Title

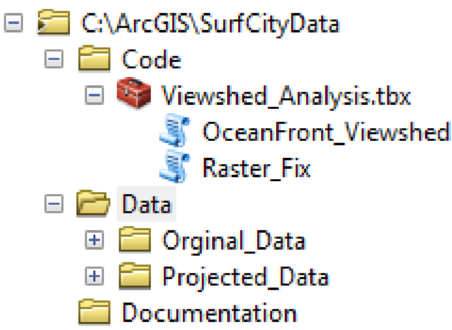
Surf City Oceanfront Viewshed Analysis

Purpose

The purpose of this tool is to provide a viewshed measure, in degrees, at both first (10ft.) and second floor heights (20ft., where applicable) for every observation point within an input observation point file.

Tool Package

The Surf_City folder provided contains three main folders; (1) Data (2) Code, and (3) Documentation. The data folder contains original data and projected data. Any data located within the projected folder also adheres to all assumptions. The Code folder contains a toolbox and related scripts to run the viewshed analysis. This is the folder you'll want to connect to in ArcMap. The Documentation folder contains the all the documentation for scripts contained within the toolbox.

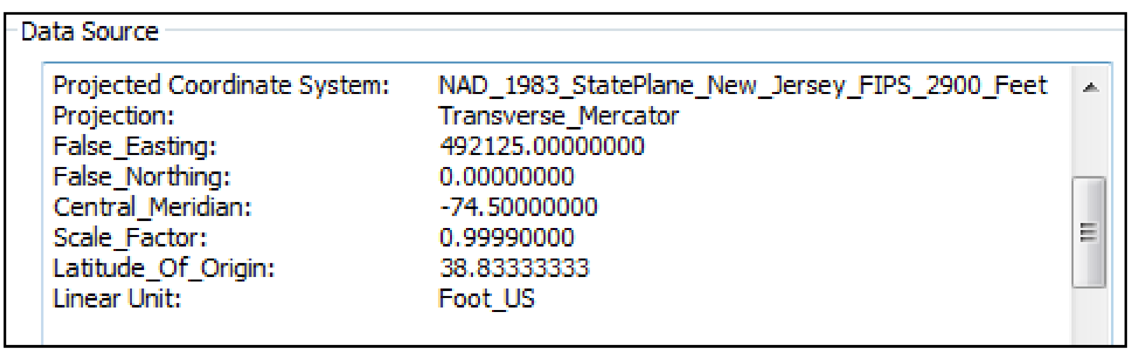


Tool Use

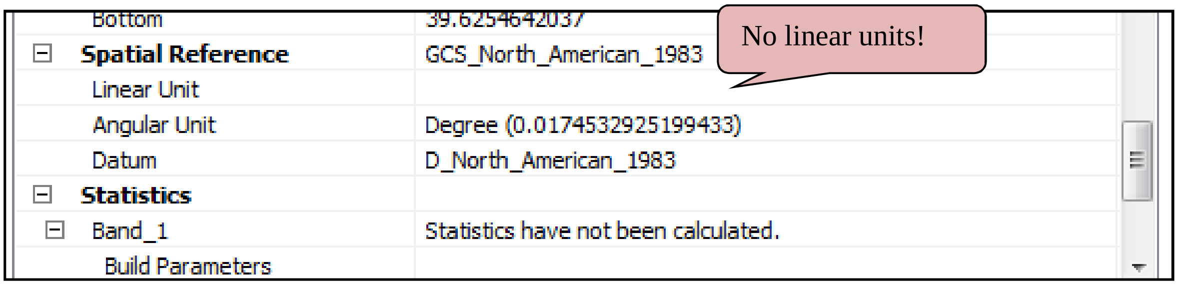
<u>Oceanfront Viewshed Tool Assumptions</u>

The oceanfront viewshed tool has three assumptions, each are described below.

Assumption #1: This tool assumes that all data inputs have been projected into a coordinate system that has linear units.



If a shapefile or raster is projected in a geographic coordinate system that only has angular units, the results may be invalid, and the tool may fail completely.



Assumption #2: This script also assumes that any null values that may be present within the elevation data have been converted to a value of 0. The Raster_Fix.py script located within the toolbox provided will complete this task, and is discussed in more detail in the next section.   This tool does assume that the original raster is in a non GRID format (i.e .tif, .sid, .img).

Assumption #3: This tool assumes that the observation point shapefile already contains an attribute field containing the number of floors for each observation point. The user will be required to indicate this field within the tool.

<u>Raster Fix tool Assumptions</u>

The raster fix tool makes two assumptions.

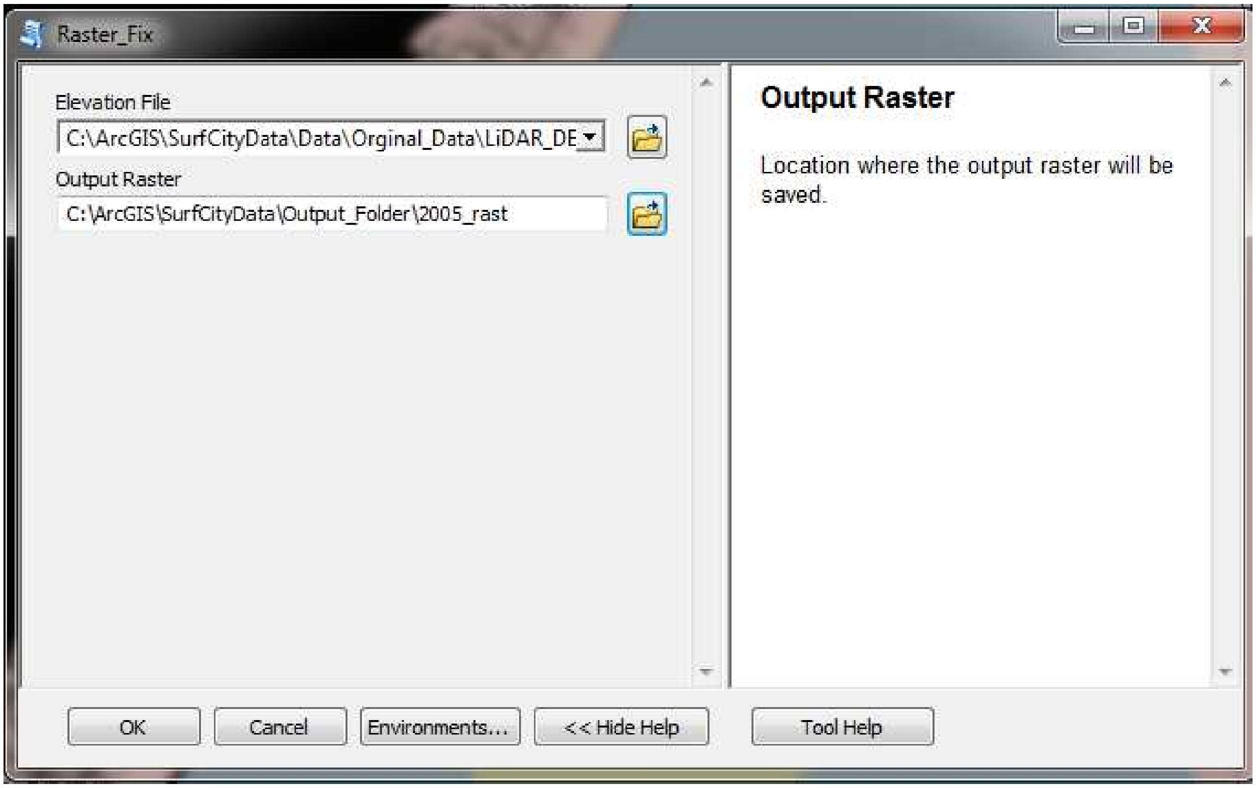
Assumption #1: The tool assumes that the input raster is in a non-GRID format. This is common for lidar data which tends to be in a .tif or .sid format.

Assumption #2: This tool assumes that the raster is floating point. This is also common for lidar data.

<u>Inputs: Raster Fix</u>

The raster fix analysis tool takes a non-grid, floating point raster containing null values and converts it to a GRID, integer raster whose null values have been replaced with the value of 0. This tool should only need to be ran once on a single raster, and takes two inputs

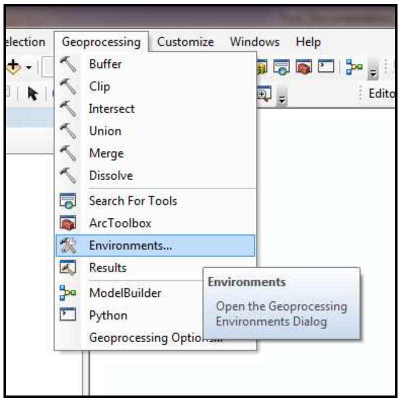
1. Elevation Raster (Non-Grid)
2. Output location where the new raster will be saved

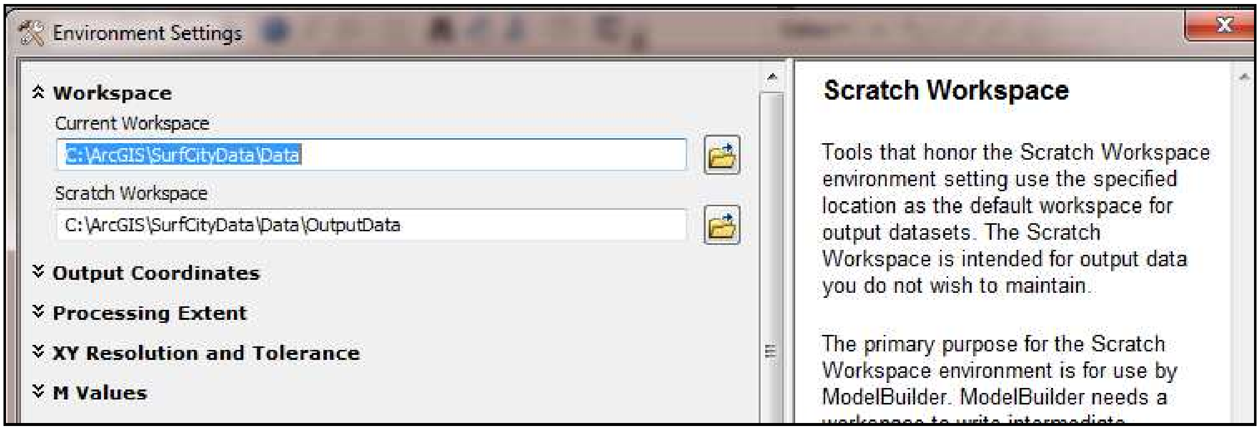


<u>Oceanfront Viewshed</u>

<u>Map Document Properties</u>

Before running the Oceanfront Viewshed tool be sure to set the workspace and scratch workspace in the maps environment settings. Go to Geoprocessing>Environment and then select Workspace.

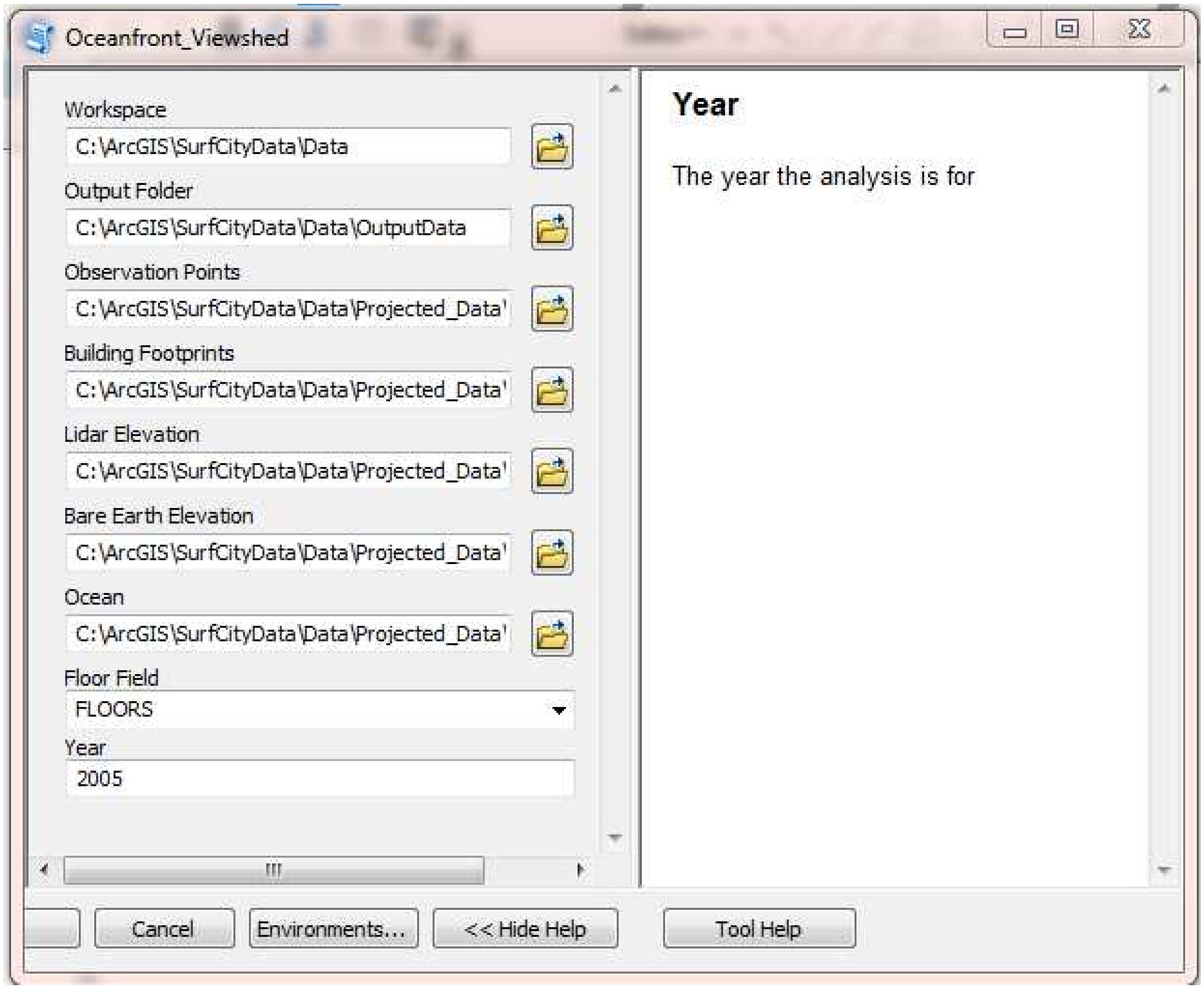




Inputs

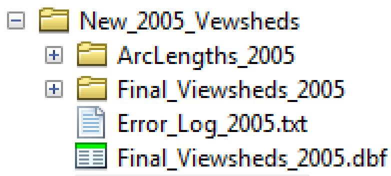
The oceanfront viewshed analysis tool takes eight inputs. Each input is described below

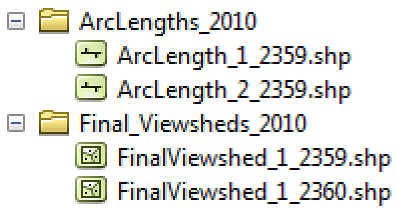
1. Workspace. This is typically where the data folder is located.
2. Output workspace, the folder where you want the results saved.
3. Observation points
4. Building footprints
5. Elevation
6. Bare Elevation
7. Ocean
8. Year the analysis is for
9. Floors. The field within the observation point feature class that contains the number of floors for each observation point.

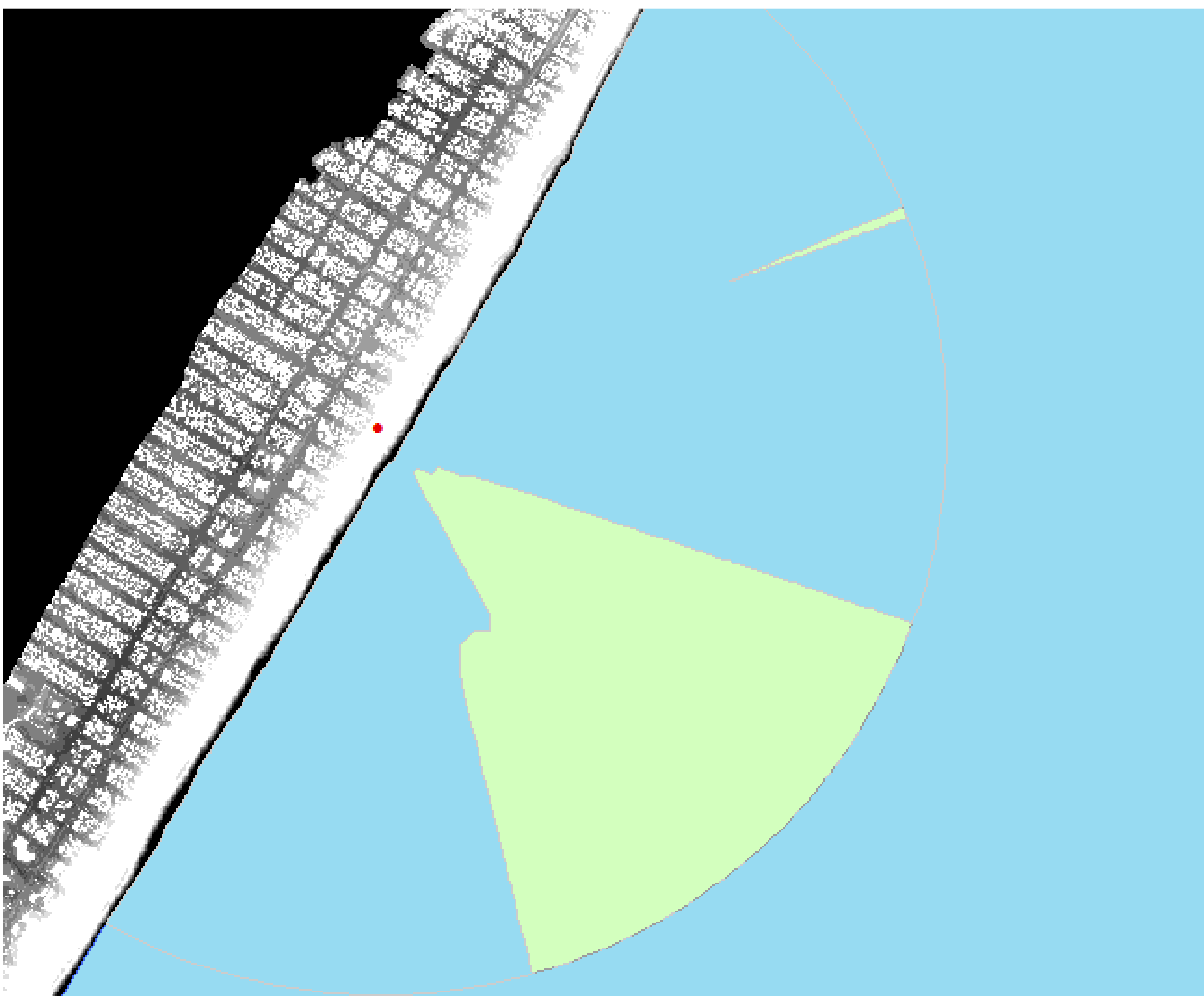


<u>Outputs</u>

The outputs of the oceanfront viewshed script tool are saved in a user specified location. Within this location, the user will find three major outputs from each run of the tool. First, there will be a folder containing the final viewsheds for each observation point, at each floor, in vector format. Secondly, there will be a folder called "ArcLengths". This folder contains the arc segments for each viewshed at each floor for any parcel that contained a viewshed. Filenames are structured to include the floor number and the unique ID number for each viewshed or arc length so that each is easily identifiable.


New_2005_Vewsheds
ArcLengths_2005
Final_Viewsheds_2005
Error_Log_2005.txt
Final_Viewsheds_2005.dbf


ArcLengths_2010
ArcLength_1_2359.shp
ArcLength_2_2359.shp
Final_Viewsheds_2010
FinalViewshed_1_2359.shp
FinalViewshed_1_2360.shp



Lastly, there will also be a .dbf table. The table contains the viewshed output in degrees, for each observation point for each floor. Below is a description of some of the fields within the output table and a description of the information the field contains.

GRIDCODE = Indicates whether there are viewable areas (1) or not (0)
Id = The unique ID assigned to each observation point
SPOT = The bare earth elevation of a parcel
OFFSETA = The height of the observer. This value is added to the SPOT value when calculating the final viewshed.
FLOORS = the total number of floors in the parcel
MAX_LENGTH = The viewshed arc-length used in calculating the viewshed in degrees for that parcel.
FLR_RAN = The floor ran for the corresponding viewshed.
VIEW_YEAR = The viewshed in degrees for the specified year (i.e 2005)

Final_Viewshed_2005

OID	GRIDCODE	Id	SPOT	OFFSETA	FLOORS	FREQUENCY	MAX_LENGTH	FLR_RAN	VIEW_2005
1	0	2358	7.5	10	2	1	4.944024	1	0
42	1	2358	7.5	20	2	3	1.433571	2	41.089628
0	1	2359	14.25	10	2	6	3.092898	1	88.649942
41	1	2359	14.25	20	2	2	3.889143	2	111.472257
12	0	2360	8.5	10	1	1	4.944385	1	0

Methods

The creation of elevation surfaces and viewshed followed the methods proposed by Patterson and Boyle 2002; Bin et al., 2008; Morgan and Ashton, 2010; Hindsley et al. 2012; and Crawford et al., 2013.

For parcels 1 to n, complete the following for both first and second floors:

1. **Observation Point** = Select footprint centroid point by FID number
2. Select the centroid points building footprint, and convert to **a temporary footprint raster**
3. Calculate an average **bare earth elevation** of the temporary footprint raster and transfer this value to the SPOT field in the Observation Point file. This SPOT value will override the footprint elevation value of 0.
4. **Elevation** = Lidar elevation raster
5. **Final Elevation** = Create final elevation raster for the selected centroid point by changing the elevation of the temporary footprint raster to zero and then merge this with the Elevation raster. This allows the selected footprint to be changed to an elevation of 0, while retaining elevation values for all other areas within the raster.
6. Calculate a **tempory viewshed** based on the Final Elevation and the selected observation point, and convert output raster to a polygon.
7. Create a 180-degree, 1-mile **oceanfront view zone** for the observation point by buffering the observation point and then clipping that buffer to the ocean.
8. Create a **final viewshed** by intersecting the temporary viewshed to the oceanfront view zone
9. Calculate the parcels viewshed in degrees

Following the guidance of previous research, a final view measure was created by extracting out the top portion of the viewshed arc for each viewshed output, and calculating the sum of viewable arcs. This arc length was divided by the total possible view radius of 3.14 miles and multiplied by the total possible view angle of 180 degrees.

Viewshed = (Sum arc-lengths/3.14)*180

Please refer to appendix II for a step by step guide with screenshots.

A viewshed analysis provides an output of both viewable (GRIDCODE = 1) and non-viewable (GRIDCODE = 0) from a given observation point, over a given terrain (elevation). For this analysis, it is possible that a given observation point at a given height would not have any viewable areas (GRIDCODE = 0). To account for this, the tool reads through all the lines for the output viewshed statistical analysis. If an observation point did not have a viewable oceanfront from a given floor, the 0 gridcode value was retained and the viewshed in degrees (i.e VIEW_2005) is set to a value of 0. If a floor did have a viewable area (Gridcode = 1) then only the viewable record was retained and the corresponding non-viewable areas (Gridcode = 0) was deleted so that then "Final Viewshed" table shows only the relevant viewsheds, in degrees for each parcel at each floor.

Appendix I. Preparing Data for Viewshed Analysis

The purpose of this appendix is to provide some general guidance in ensuring that the input data meets the assumptions of the Oceanfront Viewshed script tool.

1. Make copies of all the original data. Although this is not an assumption of the tool(s), it's good data management practice.

2. The script assumes that the input observations points field names, particularly the "Id" field, is the same in all observation input files. Field names are case sensitive.

3. Make sure all data is in the same projection that contain linear units (i.e NAD 1983 StatePlane New_Jersey FIPS 2900 Feet).

4. Mosaic rasters for each analysis year into single raster dataset (Data Management>Raster>Raster Dataset). Since copies were made of all the original data, and data preparation is being based of the copied dataset, make the target raster one of the input rasters. This will add all of the rasters to that specified target raster.

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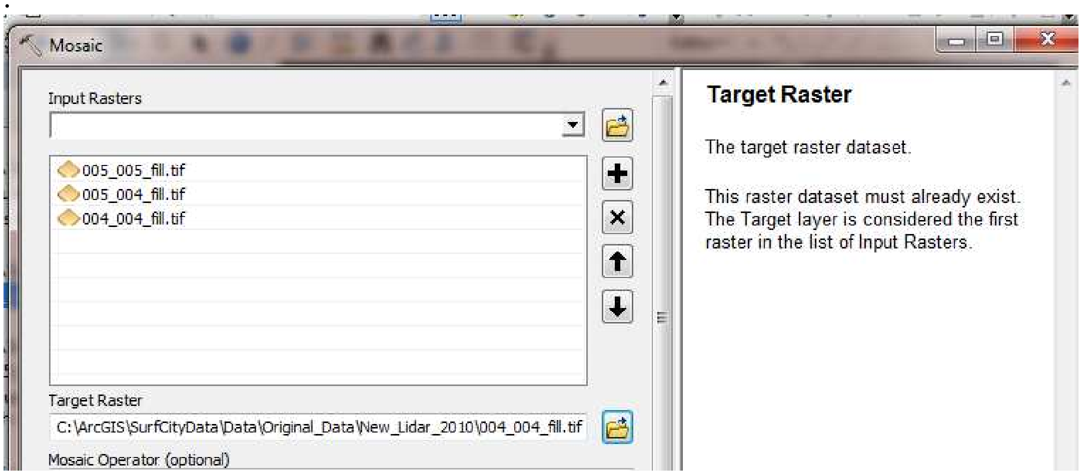


5. Use the Raster Fix script tool to convert the new mosaic to an integer base, grid raster. Results may not be automatically added to the display.

Appendix II. Calculating Viewshed Methods

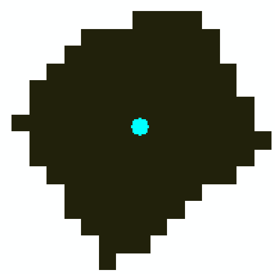
For n points perform the following to get a degree view (these steps do not include raster processing):

1. **Bare Earth.** Calculate the average bare earth elevation for each parcel. Select out the building footprint that intersects with the select (n) point. Use the selected footprint to select out the intersecting lidar data (Extract by Mask).

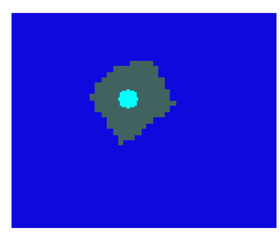
2. Use the statistics tool to get the average elevation of the selected parcel. Join the resulting statistics table to the observation point file. Use the Field calculator to transfer the average elevation to the SPOT field in the observation point file. Bare earth elevation for the parcel is set.

3. **Elevation Raster**. Create final elevation raster for the selected centroid point by changing the elevation of the temporary footprint raster to zero and merging this with the Elevation raster. This allows the selected footprint to be changed to an elevation of 0, while retaining elevation values for all other areas within the raster. This also ensures that the observer height will start at the bare earth SPOT elevation.

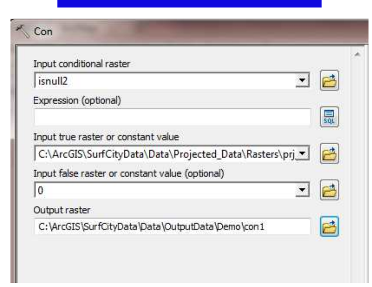
4. Convert the selected footprint to a raster based on Maximum Area.



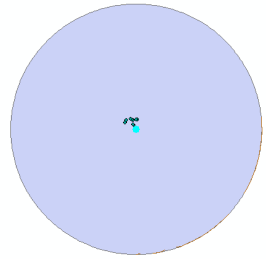
5. Use the IsNull to identify Null areas.



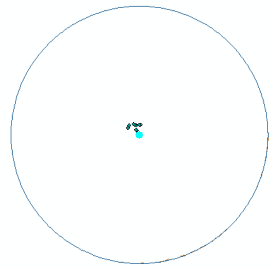
6. Use the Con tool to replace all null areas with lidar data, and keep elevation footprint as 0. This output will be the input to the viewshed analysis. The elevation footprint of 0 is replaced with the SPOT value that was calculated in steps 1-2.



7. **1-Mile Buffer.** Buffer the selected n point with a 1 mile buffer.

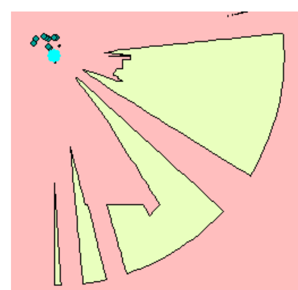


8. Convert this buffer to a polyline.



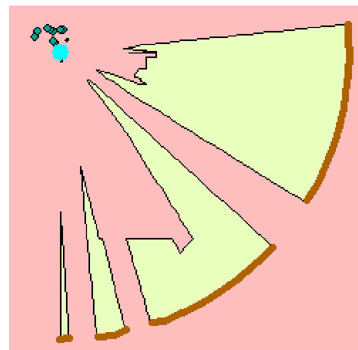
9. **Viewshed**. Perform a viewshed using the viewshed tool.

10. Convert viewshed to a polygon



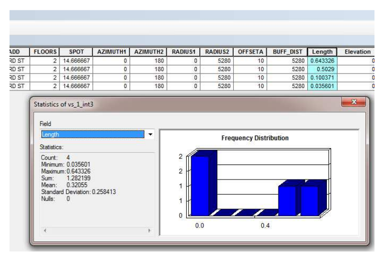
(Overlaid with viewshed polygon for reference)

11. Select gridcode values of 1 in the viewshed polygon and intersect with the buffer polyline in step 2 (tolerance = 10 ft.).



12. **Degree Value.** Calculate arc length and get sum of arc lengths using the summary statistics tool. Calculate viewshed with field calculator using the formula (arclength/3.14)*180.

    i.e. (1.28mi/3.14mi)*180 = **73.375 degrees**



Sum = 1.28 mi