

# Hydrologic Attributes of Catchments

Stream catchments are fundamental units of most landscapes. The characteristics of the master stream channel, its tributaries, and their relationship to the morphological aspects of the drainage basin can be used to predict or describe geomorphic processes that shape the landscape and impact human activities. The TNTmips Watershed process (Terrain / Watershed) can optionally compute a varied set of hydrologic and geomorphic attributes for the catchment (watershed) and subcatchment (basin) polygons it delineates from the input elevation raster. Some of these attributes are properties of the aggregate flowpath network for each polygon, and some are computed for flowpath lines of each stream order. The Geomorphic Attribute toggle buttons on the General panel of the Watershed Analysis window allow you to choose to compute these attributes for basins and/or watersheds. Other useful hydrologic attributes are computed and attached to flowpath lines; these attributes are described in the Technical Guide entitled *Terrain Operations: Hydrologic Attributes of Flowpaths*.

**Hydrologic Attributes:** The ATTRIBUTES table records a variety of derived hydrologic attributes of each watershed or basin. The table records for each polygon several simple attributes such as the number of streams (flowpath lines), total stream length in meters, and the average stream line length in meters. In addition, it records the more complex attributes defined below:

*Bifurcation Ratio* = the mean (for all stream orders) of the number of streams of a given order divided by the the number of streams of the next higher order.

*Length Ratio* = the mean (for all stream orders) of the average stream length of a given stream order divided by the average length of the next higher order.

*Drainage Density* = total stream line length divided by the polygon area.

*Constant of Channel Maintenance* = polygon area divided by the total stream length (reciprocal of drainage density).

*Length of Overland Flow* = reciprocal of (2 \* drainage density).

*Stream Frequency* = total number of streams divided by the polygon area.

*Basin Length* = maximum polygon dimension measured from the stream outlet.

*Form Ratio* = polygon area divided by the square of the basin length.

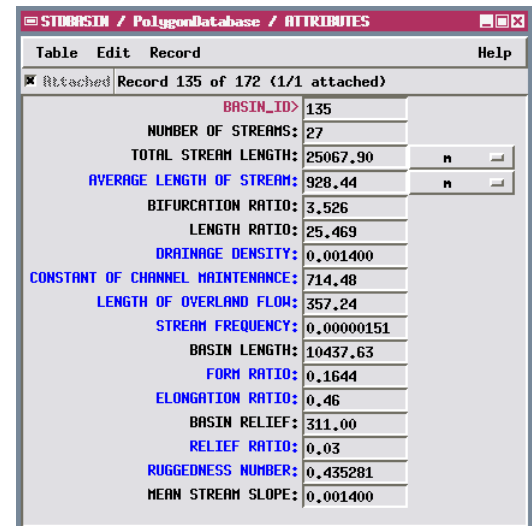
*Elongation Ratio* = ratio of the diameter of a circle with area equal to the basin area to the basin length.

*Basin Relief* = maximum elevation on the polygon boundary minus the minimum elevation (which occurs at the outlet).

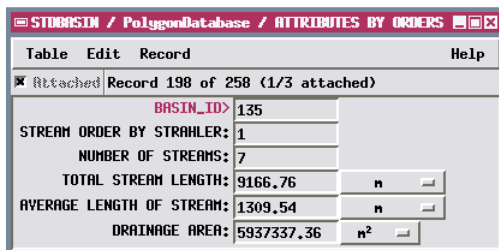
*Relief Ratio* = basin relief divided by basin length.

*Ruggedness Number* = basin relief times drainage density.

*Mean Stream Slope* = (elevation at source minus elevation at outlet) divided by stream length (using source and main stream segments as identified using the Horton stream ordering system).



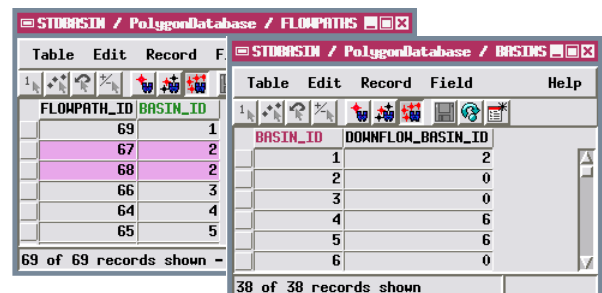
| STDBASIN / PolygonDatabase / ATTRIBUTES |            |        |
|---|------------|--------|
| Table                                   | Edit       | Record |
| Record 135 of 172 (1/1 attached)        |            |        |
| BASIN_ID                                | 135        |        |
| NUMBER OF STREAMS                       | 27         |        |
| TOTAL STREAM LENGTH                     | 25067.90   | m      |
| AVERAGE LENGTH OF STREAM                | 928.44     | m      |
| BIFURCATION RATIO                       | 3.526      |        |
| LENGTH RATIO                            | 25.469     |        |
| DRAINAGE DENSITY                        | 0.001400   |        |
| CONSTANT OF CHANNEL MAINTENANCE         | 714.48     |        |
| LENGTH OF OVERLAND FLOW                 | 357.24     |        |
| STREAM FREQUENCY                        | 0.00000151 |        |
| BASIN LENGTH                            | 10437.63   |        |
| FORM RATIO                              | 0.1644     |        |
| ELONGATION RATIO                        | 0.46       |        |
| BASIN RELIEF                            | 311.00     |        |
| RELIEF RATIO                            | 0.03       |        |
| RUGGEDNESS NUMBER                       | 0.435281   |        |
| MEAN STREAM SLOPE                       | 0.001400   |        |



| STDBASIN / PolygonDatabase / ATTRIBUTES BY ORDER |            |                |
|--|------------|----------------|
| Table  | Edit       | Record         |
| Record 198 of 258 (1/3 attached)                 |            |                |
| BASIN_ID   | 135        |                |
| STREAM ORDER BY STRAHLER                         | 1          |                |
| NUMBER OF STREAMS                                | 7          |                |
| TOTAL STREAM LENGTH                              | 9166.76    | m              |
| AVERAGE LENGTH OF STREAM                         | 1309.54    | m              |
| DRAINAGE AREA                                    | 5937337.36 | m <sup>2</sup> |

**Hydrologic Attributes by Stream Order:** The ATTRIBUTES BY ORDER table records basic hydrologic attributes for each stream order within a watershed or basin. The table includes a record for each stream order value contained within a polygon, so there may be multiple records attached to a given polygon. Each record lists the Strahler stream order value, and for that order the number of stream lines, total stream length in meters, average stream length in meters, and the drainage area in square meters.

**Basin Hydrologic Connectivity:** Each basin polygon contributes flow to only one downstream basin; the ID number of that downstream basin is provided in the BASINS table, which is created automatically whenever both basins and flowpaths are computed. The FLOWPATHS table for basin polygons records the ID numbers of all flowpath line elements that pass through each basin. This table contains one record for each stream line with its basin ID, and there may be multiple records attached to a single basin polygon (as shown by the highlighted records in the illustration to the right).



| STDBASIN / PolygonDatabase / FLOWPATHS |          | STDBASIN / PolygonDatabase / BASINS |                   |
|--|----------|-------------------------------------|-------------------|
| Table                                  | Edit     | Record                              | Field             |
| 69 of 69 records shown                 |          | 38 of 38 records shown              |                   |
| FLOWPATH_ID                            | BASIN_ID | BASIN_ID                            | DOWNFLOW_BASIN_ID |
| 69                                     | 1        | 1                                   | 2                 |
| 67                                     | 2        | 2                                   | 0                 |
| 68                                     | 2        | 3                                   | 0                 |
| 66                                     | 3        | 4                                   | 6                 |
| 64                                     | 4        | 5                                   | 6                 |
| 65                                     | 5        | 6                                   | 0                 |