

The Indiana DNR HEC-RAS Geometric Data Tool

The Indiana DNR HEC-RAS Geometric Data Tool is an ArcGIS Online application that uses an ArcGIS Geoprocessing service implemented by the State of Indiana to create a “GIS Input File” that can be imported into a HEC-RAS Geometry file. HEC-RAS, developed by the U. S. Army Corps of Engineers, is commonly used software for determining water surface elevation data for a stream reach. Input into HEC-RAS commonly is cross sections (stations and elevations) along the stream, along with other geometric and physical properties of the stream channel and overbank. More information on HEC-RAS can be found in the documentation for the program, or on the Hydrologic Engineering Center’s website at <http://www.hec.usace.army.mil/software/hecras>. The documentation that follows and correct use of the data obtained from this service assumes prior knowledge of HEC-RAS and basic computational hydraulics.

See the “quick guide” for information on running the tool from ArcGIS Online. The geoprocessing service was originally implemented for internal DNR use for computing “Zone A” models, and was tested by DNR Division of Water staff. Following are details of the data sources and modeling assumptions used by the service.

Topographic / Elevation data:

Elevation data for the cross sections are from a Digital Elevation Model (DEM) for the State of Indiana, which was derived from LiDAR data taken from 2008 through 2013. The DEM has a 5 foot pixel spacing, which results in an elevation point along the cross section every 5 feet (approximately). The DEM has also been hydro-flattened, since LiDAR data cannot accurately measure elevations beneath water surfaces. Therefore, one major limitation of this dataset is that the cross sections do not have elevations below water. The modeler will need to determine how much of an issue having no thalweg information is in the application of the model.

The DEM is in a native horizontal projection of Universal Transverse Mercator (UTM), Zone 16, North American Datum (NAD) of 1983. Since the UTM coordinate system is in meters, the cross sections derived from this dataset are translated to the appropriate Indiana State Plane coordinate system, which is in feet. Station and elevation data for the cross section points are then taken from the translated section data in order to have consistent units in the input file. The State Plane zone used (either East or West) is determined based on the centroid of the stream centerline. Caution should be used in models that extend from one zone to the other.

Indiana LiDAR project information: <http://www.igic.org/igic/projects/2011-2013-statewide-lidar-project/>

Indiana State Plane Zones: <https://alidade.wikispaces.com/Indiana+SPCS+Zones>

Stream Centerlines

The stream centerline for the output data is chosen from the map within the application, and is taken from Local Resolution National Hydrography Dataset (NHD), compiled by the State of Indiana for the U. S. Geological Survey. As with the cross section data, the NHD is in UTM horizontal coordinates, and is converted to the appropriate State Plane coordinate system. Cross sections are then numbered using the position where the cross section intersects the centerline, in feet from the beginning (downstream) of the centerline. Care should be taken when selecting cross sections not to intersect the centerline in more than one place. Intersecting the tributary lines is appropriate.

NHD: <http://nhd.usgs.gov>

Indiana NHD: <http://www.igic.org/projects/NHD>

Channel Bank Stations

Channel bank stations are derived based on a study of undisturbed natural channels around the state by the U. S. Geological Survey. This study relates drainage area vs. channel width (along with depth and area) based on the major physiographic regions within the state. The appropriate physiographic region is chosen by the centroid of the stream centerline. The drainage area above the stream is taken from StreamStats, a USGS application for hydrology. Streamstats is not always available to compute a drainage area, in that case a standard width of 25 feet is used. Streamstats is called for every 10 cross sections sent to the service, so service calls with a large number of cross sections can take excessive time to compute.

The left and right channel banks are chosen by centering the computed width on the centerline of the stream, and then choosing the closest existing point to represent the channel bank station. As with many of these parameters, review of the model should be done to be sure appropriate channel banks are set.

USGS report on channel dimensions: <http://pubs.usgs.gov/sir/2013/5078>

Streamstats (USGS): <http://streamstats.usgs.gov>

Distances between cross sections

The distance between cross sections for the channel is measured from the stream centerline. For the left and right overbank distances, a point is determined on each section at $.2 * \text{Cross section length}$ from the centerpoint of the section, to the left and right. The centerpoint of the section is where the stream centerline intersects the section. Overbank distances are then computed as a straight line from these points to the similar points on the corresponding downstream section. These lengths should be reviewed for unique cross section placements that would distort the actual overbank length.

Manning's N Roughness Values

The service uses the USGS National Land Cover Dataset (2006) (NLCD) for derivation of the Manning's N values for the channel and overbank. The NLCD is pixels of land use designated by the Anderson Land Use Classification System. Tables relating the NLCD data with Manning's N are available, the one used in this instance was from *Web-Based Implementation of Fast Dam-Break Flood Modeling Capabilities* (Altinakar, et. al, 2011 ASDSO Dam Safety Conference), and is shown below:

| Land Cover | Description | $n (m^{-1/3} s)$ | Source |
|------------|------------------------------|------------------|---|
| 0 | Unclassified * | 0.035 | |
| 11 | Open Water | 0.033 | Prachansri 2007 |
| 12 | Perennial Snow/Ice | 0.01 | Roseen et al. 2009 |
| 21 | Developed, Open Space | 0.0404 | Kalyanapu et al. 2009 |
| 22 | Developed, Low Intensity | 0.0678 | Kalyanapu et al. 2009 |
| 23 | Developed, Medium Intensity | 0.0678 | Kalyanapu et al. 2009 |
| 24 | Developed, High Intensity | 0.0404 | Kalyanapu et al. 2009 |
| 31 | Barren Land | 0.0113 | Kalyanapu et al. 2009 |
| 41 | Deciduous Forest * | 0.1 | Based on Arcement and Schneider 1984 |
| 42 | Evergreen Forest * | 0.1 | Based on Arcement and Schneider 1984 |
| 43 | Mixed Forest * | 0.12 | Based on Arcement and Schneider 1984 |
| 51 | Dwarf Scrub * | 0.035 | |
| 52 | Shrub/Scrub | 0.04 | |
| 71 | Grassland/Herbaceous | 0.04 | Arid Hydrology and Hydraulics, LLC 2007 |
| 72 | Sedge/Herbaceous * | 0.035 | |
| 73 | Lichens * | 0.035 | |
| 74 | Moss * | 0.035 | |
| 81 | Hay/Pasture | 0.035 | Bhattacharya 2010 |
| 82 | Cultivated Crops | 0.07 | Arid Hydrology and Hydraulics, LLC 2007 |
| 90 | Woody Wetlands | 0.15 | |
| 95 | Emergent Herbaceous Wetlands | 0.1825 | Kalyanapu et al. 2009 |

Regions for calculating the N values were taken from polygons derived from the cross section and channel width information, then averaging the pixel values that fell within these regions. If no pixels were in the calculated regions, then the value "-9999" was used for the value. These should be re-evaluated before the model is run.

NLCD data: <http://www.mrlc.gov/nlcd2006.php>

Output from the service

The output from the service includes the following:

dnrZoneA.import.sdf – is the sdf file for importing into HEC-RAS. To import, open an empty geometry file, then select “File / Import Geometry Data / GIS Format”. See the HEC-RAS documentation for more information

- ZoneA_001.gdb – is an ESRI geodatabase containing the following layers:
- Atemp0 – stream centerline, no elevation data, State Plane coordinates
- Atemp00 – cross sections, no elevation data, State Plane coordinates
- Ztemp0 – stream centerline, with elevation data, UTM coordinates
- Ztemp00 – cross sections, with elevation data, UTM coordinates
- Temp000 – polygon of N value zones, UTM coordinates

Disclaimer

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