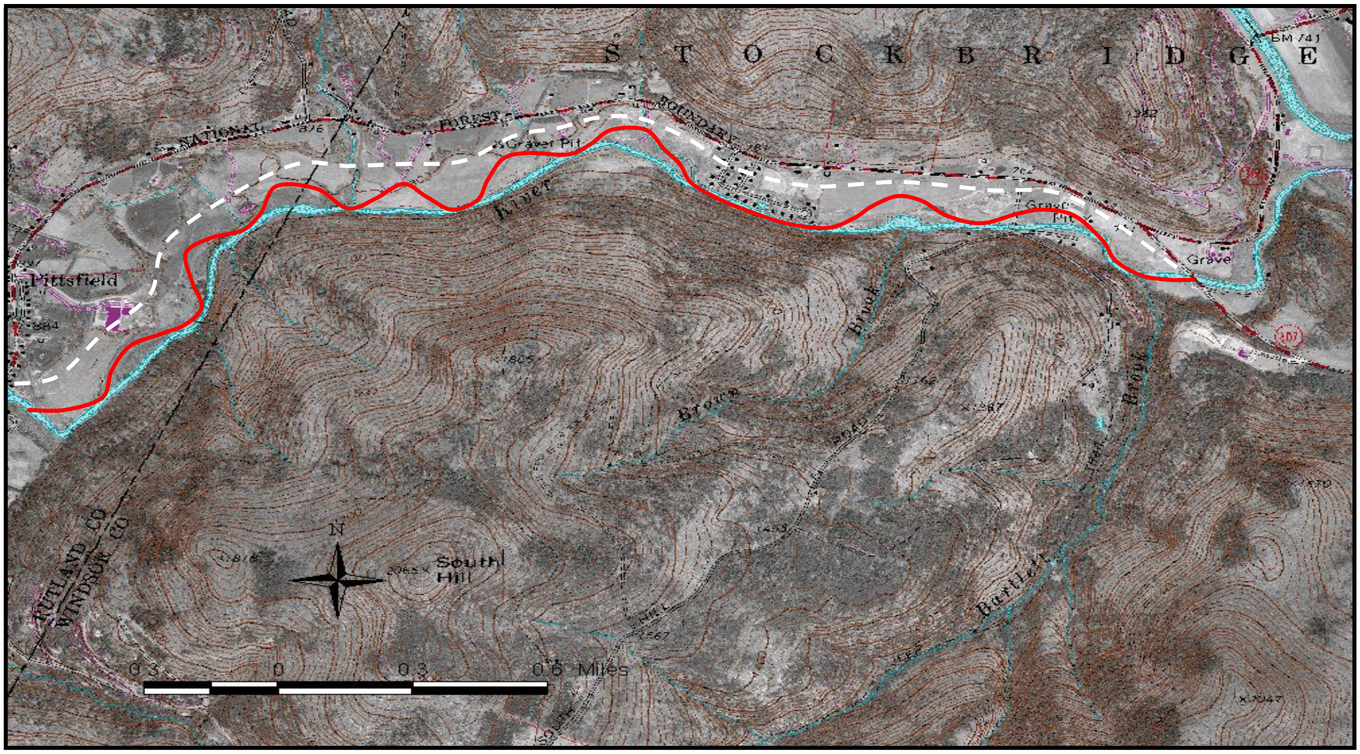
Vermont Stream Geomorphic Assessment

Appendix E



River Corridor Delineation Process

Vermont Agency of Natural Resources
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River Corridor Delineation Process

Purpose

A stream and river corridor delineation process has been developed as part of the Phase 1 Stream Geomorphic Assessment (SGA) protocol to create a map overlay area and assess:

- Surficial geologic materials and soils (Steps 3.3 and 3.5)
- Land cover / land use (Step 4.2)
- Berms, roads, and developments (Steps 6.1 and 6.2)

The corridor will also be used in the Phase 2 SGA protocols to evaluate parameters in the field.

- River corridor encroachments (Step 1.3)
- River corridor land use (Step 3.3)

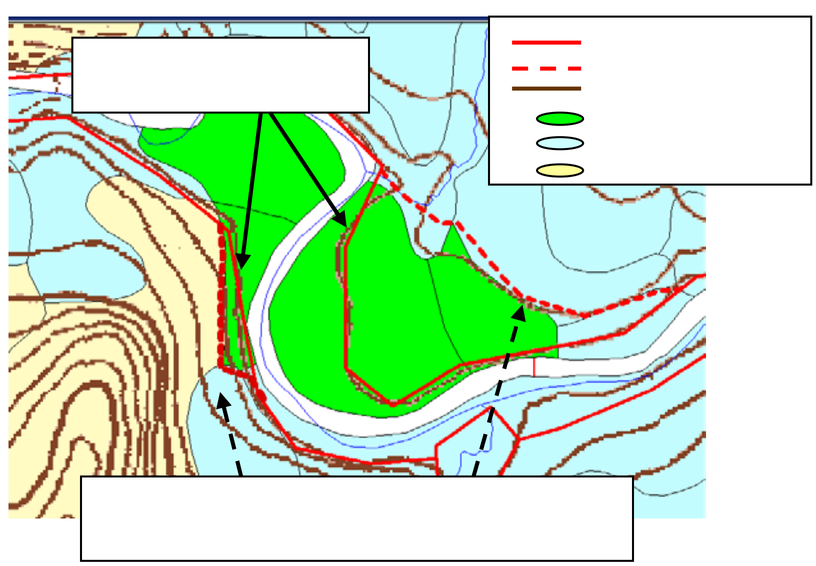
The delineation process recognizes that in some cases, the geologic and land use factors influencing runoff and erosion may extend beyond the toe of the side slope in a narrow valley. The process also recognizes that in wider valleys, human structures on the valley floor do not always alter floodplain characteristics. The process defines a width of land on either side of the river, together called the river corridor, that will capture:

- Factors influencing runoff and erosion;
- Factors influencing floodplain function; and
- A minimum width of land within the overall valley width that may be occupied by the active stream channel, as slope and dimension remain in balance with the watershed inputs.

SGAT and the Corridor Delineation Process

The SGAT extension designed for use with GIS is a significant time-saving tool in delineating the river corridor. For those stream reaches where you have used GIS to draw valley toe and meander centerlines, SGAT can be used to carry out the four-step process described below in a matter of minutes. For stream reaches where no valley toes and meander center lines were drawn, a default corridor of either 2.5 times the channel width (for a total of 5 channel widths) either side of the centerline or 100 ft (for a total of 200 feet) either side of the centerline, which ever is greatest, will be drawn by SGAT. Note, that this width is determined off the stream centerline; the 2.5 times the channel width is an attempt to recognize a portion of the channel width inherent in buffering off the stream centerline. If you are drawing the corridor from the top of the stream bank; than the calculation will be 2 times the channel width (for a total of 4 channel widths) either side of the stream bank or 100 ft (for a total of 200 ft), which ever is greatest.

A method for defining meander centerlines is described in Step 2 of the river corridor delineation process. A method for defining the toes of valley walls is described below. Draw the valley toes as a polygon theme and the meander centerlines as a line theme. See SGAT User Manual (Steps 7 and 9) for details on theme requirements and uses within the SGAT program.



Defining the Toe of the Valley:

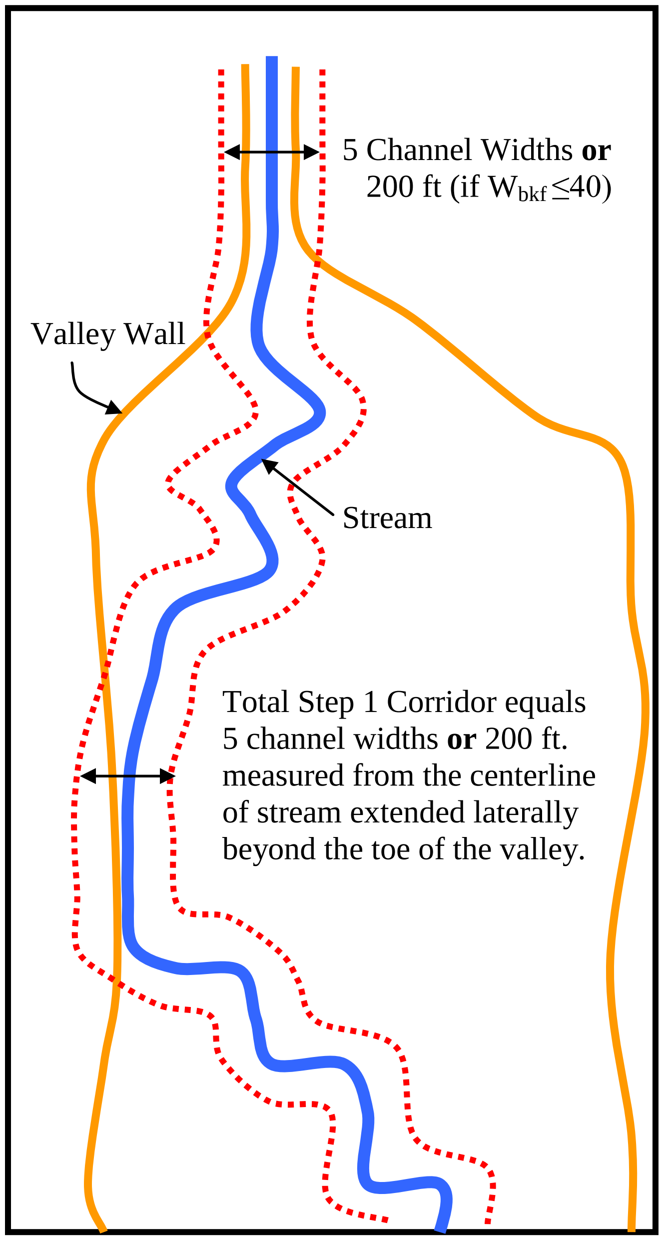
Using soils maps and data in conjunction with topographic maps determine the location of the toe of the right and left valley walls. Generally, the toe of a valley wall can be identified by looking for the break in slope as the steeper valley wall turns into the gentle sloped valley floor. Soils data help with identifying changes in slope and include other soil characteristics that may indicate the need to adjust a valley wall line one way or the other. Starting at the mouth of the main stem and tributaries, draw right and left valley wall toes as continuous lines to an upstream point where distinguishing between the valley toes and the stream line becomes difficult (in confined valleys). Additional valley wall delineation tips and rules of thumb are offered at the end of this Appendix.

Four Step Corridor Delineation Process

For the purpose of a Phase 1 and Phase 2 Assessment, river corridors are defined using the following 4 step process:

Step 1.

This delineation process requires the use of the most recent orthophoto and topographic map of the reach. The orthophoto is used to draw the corridor and the topo map is used as a guide to determine the proximity of the channel and the toe of the valley walls. The ideal mapping base to work on is an orthophoto with topographic lines overlain using a computer mapping tool such as GIS.



Shown as the dotted red lines in the example to the right, the Step 1 corridor lines are drawn parallel to the stream at a distance from the centerline of the stream of:

2.5 x channel widths, where the bankfull width is > 40 feet (for a total Step 1 Corridor of 5 channel widths);

or

100 feet, where the bankfull width is ≤ 40 feet (for a total Step 1 Corridor of 200 feet)

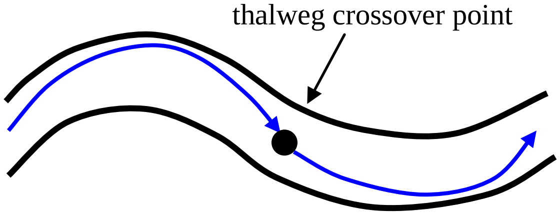
The stream can be used as a centerline where it appears, as with small streams, to be a single line. Where the valley is narrow it is important to draw the corridor lines so that they extend laterally beyond the toe of the valley walls.

Rationale: This step identifies those land areas beyond the toe of the valley wall that, may or may not be important to the stream for planform and slope adjustment, but involve land uses that significantly change runoff patterns and sediment discharges to streams in confined valleys .

Step 2.

Shown as the dashed brown lines in the example below, the Step 2 corridor lines are drawn parallel to a line that is drawn down-valley through meander crossover points. For the purposes of this delineation process this line is called the meander centerline.

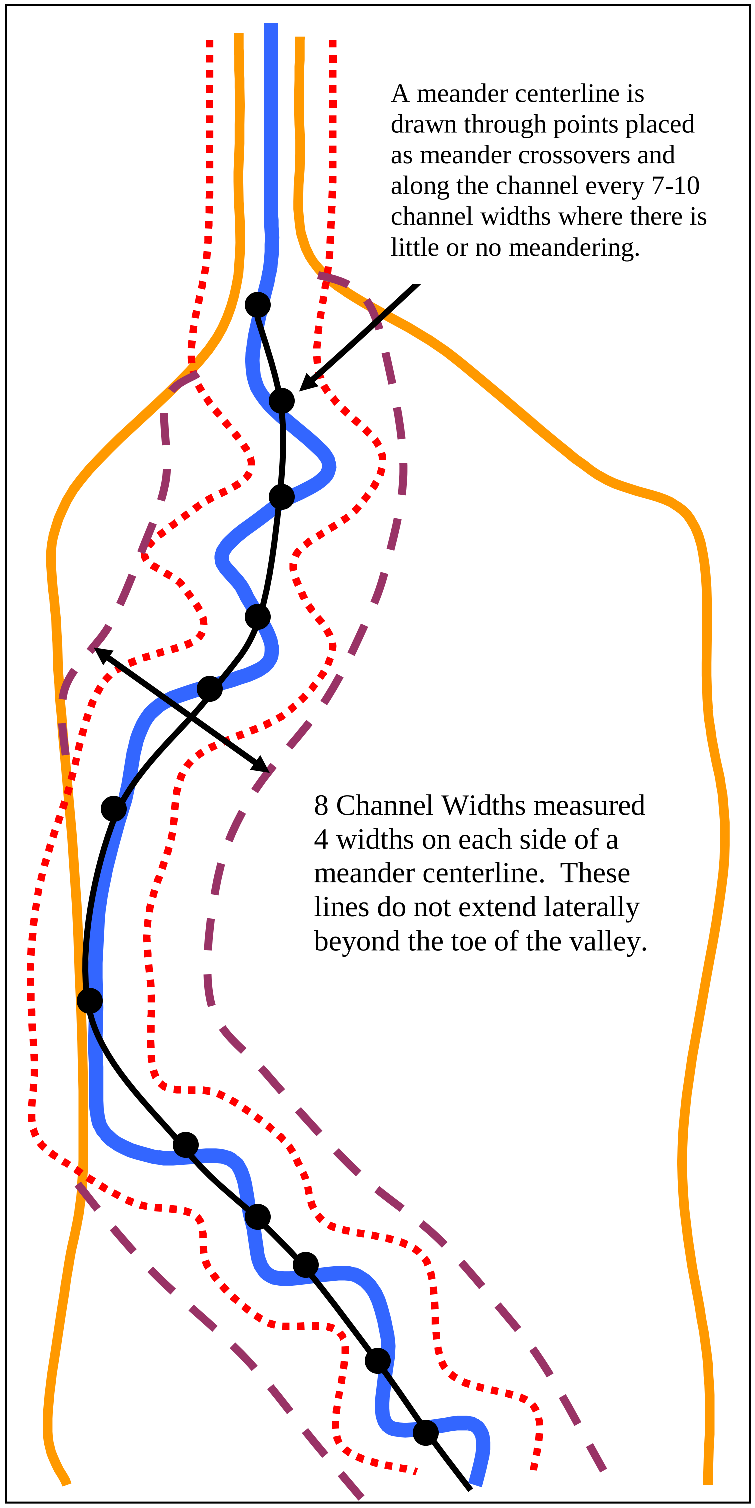
Complete Step 2 of the corridor delineation process for streams and rivers flowing in valleys measured to be at least 4 channel widths wide (valley types NW, BD, and VB). To draw the meander centerline, first place crossover points on the channel. These points are generally located in the center of the channel where the deepest thread of water (or thalweg) "crosses over" from the outside bank of one meander to the opposite bank on the next meander downstream.



Where there are no discernible meanders (in a straight or straightened reaches of channel), continue to add points along the centerline of the stream at a 7-10 channel widths interval. Draw corridor lines 4 channel widths either side of and parallel to a meander centerline drawn through the crossover points. The total corridor in an unconfined valley is 8 channel widths.

Since this stream corridor delineates lands that may influence runoff patterns and sediment discharges, as well as planform and slope adjustments in unconfined, depositional streams, the corridor lines should not extend laterally beyond the toe of the valley. As shown in the example to the right, discontinue the corridor line where the stream is close to the valley wall.

Rationale: In addition to lands affecting runoff, the Step 2 corridor includes the belt width (4-8 channel widths, depending on the stream type). The belt width is an area critical to unconfined streams as they adjust their slope consistent with their sediment regime.

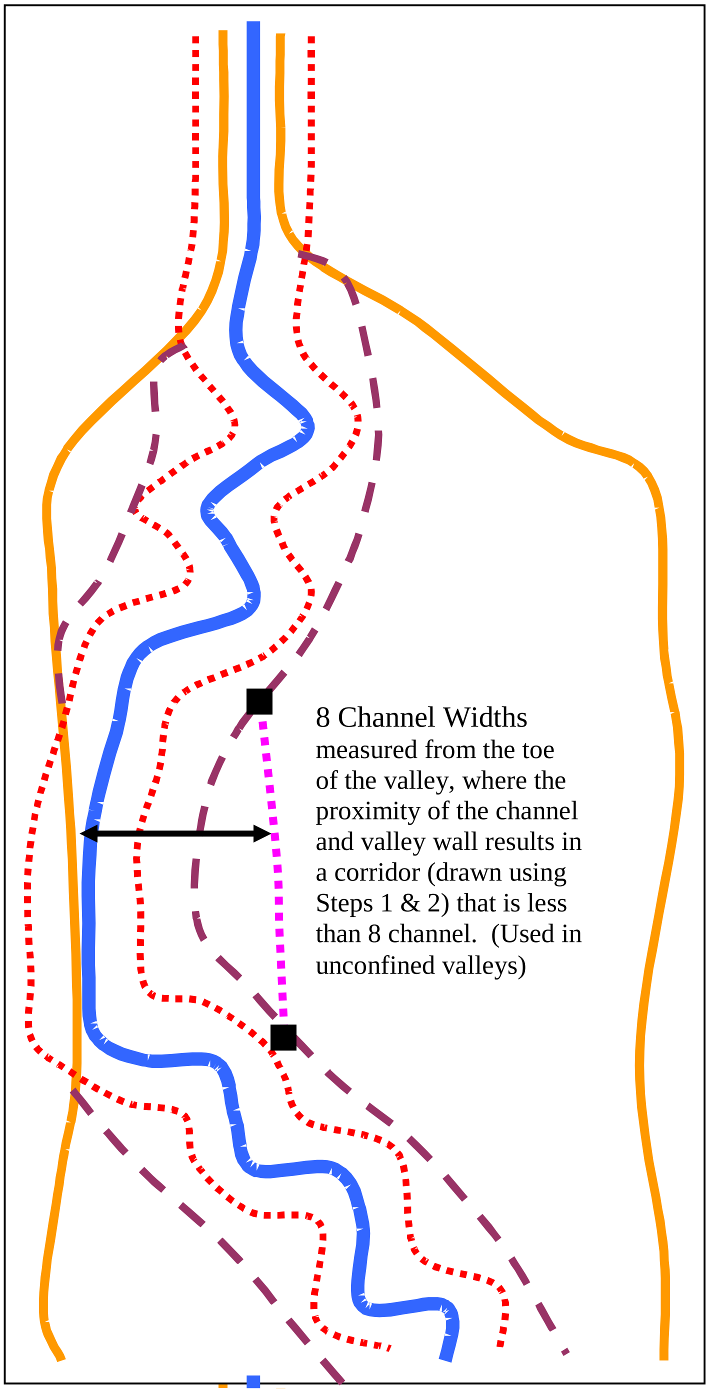


Step 3.

Shown as the dotted purple lines in the example below, a Step 3 corridor line is drawn parallel to the valley wall at a distance of 8 channel widths from the toe of the valley. Complete Step 3 of the corridor delineation process for streams and rivers flowing in valleys greater than 4 channel widths wide (Step 2-10: valley types 2 and 3).

The Step 3 delineation process is necessary only in those situations where the stream or river reach is in a broad unconfined valley and flowing within a distance of 4 channel widths from the valley wall. In reaches where the stream comes close to the valley wall, draw a line parallel to the toe of the valley at a distance of 8 channel widths. This line need not extend longitudinally (upstream or downstream) beyond lines drawn during Step 2 of this process.

Rationale: In lieu of any geologic information that may explain the straighter course of a stream, this Step assumes that a straight reach in a wide, shallow-sloped valley may attempt to adjust its planform and slope. The channel will become more sinuous to regain equilibrium with the large supply of fine grained sediments typically found in unconfined valley segments. The Step 3 delineation process attempts to include those land areas into the corridor that may be important to this adjustment process.



Step 4.

If more than one of the Steps 1 through 3 were required for a given reach, then you will want to complete Step 4 of this river corridor delineation process. The Step 4 corridor lines encompass all corridor lines drawn in Steps 1 through 3 to form a single stream or river corridor delineation.

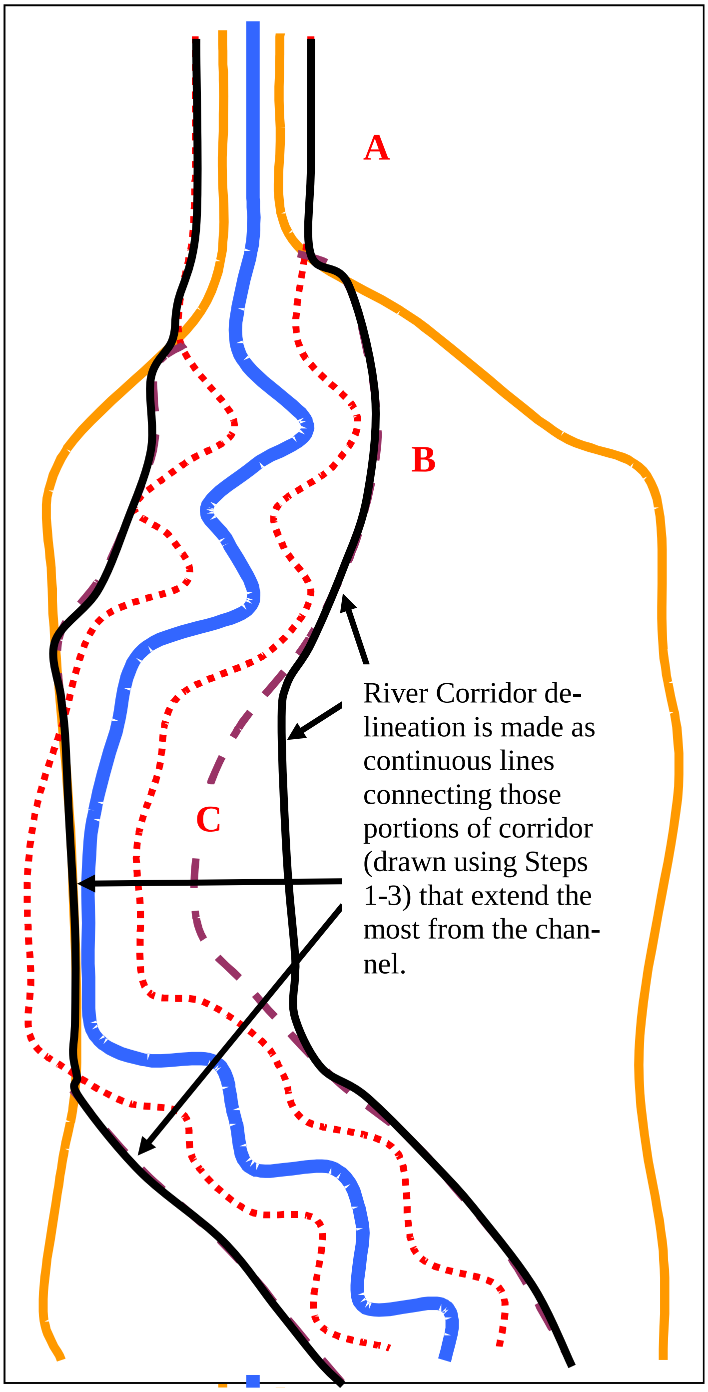
Shown as the solid black lines in the example to the right, the Step 4 corridor lines follow those segments of the Step 1-3 lines that extend laterally away from the channel.

The only corridor lines to be included outside the toe of the valley walls are Step 1 corridor lines; for streams in confined valleys where a valley wall and meander centerline could not be drawn.

In the example to the right, the corridor for the stream reach in the valley segment labeled **A,** the stream corridor follows the Step 1 corridor lines. This follows because Step 2 and 3 lines are drawn for streams flowing in broader valleys at least 4 channel widths wide.

Step 1 and 2 corridor lines were both drawn for the stream in valley segment **B**. The Step 2 lines were followed for the final corridor delineation (solid black line) because they extend further laterally than the Step 1 lines. Had there been an atypical meander with a larger amplitude (not shown) the Step 1 lines may have extended beyond the Step 2 lines around the meander.

Step 1, 2, and 3 corridor lines were drawn for the stream in valley segment **C**. The Step 1 corridor line (on the right side) and Step 3 corridor line (on the left side) were followed from the final corridor delineation because they extend further laterally than any other line drawn in this valley segment.



NOTE: The stream and river corridors delineated for the Phase 1 and Phase 2 Stream Geomorphic Assessment are determined for the purposes of evaluating the possible impacts of various factors influencing runoff (i.e., land use/cover) and floodplain modifications. They are not intended to empirically show floodplains, flood prone areas, or flood hazard areas. These delineations are determined through Phase 2 **and** Phase 3 field assessments.

Valley wall delineation tips and rules of thumb

Background and Need:
Polygon shape files showing the location of the toes of valley walls are one of the user-created inputs to the Stream Geomorphic Assessment Tool (SGAT) and are used in Step 7 of SGAT to determine valley length and average valley width (used to calculate sinuosity and confinement).

For Phase 1 uses, relatively crude valley walls are generally sufficient. In Phase 1 you are looking at the natural valley setting, and not including any man made changes to the width of the valley. During the Phase 2 geomorphic assessment a more accurate delineation of the natural valley walls can be determined; the field assessment will also allow for any potential human made changes to the valley width to be noted and used for modifications to the valley walls for FEH corridor delineation.

During the development of Fluvial Erosion Hazard (FEH) corridors in SGAT (Part E, Step FEH03), the corridor is clipped to the valley wall, as erosion hazards do not extend outside the valley floor (see Appendix H for a more detailed look at corridor development). As a result, the valley wall locations often define the limits of the FEH corridor, making an accurate valley wall shape file essential to the process. This is especially true in many of Vermont's narrower valleys, where the valley walls often define one or even *both* sides of the FEH corridor. Review the additional criteria for valley wall consideration, under "Phase 2 and FEH valley wall guidance" below.

While identifying valley walls is generally a simple task, it can be complicated by the presence of features both manmade (road and railroad beds, development), and natural (terraces, abandoned floodplains, etc) which may act as confining features . The purpose of this guidance document is to clarify both the purpose and application of the valley wall shape file in the VTANR Stream Geomorphic Assessment and related applications, and to provide guidelines that will help assessors develop the best possible valley wall shape files.

The valley walls are used, in part, to help define the lateral constraints on the river. In delineating the valley walls it is important to try to establish reasonable estimates of valley toe locations. In certain valleys it will be necessary for the user to make a reasonable best guess; erring on the side of conservative to define wider valleys where remote sensing data presents uncertainties. The user may not delineate valley walls in steeper, more confined valleys where it is harder to distinguish the toes of the valley from the stream itself.

The 20 foot contour lines on topographic maps may not be detailed enough to give a clear indication of where the toe of the valley wall may be. To assist in determining the outer limits or toes of the valley wall, it may be valuable to use the NRCS soils in conjunction with the topographic map. The soils can be linked in ArcView to the NRCS Top20 table; then displayed on parent material. One of the key parent materials to look for is alluvium. Using the surficial geology maps to locate bedrock outcrops will also provide insight into where the geology is restricting the river from moving laterally across a valley.

Once delineated as a shape file in ArcView, print out the valley walls on a topographic map and/or orthophoto, and conduct a field review of valley walls. First, field check those areas where you had questions, then if time and funds permit review the valley walls in other reaches. During your time in the field, verify the location of the valley wall whenever possible. If the valley wall location differs from your original delineation, make note of the true location on your map and change it when you return to the office. Some people like to take a laptop into the field to cut out this intermediate step. Another approach is to capture toe of valley wall locations with a GPS unit. If using this approach, be aware of the accuracy of the GPS unit being used. Given the margin of error for many handheld GPS units in many situations, it is often possible to more accurately identify locations manually using orthophotos.

On those reaches where it is not possible to field check the location of valley walls, you may consider completing a stereoscopic analysis of air photos, which allows the user to view the landscape in 3D. It is possible to see rises as low as 5 to 10 feet. This process may only be necessary where there are concerns or issues that dictate the need for more accurate valley walls and a field visit is not possible.

** In locations where LIDAR (Light Detection and Imaging) has been flown (much of Chittenden County, see the Vermont Mapping Program's website for the latest: http://www.state.vt.us/tax/mapping.shtml) and an accurate digital elevation model has been produced, it may be possible to develop a very accurate valley wall based solely on remotely sensed data.*

Guidelines

1) If SGAT is to be used; review Step 7 "*Requirements for Digitizing Valley Walls*" for additional information on the data requirements for valley walls used in SGAT. (There are a few examples below that address SGAT issues.)
2) Include all alluvial material, except unreasonable rises, as indicated by topography
3) Use the outer limits of the valley as indicated by the contour lines (where topographic map indicates a wide valley), even if the alluvial material does not fill the valley. Overlaying the topographic contours on the soils map can be a good way of reviewing both topographic features and soils at the same time.
4) Delineate the toe of the valley wall at changes in elevation greater than 20 feet (indicated by 2 or more contour lines within a short distance of each other), as this is a good indicator that the river is not likely to utilize the taller, steeper feature.
5) Include alluvial fans that are within the mainstem valley

An often asked questions is whether to include or not include pockets of other (non-alluvium) material within the valley wall? In Figure 1, the material was included, due to the location of the contour lines indicating the valley walls may be further back then what the alluvial material indicates. This is appropriate until field verification can be done.

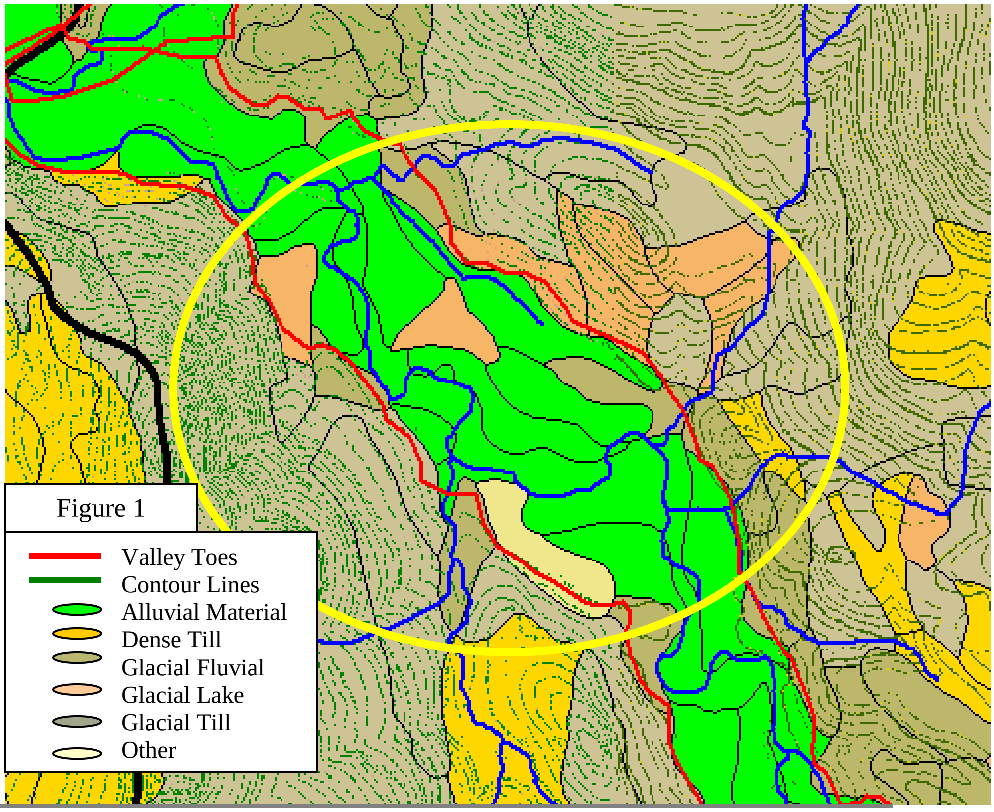
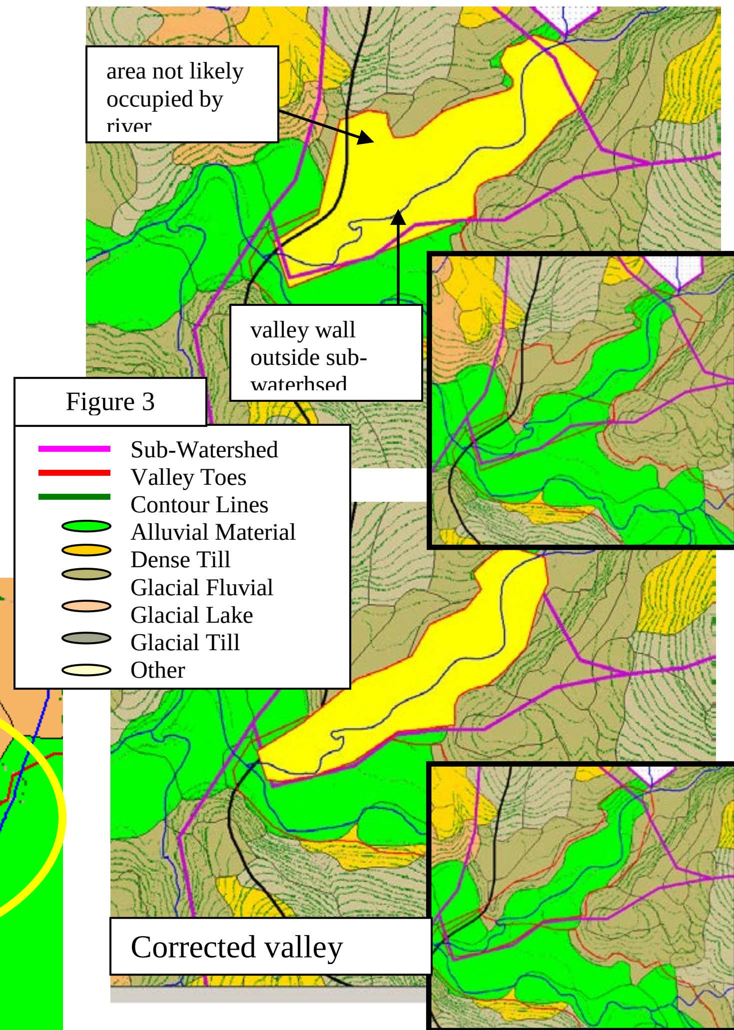


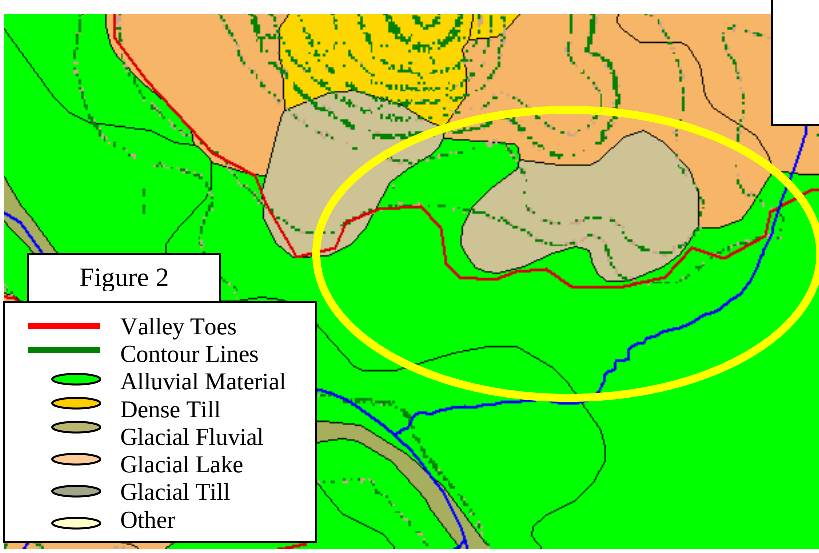
Figure 1

The valley wall in Figure 2 was not extended up to the outer extent of the alluvial depicted on the soils map. Alluvial material in the surrounding area did not extend up the contours in the same way as this lobe of alluvium. To keep the valley wall more consistent, and to not create an odd “point” in the valley, the valley wall bisected the lobe. A compromise was also made in the valley wall, where the contour lines indicated a change in elevation of greater than 20 feet. The valley wall was drawn to include as much of the alluvial material as possible without extending up the slope significantly.

In Figure 3, the small tributary had a separate polygon drawn for the valley walls (highlighted in yellow for ease of viewing). In the downstream portion the valley walls are outside of the sub-watershed for that reach. This can cause an error in the calculation of the valley width, because the program will not recognize the valley wall outside of the sub-watershed.

The walls also appear to occupy an area that is not likely accessed by the river; due to elevation change indicated by contours. Until field verified, the valley wall was moved into a lower elevation.





Be careful with valley walls outside of the sub-watershed boundaries. In SGAT, if the valley line is outside of the sub-watershed it will not be counted for the reach. In some cases it is not possible to contain both valley walls within the sub-watershed for the reach; and in those cases the user will have to manually measure the valley data for that reach (see Figure 4).

Figure 4 is an example where the user would not be able to include both sides of the valley (highlighted in yellow for ease of viewing) for one of the mainstem reaches. A tributary enters the valley and divides the valley into "two" sub-watersheds. The user will get an error in SGAT – Step 7 that the valley information can not be calculated for this reach. The user will be able to have SGAT skip this reach and continue with calculating data for the remaining reaches. Be sure to note the reach number indicated in the error message, then come back and manually measure the valley information.

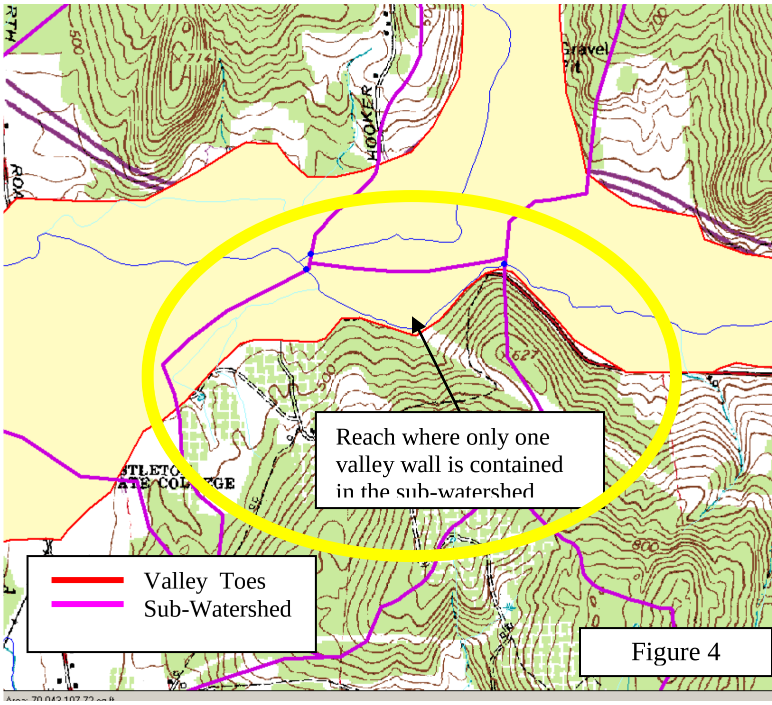


Figure 4

PHASE 2 AND FEH VALLEY WALL GUIDANCE

Phase 2 and FEH

For the purposes of Phase 2 assessments and Fluvial Erosion Hazard mapping, the goal is to adjust the valley wall shape file to reflect the presence of natural and man made features which act as barriers to lateral migration of a river.

Identifying Valley Walls in the Field

Identifying the location of the toe of the valley walls is usually straightforward. In most cases, the toe of the valley wall is located at the break in slope between the steeper valley walls and the flatter valley floor. However, there are situations that are much less straightforward, several of which are discussed in more detail below.

Terraces

As a result of heavily glaciated nature of the landscape, many types of glacial, glaciofluvial, and glaciolacustrine terraces can be found in the river valleys of Vermont, as well as more recent terraces of fluvial origin.

For the purposes of fluvial erosion hazard mapping we are concerned with whether or not a terrace is a confining feature for a stream. In other words, does (or will) the terrace act as a barrier to lateral migration of the stream channel? In general, most high (greater than 20 ft. high) glacial terraces do act as confining features, and should be mapped as the valley wall. Dense tills, and fine grained glaciolacustrine deposits are generally quite resistant to fluvial erosion, and terraces made up of these materials do act as confining features. On the other end of the spectrum, large terraces made up of unconsolidated alluvium are often very erodible and do not act as confining features. Time scale is an important factor in the decision as to whether a landform confines a stream. In geologic time scales, nothing is truly "confining" to a river. However, all of the management applications of geomorphic assessments are concerned with human time scales (several decades to hundreds of years), and this should be the time scale of concern when mapping valley walls.

It is essential that smaller alluvial terraces that are actually abandoned floodplains are not mapped as valley walls. While these features can be fairly large in deeply incised streams (like the West Branch Little River, where the old floodplain is now nearly 20' above the present day channel bed in places), such features can be easily eroded, and do not confine the lateral migration of a river.

Manmade Features

Significant human-constructed features can also act as a confining feature to lateral stream migration and should be mapped as valley walls. Major railroads and highways often act as valley walls, as can rows of structures built on fill, especially along our smaller streams. In general, smaller roads and other manmade features should not be mapped as valley walls, as they often fail due to fluvial erosion during large flow events and are not truly confining features. While communities may choose to replace Berms, levees, and floodwalls should not be mapped as valley walls. Past experience shows us that such structures are prone to failure, often with catastrophic results.

"When in doubt, leave it out"

If in doubt as to whether a manmade feature should be mapped as a valley wall, err on the side of caution and use the actual topographic or "natural" valley wall. There are many opportunities for fine-tuning river corridors (in the FEH mapping and river corridor planning processes) to account for human investments.