

A Landscape Scale Valley Confinement Algorithm

Delineating Unconfined Valley Bottoms for Geomorphic, Aquatic, and Riparian Applications

Addendum for Using NHDPlus Version 2 Data

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updated in 2024 only to include updated URLs and to bold red text for accessibility

Introduction

RMRS-GTR-321 describes procedures for running the Valley Confinement Algorithm (VCA) using NHDPlus Version 1 input data. NHDPlus Version 2 (NHDPlusV2) was released after RMRS-GTR-321 was finalized. This addendum describes procedures for running the VCA using NHDPlusV2. RMRS-GTR-321 may be accessed here: <https://research.fs.usda.gov/treesearch/45825>

The entire section, Part II-VCA Software, from RMRS-GTR-321, is reproduced here, however any changes specific to NHDPlusV2 are emphasized with **red bolded text**.

Part II – VCA Software

Software Requirements and Overview

The VCA program requires ArcGIS version 10.0 or higher, with an ArcInfo level license and the Spatial Analyst extension. Python version 2.6.2 (ArcGIS 10.0) or higher is also required.

The program is run from the ArcToolbox interface as a script. Following installation (see website) a Toolbox called Valley Confinement is added to the ArcToolbox interface and a script called Valley Confinement Algorithm will appear within the Toolbox.

Three input GIS files are used by the script, the first two are required and the third is optional: 1) a 10 or 30 m DEM clipped to a watershed boundary 2) **NHDPlusV2** stream lines, and 3) **NHDPlusV2** water bodies. A watershed boundary GIS file is also useful to clip all three input layers to the correct spatial domain. A number of user input parameters are required at the program interface, which modify the algorithm results.

The algorithm will output one of two possible products: 1) a polygon shapefile representing relatively flat, unconfined valley bottoms, or 2) a polygon shapefile representing relatively flat, unconfined valley bottoms with distance along the stream network measured to the closest valley bottom polygon. These products are referred to as Valley Type 1 and Valley Type 2, respectively. Although both products are generated from the raster DEM, the first output incorporates a line smoothing routine to create more realistic looking valley bottom polygons. The second output does not incorporate a smoothing routine because the nature of stream lines represented in a raster environment precludes this type of enhancement. As a result, the second product has a stair-stepped appearance which mimics the underlying raster data model. Valley Type 1 and 2 will provide slightly different valley bottom results because two slightly different processing procedures are used.

The VCA program and online documentation may be accessed from the Rocky Mountain Research Station valley confinement website:

<https://research.fs.usda.gov/rmrs/projects/valley-bottom-confinement>

Scale Considerations

The USGS National Elevation Dataset (NED; USGS 2006), with a 30 m spatial resolution, is well suited for valley confinement mapping at a landscape scale. These data are generally able to identify relatively flat valley bottoms as small as 60-90 m wide, depending on the VCA user-supplied input parameters and the quality of the DEM. The output will be generally applicable at the valley segment scale (100 to 10,000 m) (Bisson and others 2006; Fausch and others 2002) and suitable for mapping at about 1:50,000 to 1:100,000 scales. Assuming that the DEM processing units are clipped to the subbasin (8-digit) USGS Hydrologic Unit boundaries (USGS 2011), the VCA will run in approximately 5 to 10 minutes per subbasin.

DEMs with a 10 m spatial resolution can also be used, but run times will increase substantially. For 10 m DEMs, the program's default ground slope threshold should be decreased because smaller cells will result in less slope averaging at the interface between the valley bottom and side slopes. The user should experiment with different slope thresholds until a suitable value is obtained. Although 10 m DEM data may be used as input for the VCA, 30 m data are recommended due to their availability as part of the NHDPlus dataset.

The smallest unconfined valley that can be resolved by the VCA depends on the cell size of the DEM. In particular, the VCA has difficulty resolving unconfined valleys that are narrower than about two to three times the DEM cell size (60-90 m in width for a 30 m DEM or 20-30 m in width for a 10 m DEM).

Errors may also occur due to interactions between cell size and channel width. As bankfull width approaches two times the DEM cell size, the VCA may misinterpret the channel as a narrow unconfined valley (figure 7). This condition occurs as two or more adjacent raster cells at the same elevation abut perpendicular to the stream centerline, producing the appearance of a relatively flat valley bottom to the algorithm logic. These cells may actually represent the water surface in wider streams. Consequently, care should be exercised when narrow unconfined valleys are predicted in locations where channels have bankfull widths larger than twice the

DEM cell size (i.e., bankfull widths larger than 60 m for a 30 m DEM or larger than 20 m for a 10 m DEM).

In addition, some valley bottoms are not mapped accurately in the USGS NED data and may not be identified by the VCA. The NED data were produced using an algorithm called LT4X (USGS 1997). The LT4X program used scanned topographic contours from quadrangle maps, tagged with elevation values, for generating the raster DEM data (Underwood and Crystal 2002). LT4X performed well in areas with sufficient contour density, however, where the concentration of contours changed from dense to sparse at unconfined valley bottoms, elevation errors were sometimes created. This type of error is most obvious in relatively flat, wide valley bottoms with relatively steep adjacent side slopes (Nagel and others 2010). Since these valley bottoms exhibited very little relief, there was a paucity of contours for guiding the LT4X algorithm, resulting in valleys having a “half-pipe” shape that, instead, should have a more planar morphology (figure 8). Consequently, some valley bottoms may not be accurately captured by the VCA output. Increasing the input ground slope parameter or increasing the flood factor (described in the program parameters section below) may help alleviate this problem.

It should also be recognized that the VCA is unable to capture geomorphic features that are smaller than the resolution of the DEM. As such, ground truthing is advised to identify sub-cell topography, such as small terraces or channel entrenchment that may confine the river and its active floodplain. Riparian vegetation can also confine the river (e.g., Manners and others 2013; Smith 2004) and will not be visible to the DEM.

The VCA has been tested most extensively in montane regions of the Intermountain West and its performance in other landscapes is uncertain. Consequently, we recommend that users validate the VCA results using local field sampling. Low-relief landscapes may be particularly challenging in terms of setting an appropriate lateral ground-slope threshold.

Input and Ancillary Data Overview

It is necessary to download and pre-process five input GIS data themes (one DEM, three shapefiles, and one table) to successfully run the VCA program. This section provides a brief overview of the required inputs. The input data can be obtained from the **National Hydrography Dataset Plus, Version 2 (NHDPlusV2)** website. Additional information about downloading **NHDPlusV2** data is provided in the next section.

Average annual precipitation (cm/yr) is also needed if using the flood height factor. The precipitation value is implemented as a single value for the watershed being processed, so the GIS data layer is not required as input. The user is simply required to enter an integer value as an input parameter in the VCA interface. Readily available online sources of precipitation data include the PRISM Climate Group (<http://www.prism.oregonstate.edu/>) or the *nationalatlas.gov* website.

Elevation GIS raster

Source: **NHDPlusV2** or USGS NED

NHDPlus download layer name: elev_cm

Format: ESRI GRID

Description: This raster layer is the underlying basis for most computations in the VCA, such as ground slope and flood height. The elevation units are centimeters if the NHDPlus layer is used and will need to be converted to meters during the pre-processing phase.

Stream lines GIS layer

Source: **NHDPlusV2**

NHDPlusV2 download file name: **NHDFlowline.shp**

Format: ESRI shapefile

Description: This layer is used to restrict valley bottoms to relatively flat areas directly adjacent to the stream network. Unchanneled valleys are not considered. The user will join a field to the attribute table called **TotDASqKM**, which may be used to control the minimum drainage area (surrogate for stream size) where valley bottom polygons will be delineated. **The values in the TotDASqKM field** are also used in an equation to control the flood height parameter, however the **TotDASqKM field must be copied to a new field in the attribute table called CUMDRAINAG for the VCA script to work properly.**

Water bodies GIS layer

Source: **NHDPlusV2**

NHDPlusV2 download file name: **NHDWaterbody.shp**

Format: ESRI shapefile

Description: The layer is used to exclude water bodies such as lakes and reservoirs from analysis so that these features are not misinterpreted as valley bottoms.

Drainage area attribute table

Source: **NHDPlusV2**

NHDPlusV2 download file name: **CumulativeArea.dbf**

Format: dBase

Description: This dBase file must be joined to the stream lines theme using the key field COMID. The attribute of interest from this file is **TotDASqKM**, which is the cumulative drainage area for the stream segment. **However, the TotDASqKM field must be copied to a new field in the attribute table called CUMDRAINAG for the VCA script to work properly.**

Watershed boundary

Source: **NHDPlusV2**

NHDPlusV2 download file name: **WBD_Subwatershed.shp**

Format: ESRI shapefile

Description: This layer is an ancillary shapefile that contains watershed boundaries, which may be used to clip the elevation raster and hydrography shapefiles.

Average annual precipitation

Source: PRISM (Daly and others 1994; 1997) recommended, however other sources are acceptable

Download file name: Varies with source

Format: ESRI grid or ESRI shapefile

Description: This is a required input if the flood height option is activated for the VCA input parameters, however only a single integer value is required as input.

Input and Ancillary GIS Data Download Instructions

Obtain NHDPlus data for the production unit of interest from the web site:

http://www.horizon-systems.com/NHDPlus/NHDPlusV2_home.php

NHDPlusV1 data were used to develop the VCA, however since that time NHDPlus Version 2 (NHDPlusV2) data have been released. NHDPlusV2 data may be substituted for NHDPlusV1. The processing instructions will be very similar, but may require substitution of certain file names.

Processing instructions for using NHDPlusV2 are emphasized in red throughout this document. Also see the NHDPlusV2 documentation for more information.

Download Instructions:

- 1) Download the elevation GIS raster, which will have a **download file name** similar to:
NHDPlusV21_PN_17a_NEDSnapshot_01.7z
- 2) Download the NHDPlus stream lines, water bodies, and subbasins, which will have a **download file name** similar to:
NHDPlusV21_PN_17_NHDSnapshot_04.7z
- 3) Download the associated attribute tables, which will have a **download file name** similar to:
NHDPlusV21_PN_17_NHDPlusAttributes_05.7z

Input and Ancillary GIS Data Pre-processing Instructions

These pre-processing instructions should provide an intermediate level GIS user with enough information to prepare the input data files for the VCA program. An intermediate level of GIS theory and ArcGIS knowledge is necessary to complete these steps.

Map projection - Choosing an appropriate map projection for processing the data is an important consideration. The elevation raster resides in the following native projection when downloaded from the NHDPlus web site:

Albers Conical Equal Area
Standard Parallel 1: 29.5
Standard Parallel 2: 45.5
Longitude of Central Meridian: -96.0
Latitude of Projection Origin: 23.0
False Easting: 0.0
False Northing: 0.0
Datum: NAD 83

This projection may not be appropriate for all study areas. The user may select a more appropriate projection such as Universal Transverse Mercator (UTM) if desired, which will require projecting the elevation raster to the desired coordinate system. In doing so, it is important to intentionally select an output cell size of 30 m to match the native cell size. In addition, the bilinear interpolation or cubic convolution resampling algorithm should be used.

The vector GIS data from the NHDPlus dataset (stream lines, water bodies, and subbasins) reside in the geographic coordinate system (latitude-longitude). Because this coordinate system is based on units of degrees rather than meters, these shapefiles must be projected to a rectangular coordinate system, such as Albers Conical Equal Area or UTM. It is assumed that the user is experienced in projecting raster and vector data and can accomplish these tasks without detailed instructions. **The raster and vector projections must match one another before being input to the VCA program.**

The workflow for projecting the various GIS layers will vary by user and is complicated by the fact that the NHDPlus elevation and hydrography data reside in different projections. It will be incumbent on the user to devise a workflow for reconciling the GIS layers into a single projection for processing with the VCA.

Watershed boundary – The **subwatershed** shapefile will have been extracted to a folder named **\WBDSnapshot**. The **subwatershed** data reside in the geographic coordinate system and should first be projected to the NHDPlus Albers coordinate system. This step will produce a subbasin dataset matching the projection of the elevation data. Next, a single watershed should be selected from the projected subbasin dataset to use for clipping the elevation data. The extent of a single subbasin is an appropriate size for implementing a VCA run. Subbasins are defined by 8-digit or 4th code hydrologic units (Seaber and others 1987). The HUC_8 field in the **WBD_Subwatershed.shp** attribute table may be used to “select out” or “dissolve by” 8-digit units.

Elevation GIS raster - After unzipping the download file, the DEM data will reside in a folder named **\NEDSnapshot**. The DEM raster is named elev_cm. This DEM has vertical units of cm that must be converted to units of meters.

To convert the units with ArcGIS 10 use the Raster Calculator tool as follows:

Arc Toolbox > Spatial Analyst Tools > Map Algebra > Raster Calculator

Raster calculator input box:

Float(elev_cm)/100

Next use the appropriate subbasin shapefile to extract the elevation data from the NHDPlus DEM.

Spatial Analyst Tools > Extraction > Extract by Mask.

Fill in the required fields. Click the “Environments...” button and then the “Processing Extent” option.

Extent: Use the selected subbasin shapefile name

Snap Raster: Use the DEM name

Output: elevclip

This clipped raster may now be projected to the user’s study area projection, if desired.

Stream lines and water bodies - Use the same selected subbasin shapefile to clip the NHDPlus stream lines from the shapefile called **NHDFlowline.shp**:

Analysis Tools > Extract > Clip

Output: FlowLine.shp

Also clip the shapefile called NHDWaterbody.shp using the same procedure
Output: Waterbody.shp.

Project the shapefiles to the appropriate projection as necessary.

Drainage area attribute - Find the table **CumulativeArea.dbf** in the folder **\NHDPlusAttributes**. This file will need to be joined to the shapefile FlowLine.shp (**the clipped version of NHDFlowline.shp**). Implement the table join using COMID as the common ID. Export to a new shapefile.
Output: FlowLineJoin.shp.

Important

Open the attribute table for FlowLineJoin.shp. Add a new field called CUMDRAINAG. Be sure that the field is of type Float, with Precision = 12 and Scale = 2. Calculate CUMDRAINAG = TotDASqKM. The VCA requires that the field CUMDRAINAG is populated with the cumulative drainage area for each stream segment.

The flow line shapefile, water body shapefile and DEM will be used as input by the VCA. All of the files should now reside in the same projection.

Precipitation – Download data from the PRISM Climate Group (Daly and others 1994; 1997) or the nationalatlas.gov website. Project GIS data as necessary and convert units from inches to centimeters if required. **Compute the average precipitation in units cm for the subwatershed area.**

Substituting Higher Resolution Input Data

Higher resolution data such as 10 m National Elevation Dataset (NED) DEMs and 1:24,000 scale National Hydrography Dataset (NHD) may be substituted for the NHDPlus data. However, care must be taken to ensure that the substituted data adhere to certain consistency standards.

- 1) It is always a good idea to clip the DEM, stream lines, and water bodies to a watershed boundary. This step ensures that all layers have the same extent and that streams and valleys maintain their full extent.
- 2) If 1:24,000 scale NHD data or other stream lines are used, the shapefile must contain a numeric attribute field called CUMDRAINAG. This field must be populated with a number, such as the value 1, even if it is a mock number used to satisfy the program requirements. The CUMDRAINAG attribute has two important functions in the VCA program. First, it is used for computing the modeled bankfull depth which, in turn, is used by the flooding function. Second, it is used to exclude streams with a drainage area smaller than the user defined threshold.
- 3) If water bodies such as lakes or reservoirs are present in the study area, a water body shapefile, defined as polygon type, should be input into the program. The shapefile may come from the NHDPlus data, another source, or be hand digitized. This layer will prevent water bodies from being identified as unconfined valley bottoms.

Program Inputs, Parameters, and Output

The program inputs, parameters, and output are defined through the Arc Toolbox user interface (figure 9.) The interface options are described below.

Inputs

Workspace location – The computer location where the input data are stored and where the output shapefile will be saved. Scratch data are also written to this folder and cleaned up at the end of the process. Available scratch space should equal 12 times the size of the input DEM.

Input DEM – Name of the input 10 or 30 m digital elevation model (DEM), derived from the NHDPlus data, USGS National Elevation Dataset, or other source.

Input streams – Name of the input flow line data derived from the NHDPlus dataset or other source.

Input waterbodies – Name of the input waterbodies shapefile derived from the NHDPlus dataset or other source.

Parameters

Output valley type – Two output products are available: 1) unconfined valley bottoms only, or 2) unconfined valleys with distance measures along the stream network to the nearest unconfined valley.

Maximum ground slope threshold – A ground slope threshold with units of percent slope. Only grid cells below the threshold will be preserved to represent unconfined valley bottom extent.

Flood factor – The flood factor is a dimensionless value that is multiplied by the estimated bankfull depth to generate a nominal “flood height” above the channel elevation (e.g., Hall and other’s (2007) figure 2b). Bankfull depth (h_{bf} , m) is empirically predicted by the VCA as a function of drainage area (A , km²) and average annual precipitation (cm/yr) by combining hydraulic geometry equations developed by Hall and others (2007) for channels in the Columbia River Basin: $h_{bf}=0.054A^{0.170}P^{0.215}$. The flood height (m) is used to conceptually flood the valley floor to a variable height above the channel elevation. Only grid cells that are “submerged” are preserved.

Average annual precipitation – The precipitation value (cm/yr) is used as described above to predict bankfull depth and flood height. An average annual precipitation value equal to the highest estimate in the watershed is recommended. Using the highest estimate will produce a more liberal valley bottom extent, helping to compensate for the DEM rounding of valley bottoms discussed above (figure 8).

Maximum Valley Width – This parameter allows the user to select a width (m) for clipping the extent of the valley floor orthogonal to the channel. This parameter is useful in very low relief regions where a valley side slope is not portrayed in the DEM data, causing the valley bottom polygon to extend beyond the influence of the stream channel.

Minimum Drainage Area – This parameter deletes valley bottom polygons that are smaller than the user defined minimum drainage area (km²).

Minimum Stream Length – This parameter will delete valley bottom polygons that do not contain the specified minimum total stream length (m).

Minimum Valley Area – This parameter is used to delete valley bottom polygons under a specified minimum area (m²).

Output

Output Shapefile – The name of the output shapefile.

Algorithm Sequence

The input GIS layers work together to create intermediate files that will vary based on the input data characteristics and user supplied parameters. These intermediate files are referred to as variables. The variables fall into two general categories: 1) valley bottom extent variables, and 2) valley bottom exclusion variables. The valley bottom extent variables control polygon initiation and the extent of the valley bottom area. The valley bottom exclusion variables operate on the output from the extent procedures to eliminate selected valley bottom polygons based on user defined criteria. All calculations are completed using standard programs within ArcGIS version 10.0.

Controlling Valley Bottom Polygon Initiation and Size - Valley Bottom Extent Variables

Four rasters are computed and used as variables for controlling valley bottom initiation and extent. The variables are: 1) slope cost distance, 2) flood height, 3) ground slope, and 4) maximum valley width. A threshold is applied to each variable to generate a binary (0 or 1) intermediate output. Each output grid has equal weight in the algorithm. When overlain together, each theme must have a value of 1 to instantiate a valley bottom cell. Variable 1 above sets the gross extent of unconfined valleys. Variables 2 and 3 refine the gross valley bottom extent, while variable 4 is a user defined channel buffer that restricts the unconfined valley width.

Variable 1 – Slope cost distance

Function: Generates an initial valley bottom domain that is refined by subsequent procedures in the algorithm.

The slope cost distance variable is derived from the ArcGIS Cost Path tool. A rasterized version of the stream channel is used as the algorithm source. This cell-by-cell operation computes accumulated cost, using a cost grid, as the focal cells are processed with increasing distance

from the source cells (stream channel). The cost grid for this operation is the result from the ArcGIS Slope tool, with percent rise as the measurement parameter. The cost at each cell is computed as the cell size (10 or 30 m) multiplied by the cell slope (percent). As distance from the stream channel increases, the accumulated product of slope and distance are computed. In wide unconfined valleys with relatively low ground slope values, the slope cost distance measure increases gradually, whereas in confined valleys with steep side slopes the value increases rapidly. Empirical testing in the Intermountain West indicates that a slope cost distance threshold of 2,500 adequately captures an initial valley bottom domain that can be refined by further processing. This variable has no physical meaning and is simply an empirical rule that is used to set the initial processing domain for subsequent operations in the algorithm. The variable is intended to capture a relatively low-sloped domain near the stream network and eliminate low slope features outside of valleys. The variable threshold intentionally overestimates valley extent to ensure that all legitimate valley bottom cells are included for subsequent processing.

Variable 2 - Flood factor

Function: Controls the lateral extent of valley bottom polygons by conceptually raising the stream water surface above the channel elevation.

The flood factor is a user defined multiplier that conceptually raises the stream water surface to “flood” the valley to a specific height above the channel elevation. Bankfull depth is predicted by the VCA using an equation developed by Hall and others (2007) as described in the previous section. The flood factor variable is multiplied by the predicted bankfull depth to determine the flood height for each stream segment. Stream segments are defined by the NHDPlus data model.

Selecting the most appropriate flood factor is an important component for regulating the VCA results. Previous investigators have used similar approaches for defining valley extent, but different flood heights have been proposed. For example, based on field studies Rosgen (1994; 1996) defined the flood prone extent of a valley as the width measured at an elevation twice the maximum bankfull depth. This value roughly corresponded with the 50-year flood stage or less (Rosgen 1994). However, investigators working with DEM data have found that larger flood height multipliers are needed. Using 10 m DEM data, Hall and others (2007) found that an elevation of three times the bankfull depth provided the best results for estimating the historical floodplain width. In contrast, Clarke and others (2008) used a factor of five times the bankfull depth to estimate the elevation for measuring valley-floor width when using 10 m DEM data. This seemingly high multiplier is necessary because, as discussed above, the rounding of valley bottoms by the DEM may sometimes generate stream channels that are inset deeper into the valley than would be encountered in the field (figure 8). The VCA flood factor parameter defaults to a value of five, however a value of 5-7 is recommended based on the user’s familiarity with the terrain and field observations. Comparison of predicted and observed valley extent for field sites in central Idaho (Part III) indicates that a flood factor of seven is most appropriate for 30 m DEMs. The coarser vertical resolution of 30 m DEMs relative to 10 m data requires a larger flood factor (7 vs. 5) to obtain similar results.

For the VCA, the unconfined valley bottom is defined by the “flooded” area, below the elevation where the flooded height intersects the valley side slope. This extent is further modified by the ground slope variable.

Variable 3 – Ground slope

Function: Sets an upper ground slope threshold controlling the extent of valley bottom polygons.

Ground slope is generated from the input DEM using the ArcGIS Slope tool. Slope is computed by querying the eight neighboring cells to the focal cell and finding the neighbor with the maximum elevation change. Although the VCA queries all nearest neighbors, rather than specifically examining lateral slopes, the steepest slope generally becomes a lateral value as cells approach confining features. Percent slope is computed by dividing the elevation change (rise) by the distance between cell centers (run), and multiplying by 100. Only cell values less than the user defined slope criteria will be included in the output unconfined valley bottom layer. A default slope threshold of 9% is used by the VCA. This value was derived empirically by generating transects across 30 m DEMs in unconfined valleys that were identified from field surveys in central Idaho (Part III). The slope value of 9% seems high, however valley bottoms in USGS DEMs are generally modeled at a higher gradient than their true value on the ground (Nagel and others 2010). Users are advised to run the ArcGIS slope program independently to estimate an appropriate slope threshold value for the project area, prior to running the VCA.

Variable 4 – Maximum valley width

Function: Controls lateral width of valley bottom polygons at a specific user defined value.

This parameter is meant to confine the valley extent within wide floodplains and plateau regions. The width parameter (m) includes the entire valley width on both sides of the stream.

Eliminating Valley Bottom Polygons - Valley Bottom Exclusion Variables

Valley bottom polygons can be eliminated from the above data set based on the following criteria.

Variable 5 - Drainage Area

Function: Eliminates valley bottom polygons where all of the stream segments are smaller than the minimum specified value (km²).

Variable 6 – Stream Length

Function: Eliminates valley bottom polygons with a cumulative internal stream length less than the minimum specified length (m).

This variable is included for fisheries applications where a minimum stream length is necessary to support biological requirements. Total stream length is computed for each valley bottom polygon. The sum is calculated using all stream segments within the polygon, including streams smaller than the minimum drainage area. Polygons with a total stream length smaller than the cumulative stream length threshold will be eliminated.

Variable 7 - Valley Area

Function: Eliminates valley bottom polygons smaller than a specified area (m²).

Output Shapefiles

Two output products are possible from any given input dataset as described below. Only one product may be generated per algorithm run.

Output Valley Type 1 - Valley Bottoms Only

Choosing Output Valley Type 1 as the output type will produce a polygon shapefile that only includes the unconfined valley bottoms. The polygon outline for each valley is smoothed to remove the stair-stepped appearance resulting from the underlying raster DEM. The shapefile will have an attribute field called VB_CLASS. All records will be populated with value = 1 (figure 10).

Output Valley Type 2 – Valley Bottoms With Distance Measures

Choosing Output Valley Type 2 as the output will produce a polygon shapefile that includes unconfined valley bottoms as well as confined stream reaches (both represented as polygons). Each polygon feature is attributed with distance along the stream network to the nearest unconfined valley bottom. The polygon outline for each valley is not smoothed for this output type because the linear nature of the confined valleys does not support this procedure (figure 11).

The attribute field will contain integer records representing the following classes:

- 0 – Valley bottom polygon
- 1-30 – Network distance to nearest unconfined valley bottom (km)
- 31 – Distance greater than 30 km
- 50 – Lakes and reservoirs