

## OBJECTIVES

- Load ArcGIS 3D Analyst extension
- Create 3D Scenes
- Create a TIN from contours
- Drape features onto a TIN
- Create 3D buildings
- Set observer and target locations
- Fly through a scene
- Create multiple views
- Add 3D effects
- Create animations
- Use 3D symbols
- Perform a line of sight analysis
- Explore ArcGlobe

## ***GIS Tutorial 10***

# **ArcGIS 3D Analyst**

This tutorial is an introduction to ArcGIS 3D Analyst, an extension for ArcGIS. The extension needs to be installed on your computer before you can start this chapter. 3D viewing can provide insights that would not be apparent readily from a 2D map of the same data. For example, instead of inferring the presence of a valley from 2D contours, in 3D you can actually see the valley and perceive the difference in height between the valley floor and a ridge. This tutorial uses topography, curb, and building data from the city of Pittsburgh's Mount Washington and Central Business District neighborhoods to show you how to display and analyze data in 3D.

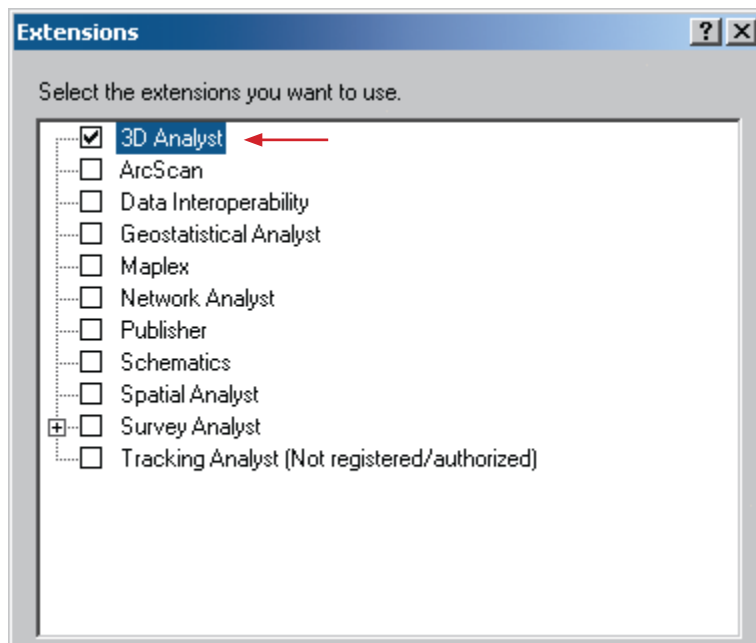
# Load ArcGIS 3D Analyst Extension

## *Launch ArcMap*

- 1 From the Windows taskbar, click Start, All Programs, ArcGIS, ArcMap.
- 2 Click the A new empty map radio button in the ArcMap window and click OK.

## *Add 3D Analyst extension*

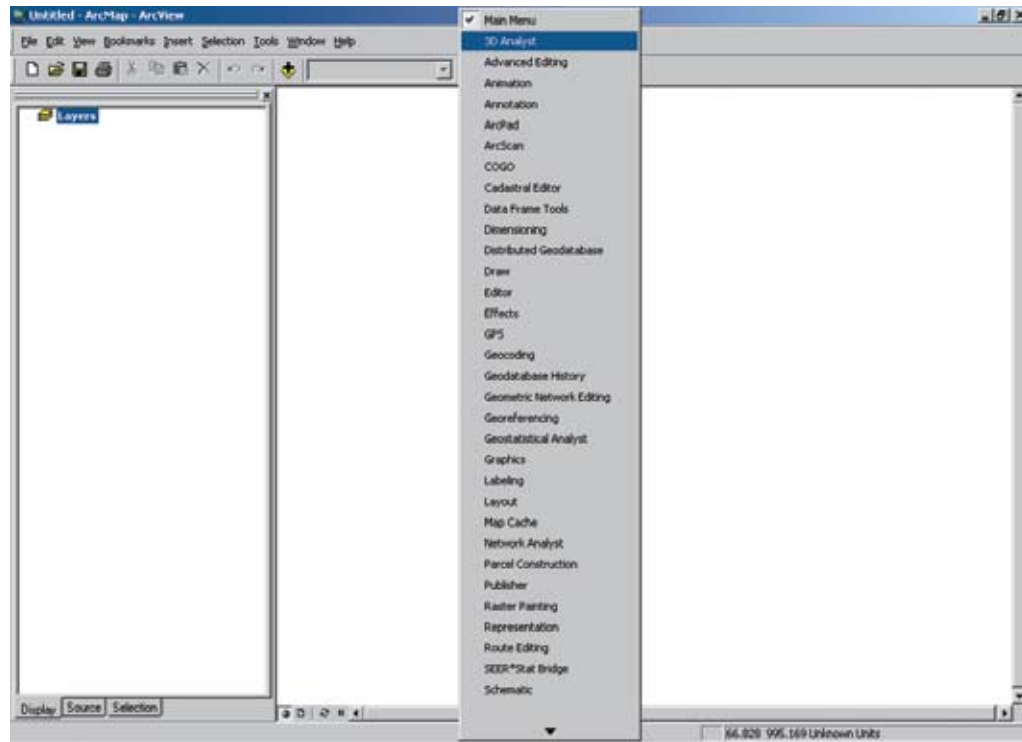
- 1 Click Tools, Extensions.
- 2 Click the check box beside the 3D Analyst extension and click Close.



### Add 3D Analyst toolbar

- 1 Right-click on any toolbar and click 3D Analyst.

A check appears beside the name of the extension if its toolbar is loaded.



The following is the toolbar for 3D Analyst functions. The toolbar can be docked or free-floating.



# Create 3D scenes

ArcScene is an application that allows you to display and navigate data in 3D.


## Launch ArcScene

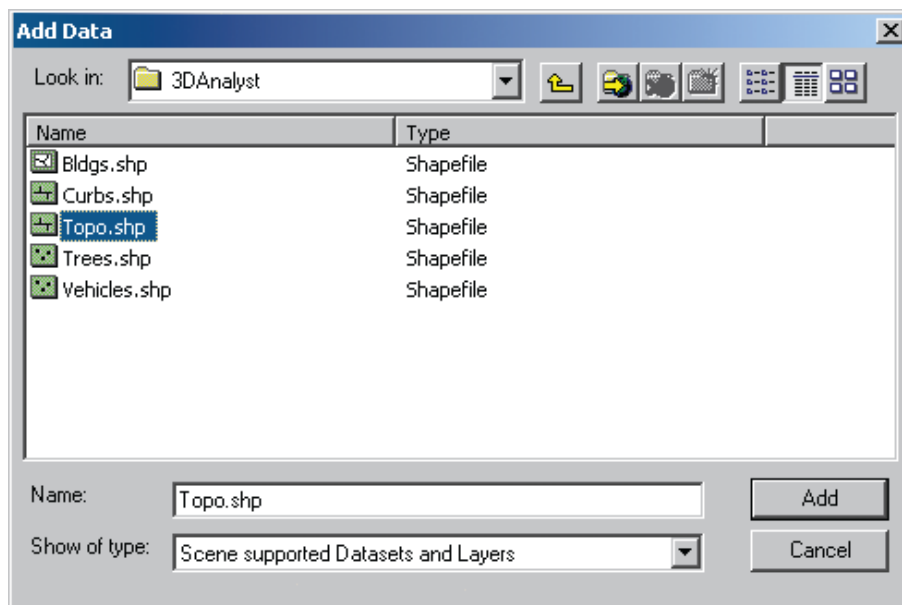
- 1 From the 3D Analyst toolbar click the ArcScene button. 

A new untitled scene opens and you need to add your 2D layers to it.

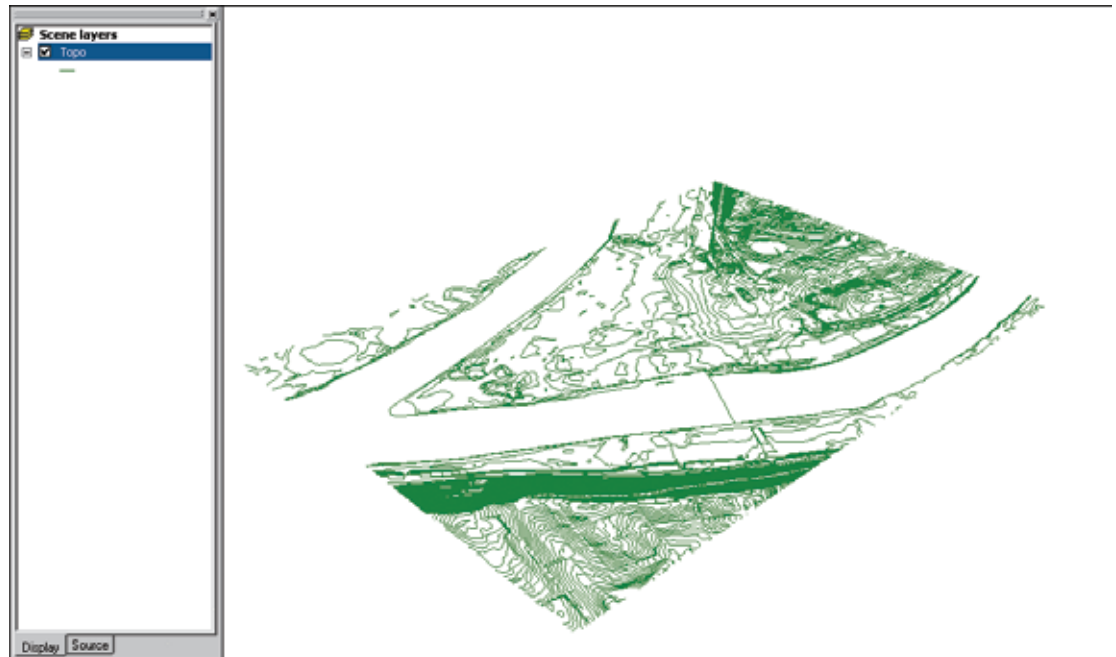
- 2 Close ArcMap.

## Add topo layer

- 1 In ArcScene click the Add Data button. 
- 2 In the Add Data browser, browse to \Gistutorial\3DAnalyst, click Topo.shp, and click Add.



A topography layer of contours near downtown Pittsburgh, Pennsylvania, appears as a 3D view.

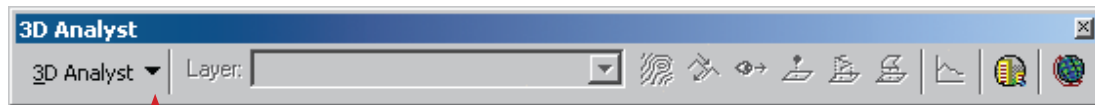


# Create a TIN from contours

## Create a TIN (triangulated irregular network)

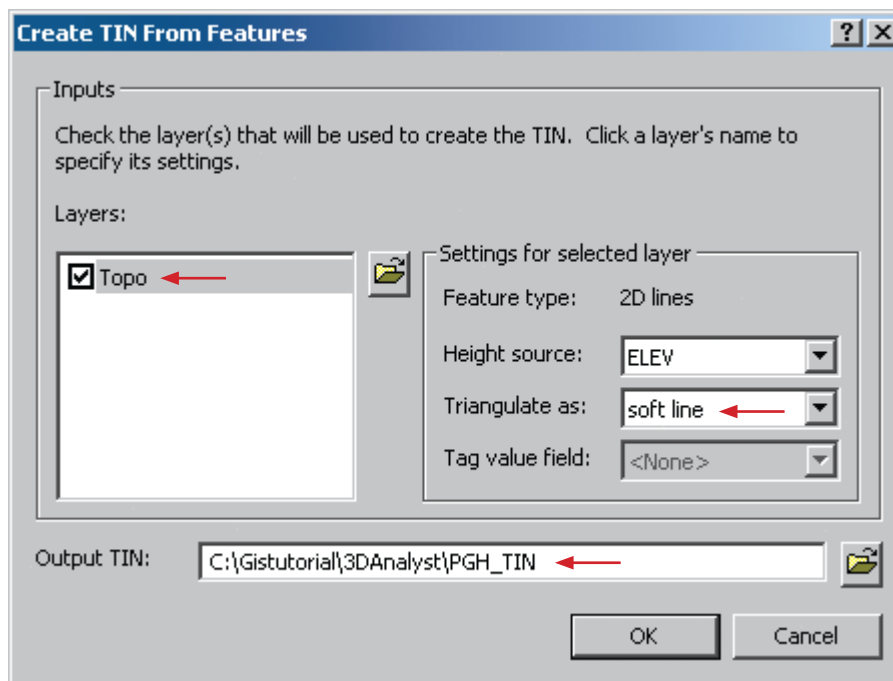
3D topography known as TIN uses elevation data of the 2D topographic lines as input. A TIN is a vector data model of contiguous nonoverlapping triangles whose vertices are created from sample points of x, y, and z values and displayed as a surface model.

- 1 Turn on the 3D Analyst toolbar in ArcScene.
- 2 On the 3D Analyst commands menu from the 3D Analyst toolbar, click Create/Modify Tin, then click Create TIN from Features.

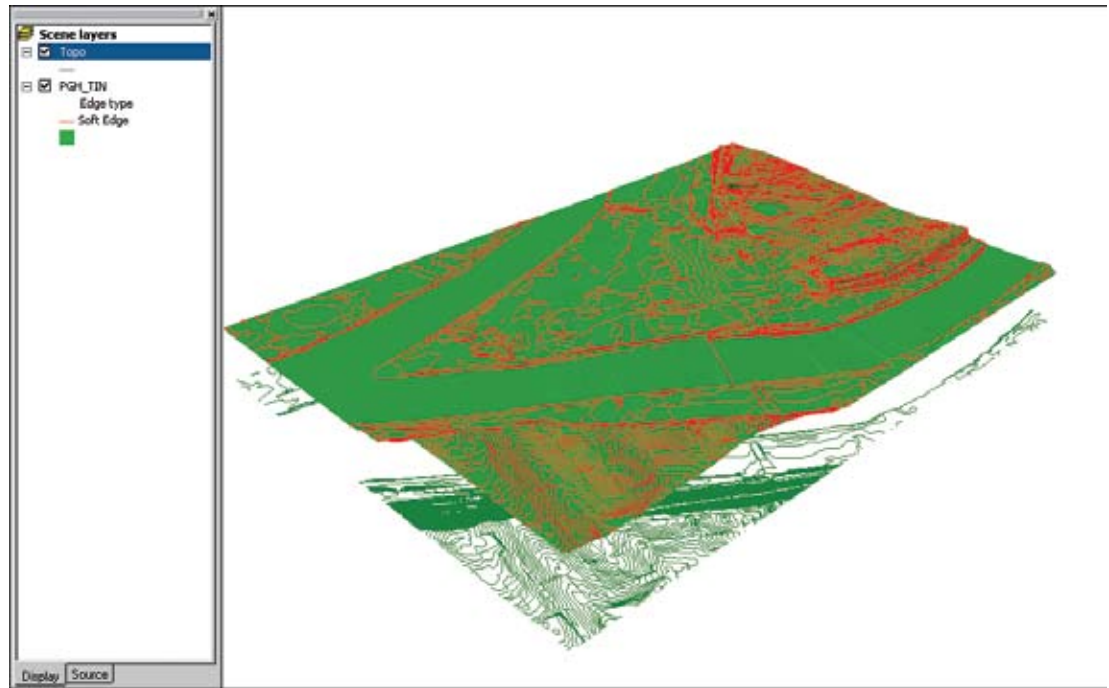


Command menu

- 3 In the Create TIN from Features window, click the check box to the left of Topo.
- 4 Click the drop-down list for Triangulate as and choose soft line.
- 5 Change the output TIN to \Gistutorial\3DAnalyst\PGH\_TIN.
- 6 Click OK.




3D Analyst creates a triangulated irregular network (TIN) from the topography contour lines and adds it as a new layer.

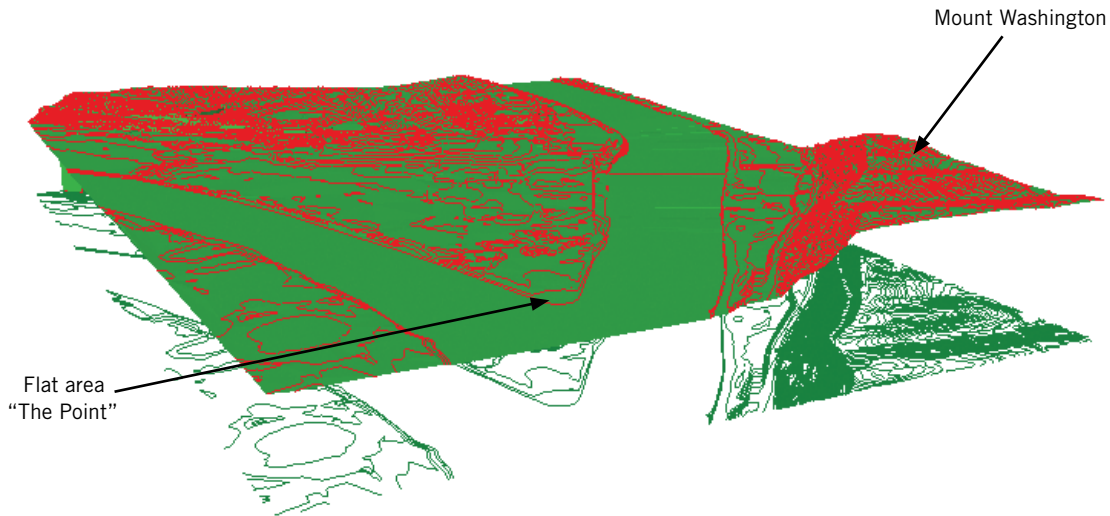


### Navigate 3D view

It is often useful to view 3D maps from different angles and the 3D Analyst extension makes it easy to do so.

- 1 From the Tools toolbar, click the Navigate button. 
- 2 Click and drag the map to view the scene from different angles.


You will see that Pittsburgh is fairly flat where the three rivers converge (this area is known as “The Point”) and more hilly in the Mount Washington neighborhood to the right of the point in the map below.

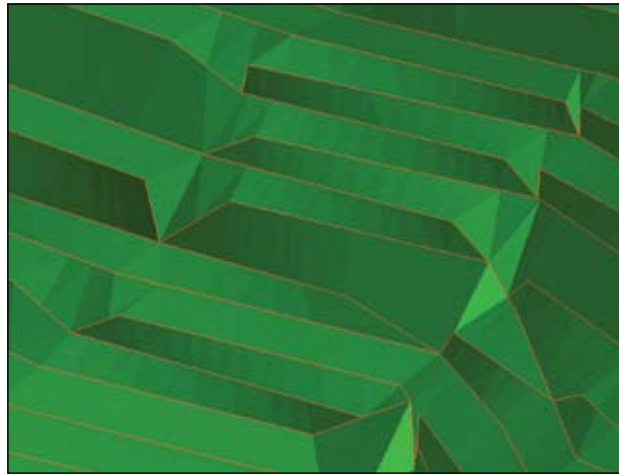




### ***Zoom to TIN***

Zooming to a small area allows you to see the triangulated irregular network better. You can see the many small triangular facets making up the surface of the pgh\_tin.

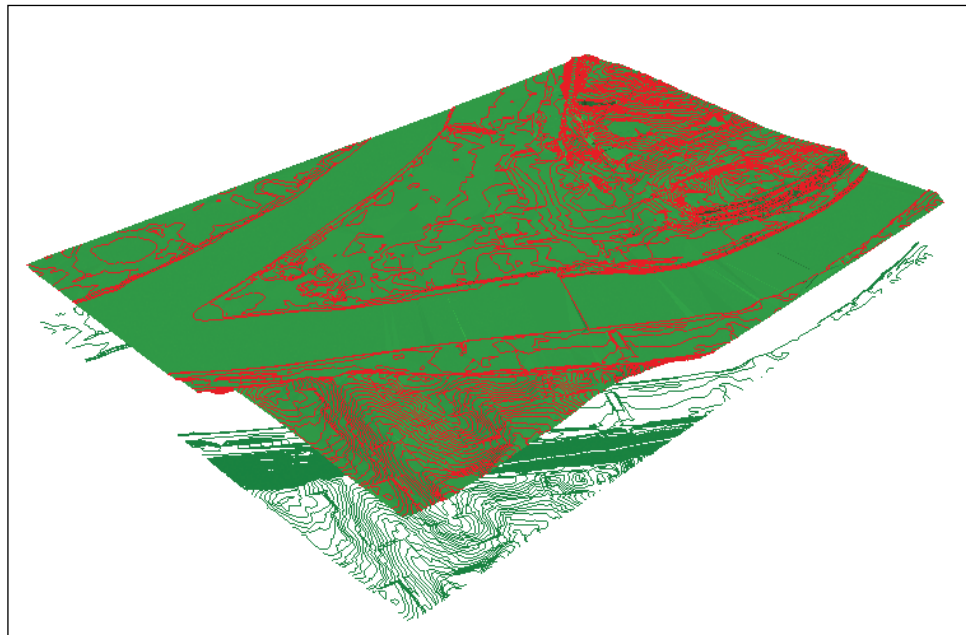
- 1 Click the Zoom In button. 
- 2 Zoom to a small area on Mount Washington.



### ***Zoom to extents***

Navigation changes to the view in your 3D scene may become confusing. Zooming to the full extent returns the view to the original 3D isometric scene.

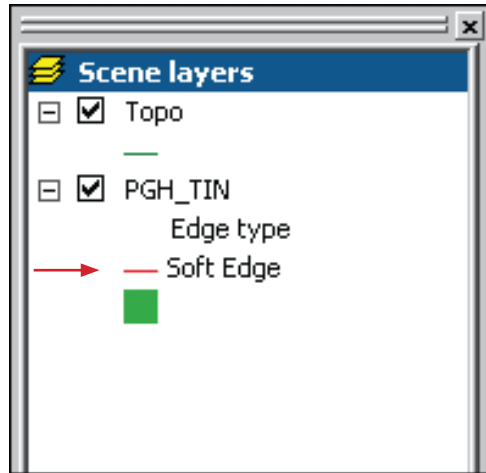
- 1 Click the Full Extent button. 



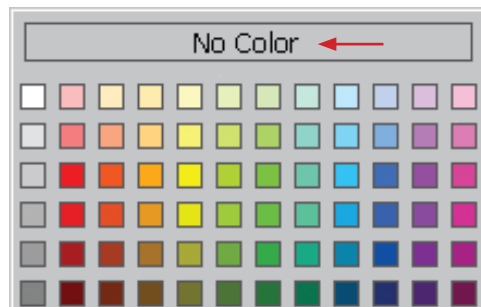
### Turn soft edges off

Changing the appearance of edges on the TIN contours and turning off the topography lines will allow you to see other features (added later) more clearly. It can also help you to see the 3D contours better.

- 1 In the Table of Contents, double-click the PGH\_TIN layer's symbol for soft edge.



- 2 Set the line symbol to No Color.



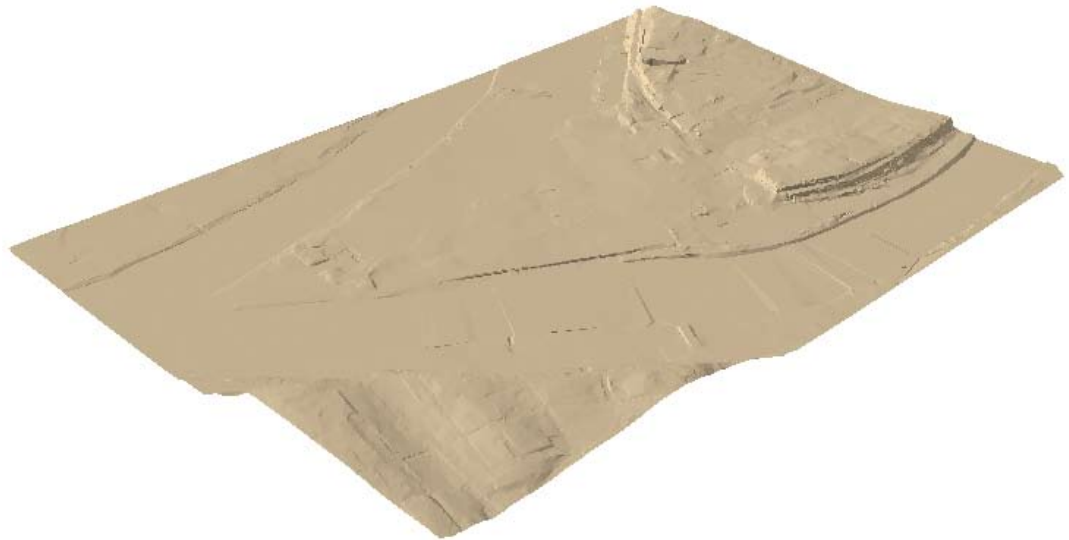
- 3 Turn off the original Topo layer.

### *Change TIN color*

- 1 In the table of contents, double-click the green symbol for the PGH\_TIN layer.
- 2 Set the fill color to Tecate Dust or a similar light brown color.



The resulting scene shows just the PGH\_TIN layer as a light brown color.

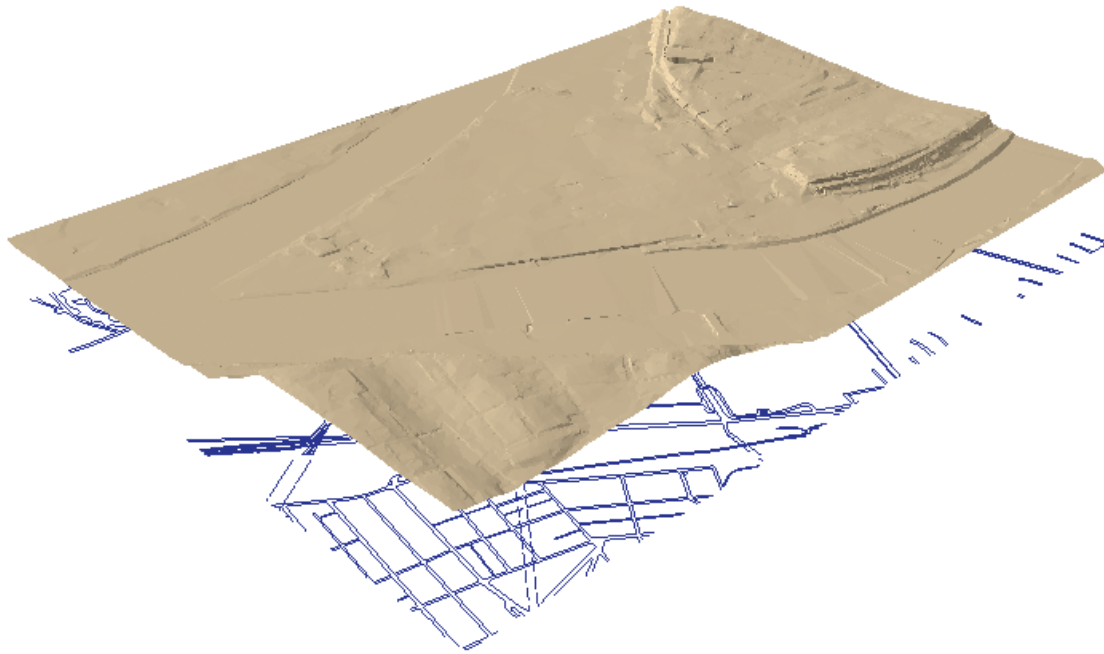


# Drape features onto a TIN

## *Add curbs data*

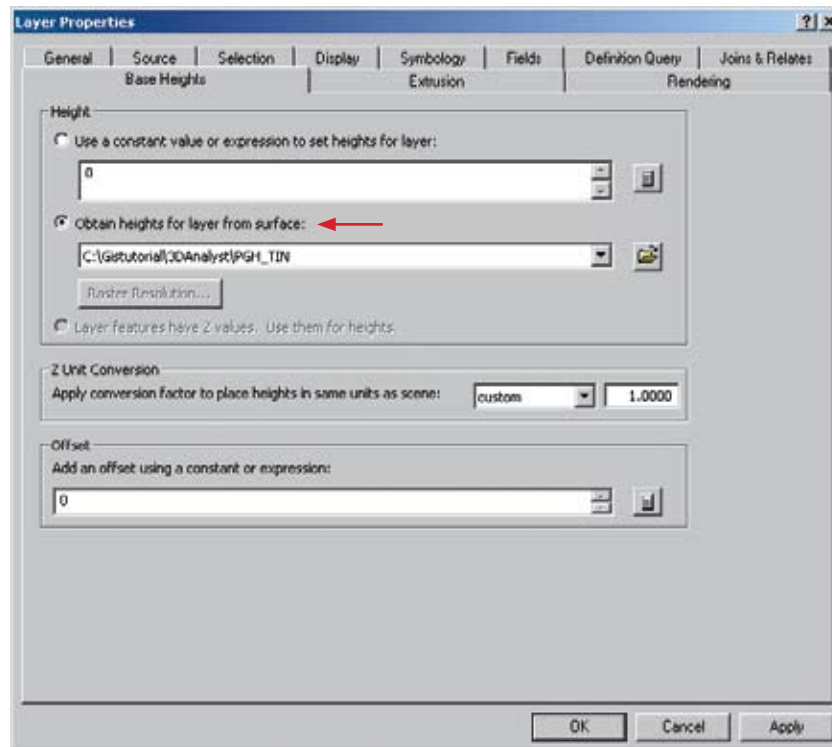
- 1 Click the Add Data button, browse to \Gistutorial\3DAnalyst, click **Curbs.shp**, and click Add.

Curbs appear below the TIN contours.

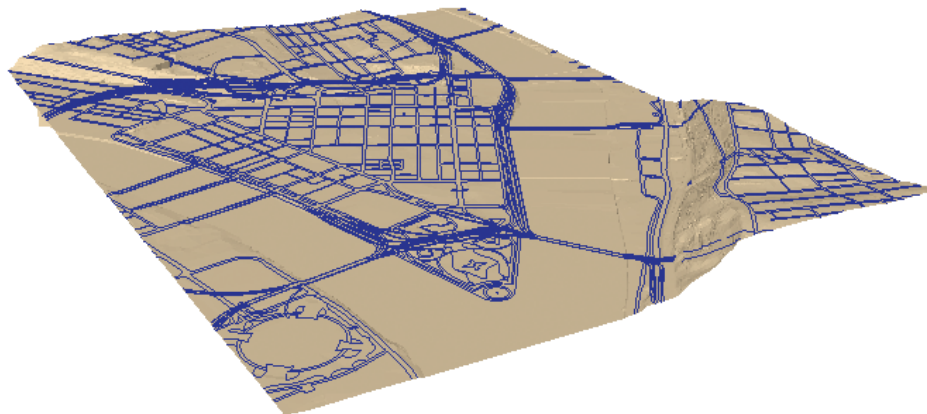


### *Drape curbs*

- 1 In the table of contents, right-click the Curbs layer and click Properties.
- 2 Click the Base Heights tab, click the radio button beside Obtain heights for layer from surface, click Apply and OK.



The resulting map displays the curbs draped over contours.



### ***YOUR TURN***

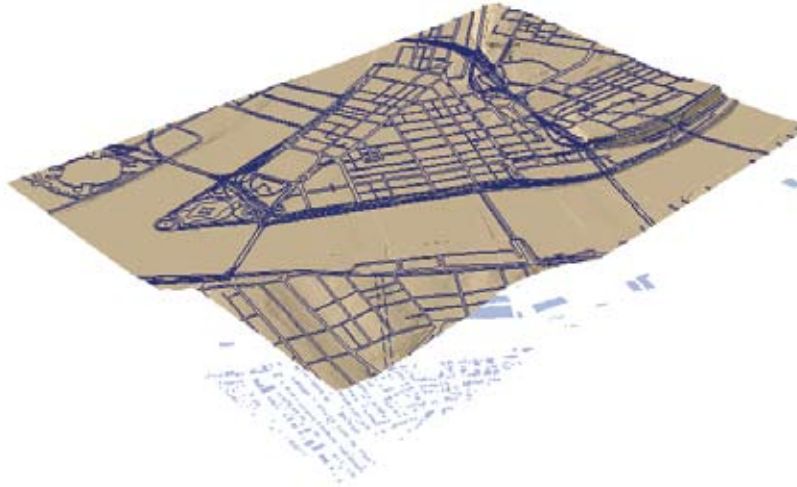
Use the Navigate tool to view the scene from different angles. When finished, zoom to full extent.

# Create 3D buildings

## Add buildings data

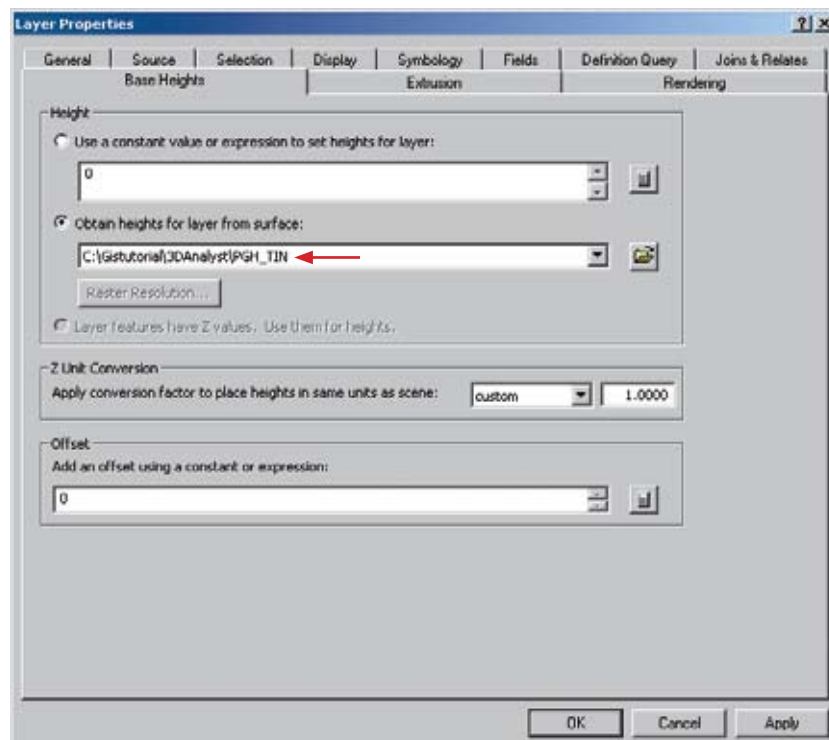
- 1 Click the Add Data button, browse to \Gistutorial\3DAnalyst, click Bldgs.shp and Add.


This action adds the buildings layer with fictitious heights which were assigned in the attribute table.

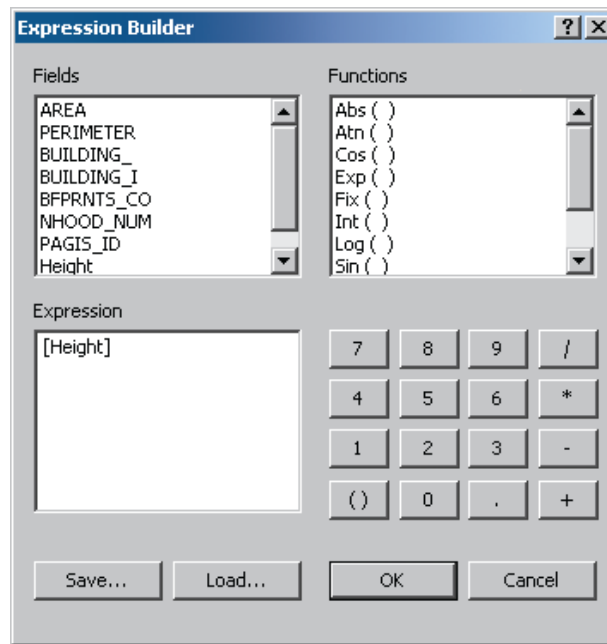


## Drape buildings to TIN and extrude buildings

- 1 Right-click the Bldgs layer and click Properties.
- 2 Click the Base Heights tab and click the radio button beside Obtain heights for layer from surface.

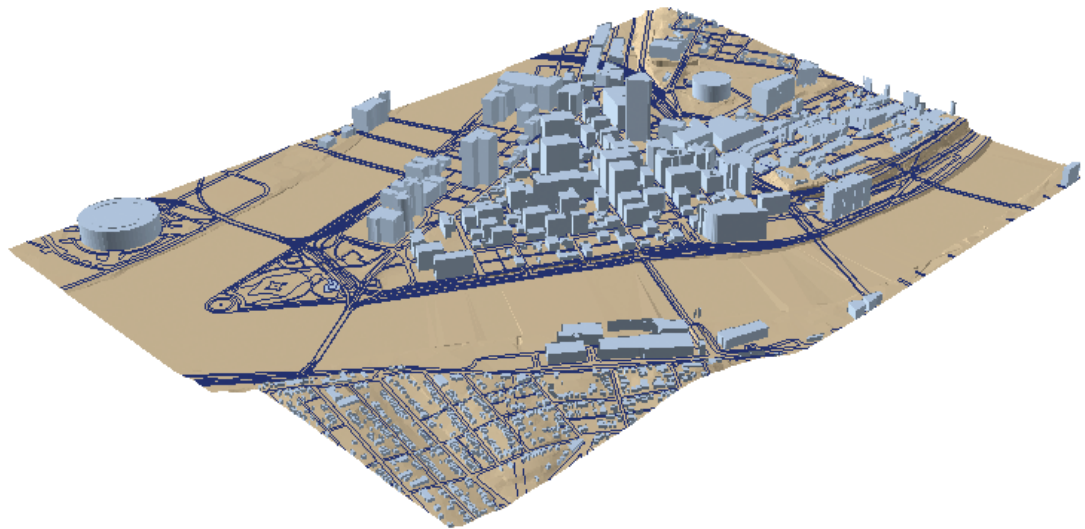


- 3 Click the Extrusion tab.
- 4 Click the Calculator button. 
- 5 Double-click the Height field to extrude the buildings based on the value in the height field.




- 6 Click OK twice.

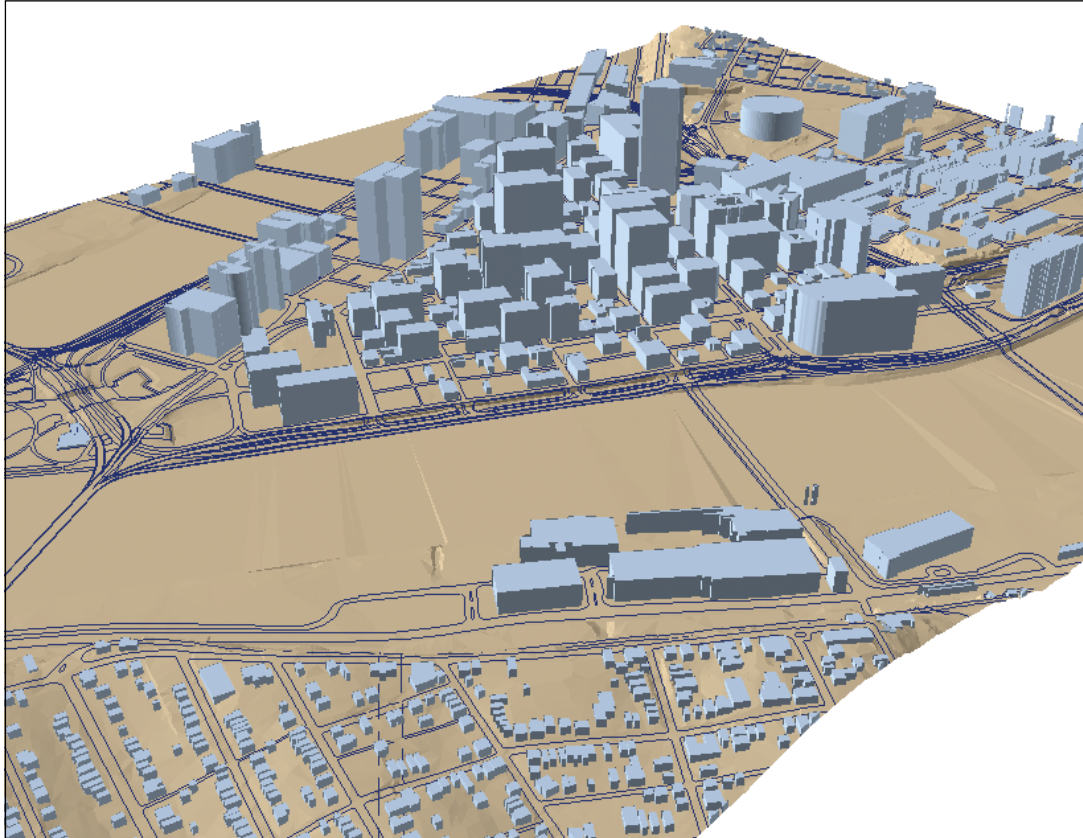
The resulting view is buildings with various heights all positioned on the topography TIN contours. Note that most of the buildings in the Mount Washington neighborhood appear to be residential houses, and the downtown area contains high-rises.



# Set observer and target locations

## *Zoom in and out*

- 1 Click the Zoom In/Out button. 
- 2 Click and Drag the cursor in the middle of the scene to zoom in or out.




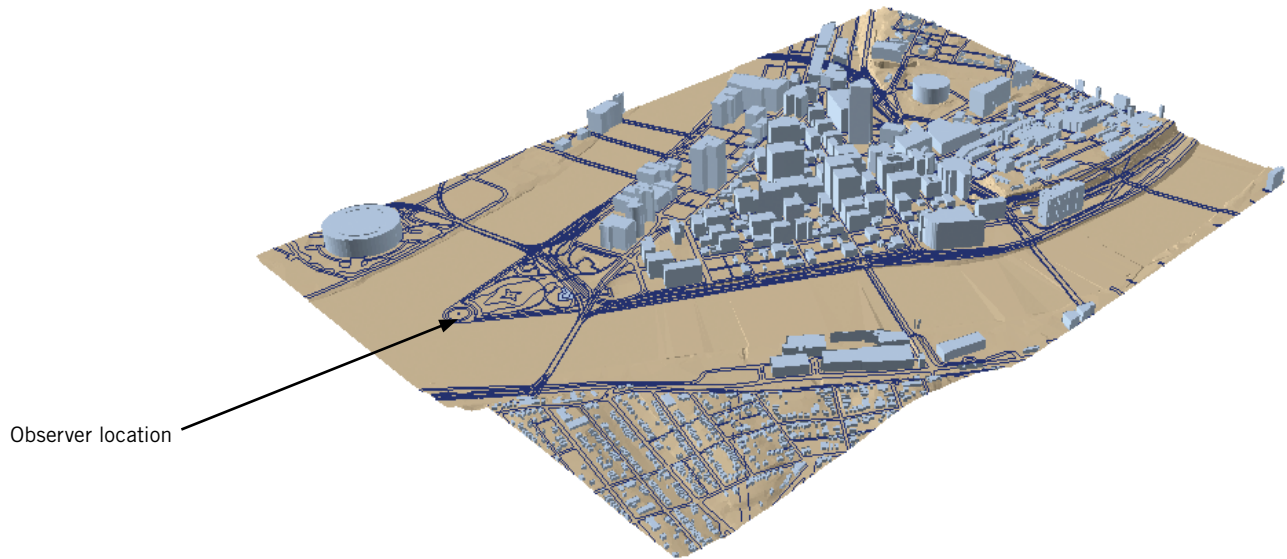
### ***YOUR TURN***

Practice viewing the scene using the other standard viewing buttons such as Pan, Fixed Zoom In, and Fixed Zoom Out. When finished, zoom to full extent.

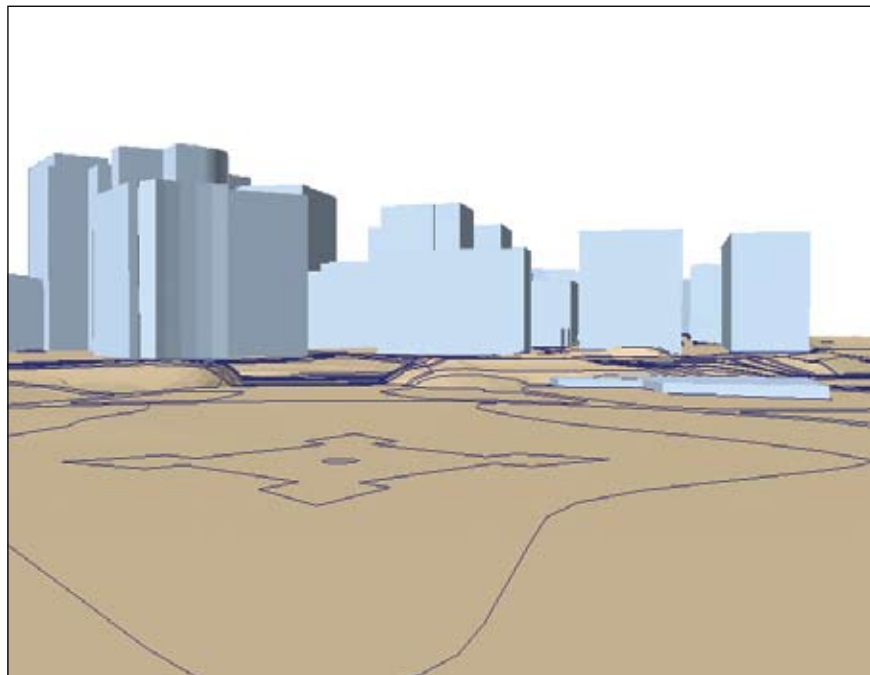


### ***Set observer location***

- 1 From the Tools toolbar, click the Set Observer button. 
- 2 Click a location at the point where the three rivers in Pittsburgh meet to set the observer location.

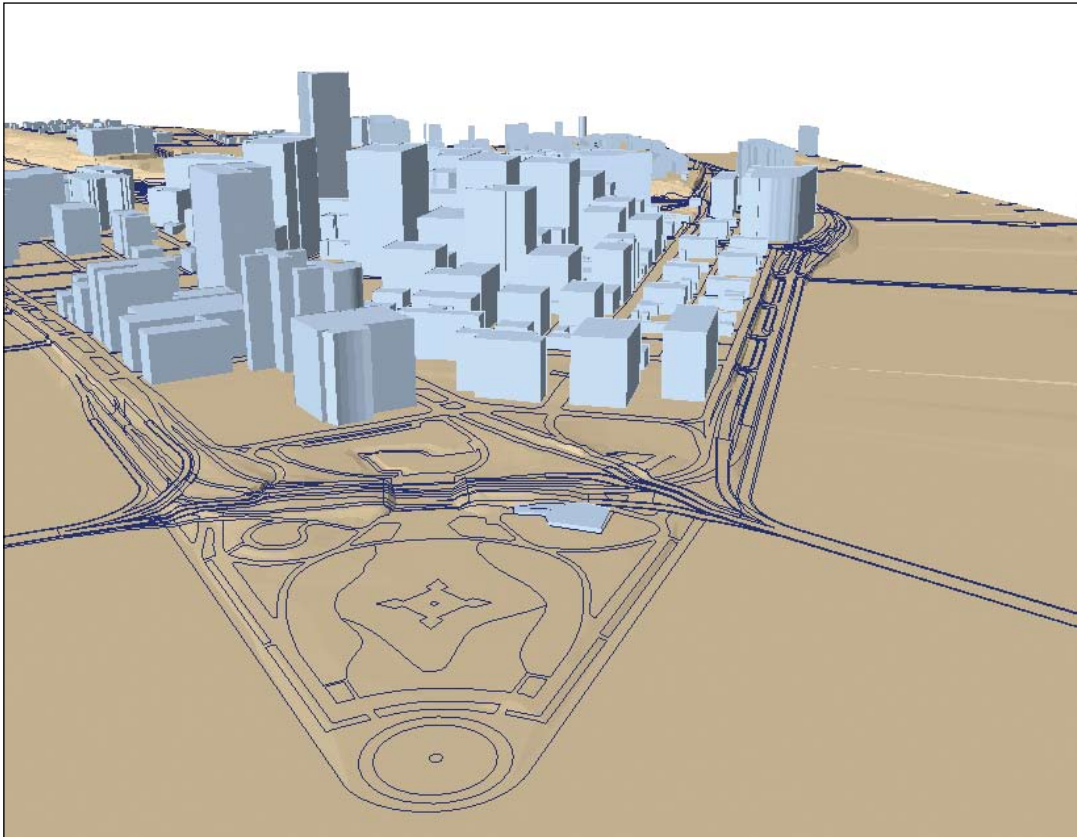


The 3D scene places the observer location at the point you pick.





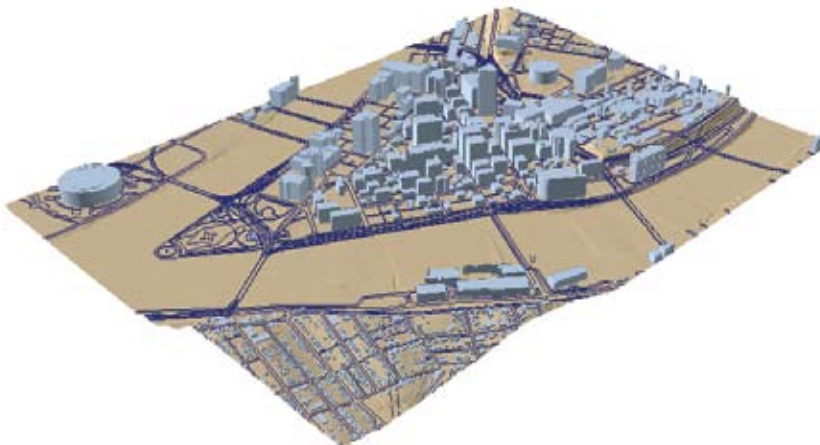
### *Navigate and zoom*

- 1 Click the Navigate  and Zoom In/Out  buttons to move in or out from the observer location.



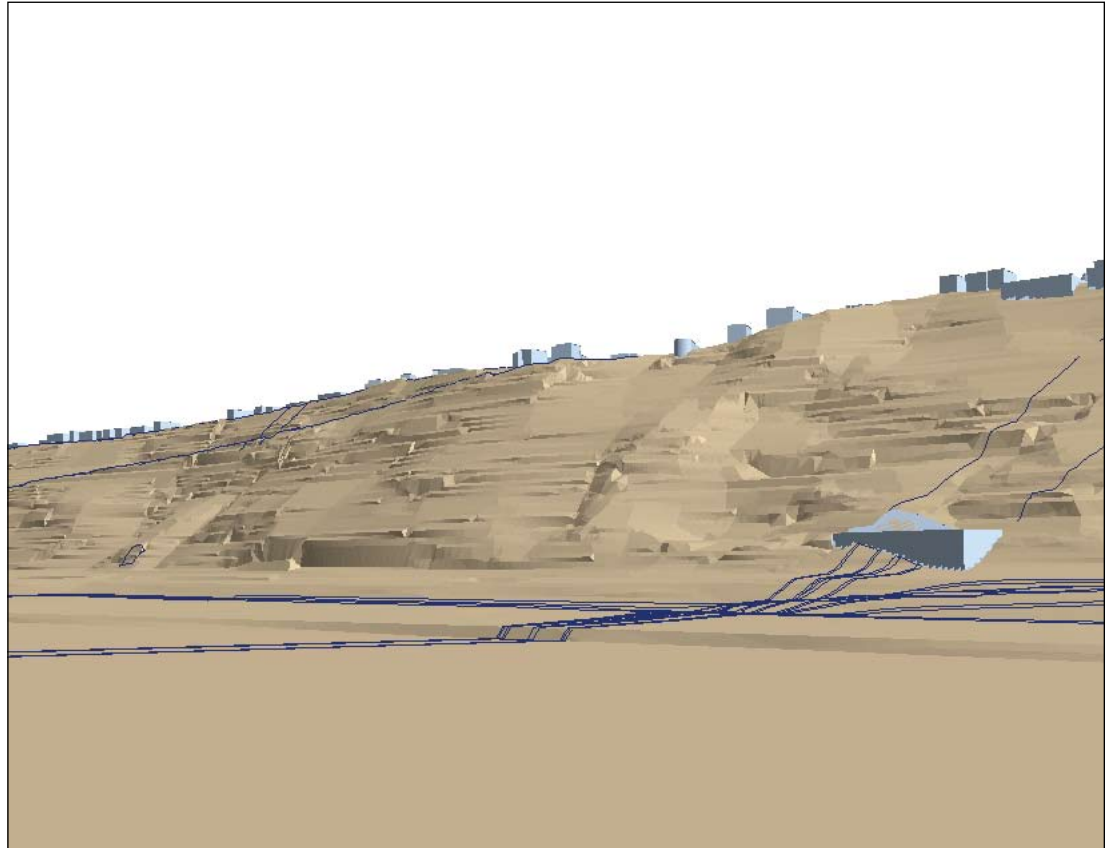
### *Center view on target location and observer*

- 1 Click the Full Extent button. 
- 2 From the Tools toolbar, click the Center on Target button. 
- 3 Click a location on the Mount Washington neighborhood that overlooks the city of Pittsburgh.





- 4 Click the Set Observer button. 
- 5 Click the previous observer location at the point, where the three rivers in Pittsburgh meet.

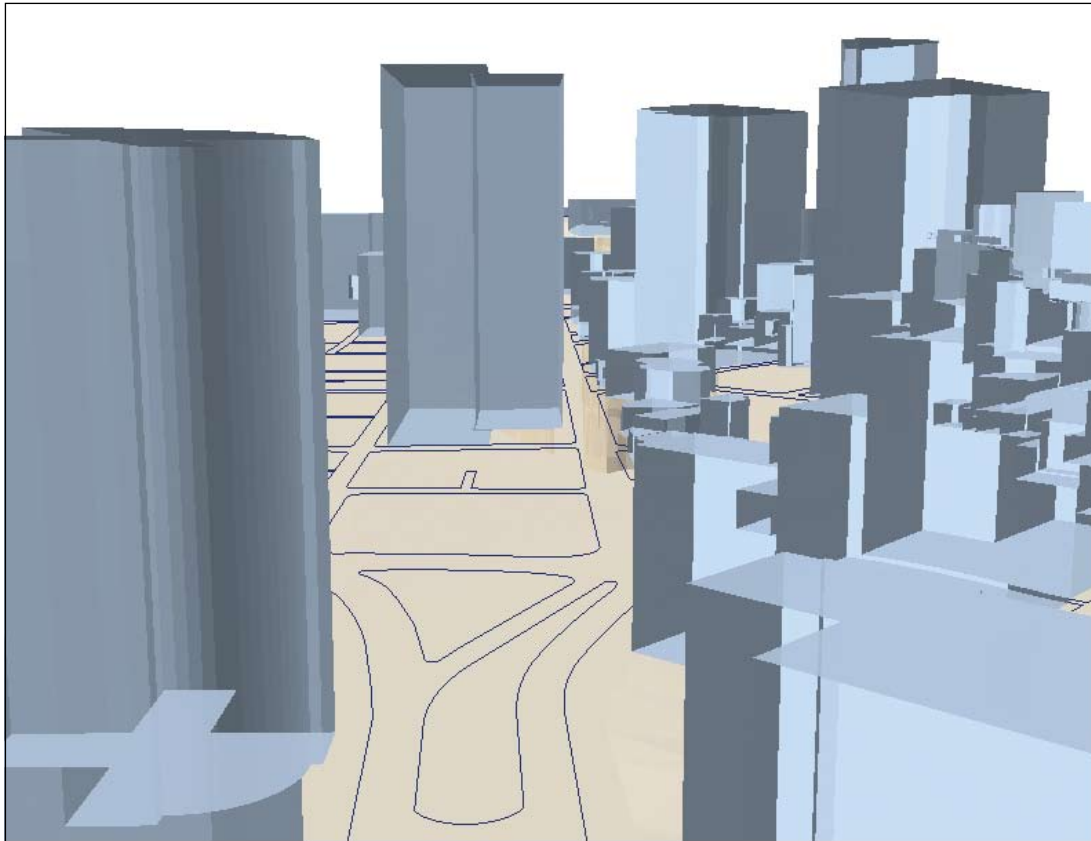
The resulting view will be the observer looking from Point State Park to the Mount Washington neighborhood.



# Fly through a scene


- 1 Click the Full Extent button. 
- 2 From the Tools toolbar, click the Fly button. 
- 3 Click anywhere in the scene with the bird cursor.
- 4 Slowly move the mouse to the left, right, up, or down.
- 5 Click the left mouse button to increase your speed.
- 6 Click the right mouse button to decrease your speed.
- 7 Press Escape (Esc) key on the keyboard to stop flight.

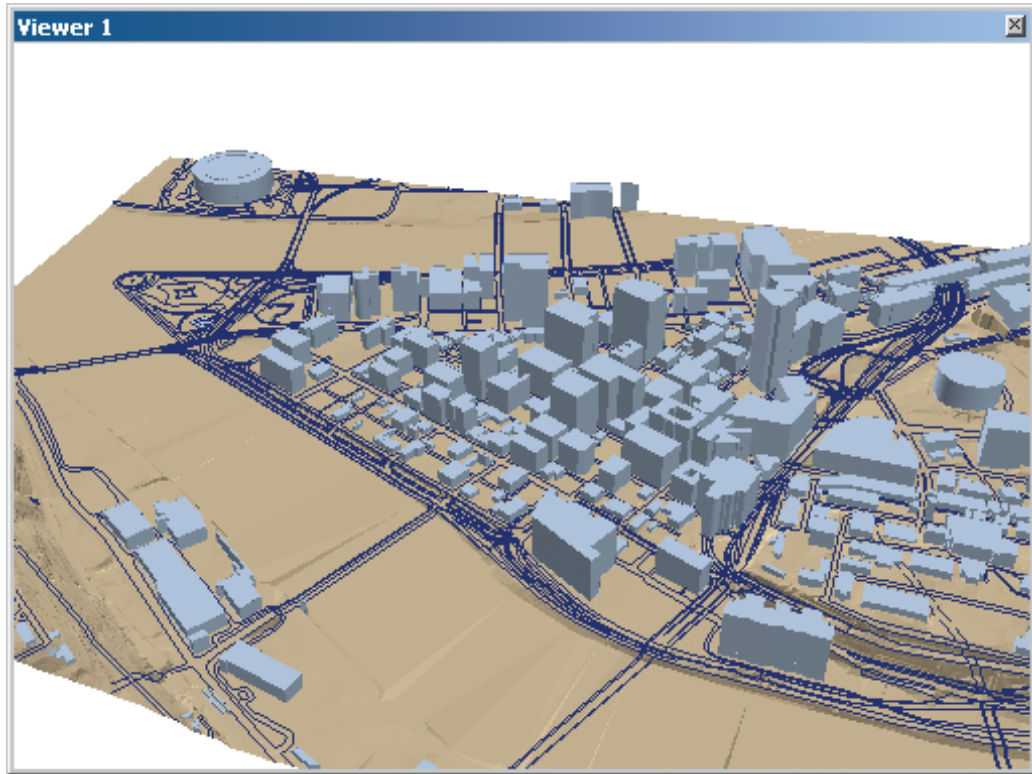
A new view appears where you stop the fly-through.



- 8 Zoom to the full extent.

# Create multiple views

- 1 From the Standard toolbar, click the Add New Viewer button. 
- 2 Click the Navigate and Zoom In/Out buttons to change the view. You may also use the scroll wheel on your mouse to zoom in and out.



## YOUR TURN

Using the Add New Viewer button, create another view of the opposite side of the study area. Close your new views when finished.

## Save the 3D scene

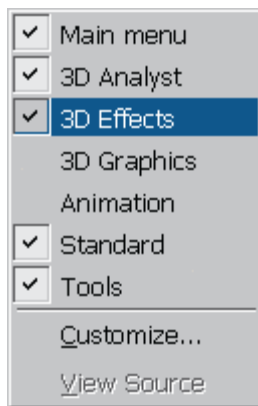
1. Click File, Save As.
2. Navigate to `\Gistutorial` and save the 3D scene as **Tutorial10-1.sxd**.

# Add 3D effects

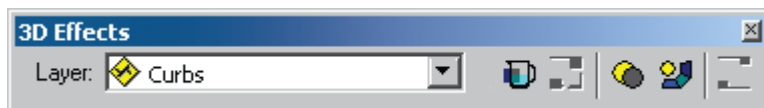
Special effects such as transparencies, lighting, and shading modes can greatly enhance the 3D experience for the viewer. The Layer Face Culling command turns off the display of front or back faces of an aerial feature or graphic, Layer Lighting turns lighting on or off for the selected layer, Shading Mode allows you to define the type of shading (smooth or flat) to use for the layer selected, and Depth Priority allows you to define which 3D layer should be given higher priority. This is useful when you have two 3D polygon layers that share the same location and might obstruct each other (e.g., parcels and buildings).

## Add 3D Effects toolbar


- 1 In the Tutorial10-1.sxd ArcScene document, right-click anywhere in the blank area of a toolbar.
- 2 Click 3D Effects to turn this toolbar on.



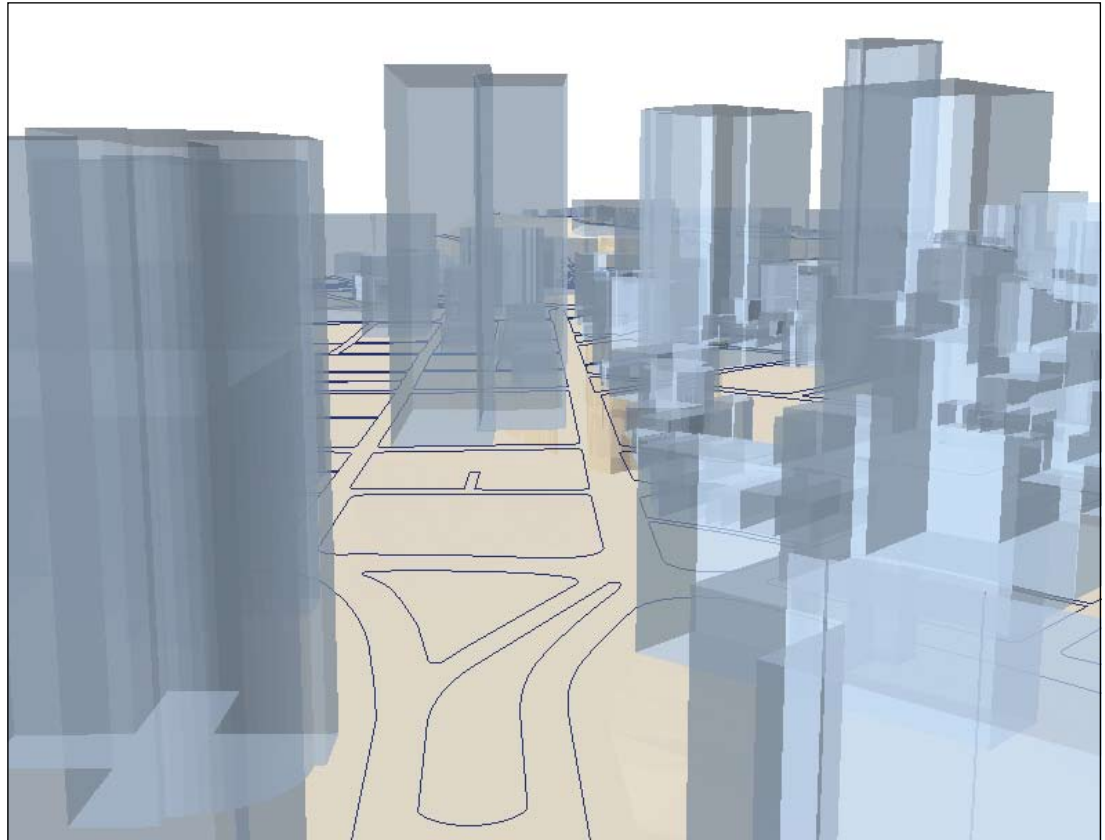
The following toolbar appears with options for 3D Effects.



### ***Create transparency effect***

- 1 From the 3D Effects toolbar, click the Layer drop-down, and click Bldgs.
- 2 Click the Layer Transparency button  and change the layer's transparency to 50%.

Below is the resulting transparency effect for the 3D buildings.



### ***YOUR TURN***

Change other effects for your 3D buildings including Layer Face Culling, Layer Lighting, Shading Mode, and Depth Priority. Change the effects for the Curbs and PGH TIN layers in your 3D scene.

### ***Save the 3D scene***

- 1 Click File, Save As.
- 2 Navigate to `\Gistutorial` and save the 3D scene as **Tutorial10-2.sxd**.

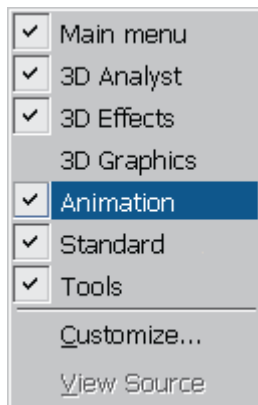


# Create animations

3D Animations allow you to record movements within your views so that you can save and play them back at a later time.

## Add animation toolbar





- 1 Working in the same scene, right-click anywhere in the blank area of a toolbar.
- 2 Click Animation to turn this toolbar on.



The following toolbar appears with options for Animations.



## Record an animation

- 1 Click the Open Animation Controls button  from the Animation toolbar.
- 2 Click the Record button. 
- 3 Click the Fly button  and create a fly-through anywhere in your scene. Click the Esc key to end your flight.
- 4 Click the Stop button. 



### *Play an animation*

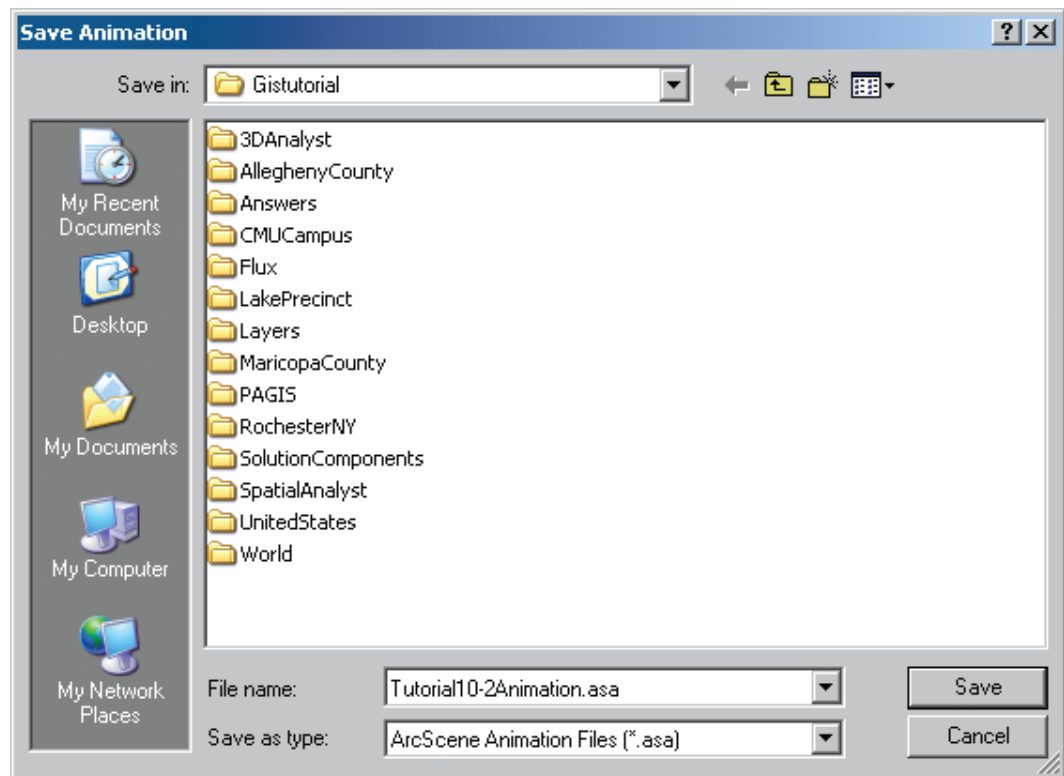
- 1 Click the Play button ► from the Animation Controls toolbar.

#### **YOUR TURN**

Practice creating animations by zooming into a small area first. Explore the Options menu in the Animation Controls toolbar to see animation play and restore options.

### *Save an animation*

- 1 From the Animation toolbar, click Animation, Save Animation File.

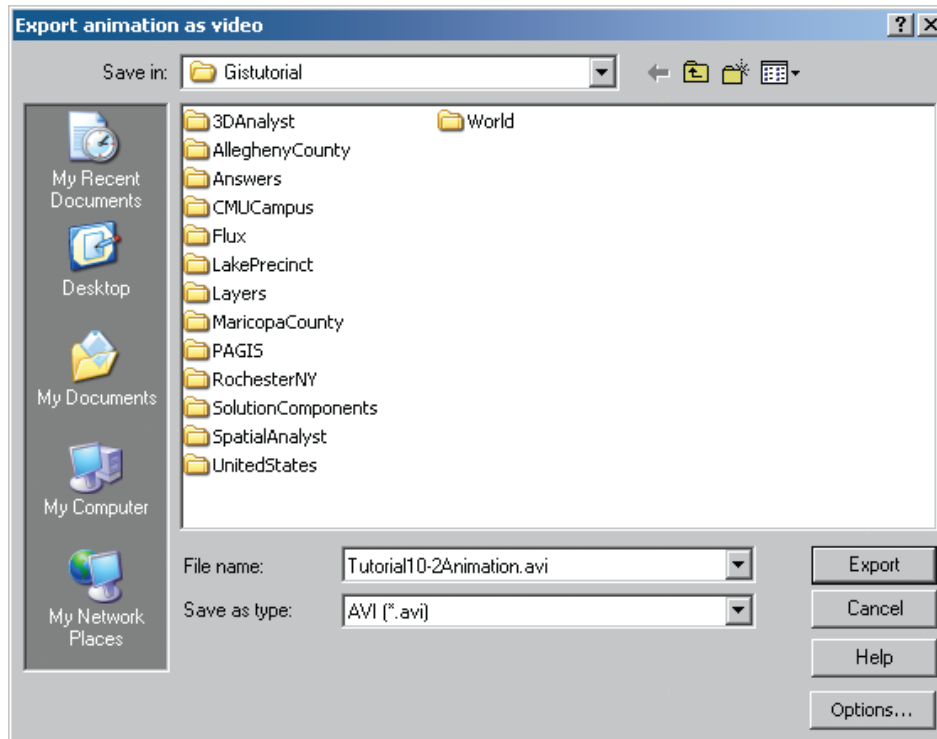


- 2 Navigate to \Gistutorial and save the animation as **Tutorial10-2Animation.asa**.

### Export an animation to video

- 1 From the Animation toolbar, click Animation, Export to Video.
- 2 Navigate to \Gistutorial and save your animation as **Tutorial10-2Animation.avi** click Export, and OK.

Note: Wait until the animation is fully exported before opening other windows, otherwise they may appear in your animation.



### Load an animation

- 1 From the Animation toolbar, click Animation, Load Animation File.
- 2 In the Open Animation dialog box, navigate to \Gistutorial, click **Tutorial10-2Animation.asa** and click Open.
- 3 Click the Play button ► from the Animation Controls toolbar.
- 4 Zoom to the full extents and save your ArcScene as \Gistutorial\Tutorial10-3.sxd.


### YOUR TURN

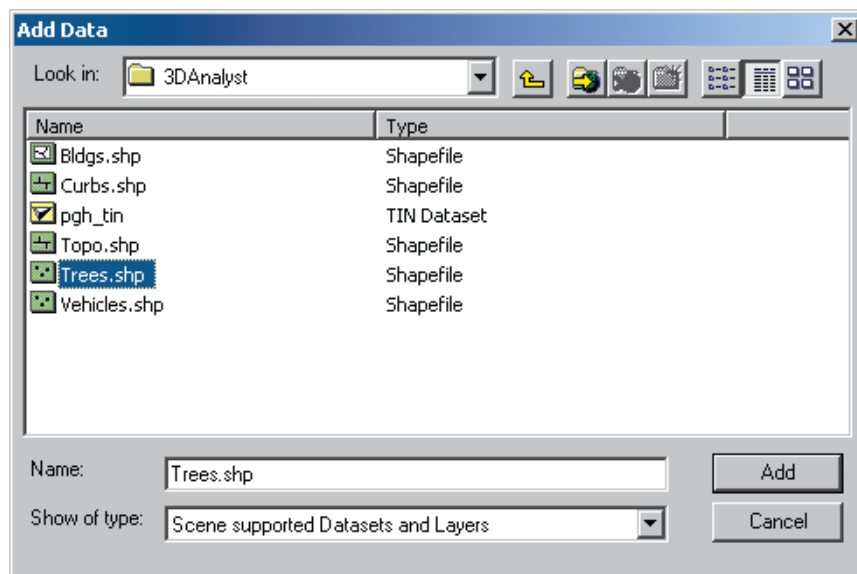
Launch a video player such as Windows Media Player and play the AVI video that you created. If you have trouble loading and playing your video, choose the animation files in \Gistutorial\SolutionComponents\Tutorial10. Close the Animation toolbars and zoom to the full extent of your map when finished.

# Use 3D symbols

The 3D Analyst extension comes with many symbols that can be displayed as 3D symbols in ArcScene. You can also create your own symbols and textures to import and display.

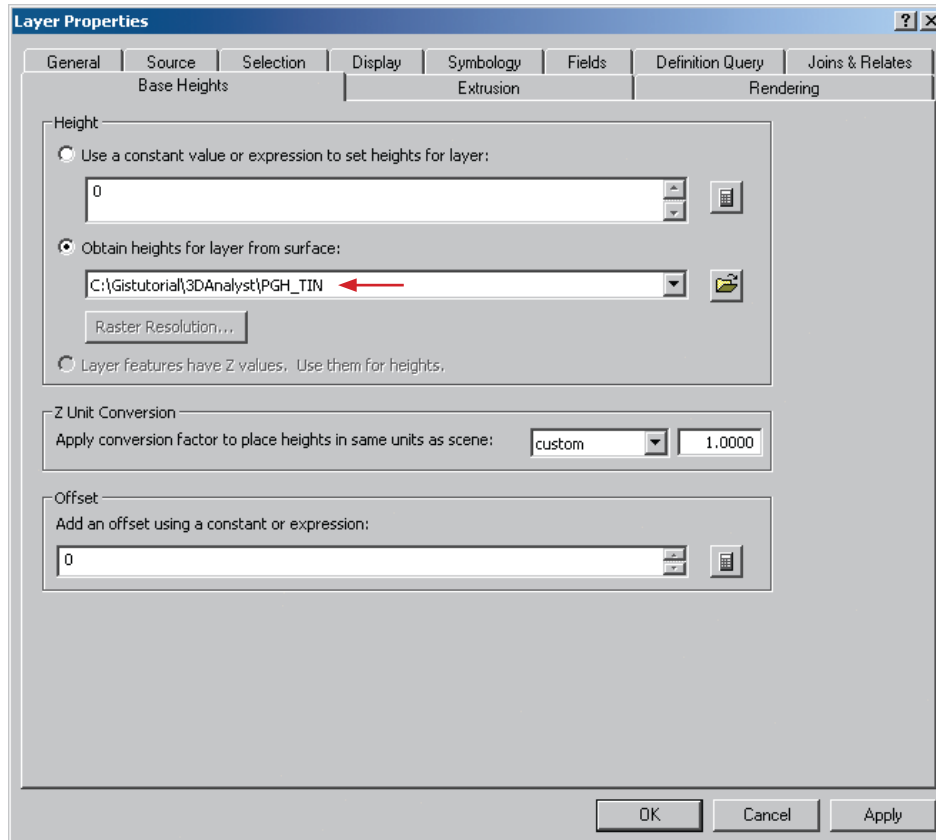
## Add trees layer


- 1 Working in the same scene, click the Add Data button. 
- 2 In the Add Data browser, browse to \Gistutorial\3DAnalyst, click **Trees.shp**, and click Add.



### *Display points as 3D trees*

- 1 In the table of contents, right-click the Trees layer, and click Properties.
- 2 Click the Base Heights Tab.
- 3 Click the radio button beside Obtain heights for layer from surface.

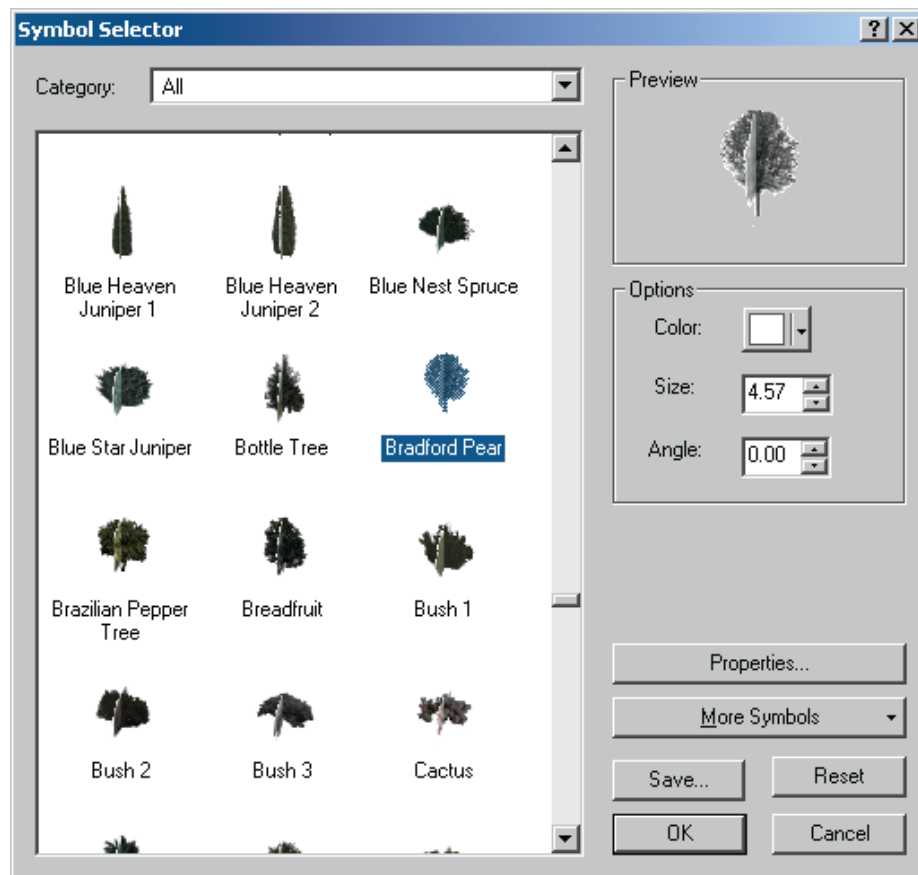


- 4 Click the Symbology Tab.
- 5 Click the Symbol button. 

- 6 In the Symbol Selector dialog, click the More Symbols drop-down option and click 3D Trees.



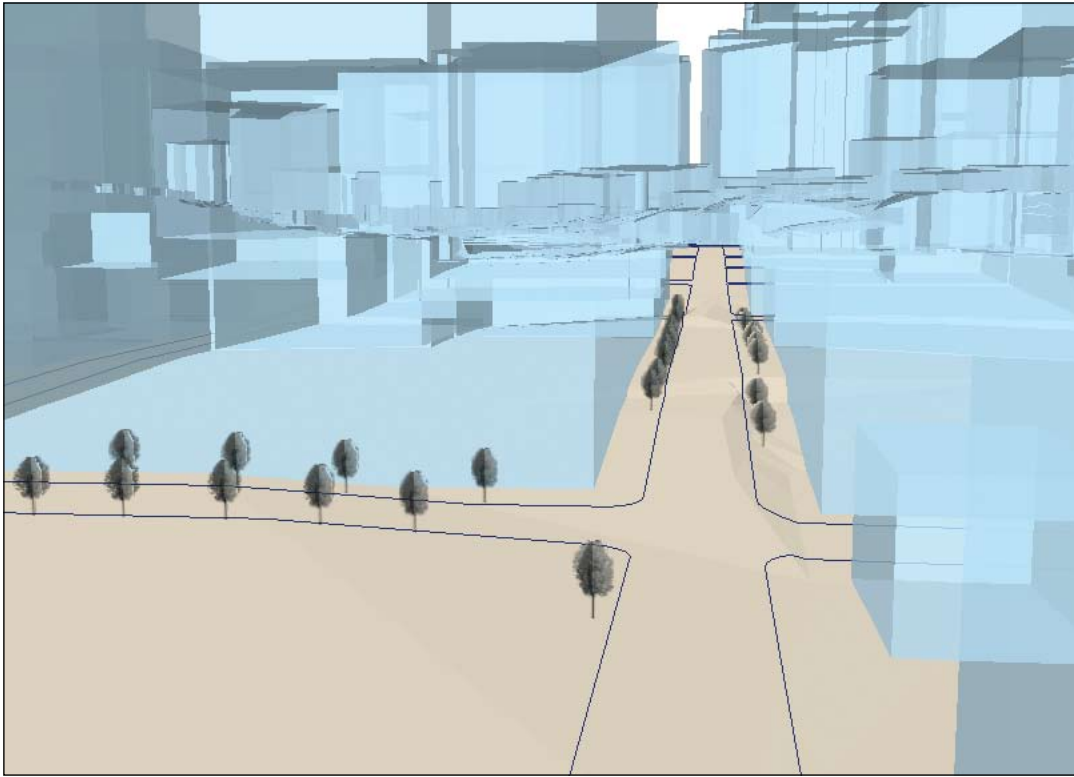
- 7 Scroll through the symbols until you see the 3D trees, choose Bradford Pear, OK, and OK again.



- 8 In the table of contents, right-click the Trees layer and click Zoom to Layer.

- 9 Click the Navigate  and Zoom In/Out  buttons to view the trees from street level.

The view below shows trees along a few streets in Pittsburgh in an area undergoing revitalization known as the “Fifth and Forbes” corridor.



- 10 Save your ArcScene as `\Gistutorial\Tutorial10-4.sxd`.

### YOUR TURN

Add the shapefile called **Vehicles.shp** and display the vehicles as 3D vehicle symbols using Unique Values based on the "Type" value field from the shapefile's attribute table. Set an angle of 240 degrees for each vehicle so they are driving in the correct direction down this one-way street.

*Hints: Set the base height for the surface to `pgh_tin`, and zoom to the layer.*

Explore the other 3D symbols that come standard with ArcView including 3D Basic, 3D Billboards, 3D Buildings, 3D Industrial, 3D Residential, and 3D Street Furniture.

# Perform a line-of-sight analysis

In this section you will explore how to create a line-of-sight analysis using a 2D TIN in ArcMap. A line-of-sight analysis creates a graphic line between two points showing where the view is obstructed between those points. This line of sight can be copied and pasted into a 3D Scene if necessary.

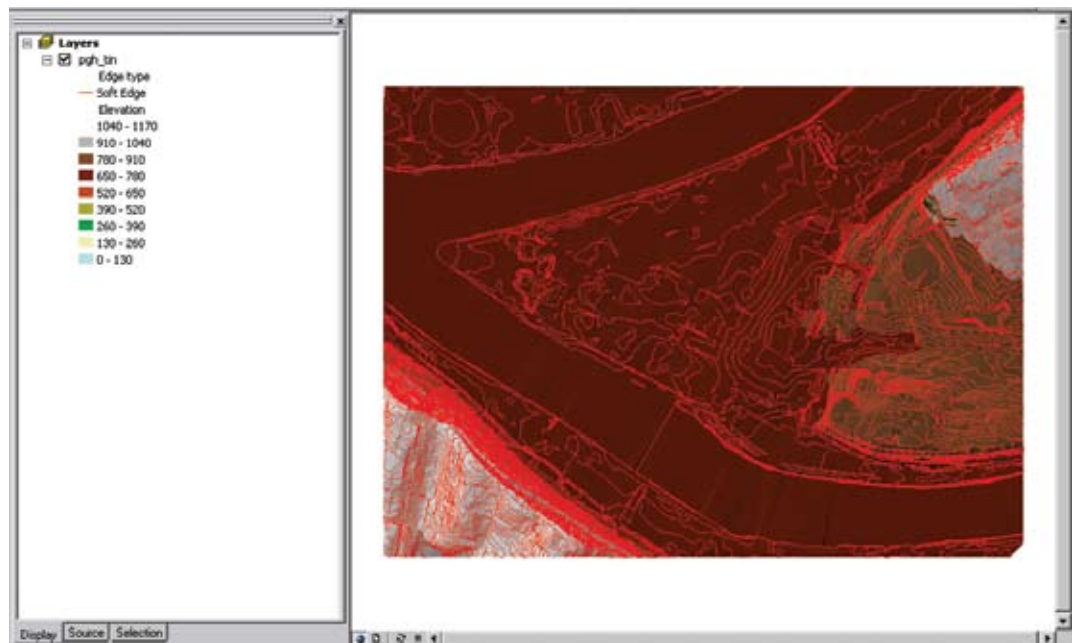
## *Start a map document*

- 1 Start ArcMap and open a new empty map. Make sure the 3D Analyst toolbar is turned on.


## *Add TIN*

- 1 Click the Add Data button, navigate to `\Gistutorial\3DAnalyst`, click `pgh_tin`, click Add, and OK in the message box.

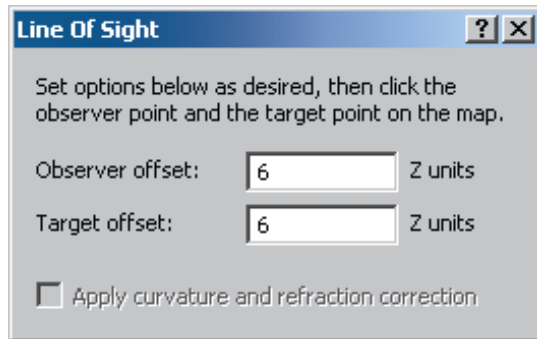
The view below shows 2D tin contours.



## *Create a line of sight*

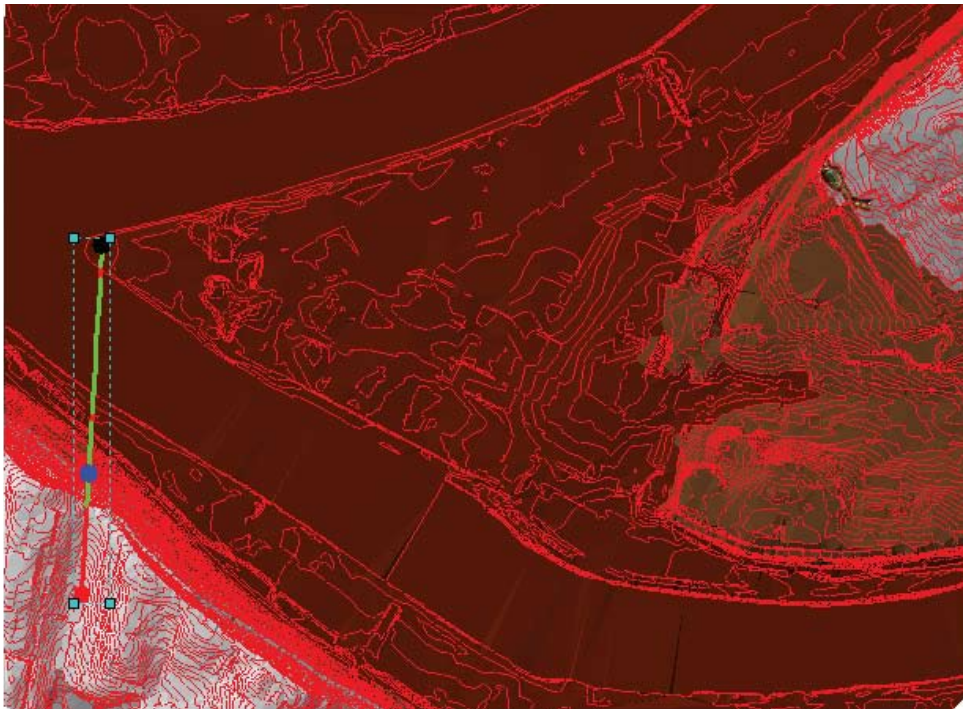
- 1 From the 3D Analyst toolbar, click the Create Line of Sight button. 
- 2 In the Line of Sight window, enter observer and target offsets of 6.

If you set the observer and target heights to zero the units are the same as the surface's z units and will typically have a view that is more obstructed than one with a height greater than one.



- 3 Click a point near Pittsburgh's "Point" where the three rivers meet.
- 4 Click a point on Mount Washington where the elevation is above 910 feet.

The resulting map will show red along the line where the observer's line of sight is obstructed and green along the line where the view is not obstructed.



### YOUR TURN

Choose additional observer and target points to see line-of-sight visibility. Change the observer and target heights to see if the visibility changes. Save your ArcMap document as **\Gistutorial\Tutorial10-5.mxd**.



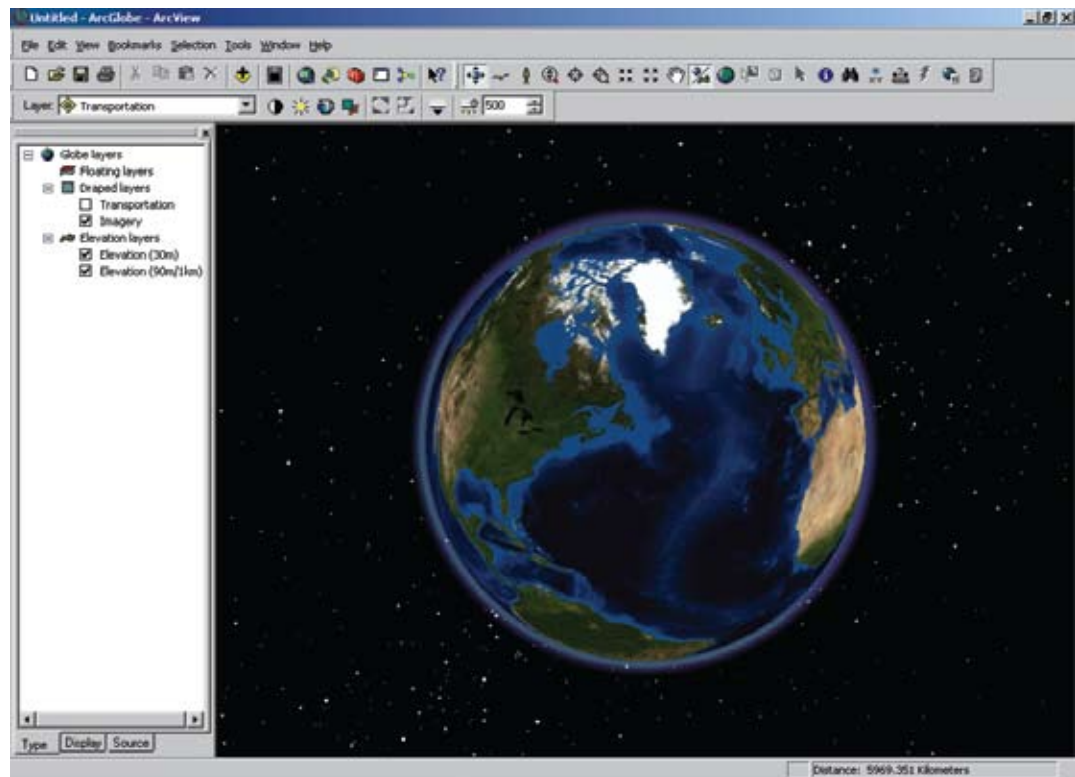
# Explore ArcGlobe

In this tutorial you used ArcScene and ArcMap, which are designed for those with smaller spatial datasets who wish to examine a defined study area. If you work with larger datasets and need a seamless visualization of both raster and feature data you should consider using ArcGlobe. This section introduces you to some of the basic capabilities of ArcGlobe.

## Launch ArcGlobe

- 1 From the 3D Analyst toolbar in ArcMap, click the ArcGlobe button. 

ArcGlobe opens in a new window.



- 2 Click and drag the globe view to various parts of the world.

### *Add and display vector data*

1. Click the **Add Data** button, navigate to `\Gistutorial\World`, click **Country.shp**, **Add**, then **Finish**.
2. Drag the **Countries** layer to the top of the table of contents and change its symbology to a hollow fill, medium gray outline.
3. Click and drag the globe to various parts of the world in the **ArcGlobe** window.

ArcGlobe with added vector layer.



### **YOUR TURN**

Add additional vector layers from the `\Gistutorial` folder. Explore other zooming and display options in ArcGlobe.

### *Save the ArcGlobe document*

1. Click **File, Save As**.
2. Navigate to `\Gistutorial` and save the ArcGlobe document as **Tutorial10-6.3DD**.

## Assignment 10-1

# Develop a 3D presentation for downtown historic-site evaluation

Many U.S. cities, including the city of Pittsburgh, are experiencing a surge of downtown revitalization. New condominium and apartment projects are in progress and the city planning department wants to verify that this new development does not interfere with existing historic sites. In this assignment, you will help the city planning department raise the awareness of historic sites in downtown Pittsburgh by developing a 3D model and animation of these areas.

Start with the following:

- **C:\Gistutorial\AlleghenyCounty\Parks.shp**—polygon shapefile of Allegheny County Parks
- **C:\Gistutorial\AlleghenyCounty\Rivers.shp**—polygon shapefile of Allegheny County rivers
- **C:\Gistutorial\PAGIS\CentralBusinessDistrict\Histsite.shp**—polygon shapefile of historic sites in the city of Pittsburgh's central business district
- **C:\Gistutorial\3DAnalyst\Bldgs.shp**—polygon shapefile of buildings in downtown Pittsburgh
- **C:\Gistutorial\3DAnalyst\Curbs.shp**—polyline shapefile of curbs (sidewalks) in downtown Pittsburgh
- **C:\Gistutorial\3DAnalyst\Topo.shp**—polyline shapefile of topography contours in downtown Pittsburgh

### Create a 3D map and animation of historic district

Open ArcMap and add the buildings and historic site shapefiles. Create a new shapefile of buildings whose centroids are within historic sites and another shapefile of buildings whose centroids are not within historic sites. Save the new files in C:\Gistutorial\Answers\Assignment10. In ArcCatalog, create new point shapefiles for trees and street furniture (e.g., benches, signs, trash cans, streetlights, etc.) called \Assignment10\HistoricSiteTrees.shp and \Assignment10\HistoricSiteFurniture.shp and assign them the same coordinate system as the historic sites (NAD\_1983\_StatePlane\_Pennsylvania\_South\_FIPS\_3702\_Feet). Digitize these points anywhere in historic site locations.

Create a new 3D ArcScene called \Assignment10\Assignment10-1.sxd with all of the above shapefiles added. Create a new TIN from the topo layer called \Assignment10\HistoricSiteTIN. Drape the new shapefiles for buildings, street furniture, and trees as well as curbs, parks, and rivers to the TIN. Extrude the buildings using the building height field. Show the nonhistoric buildings using a transparency of 90% and the historic buildings as opaque (0% transparency). Swap the 2D points for trees and street furniture with 3D symbols.

Create a fly-through animation focusing on the historic sites called \Assignment10\Assignment10-1.avi.

## Assignment 10-2

# Perform a 3D analysis of conservatory building addition

Pittsburgh's local conservatory, Phipps Conservatory ([www.phipps.conservatory.org](http://www.phipps.conservatory.org)) was built in 1893 by Henry Phipps as a gift to the city of Pittsburgh. Phipps Conservatory recently underwent a major renovation with the addition of a 10,885-square-foot green-engineered welcome center.

Future additions will include state-of-art production greenhouses and a one-of-a-kind tropical forest. 3D Analyst extension is very useful to envision the expansion of the conservatory and to also view the entire topography of the study area where the conservatory is located. In this assignment, you will create a 3D TIN; perform a line-of-sight analysis; drape buildings, sidewalks and an aerial photo to the TIN; and create new 3D features.

Start with the following:

- **C:\Gistutorial\PAGIS\Phipps\Bldgs.shp**—polygon layer buildings in the Phipps Conservatory study area.
- **C:\Gistutorial\PAGIS\Phipps\Curbs.shp**—polyline layer sidewalk curbs in the Phipps Conservatory study area.
- **C:\Gistutorial\PAGIS\Phipps\Topo.shp**—polyline layer topography contours in the Phipps Conservatory study area.
- **C:\Gistutorial\CMUCampus\25\_45.tif**—digital orthographic map.

### Create line of sight and perform 3D analysis

Create a new ArcMap document called C:\Gistutorial\Answers\Assignment10\Assignment10-2.mxd and add the above shapefiles. Create a new TIN from the topo layer called \Assignment10\PhippsTIN. In ArcCatalog, create a new polygon shapefile (coordinate system NAD\_1983\_StatePlane\_Pennsylvania\_South\_FIPS\_3702\_Feet) for a new building addition to Phipps Conservatory called \Assignment10\PhippsAddition.shp and digitize a simple 20-foot-tall addition in the front of the conservatory (Phipps Conservatory is labeled as building FID 118 in the bldgs shapefile). Use 3D effects where you think appropriate to focus attention on the new addition. Create a line-of-sight analysis from your new building to the Carnegie Museum of Pittsburgh (FID 20) and to the Café Phipps (FID 180). Export your line-of-sight analysis to a JPEG file called \Assignment10\LineofSight.jpg.

Create a new 3D ArcScene called \Assignment10\Assignment10-2.sxd with the above shapefiles added. Drape curbs and the aerial photo to the new TIN with an offset of one foot (to avoid bleeding into the contours). Drape the buildings shapefiles (again with an offset of one foot) and display using the building height field.

Create a Power Point presentation called \Assignment10\Assignment10-2.ppt and insert your line of sight images into it. Create 3D views from various angles showing some with the ortho image and some without the ortho image. Copy and paste these into your PPT along with any other information you think useful to show the funders of the Phipps Conservatory addition.

#### Hints

- Use labels or the attribute table to find the building's FID number.
- Be sure to apply the aerial photo to the base height of the new TIN and not the aerial photo itself.



### What to turn in

If you are working in a classroom setting with an instructor, you may be required to submit the exercises you created in tutorial 10. Below are files that you are required to turn in. Be sure to use a compression program such as PKZIP or WinZIP to include all files as one .zip document for review and grading. Include your name and assignment number in one .zip document (YourNameAssn10.zip).

#### ***ArcMap and ArcScene files***

C:\Gistutorial\Answers\Assignment10\Assignment10-1.sxd  
C:\Gistutorial\Answers\Assignment10\Assignment10-2.mxd  
C:\Gistutorial\Answers\Assignment10\Assignment10-2.sxd

#### ***TIN***

C:\Gistutorial\Answers\Assignment10\HistoricSiteTIN  
C:\Gistutorial\Answers\Assignment10\PhippsTIN  
(be sure to include all files associated with the TIN)

#### ***Shapefiles***

C:\Gistutorial\Answers\Assignment10\HistoricSiteBldgs.shp  
C:\Gistutorial\Answers\Assignment10\NonHistoricSiteBldgs.shp  
C:\Gistutorial\Answers\Assignment10\HistoricSiteTrees.shp  
C:\Gistutorial\Answers\Assignment10\HistoricSiteFurniture.shp  
C:\Gistutorial\Answers\Assignment10\PhippsAddition.shp

#### ***Image, animation, and presentation files***

C:\Gistutorial\Answers\Assignment10\LineofSight.JPG  
C:\Gistutorial\Answers\Assignment10\Assignment10-1.avi  
C:\Gistutorial\Answers\Assignment10\Assignment10-2.ppt

