Viewshed Analysis Methodology - CPA2021-00004, PW Digital Gateway

The purpose of this viewshed analysis is to provide information to inform development of policies for Comprehensive Plan Amendment, CPA2021-00004, PW Digital Gateway. This analysis is not based on any specific development or rezoning proposal and did not use data such as:

- specific, proposed, building locations,
- finished grades,
- building elevations above finished grades,
- rooftop mechanical heights; and
- removal of existing vegetation or the inclusion of new vegetation/buffers.

This viewshed analysis shows the locations where potential buildings or structures, at the tested height, are likely to be visible from one or more observer points. Potential heights of 35 feet through 105 feet from existing grades were evaluated. The evaluated heights represent potential data center building heights and their associated structures like rooftop mechanical equipment.

Key Tools and Data

See the attached methodology in Appendix A for a full technical description for preparation of the Viewshed Analysis maps.

- ESRI's ArcGIS Pro (v2.8.0) – mapping program
- ESRI's Geodesic Viewshed tool
- average person is just over 5 foot tall
- 20 observation points
- 2011Digital Surface Model (DSM) includes terrain, existing vegetation and trees

Observation Points

Twenty (20) Observation Points were selected for this analysis. These locations were determined in consultation with Planning staff and staff at Manassas National Battlefield Park. Of these 20 points, 10 points used in this study, were identified during the *Manassas Battlefields Viewsheds Plan* (2010). Three points were identified during viewshed analysis for the Gainesville Crossing and Westview 66 rezonings and in consultation with staff from Manassas National Battlefield Park. Seven observation points were added to this current analysis to ensure coverage, due to the large number of unknowns about this comprehensive plan amendment. These seven points were identified in consultation with staff from Manassas National Battlefield Park and at the direction of the County Archaeologist.

Observation Point Criteria

- Areas selected feature a high elevation in order to include the optimal amount of relevant land area
- Areas selected feature the most historically significant lands relative to the two battles
- Areas selected either currently have reasonable public accessibility or have the potential to have reasonable public accessibility to benefit the broadest spectrum of visitors. Accordingly, selected areas have reasonable access to the park's driving tour route or trail network
- Points were selected that assess impacts to both the First and Second Manassas. Although, it is likely the greatest impacts will occur to historical resources associated with Second Manassas

Battlefields Areas

The American Battlefield Protection Program, a division of the National Park Service, identifies three primary areas of a battlefield.

> *Battlefield Core Area*: This area consists of locations where the primary combat occurred. These are lands from which fire was delivered or received. In other words, shots were fired and soldiers were killed or wounded.
>
> *Battlefield Study Area*: In addition to the Battlefield Core Areas, this area consists of lands peripheral to the Battlefield Core Area where troop movements, encampments, staging areas, field hospitals and similar activities occurred and are directly related to, but ancillary to, combat.
>
> *Areas of Integrity*: This area consists of locations where a high level of visual integrity has survived and the historic landscape has remained substantially intact with only minor intrusions. Intrusions are changes to the landscape since the battles, such as post-war roads, buildings, parking areas, utility poles and lines, and significant landscape alterations.

The plan area's southern sector possesses a high degree of integrity. It is in the Manassas Battlefield Historic District (076-0271), which is listed on the National Register of Historic Places. While just outside the primary of engagement, the Core Area, it is in the Battlefield Study Area. Field hospital(s), mass burials, troop movements, and artillery battery locations are documented in this area.

Digital Gateway Viewshed Process

Project Summary

Conduct a viewshed analysis for CPA2001-00004, PW Digital Gateway. The viewshed analysis will provide data about which areas, if buildings were to be built at specific elevations, are more or less likely to be visible from predetermined observation points in Manassas National Battlefield Park.

Analysis Method

The “Geodesic Viewshed” ESRI tool, found in the Visibility (3D Analyst) toolset, was chosen to provide the viewshed analysis. A viewshed analysis determines visibility to an observer (or multiple observers) in all directions. Another option would have been the ESRI “Visibility” tool, however the “Geodesic Viewshed” tool, according to ESRI, has enhanced performance and functionality. The Geodesic Viewshed tool seems to be a more accurate option due to the fact that it takes the curvature of the earth at each cell into consideration. Additionally, the performance speed can be increased since the Geodesic Viewshed tool can leverage the computing power of a graphics card. See Appendix A for more information on the Geodesic Viewshed tool from the ESRI website.

Coordinate Systems

County standard coordinate systems of “NAD 1983 StatePlane Virginia North FIPS 4501 (US Feet)” for XY and “NAVD 1988” for Z values were used.

Project Details

Geodesic Viewshed Inputs

All the data used in this project can be found in the ArcPro Package “DigGatewayViewshed_2022.ppkx”. See Appendix B for a pictorial example of these inputs for a 35-foot building height.

- Input raster: “DSM_2011” (see more information below)
- Input point or polyline observer features: “Observer Points” (see more information below)
- Output raster: “Viewshed_Xft”
    - X is a numerical placeholder here that represents the appropriate surface offset in feet, and was changed for each viewshed analysis, as specified below.
- Analysis method: All Sightlines
    - This provides a more accurate viewshed with a full sightline on every cell of the raster rather than only on the perimeter of the visible areas.
- Analysis type: Frequency
    - This method will provide the number of occurrences each cell is visible from an observer point. This option allows us to run the tool on all observer points simultaneously, simplifies the output for usability purposes, and provides improved performance time. It does not specify which observers are likely or unlikely to see any given area.
    - To determine which specific observation points were likely visible, you could use the “Observers” option instead.
- Surface offset (e.g. building height): 35, 45, 55, 65, 75, 85, 95 and 105 ft
    - The tool was run 6 times using each of these values separately.
    - These potential building heights were provided by Planning.

- Observer offset: 1.54 Meters
    - This height of just over 5 feet, depicts a standard eye height of a person, the value of which is used for similar calculations.
- Default parameters used for:
    - Vertical error: 0 Meters
    - Refractivity coefficient: 0.13
    - Observer elevation: Unknown (uses the raster)
    - Inner radius: blank, Unknown (defaults to 0)
    - Outer radius: blank, Unknown
    - Horizontal start angle: Double, 0
    - Horizontal end angle: Double, 360
    - Vertical upper angle: Double, 90
    - Vertical lower angle: Double, -90
- On the Environment tab, we updated the output coordinate system to match county standards as listed above. We are able to transform on the fly because the underlying geographic coordinate system of the two layers is the same. See Appendix C for more information.

Project Layers

- "Observer Points" are the points provided by the Planning Office that are a combination of (1) locations determined by the Manassas Battlefields Viewsheds Study (see methodology) and (2) sites used to evaluate specific rezoning proposals, identified based on interpretive focal points, and areas identified during the evaluation that were visible.
- "Study Area" is the single polygon representing planning case "CPA2021-00004", taken directly from "VECTOR.PLAN_PENDING" in the production database. This study area represents approximately 2,133 acres which are being examined for potential data center development.
- "DSM_2011" is a digital surface model (DSM) that was provided by the Manassas National Battlefield Park, a division of the National Park Service, based on data from 2011. The model was completed by graduate students from George Mason University and provided to NPS.
- Viewsheds:
    - "Viewshed_35ft" is the layer showing visibility frequency from the observer sites at a 35-foot surface offset or building height. In other words, it portrays the parts of the surface where a 35-foot building is likely to be visible to any of the observer points, and how many different observer points it would likely be visible to.
    - "Viewshed_45ft" is similar to the "Viewshed_35ft" layer, except using a 45 ft surface offset.
    - "Viewshed_55ft" is similar to the "Viewshed_35ft" layer, except using a 55 ft surface offset.
    - "Viewshed_65ft" is similar to the "Viewshed_35ft" layer, except using a 65 ft surface offset.
    - "Viewshed_75ft" is similar to the "Viewshed_35ft" layer, except using a 75 ft surface offset.

- "Viewshed_85ft" is similar to the "Viewshed_35ft" layer, except using an 85 ft surface offset.
- "Viewshed_95ft" is similar to the "Viewshed_35ft" layer, except using a 95 ft surface offset.
- "Viewshed_105ft" is similar to the "Viewshed_35ft" layer, except using a 105 ft surface offset.

Limitations and Assumptions

- The digital surface model is from 2011 even though the analysis is being performed in 2022. This is the most recent digital surface model available at PWC that fully covers the Manassas National Battlefield Park and study area. Trees may have grown or been removed from the landscape since 2011.
- This analysis is not based on any specific development proposal and does not include data such as specific, proposed, building locations; finished grade; building elevations above finished grade; rooftop mechanicals; removal of existing vegetation; addition of new vegetation, etc.
- The GTS viewshed data is intended to assist Planning's efforts to provide a sensitivity model and not a definitive recommendation.
- The vertical datum used [NAVD88 (height) (ftUS)] is not tied to a spheroid and therefore may not be utilizing the geodesic functionality (related to the curvature of the earth) of the "Geodesic Viewshed" tool to its fullest.
- That if A can see B, the reverse is also true.

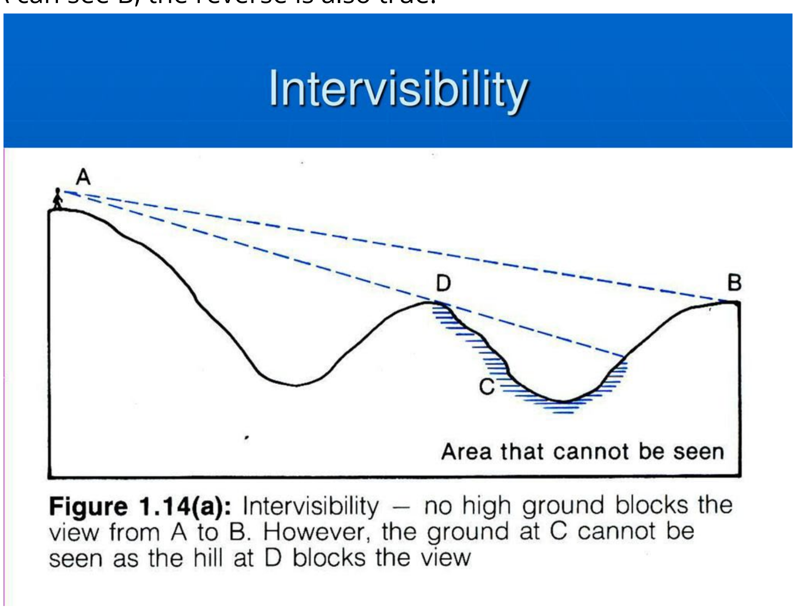


Image from Google Images, published by Márton Pataki on slideplayer.com: https://images.app.goo.gl/n8M5NFMjiwCCGyGr9

- The version of ArcPro used to perform these calculations was 2.8.0. The tools and projections may behave or look differently in other versions of ArcPro.

Appendix A

These are screen shots of what ESRI has currently published about the Geodesic Viewshed Tool.

Geodesic Viewshed (3D Analyst)

ArcGIS Pro 2.8

In this topic

Available with Spatial Analyst license.

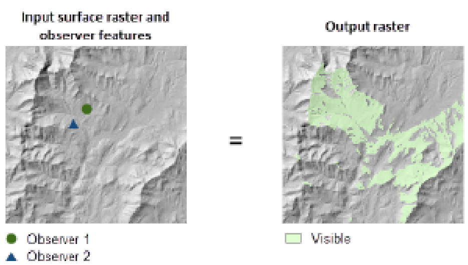
Available with 3D Analyst license.

Summary

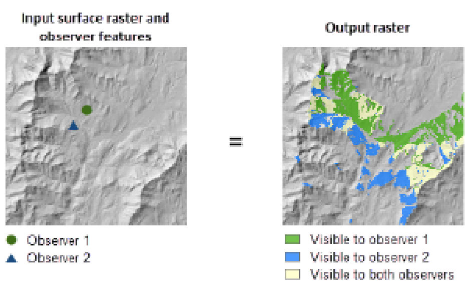
Determines the raster surface locations visible to a set of observer features using geodesic methods.

Learn more about how the Geodesic Viewshed tool works

Illustration



Geodesic Viewshed output with the Frequency option, displayed on a hillshaded elevation surface



Geodesic Viewshed output with the Observers option, displayed on a hillshaded elevation surface

Usage

- This tool performs two types of visibility analysis, Frequency and Observers, which can be set using the Analysis type parameter.
- To ensure the accuracy of the output, assign a vertical coordinate system to the input raster, if it does not already have one.
- This tool does not require a z-factor parameter. It will compute a z-factor internally using the vertical (Z) unit and the map (XY) units from the spatial reference of the input raster.
- Input rasters that contain noise, most commonly seen in high resolution data, may produce some unexpected results. Before running this tool, you can correct the data in a pre-processing step. If you have the ArcGIS Spatial Analyst extension available, you can smooth out the effect of the error by first using the Focal Statistics or the Filter tool before performing the viewshed operation.
- When the input raster needs to be resampled, the bilinear technique will be used. An example of when an input raster may be resampled is when the output coordinate system, extent, or cell size is different from that of the input.

- To enhance performance, you can explicitly set the Outer radius parameter to a value that represents the maximum viewing distance of interest for your analysis.
- By default, the Analysis Method parameter uses the All Sightlines option, which gives the most accurate output. To improve the performance of the tool in terms of processing time, use the Perimeter Sightlines option.
- The observer parameters related to height, such as Surface offset, Observer elevation and Observer offset, can be specified as a linear unit or as a field. During the calculation, the linear unit value will be converted internally to the Z unit of the input raster. However, if the linear unit is unknown or a numeric field is specified, the value is assumed to be in the Z unit of the input raster.
- The observer parameters related to viewing distances, such as the Inner radius and the Outer radius, can be specified as a linear unit or as a field. During the calculation, the linear unit value will be converted internally to the XY units of the input raster. However, if the linear unit is unknown or a numeric field is specified, the value is assumed to be in the XY unit of the input raster.
- The field specified for an observer parameter, such as Surface offset or Observer offset, can be string type that contains a numerical value and a unit. For example, if field obs_height is specified for Observer offset, it can contain values like '6 Feet'.

  In scripting, the observer parameters like observer_offset can be specified in various forms of strings. In each form, a value and a linear unit is parsed from the string. The following table list some example input strings and how the linear unit is determined for each case. For other parameters, you can follow the same pattern.

  Examples of input strings and linear units

Example of input string for Observer offset	Linear unit used
' ' or '#'	Default value and unit is used, which is 1 meter.
'6'	The Observer offset is 6 and since no unit is specified, the tool would use the default unit, meter.
'6 Feet'	The Observer offset is 6 Feet.
'6 Unknown'	The Observer offset is 6 and since no unit is specified, the tool would use the default unit, meter.

- This tool will automatically take advantage of a GPU (Graphics Processing Unit) for enhancing the performance of the tool, if it is available in your system and is configured correctly.

  More information on how to configure your GPU device is available in ArcGIS Spatial Analyst extension help in the GPU processing with Spatial Analyst help topic.
- If you do not want the tool to take advantage of the available GPU devices installed in your system, create a system environment variable CUDA_VISIBLE_DEVICES, set its value to -1 and restart your application. The tool will then execute using the CPU only. To enable your tool to use a GPU device again, either delete the system environment variable CUDA_VISIBLE_DEVICES or set the value of this environment variable to the index value (0 for the first one, 1 for the second one and so on) of the GPU device you would like to use, and restart your application.

Parameters

DialogPython

Label	Explanation	Data Type
Input raster	The input surface raster. It can be an integer or a floating-point raster. The input raster is transformed into a 3D geocentric coordinate system during the visibility calculation. NoData cells on the input raster do not block the visibility determination.	Raster Layer
Input point or polyline observer features	The input feature class that identifies the observer locations. It can be point, multipoint, or polyline features. The input feature class is transformed into a 3D geocentric coordinate system during the visibility calculation. Observers outside of the extent of the surface raster or located on NoData cells will be ignored in the calculation.	Feature Layer
Output raster	The output raster. For the Frequency analysis type, when the vertical error parameter is 0 or not specified, the output raster records the number of times that each cell location in the input surface raster can be seen by the input observation points. When the vertical error parameter is greater than 0, each cell on the output raster records the sum of probabilities that the cell is visible to any of the observers. For the Observers analysis type, the output raster records the unique region IDs for the visible areas, which can be related back to the observer features through the output observer-region relationship table.	Raster Dataset

Label	Explanation	Data Type
Output above ground level raster (Optional)	The output above ground level (AGL) raster. The AGL result is a raster where each cell value is the minimum height that must be added to an otherwise nonvisible cell to make it visible by at least one observer. Cells that were already visible will be assigned 0 in this output raster. When the vertical error parameter is 0, the output AGL raster is a one-band raster. When vertical error is greater than 0, to account for the random effects from the input raster, the output AGL raster is created as a three-band raster. The first band represents the mean AGL values, the second band represents the minimum AGL values, and the third band represents the maximum AGL values.	Raster Dataset
Analysis type (Optional)	Specifies the type of visibility analysis you wish to perform, either determining how visible each cell is to the observers, or identifying for each surface location which observers are visible. • Frequency —The output records the number of times that each cell location in the input surface raster can be seen by the input observation locations (as points or as vertices for polyline observer features). This is the default. • Observers —The output identifies exactly which observer points are visible from each raster surface location. The allowed maximum number of input observers is 32 with this analysis type.	String
Vertical error (Optional)	The amount of uncertainty (the Root Mean Square error, or RMSE) in the surface elevation values. It is a floating-point value representing the expected error of the input elevation values. When this parameter is assigned a value greater than 0, the output visibility raster will be floating point. In this case, each cell value on the output visibility raster represents the sum of probabilities that the cell is visible to any of the observers. When the analysis type is Observers or the analysis method is Perimeter Sightlines, this parameter is disabled.	Linear Unit
Output observer-region relationship table (Optional)	The output table for identifying the regions that are visible to each observer. This table can be related to the input observer feature class and the output visibility raster for identifying the regions visible to given observers. This output is only created when the analysis type is Observers.	Table
Refractivity coefficient (Optional)	The coefficient of the refraction of visible light in air. The default value is 0.13.	Double
Surface offset (Optional)	A vertical distance to be added to the z-value of each cell as it is considered for visibility. It must be a positive integer or floating-point value. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is 0.	Linear Unit; Field
Observer elevation (Optional)	The surface elevations of the observer points or vertices. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is not specified, the observer elevation will be obtained from the surface raster using bilinear interpolation. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset.	Linear Unit; Field
Observer offset (Optional)	A vertical distance to be added to the observer elevation. It must be a positive integer or floating-point value. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is 1 meter.	Linear Unit; Field
Inner radius (Optional)	The start distance from which visibility is determined. Cells closer than this distance are not visible in the output but can still block visibility of the cells between inner radius and outer radius. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is 0.	Linear Unit; Field

Label	Explanation	Data Type
Inner radius is 3D distance (Optional)	Specifies the type of distance for the inner radius parameter. • Unchecked—The inner radius is to be interpreted as a 2D distance. This is the default. • Checked—The inner radius is to be interpreted as a 3D distance.	Boolean
Outer radius (Optional)	The maximum distance from which visibility is determined. Cells beyond this distance are excluded from the analysis. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset.	Linear Unit; Field
Outer radius is 3D distance (Optional)	Specifies the type of distance for the outer radius parameter. • Unchecked—The outer radius is to be interpreted as a 2D distance. This is the default. • Checked—The outer radius is to be interpreted as a 3D distance.	Boolean
Horizontal start angle (Optional)	The start angle of the horizontal scan range. The value should be specified in degrees from 0 to 360, either as integer or floating point, with 0 oriented to north. The default value is 0. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset.	Double; Field
Horizontal end angle (Optional)	The end angle of the horizontal scan range. The value should be specified in degrees from 0 to 360, either as integer or floating point, with 0 oriented to north. The default value is 360. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset.	Double; Field
Vertical upper angle (Optional)	The upper vertical angle limit of the scan relative to the horizontal plane. The value is specified in degrees and can be integer or floating point. The allowed range is from above -90 up to and including 90. This parameter value must be greater than the Vertical Lower Angle parameter value. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is 90 (straight up).	Double; Field
Vertical lower angle (Optional)	The lower vertical angle limit of the scan relative to the horizontal plane. The value is specified in degrees and can be integer or floating point. The allowed range is from -90 up to but not including 90. This parameter value must be less than the Vertical Upper Angle parameter value. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is -90 (straight down).	Double; Field
Analysis method (Optional)	Specifies the method by which the visibility will be calculated. This option allows you to trade some accuracy for increased performance. • All Sightlines — A sightline is run to every cell on the raster in order to establish visible areas. This is the default method. • Perimeter Sightlines — Sightlines are only run to the cells on the perimeter of the visible areas in order to establish visibility areas. This method has a better performance than the All Sightlines method since less sightlines are run in the calculation.	String

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arcpy.ddd.Viewshed2(in_raster, in_observer_features, out_raster, {out_agl_raster}, {analysis_type}, {vertical_error}, {out_observer_regic
```

Name	Explanation	Data Type
in_raster	The input surface raster. It can be an integer or a floating-point raster. The input raster is transformed into a 3D geocentric coordinate system during the visibility calculation. NoData cells on the input raster do not block the visibility determination.	Raster Layer
in_observer_features	The input feature class that identifies the observer locations. It can be point, multipoint, or polyline features. The input feature class is transformed into a 3D geocentric coordinate system during the visibility calculation. Observers outside of the extent of the surface raster or located on NoData cells will be ignored in the calculation.	Feature Layer
out_raster	The output raster. For the Frequency analysis type, when the vertical error parameter is 0 or not specified, the output raster records the number of times that each cell location in the input surface raster can be seen by the input observation points. When the vertical error parameter is greater than 0, each cell on the output raster records the sum of probabilities that the cell is visible to any of the observers. For the Observers analysis type, the output raster records the unique region IDs for the visible areas, which can be related back to the observer features through the output observer-region relationship table.	Raster Dataset
out_agl_raster (Optional)	The output above ground level (AGL) raster. The AGL result is a raster where each cell value is the minimum height that must be added to an otherwise nonvisible cell to make it visible by at least one observer. Cells that were already visible will be assigned 0 in this output raster. When the vertical error parameter is 0, the output AGL raster is a one-band raster. When vertical error is greater than 0, to account for the random effects from the input raster, the output AGL raster is created as a three-band raster. The first band represents the mean AGL values, the second band represents the minimum AGL values, and the third band represents the maximum AGL values.	Raster Dataset
analysis_type (Optional)	Specifies the type of visibility analysis you wish to perform, either determining how visible each cell is to the observers, or identifying for each surface location which observers are visible. • FREQUENCY —The output records the number of times that each cell location in the input surface raster can be seen by the input observation locations (as points or as vertices for polyline observer features). This is the default. • OBSERVERS —The output identifies exactly which observer points are visible from each raster surface location. The allowed maximum number of input observers is 32 with this analysis type.	String
vertical_error (Optional)	The amount of uncertainty (the Root Mean Square error, or RMSE) in the surface elevation values. It is a floating-point value representing the expected error of the input elevation values. When this parameter is assigned a value greater than 0, the output visibility raster will be floating point. In this case, each cell value on the output visibility raster represents the sum of probabilities that the cell is visible to any of the observers. When the analysis type is Observers or the analysis method is Perimeter Sightlines, this parameter is disabled.	Linear Unit
out_observer_region_relationship_table (Optional)	The output table for identifying the regions that are visible to each observer. This table can be related to the input observer feature class and the output visibility raster for identifying the regions visible to given observers. This output is only created when the analysis type is Observers.	Table
refractivity_coefficient (Optional)	The coefficient of the refraction of visible light in air. The default value is 0.13.	Double
surface_offset (Optional)	A vertical distance to be added to the z-value of each cell as it is considered for visibility. It must be a positive integer or floating-point value. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is 0.	Linear Unit; Field

Name	Explanation	Data Type
observer_elevation (Optional)	The surface elevations of the observer points or vertices. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is not specified, the observer elevation will be obtained from the surface raster using bilinear interpolation. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset.	Linear Unit; Field
observer_offset (Optional)	A vertical distance to be added to the observer elevation. It must be a positive integer or floating-point value. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is 1 meter.	Linear Unit; Field
inner_radius (Optional)	The start distance from which visibility is determined. Cells closer than this distance are not visible in the output but can still block visibility of the cells between inner radius and outer radius. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is 0.	Linear Unit; Field
inner_radius_is_3d (Optional)	Specifies the type of distance for the inner radius parameter. • GROUND —The inner radius is to be interpreted as a 2D distance. This is the default. • 3D —The inner radius is to be interpreted as a 3D distance.	Boolean
outer_radius (Optional)	The maximum distance from which visibility is determined. Cells beyond this distance are excluded from the analysis. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset.	Linear Unit; Field
outer_radius_is_3d (Optional)	Specifies the type of distance for the outer radius parameter. • GROUND —The outer radius is to be interpreted as a 2D distance. This is the default. • 3D —The outer radius is to be interpreted as a 3D distance.	Boolean
horizontal_start_angle (Optional)	The start angle of the horizontal scan range. The value should be specified in degrees from 0 to 360, either as integer or floating point, with 0 oriented to north. The default value is 0. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset.	Double; Field
horizontal_end_angle (Optional)	The end angle of the horizontal scan range. The value should be specified in degrees from 0 to 360, either as integer or floating point, with 0 oriented to north. The default value is 360. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset.	Double; Field

Name	Explanation	Data Type
vertical_upper_angle (Optional)	The upper vertical angle limit of the scan relative to the horizontal plane. The value is specified in degrees and can be integer or floating point. The allowed range is from above -90 up to and including 90. This parameter value must be greater than the Vertical Lower Angle parameter value. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is 90 (straight up).	Double; Field
vertical_lower_angle (Optional)	The lower vertical angle limit of the scan relative to the horizontal plane. The value is specified in degrees and can be integer or floating point. The allowed range is from -90 up to but not including 90. This parameter value must be less than the Vertical Upper Angle parameter value. You can select a field in the input observers dataset, or you can specify a numerical value. If this parameter is set to a value, that value will be applied to all the observers. To specify different values for each observer, set this parameter to a field in the input observer features dataset. The default value is -90 (straight down).	Double; Field
analysis_method (Optional)	Specifies the method by which the visibility will be calculated. This option allows you to trade some accuracy for increased performance. • ALL_SIGHTLINES —A sightline is run to every cell on the raster in order to establish visible areas. This is the default method. • PERIMETER_SIGHTLINES —Sightlines are only run to the cells on the perimeter of the visible areas in order to establish visibility areas. This method has a better performance than the All Sightlines method since less sightlines are run in the calculation.	String

Code sample

Viewshed2 example 1 (Python window)
This example determines the surface locations visible to a set of observers without using any observer parameters.

```
import arcpy
from arcpy import env
env.workspace = "C:/data"
result = arcpy.Viewshed2_3d("elevation", "obser1.shp", "C:/output/outvwshd01",
                             "", "OBSERVERS", "", "C:/output/obstable01.dbf")
```

Viewshed2 example 2 (stand-alone script)
This example determines the surface locations visible to a set of observers using attributes in the input feature class as the observer parameters.

```
# Name: Viewshed_3d_Ex_02.py
# Description: Determines the raster surface locations visible to a set of
#              observer features.
# Requirements: 3D Analyst Extension

# Import system modules
import arcpy
from arcpy import env

# Set environment settings
env.workspace = "C:/data"


parmSurface = "elevation"
parmObservers = "obser2.shp"
parmOutput = "c:/output/outvshd02"
parmAGL = ""
parmAnalysisType="OBSERVERS"
parmVerticalError = ""
parmAnalysisRelationTable = "C:/output/obser_region2.dbf"
parmRefractCoeff = ""
parmSurfaceOffset = "offsetb"
parmObserverElevation="spot"
parm_ObserverOffset="offseta"
```

```
parmInnerRadius = "radius1"
parmInnerIs3D="False"
parmOuterRadius = "radius2"
parmOuterIs3D="True"
parmAz1 = "azimuth1"
parmAz2 = "azimuth2"
parmVert1 = "vert1"
parmVert2 = "vert2"

# Execute Viewshed2
result = arcpy.Viewshed2_3d(parmSurface, parmObservers, parmOutput, parmAGL,
parmAnalysisType, parmVerticalError, parmAnalysisRelationTable,
parmRefractCoeff, parmSurfaceOffset, parmObserverElevation,
parm_ObserverOffset,parmInnerRadius, parmInnerIs3D, parmOuterRadius,
parmOuterIs3D, parmAz1, parmAz2, parmVert1, parmVert2)
```

Environments

Auto Commit, Cell Size, Cell Size Projection Method, Compression, Current Workspace, Extent, Geographic Transformations, Mask, Output CONFIG Keyword, Output Coordinate System, Parallel Processing Factor, Scratch Workspace, Snap Raster, Tile Size

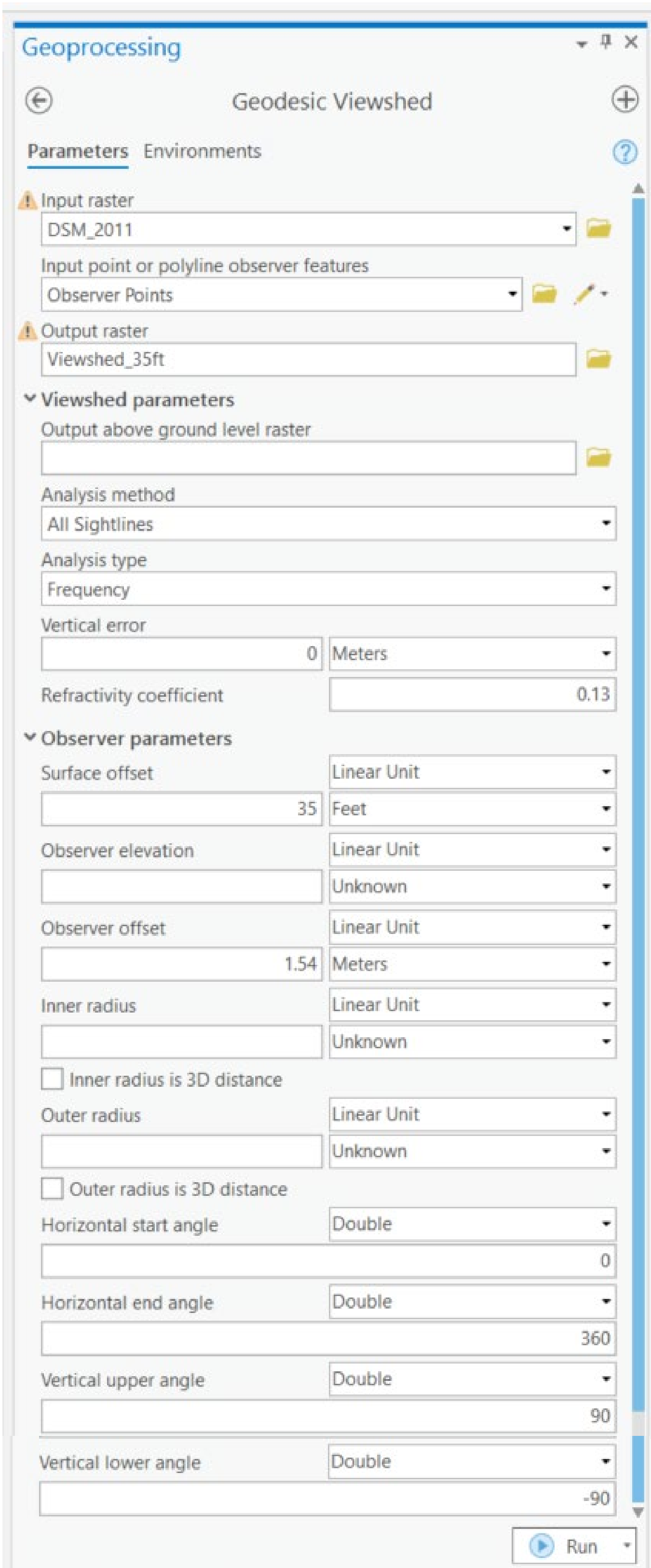
Licensing information

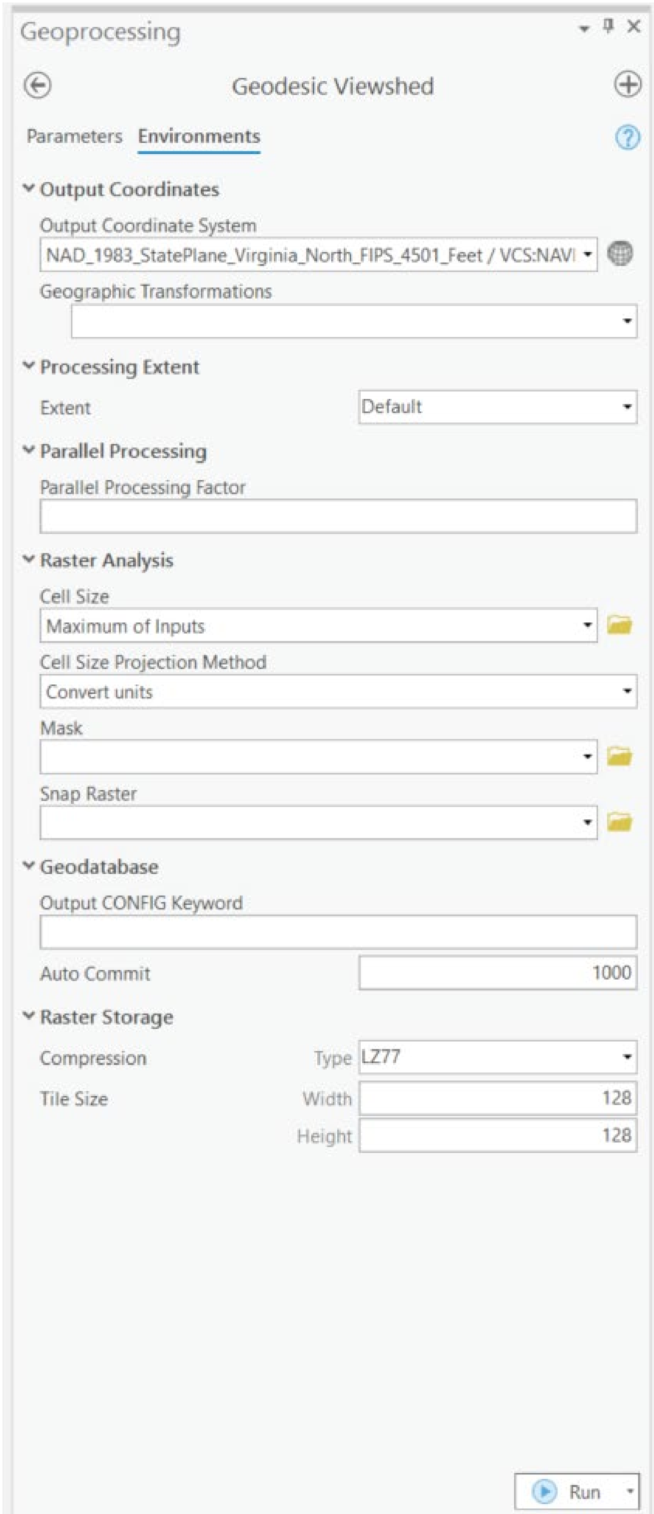
- Basic: Requires 3D Analyst or Spatial Analyst
- Standard: Requires 3D Analyst or Spatial Analyst
- Advanced: Requires 3D Analyst or Spatial Analyst

Related topics

- An overview of the Visibility toolset
- Find a geoprocessing tool
- Analyze Visibility

Appendix B


Geoprocessing
Geodesic Viewshed
Parameters
Environments
Input raster
DSM_2011
Input point or polyline observer features
Observer Points
Output raster
Viewshed_35ft
Viewshed parameters
Output above ground level raster
Analysis method
All Sightlines
Analysis type
Frequency
Vertical error
0
Meters
Refractivity coefficient
0.13
Observer parameters
Surface offset
Linear Unit
35
Feet
Observer elevation
Linear Unit
Unknown
Observer offset
Linear Unit
1.54
Meters
Inner radius
Linear Unit
Unknown
Inner radius is 3D distance
Outer radius
Linear Unit
Unknown
Outer radius is 3D distance
Horizontal start angle
Double
0
Horizontal end angle
Double
360
Vertical upper angle
Double
90
Vertical lower angle
Double
-90
Run


Geoprocessing
Geodesic Viewshed
Parameters
Environments
Output Coordinates
Output Coordinate System
NAD_1983_StatePlane_Virginia_North_FIPS_4501_Feet / VCS:NAVI
Geographic Transformations
Processing Extent
Extent
Default
Parallel Processing
Parallel Processing Factor
Raster Analysis
Cell Size
Maximum of Inputs
Cell Size Projection Method
Convert units
Mask
Snap Raster
Geodatabase
Output CONFIG Keyword
Auto Commit
1000
Raster Storage
Compression
Type
LZ77
Tile Size
Width
128
Height
128
Run

Appendix C

These are screen shots of what ESRI has published about on the fly projections and coordinate system transformations in ArcPro.

esri

Geographic datum transformations

This ArcGIS 2.7 documentation has been archived and is no longer updated. Content and links may be outdated. See the latest documentation.

In this topic

A geographic datum transformation is a calculation used to convert between two different geographic coordinate systems to ensure that data is properly aligned.

Transformations convert between geographic coordinate systems

Geographic coordinate systems describe how locations on the earth are placed on a hypothetical reference spheroid. They use angular units, such as degrees, to assign locations to coordinates on a reference spheroid. There is more than one geographic coordinate system because each is meant to best fit certain portions of the earth. This is necessary because the earth is actually a lumpy and slightly squashed sphere. The transformation is a calculation to convert the geographic coordinate system of the layers to match the geographic coordinate system of the map as the map draws so that everything is aligned. The data is not changed by a transformation. This real-time translation is sometimes referred to as projecting on the fly.

The best geographic coordinate system to use depends on where and how much of earth's geography you are mapping. In ArcGIS Pro, the best transformation for your map is suggested based on the data and the extent, but you can specify a different one.

Learn how to specify a transformation

Note:

Some transformations that require files are not installed with ArcGIS Pro. You can download and install the ArcGIS Pro Coordinate System Data files from My Esri. The additional files are the EGM2008 and GEOID12b geoid models; VERTCON files; GEOCON v1; and three NTv2 files for Switzerland, XRail, and OSTN15.

In ArcGIS Pro, both maps and their layers have coordinate systems, and they are not always the same. Each coordinate system may be either geographic or projected. Projected coordinate systems always include an underlying geographic coordinate system. A projection transforms the angular coordinates (such as latitude and longitude) from the reference spheroid to distance units (such as meters) on a flat surface. For example, the projection may describe how the spheroid coordinates will map to a flat rectangle hypothetically wrapped around the reference spheroid as a cylinder. See a list of the map projections supported in ArcGIS Pro.

Transformations relate to the underlying geographic coordinate systems only. **A transformation is applied only when the geographic coordinate systems are not identical. If layers have a different projected coordinate system than the map they are in, but both the layers and the map reference the same underlying geographic coordinate system, a transformation is not needed.**

Transformations in scenes

When you work with global scenes, there are only two available coordinate systems available: World Geodetic System 1984 (WGS84) or China Geodetic Coordinate System 2000 (CGCS 2000). In the case of CGCS 2000, there are no publicly available transformations. In the absence of a custom transformation, data added to a scene that uses CGCS 2000 is transformed to WGS84. In or near China, WGS84 closely matches CGCS 2000, but datum shifts may be substantial outside China.

Project data to a new coordinate system

Relying on transformations to project layers in real time is helpful when you are exploring data because everything aligns. However, applying a transformation comes with costs in drawing performance and accuracy. It is a best practice to work with data in the same coordinate system when performing edits or analysis on your data. It is recommended that you use one coordinate system for the map and all the data in it. Use the Project tool to project vector spatial data from one coordinate system to another. If you are working with raster data, use the Project Raster tool.

Related topics

- Specify a datum transformation
- Specify a coordinate system
- Coordinate systems, projections, and transformations
- Vertical coordinate systems