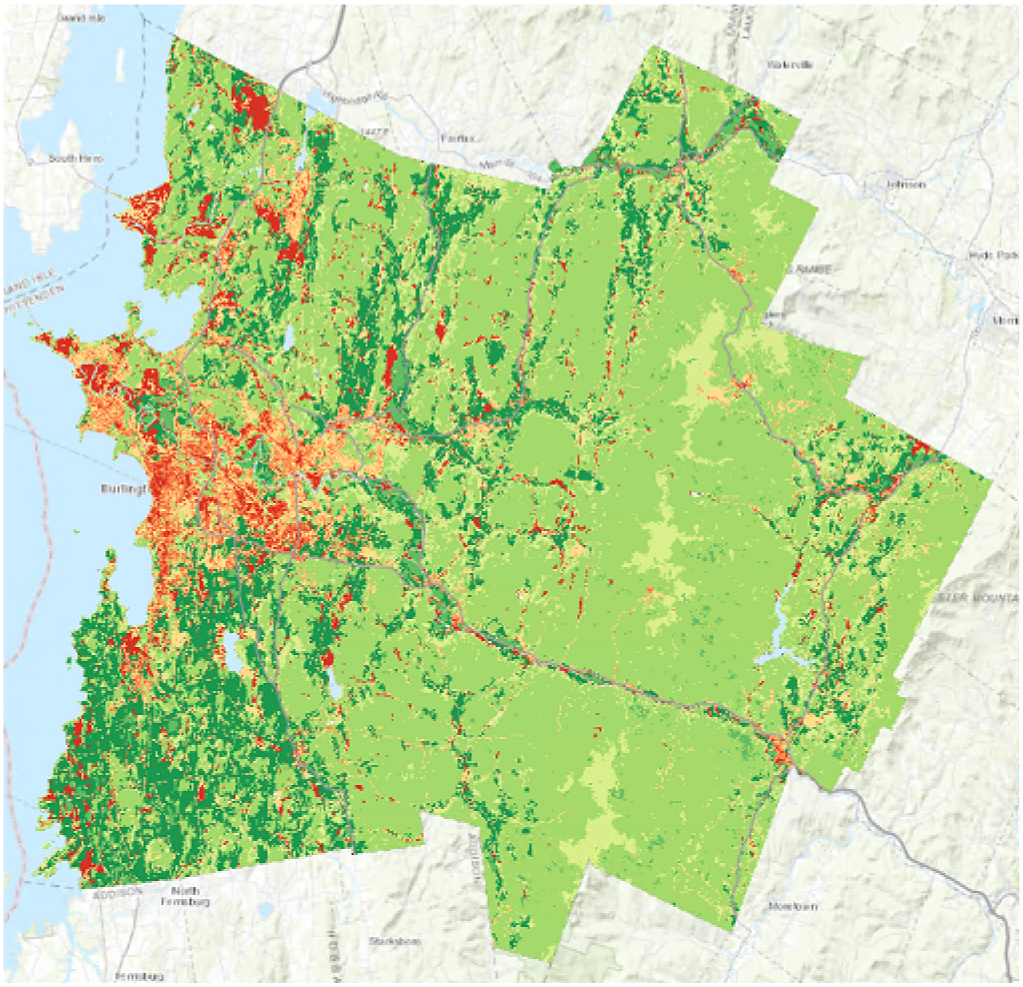
h Run the tool, and then add the analysis output to the map.

i Click the Map view tab, and then in the Contents pane, right-click Trans_LandUse and choose Symbology.

j In the Symbology pane, enter the following parameters:

- Primary Symbology: Unique Values
- Field 1: Value
- Color Scheme: Red-Yellow-Green (8 Classes)

Hint: To see the names of the color schemes, click the Color Scheme down arrow and check the box for Show Names.



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The Reclassify tool transformed the categorical land use data (open water, mixed forest, and so on) to a common preference scale ranging from 1 to 10, where 1 is not preferable and 10 is very preferable. The Trans_LandUse layer indicates that the most preferred areas are in green and the least preferred areas are in red.

k Add the Rescale By Function (Spatial Analyst Tools) tool to the model, and then enter the following tool parameters:

- Input Raster: Slope (2)
- Output Raster: **Trans_Slope**

Hint: In the model, drag Slope (2) to Rescale By Function to set it as the Input Raster, and then double-click Rescale By Function to open the dialog box.

The Rescale By Function tool transforms continuous data into a preference scale using linear and nonlinear functions. To choose a function, you must determine the preference interaction between the item being modeled and the criterion.

In this example, the item being modeled is the location for a corporate headquarter, and the criterion is slope. The preference decreases as the slope increases, which means that the MS Small function is the best function for this transformation. With this function, the suitability continuously decreases with every degree increase in the slope.

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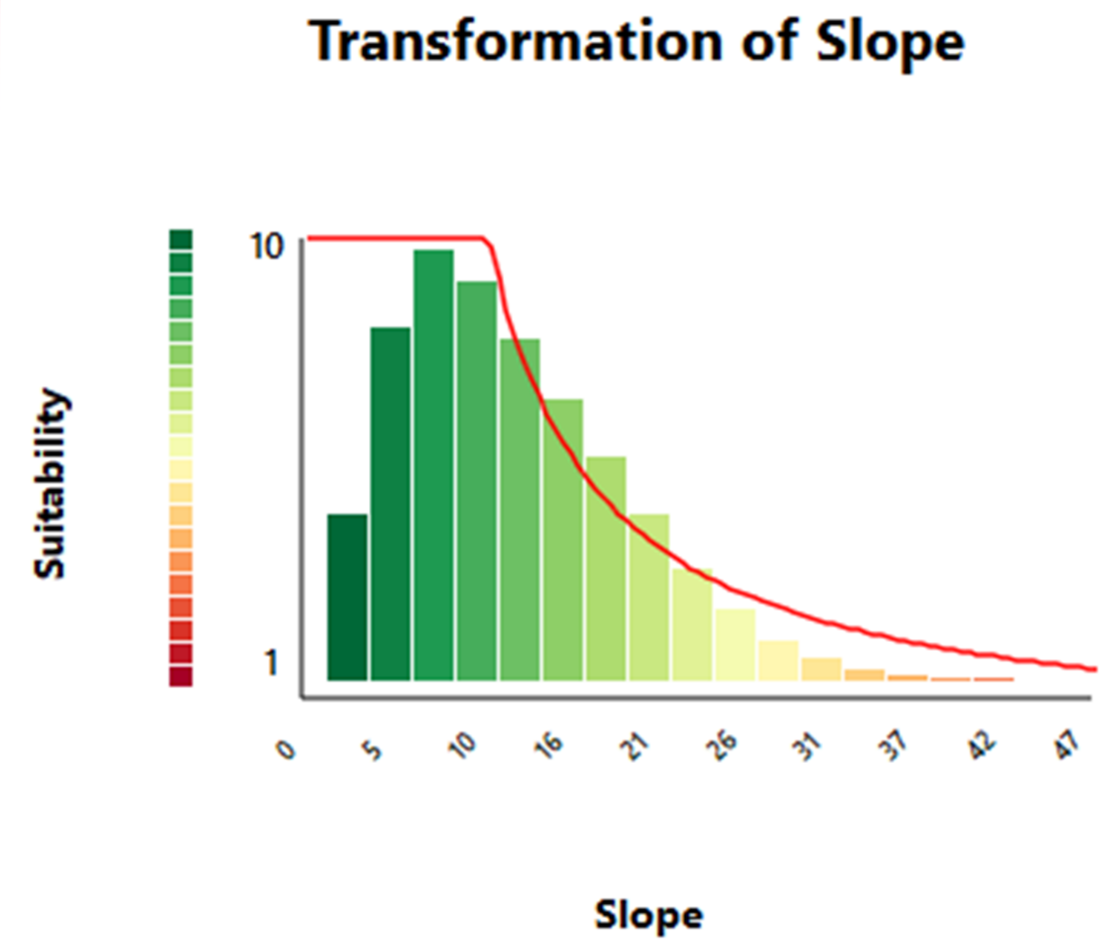

The histogram indicates the number of cells from the input raster that will be transformed to a specified suitability value.

To learn more about the Rescale By Function tool, see ArcGIS Pro Help: How Rescale by Function works.

- Run the tool, and then add the analysis output to the map.

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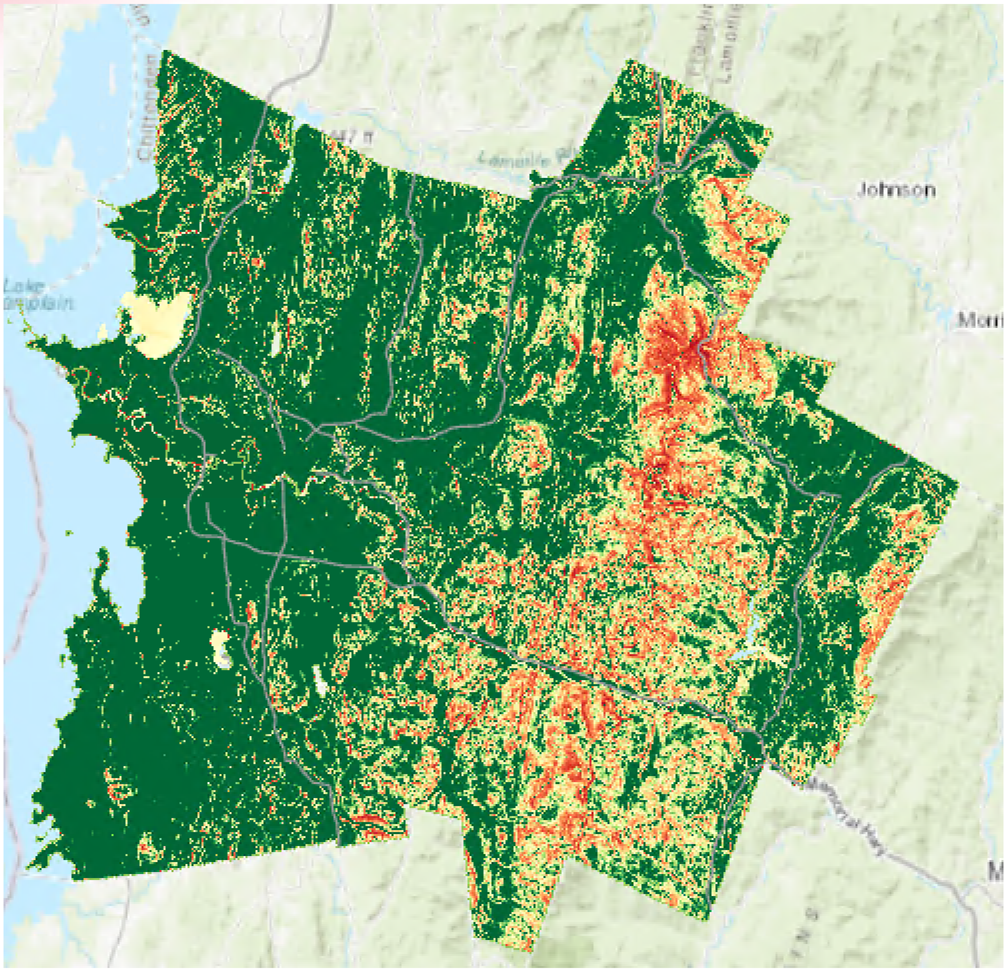

The Rescale By Function tool rescaled to a common preference scale ranging from 1 to 10, where 1 is not preferable and 10 is very preferable. The Trans_Slope layer indicates that the most preferred areas are in green and the least preferred areas are in red.

m. Add two Rescale By Function (Spatial Analyst Tools) tools to the model to rescale the remaining criteria using the following parameters:

	Input Raster	Output Raster	Transformation Function
Rescale By Function	Dist_MRoads	**Trans_MRoads**	Small
Rescale By Function	Views_Zero	**Trans_Views**	Logistic Decay

n. Click Auto Layout.

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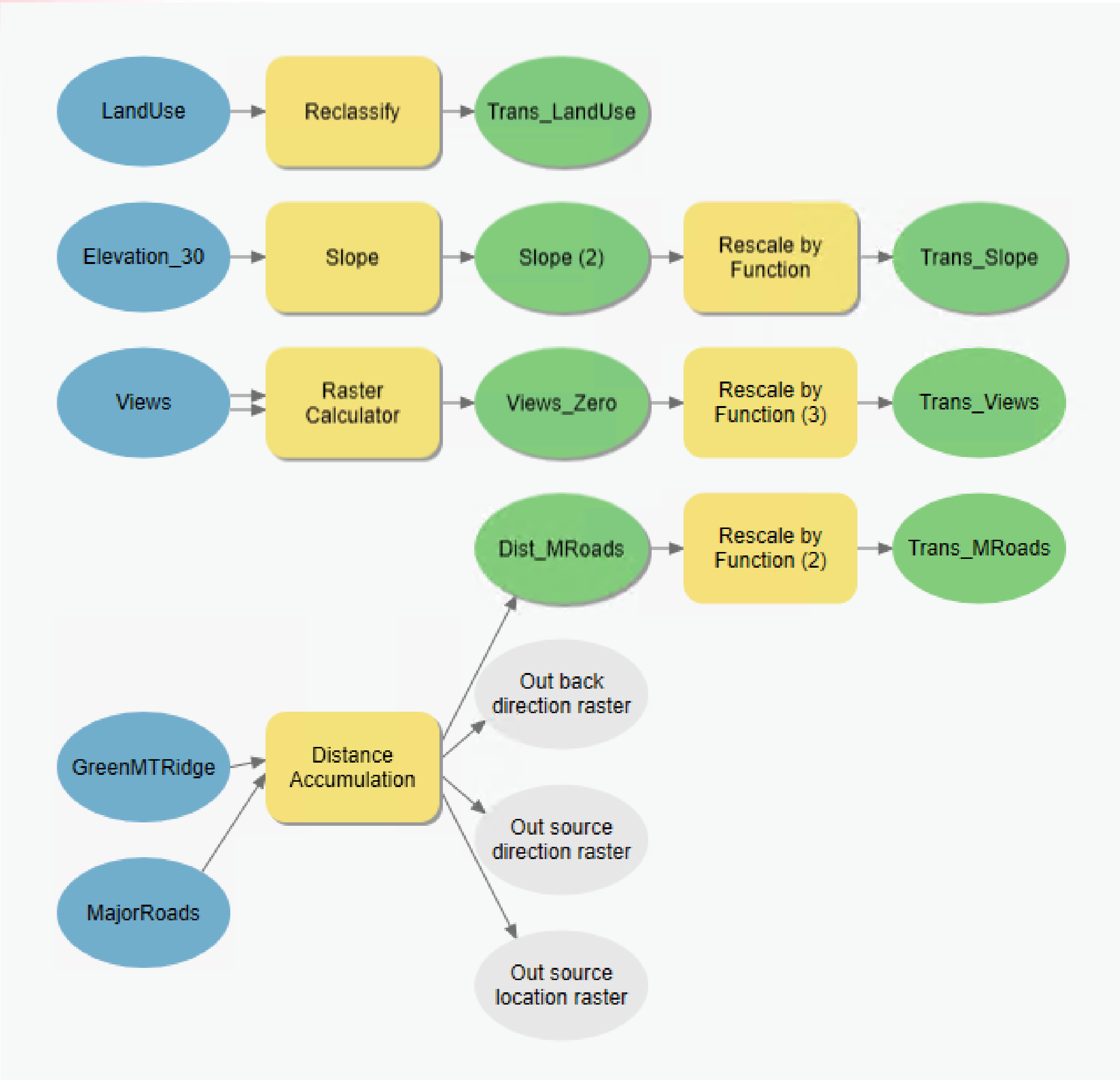

The additional Rescale By Function tools use different transformation functions. The distance from roads uses a small function to indicate that locations closer to roads (smaller values) have the highest preference. The visibility from roads uses logistic decay to indicate that preference decreases the more visible you are to the road. To learn more about the transformation functions, see ArcGIS Pro Help: The transformation functions available for Rescale by Function.

- Run the tools, and then add the analysis outputs to the map.

Each criterion for the building siting submodel has been transformed to a common preference scale ranging from 1 to 10, where 1 is not preferable and 10 is very preferable. The most

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preferred areas are indicated using the color green, and the least preferred areas are indicated using the color red.

p Save the model.

Step 10: Weight and combine criteria

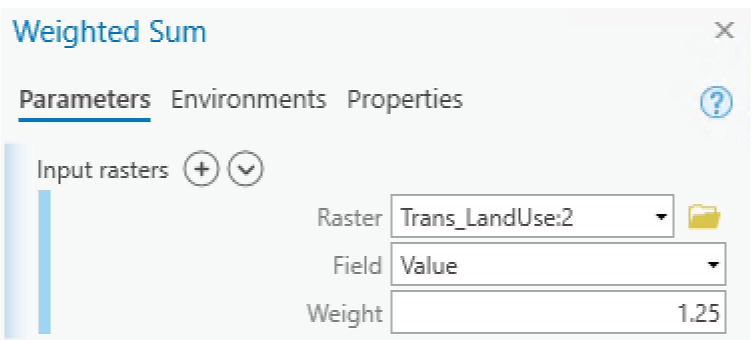
Certain criteria in the submodel may be more significant than others. To account for these differences, you will weight the criteria relative to one another before combining the criteria.

You will use the Weighted Sum tool to weight and combine these criteria. The Weighted Sum tool multiplies each criterion raster by its specified weight and then combines, or sums, the criteria into one raster.

a Add the Weighted Sum (Spatial Analyst Tools) tool to the model.

b Drag Trans_LandUse to Weighted Sum, and then open the Weighted Sum dialog box.

c Under Input Rasters, for Weight, type **1.25**.



This input raster represents the first criterion, land use, which will be multiplied by 1.25 before combined with the other criterion.

d Next to Input Rasters, click the Add New button, and then add the remaining criteria:

Input Raster	Weight
Trans_Slope:2	**1.25**
Trans_MRoads:2	1
Trans_Views:2	1

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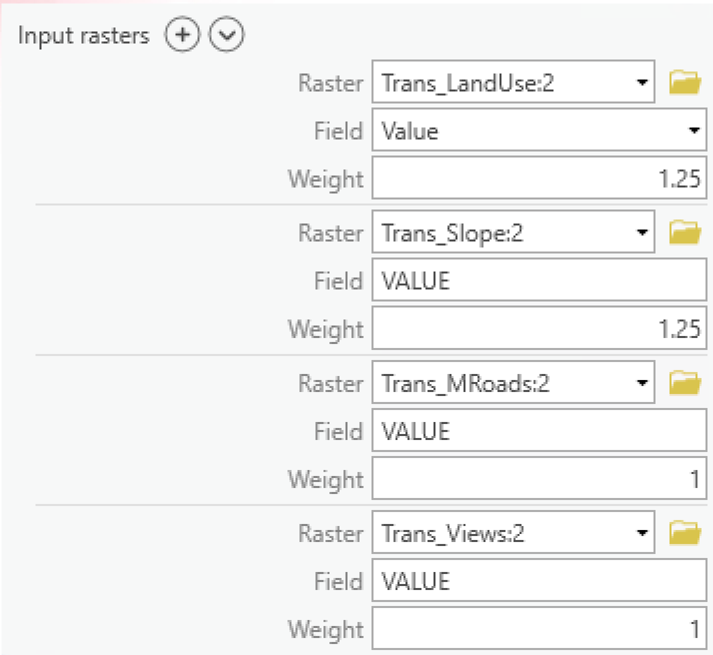

The four criteria have been added to the tool, with greater weight added to land use and slope.

- **e** For Output Raster, type **Building** and click OK.
- **f** Run the tool, and then add the analysis output to the map.

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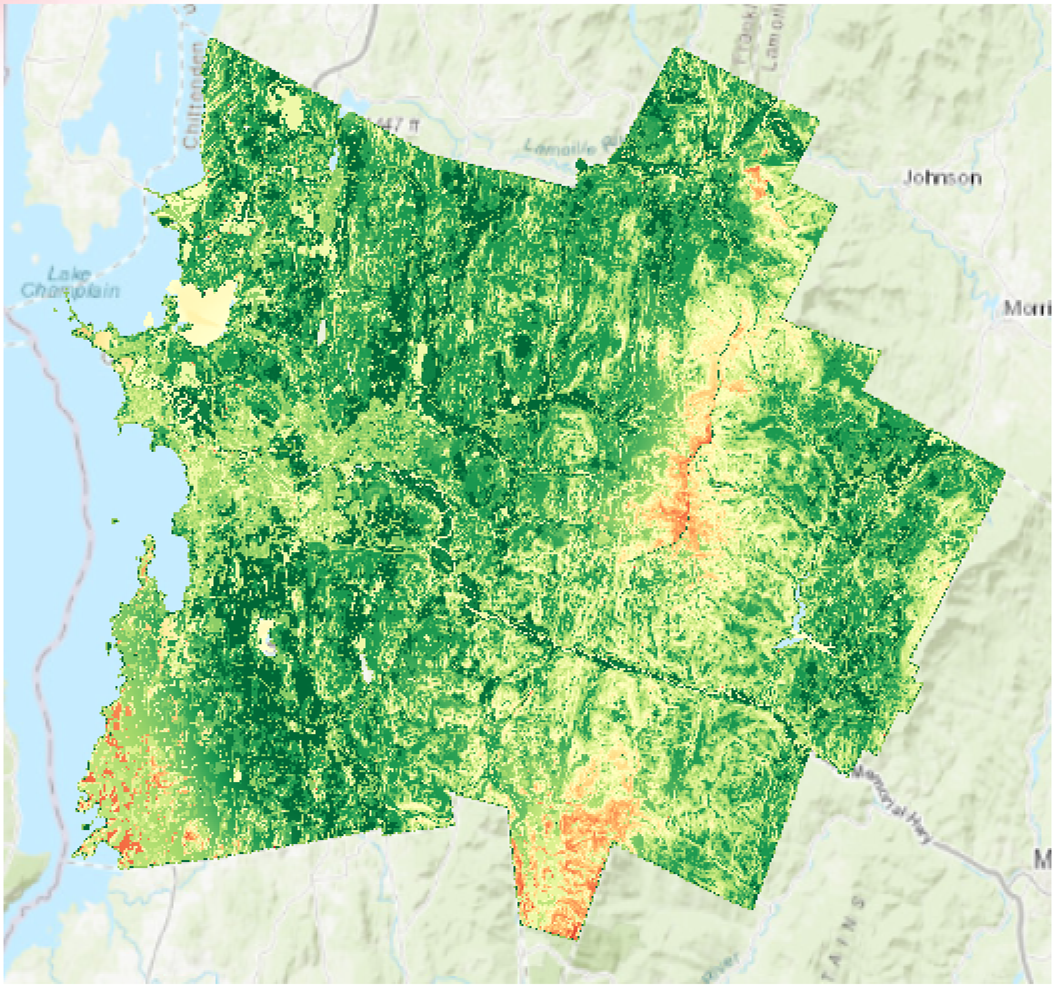

This tool multiplies each criteria by their assigned weight and then combines the layers, generating a single suitability raster. The values range from approximately 45, which is the most preferable, to approximately 20, which is the least preferable. Areas that are more preferable are symbolized in green, and areas that are least preferable are symbolized in red. This suitability layer is based on the building site submodel criteria, which means that it only represents a subset of the overarching analysis criteria.

g Save the model.

Step 11: Weight and combine submodels

The building site submodel is one of four submodels in this suitability analysis. To save time, the other three submodels were created for you. Similar to the criteria, certain submodels may be more significant than others. In this step, you will weight and combine each submodel to create one overarching suitability raster.

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> This model can take some time to run. The results have been provided for you if you do not want to run the model. If you do not run the model, proceed to the *Analyze the results* step.

a. In the Catalog pane, expand Toolboxes and expand Headquarters_Siting.tbx, if necessary.

b. Right-click Suitability Model and choose Edit.

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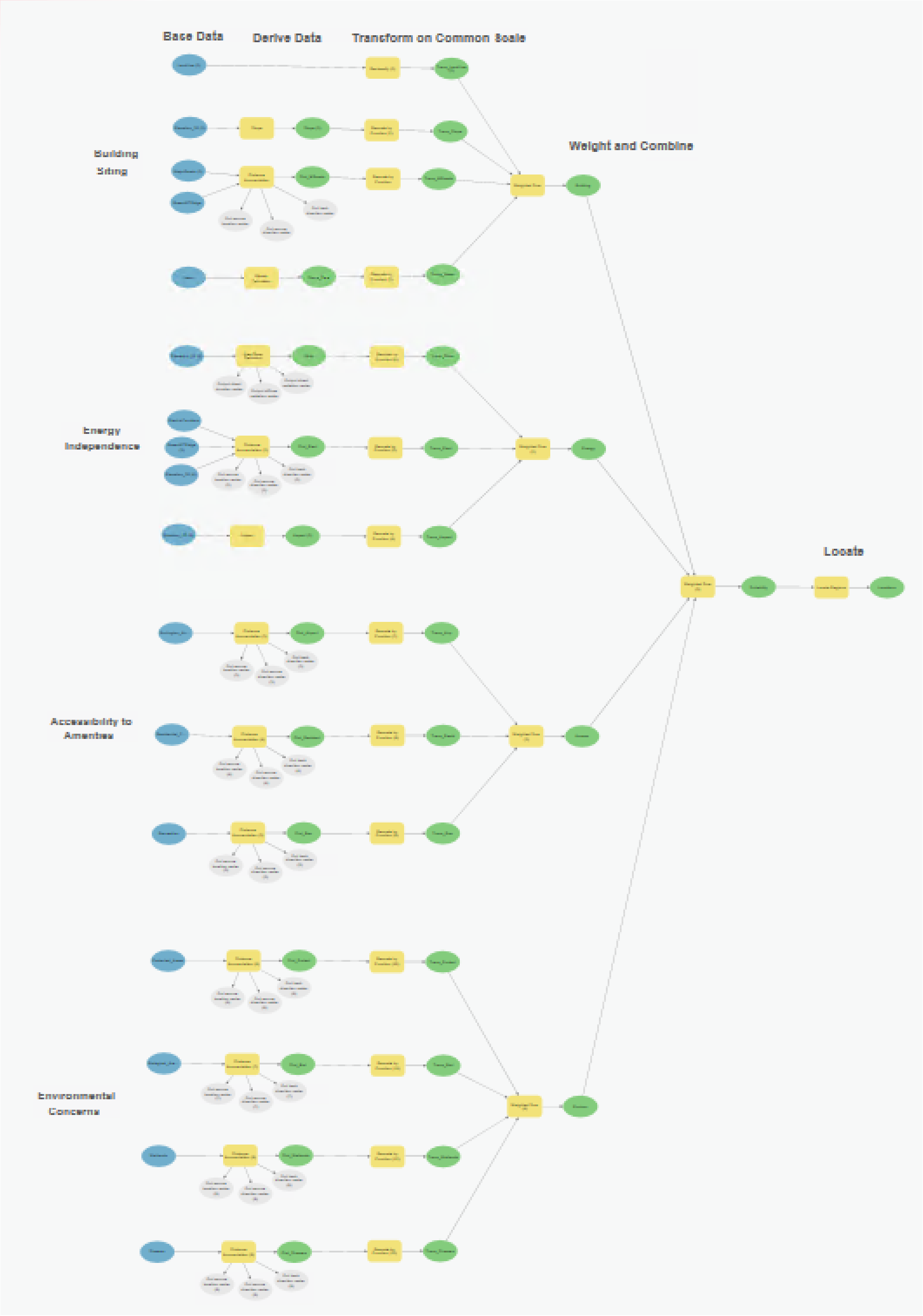

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This model includes the building site submodel, along with the other three submodels: energy independence, access to amenities, and environmental concerns. You can review the other submodels to learn how the criteria were derived, transformed, and weighted.

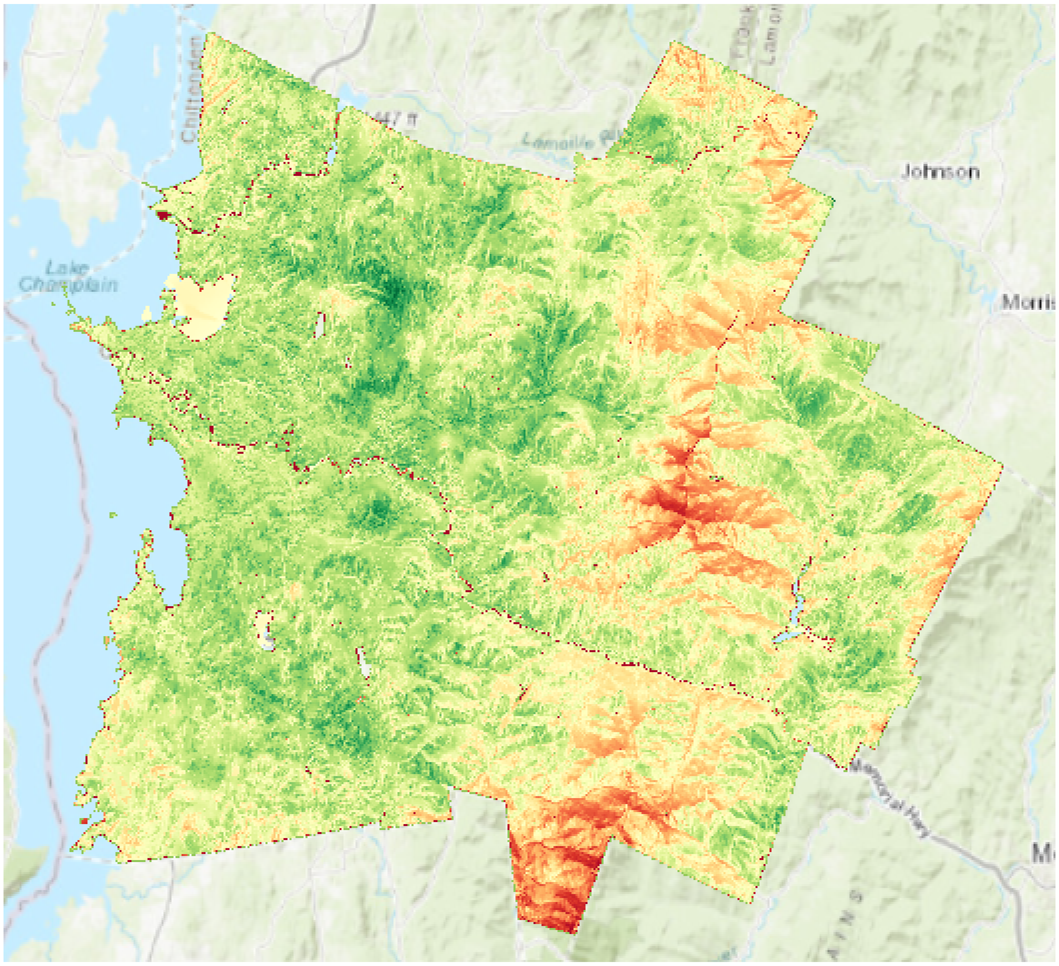
c In the model, double-click Weighted Sum (5).

Based on the tool parameters, the energy independence submodel will have the most weight, followed by the building site, environmental concerns, and access to amenities submodels.

d Close the Weighted Sum (5) dialog box.

e Run the tool and, if necessary, add the Weighted Sum analysis output to the map.

Note: The model will take some time to run.



This tool generates a suitability raster that accounts for all the analysis criteria. The more suitable areas are symbolized using green, and the less suitable areas are symbolized using

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red. You will use this information to determine the most suitable locations for the corporate headquarters.

Step 12: Locate the site

The suitability model accounts for the required attributes for the location (slope, visibility, and so on) of the corporate headquarters. However, it does not account for the spatial requirements of the headquarters (number and size of sites for the buildings). In this step, you will use the Locate Regions tool to incorporate the spatial requirements with the attribute requirements to identify the best location or a configuration of locations that are best for the headquarters.

a Click the Suitability Model view tab and double-click the Locate Regions tool.

The Locate Regions tool identifies contiguous areas that have the highest overall suitability given the specified spatial requirements. The corporate shareholders have indicated that they want the headquarters to be a campus with five buildings within walking distance to each other. After further research and discussion, you used this information to define the following spatial requirements.

- The site must include 500 hectares of total area.
- The areas will be divided into five different areas, or regions.
- No two regions can be closer than 0.5 kilometers or further than 2 kilometers.

b Review the parameters in the Locate Regions dialog box.

The shareholders' spatial requirements translate into the following tool parameters:

- Total Area: 500
- Area Units: Hectares
- Number Of Regions: 5
- Region Shape: Circle
- Shape/Utility Tradeoff (%): 50
- Evaluation Method: Highest Average Value
- Minimum Distance Between Regions: 0.5
- Maximum Distance Between Regions: 2
- Distance Units: Kilometers

c Close the Locate Regions dialog box

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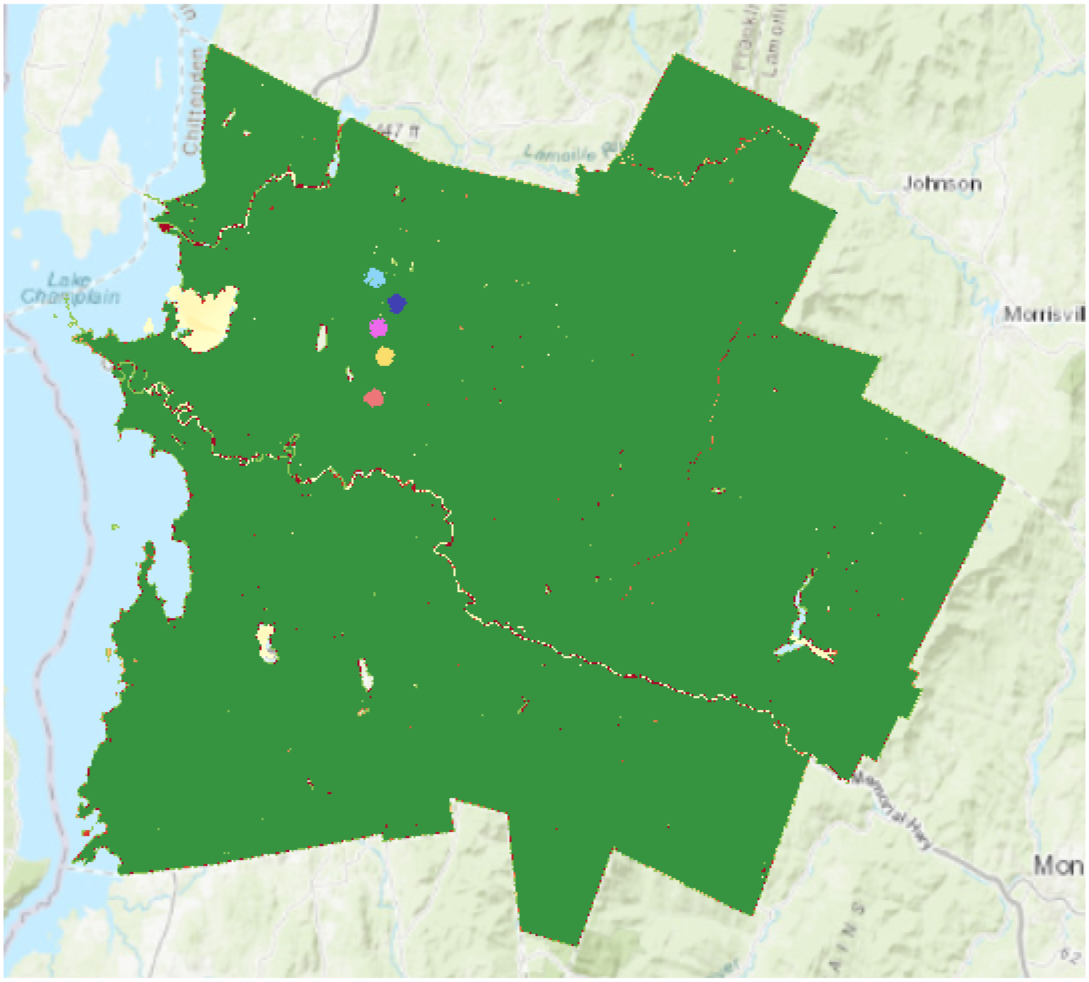
d Run the tool, and then add the analysis output to the map.

Note: The model may take a few minutes to run.



The tool used the suitability raster to select the best, or most preferable, configuration of five regions that meets the specified spatial requirements. The five regions are categorized using different cell values. You can change the symbology to better identify the five areas.

e In the Contents pane, under Locations, click the symbol next to 0.

The Symbology pane opens.

f In the Symbology pane, under the Values tab, next to 0, click the symbol.

g In the color swatch window, click No Color.

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h In the Contents pane, turn off all layers except for the following layers:

- Locations
- Suitability
- World Topographic Map

i From the Map tab, in the Navigate group, click Bookmarks and choose Headquarters.

Note: The light blue areas surrounding the five regions are lakes.

The five regions are located within the dark green areas of the suitability map, which represent the more preferable locations of the suitability analysis. Based on the suitability site criteria and the spatial requirements, these are the most suitable configurations of five building sites to locate the corporate headquarters.

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Step 13: Analyze the results

After locating the most suitable locations for the headquarters, you can analyze the results to ensure that they meet the requirements of the analysis. There are various methods that you can use to analyze the results:

- Validate the suitability model with experts from different disciplines.
- Confirm that the sites meet the required criteria.
- Modify parameter values in the data transformations and weights to gauge the effect on the overall model.

In this step, you will confirm that the sites meet the required criteria.

a. Click the Map view tab, if necessary, and then in the Contents pane, turn off all layers except for the following layers:

   - Locations
   - Views_Zero
   - World Topographic Map

b. If you did not run the model from the Suitability Model view tab, in the Contents pane, drag the Locations layer above the Building layer.

c. In the Contents pane, select the Locations layer.

d. From the Appearance tab, in the Effects group, click Swipe.

e. Near the top of the map, click and hold, and then move your pointer down and up to compare the Locations and Views_Zero layers.

The site locations are generally in areas that are not visible (black) or have limited visibility (dark gray) from the major roads.

f. In the Contents pane, turn off Views_Zero and turn on Slope.

g. Use the Swipe tool to compare the Locations and Slope layers.

The site locations are situated in areas with fairly gentle slopes (tan and light brown), which is in alignment with the original criteria in the analysis.

h. Continue using the Swipe tool to compare the site locations with the remaining criteria.

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Overall, the site locations meet the requirements of the analysis. Based on this information, you can move into the next phase of this analysis.

The shareholders would like the headquarters to connect to a nearby park so that employees can walk or bike between the campus buildings and the park. In this analysis, you would be identifying the best paths, or corridors.

The models for this analysis have been completed for you and are available in the Headquarters_Siting.tbx for you to optionally review or run.

- **Cost Surface:** This model identifies the cost that a traveler (walker or biker) encounters as they move through each cell. The criteria that the traveler prefers includes less steep slopes, being farther from roads, and being closer to streams. The preferred values are assigned a lower cost. The result is a cost surface identifying the cost to move through each cell with the most preferred areas having the lower values. This is the reverse of a suitability model.
- **Connect Campuses:** This model converts the park from a vector polygon to a raster, adds the park to the layer with the five headquarter buildings, and then runs a connectivity tool. The tool connects the five headquarter buildings and park using the cost surface created in the previous model. The result identifies the most suitable network of paths that connect the buildings to each other and to the park.

ⓘ If you would like to continue analyzing this model, proceed to the optional stretch goal; otherwise, save the project and exit ArcGIS Pro.

Stretch goal (Optional)

If you would like to continue analyzing this model, you can modify the criteria and submodel weights to gauge the effect on the overall model. You can then use the R statistical package to compare the difference between the original and alternative suitability models for a specific criterion.

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Note: To complete the stretch goal, you must install the following software:

- *R 3.5.3 (https://cran.r-project.org/bin/windows/base/old/3.5.3/) or Microsoft R (https://mran.microsoft.com/open)*
- *RStudio Desktop (https://rstudio.com/products/rstudio/download/#download)*
- *R-ArcGIS Bridge (https://community.esri.com/videos/4136-installing-the-r-arcgis-bridge-for-arcgis-pro-20)*

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The following is a list of high-level tasks that you can follow to complete this analysis:

1. In ArcGIS Pro, run an alternative suitability model, adjusting the weights and renaming the output.
2. From RStudio, in the R Command Promt, use **install.packages** to install R's raster data manipulation library (raster), comparing suitability scenarios package (rsMove), and two spatial data manipulation packages (sf and sp).
3. Open a blank R file by typing Ctrl + Shift + N on your keyboard.
4. In the blank R file, use **library()** to import the arcgisbinding, raster, and rsMove packages.
5. Confirm that the R-ArcGIS bridge is connected to ArcGIS Pro.

   Note: You may be prompted to run the arc.check.product() function to confirm that the R-ArcGIS bridge can connect to a valid ArcGIS Pro license.
6. Define variables for the original suitability raster and the alternative suitability raster and make them read-only.
7. Use **arc.open** and **arc.raster** to read in raster data from the suitability raster definitions.
8. Convert the suitability rasters to an R raster format.
9. Confirm that the suitability raster extents are the same.
10. Visualize the suitability rasters in R.
11. Use a **plot** function to plot the optimal locations from both suitability rasters, using a new extent.
12. Define a variable for the land use criterion raster.
13. Confirm that the land use raster has the correct projection and extent.
14. Stack the suitability rasters for comparison.
15. Define the land use types that correspond to the land use raster integers.
16. Use the **plausibilityTest** function to compare the land use types from the optimal locations in the original suitability raster with the land use types from the optimal locations in the alternative suitability raster.
17. Continue comparing the optimal locations in the original and alternative suitability rasters using other criteria from the models.

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The following resources can help with the syntax required to complete this analysis:

- GitHub: R-Bridge-Tutorial-Notebooks
- RDocumentation: Stacking Rasters
- Predicting Resource Suitability with rsMove

Use the Lesson Forum to post your questions, observations, and syntax examples. Be sure to include the **#stretch** hashtag in the posting title.

Note: The R-ArcGIS bridge enables you to combine the power of ArcGIS and R to solve spatial problems. This stretch goal introduces you to the R-ArcGIS bridge with a simple analysis. For more examples of analyses that you can complete using the R-ArcGIS Bridge, see GitHub: R-Bridge-Tutorial-Notebooks.

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