STREAM CORRIDOR ASSESSMENT
A PROCESS GUIDE



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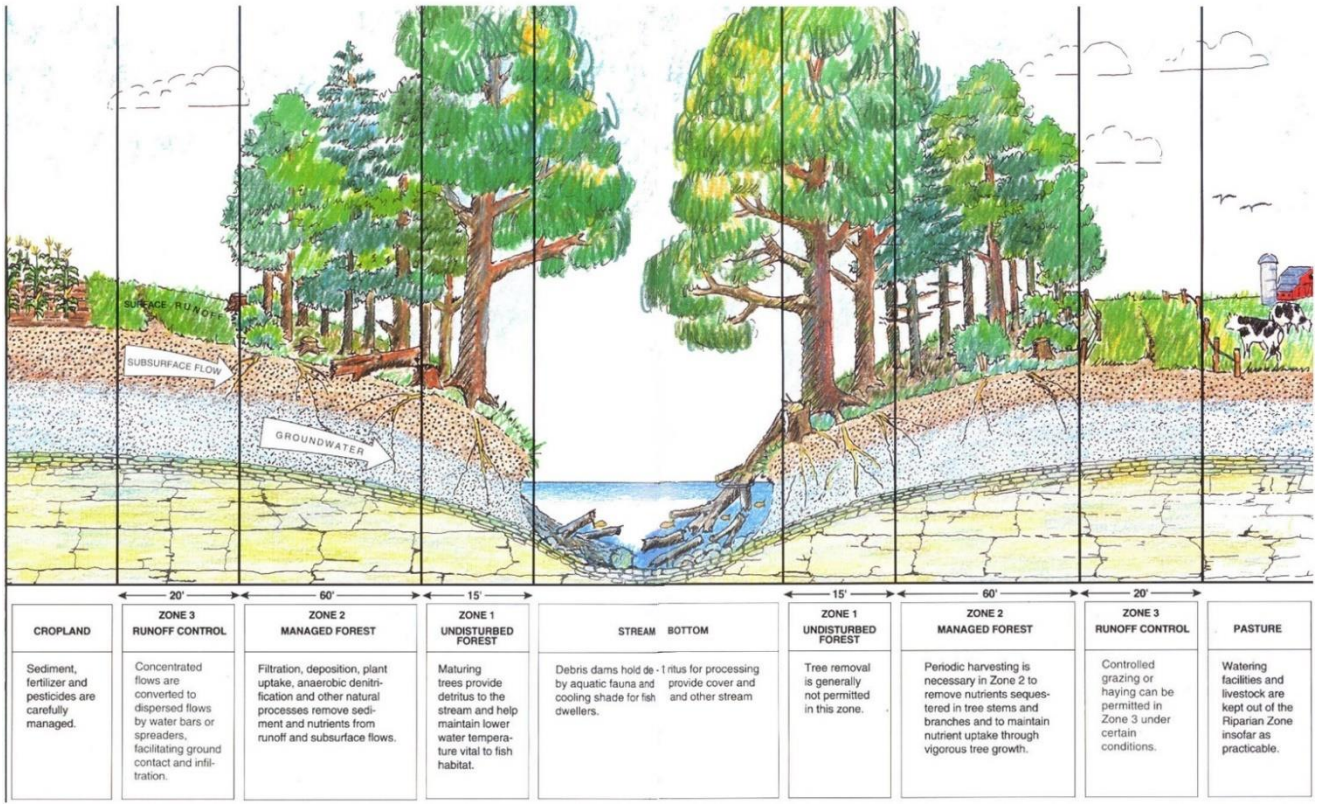
Purpose for this Guide

This document outlines the criteria for completion of a visual assessment of the stream corridor functional health and flooding resiliency as described below as part of a landowner/farmer site visit, potentially in conjunction with an AEM Inventory. The inventory is meant to be a ***base level inventory*** in that it helps identify potentially critical issues that may call for further evaluation and design by parties trained in more advanced stream corridor management planning. The assessment sheets provide visual cues to determining stream corridor component status, as well as suggested planning protocol to consider. Wherever possible, existing methodology and inventory tools are cited and were utilized to provide consistency in approach and conclusions. The inventory looks at stream corridor components and their function and does not address all impacts such as animal and human access/modifications to the corridor, which are addressed in other assessments. This guidance is to be supported through an associated classroom and field training component.

The Stream Corridor



Stream Corridor Components act as an integral unit in addressing and reflecting watershed water quality and quantity
(Source – Federal Stream Corridor Restoration Manual)

Streams, and their associated features within the stream corridor, are both the conduits for watershed functions as well as often being the point of impact of changes in its contributing

watershed's hydrology, hydraulics and water runoff quality and respond accordingly. This "stream corridor" also serves as the last opportunity for addressing upland runoff before reaching the active stream channel and being transported downstream. Stream corridor components include the: active stream channel; the stream channel banks; the floodplain; the riparian zone; and the immediate areas upland that directly impact the corridor. These stream corridor components act in concert to provide the functions needed to manage normal and flood flow events and transport both sediment and water in a stable manner. Disruptions or failures of any of these stream corridor components can often be attributed to weaknesses or malfunctions of one or more of the other associated components.

Both the health and stability of the stream corridor have direct impacts on the associated land uses the corridor flows through. Land use management decisions such as where to place structures, transportation infrastructure, animal access, crop fields, septic systems, etc. can be significantly impacted by and create impacts to stream corridor functions such as flooding, channel and bank stability and water quality.

Stream Corridor - Inventory

Objectives

- ✓ Establish basic information on the landowner/farming operation.
- ✓ Identify potential natural resource concerns, opportunities and landowner/farmer interests.
- ✓ Document environmental stewardship opportunities and establish benchmark conditions.
- ✓ Identify resource concerns and opportunities.
- ✓ Determine the general conditions of stream corridor components.
- ✓ Determine if additional technical resources are needed to determine level of intervention/remediation
- ✓ Provide an educational opportunity.

Procedure – Landowner/*Farmer*

- ✓ Complete AEM Tier 1 & 2 Questionnaire.
- ✓ Thoroughly answer all Tier 1 & 2 questions.
- ✓ Identify on-farm natural resource issues, concerns and interests.
- ✓ Agree to notify the AEM Team when a significant change in farm type, farm management or farm resources occurs, or is being considered.

Procedure – *Resource Professional*

1. Select the planning unit to be addressed, which was prioritized in your AEM Strategic Plan.
    a) Define the extent of the stream reach to be evaluated (i.e. landowner property, field border, stream segment)
    b) Geographic (i.e. – watershed, aquifer recharge area)
    c) Types of land use/agriculture that may impact on defined unit upstream
    d) Consider developing a planning unit advisory committee
2. Determine steps to ensure good participation.
    a) Establish methods (mail, personal contact, general meeting, newsletter, newspaper, etc.).
    b) Develop a follow-up strategy for non-responders.
    c) Explain AEM, local program objectives and the *Tiered Approach to Conservation Planning* as part of your outreach effort.
3. Complete the full Stream Corridor Questionnaire based on the stream corridor component guidance provided in this document with each willing participant in the planning unit.
    - ✓ Review the *Watershed Site/Stream Corridor Evaluation Worksheet* with the landowner/farmer. Results of the *Watershed/Stream Corridor Site Evaluation Worksheet* will determine the follow up activities to address identified concerns.
    - ✓ The *Watershed Site/Stream Corridor Evaluation Worksheet* is an excellent tool for explaining watershed concerns to the farmer and the reason for District interest in farm operations.
4. Provide feedback to the farmer.
5. Create a Cooperator file, or add to the existing file for the land use/farm operation.

STREAM CORRIDOR ASSESSMENT FRAMEWORK

I - STREAM CORRIDOR AREA – Stream Channel

1. **Stream Channel Component -** Channel Width and Depth at bankfull

2. **Stream Channel Component -** Channel Incision or Deposition

3. **Stream Channel Component -** Channel Obstructions
    a. Culvert
    b. Bridge
    c. Crossing
    d. Gravel
    e. Wood
    f. Other

4. **Stream Channel Component -** Avulsions

5. **Stream Channel Component -** Habitat Quality
    a. Bed material
    b. Embeddedness
    c. Morphology
    d. Cover
    e. Water Levels
    f. In-stream cover

ASSESSMENT TOOLS

- USGS Stream Stats
- Emergency Stream Intervention (ESI) Tables

REFERENCES

1. **USGS Stream Stats Instructions**
2. **Post Flood Emergency Stream Intervention Training Manual**. NYDEC, 2013
3. **Stream Visual Assessment Protocol**. USDA-Natural Resources Conservation Service, 1998. National Water and Climate Center Technical Note 99-1

II - STREAM CORRIDOR AREA – Stream Banks

1. **Stream Banks Component -** Bank Materials

2. **Stream Banks Component -** Bank Stability

ASSESSMENT TOOLS

- BEHI (bank erosion hazard index)

REFERENCES

1. **Stream Visual Assessment Protocol**. USDA-Natural Resources Conservation Service, 1998. National Water and Climate Center Technical Note 99-1

III – STREAM CORRIDOR AREA – Stream Floodplain

1. **Stream Floodplain Component –** Floodplain Elevation from thalweg

2. **Stream Floodplain Component –** Width of floodplain (left + right)

3. **Stream Floodplain Component –** Land Cover/Use of Floodplain
    a. Forest
    b. Shrub
    c. Pasture
    d. Crop Field
    e. Residential
    f. Industrial/Commercial
    g. Urban

4. **Stream Floodplain Component –** Floodplain Obstructions
    a. Berms
    b. Buildings
    c. Debris piles
    d. Other

5. Stream Floodplain Component – Impairments
    a. Avulsions
    b. Floodplain channels
    c. Scour/erosion
    d. Lack of stabilizing cover

6. **Stream Floodplain Component –** Invasives

ASSESSMENT TOOLS

- ESI tables

REFERENCES

1. Stream Visual Assessment Protocol. USDA-Natural Resources Conservation Service, 1998. National Water and Climate Center Technical Note 99-1

IV – STREAM CORRIDOR AREA – Riparian Areas

1. **Riparian Areas Component –** Width of Zones
    a. Zone 1 – 0’ to 15’
    b. Zone 2 – 15’ to 60’
    c. Zone 3 – 60’ to 80’

2. **Riparian Areas Component –** Land Cover Types of each Zone
    a. Grass
    b. Shrub
    c. Trees
    d. Percent canopy and ground cover

3. **Riparian Areas Component –** Vegetative Health of each Zone
    a. Disease, pest or invasives
    b. Mortality rate

4. **Riparian Areas Component –** Slope of each Zone

5. **Riparian Areas Component –** Habitat Type & Quality
    a. Age of woody vegetation
    b. Species diversity

ASSESSMENT TOOLS

REFERENCES

1. Riparian Forest Buffers – Function and Design for Protection and Enhancement of Water Resources – USDA NA-PR-07-91

2. Riparian Area Management – Process for Assessing Proper Functioning Condition – USDI TR 1737-9 1993

3. **Stream Visual Assessment Protocol**. USDA-Natural Resources Conservation Service, 1998. National Water and Climate Center Technical Note 99-1

V - STREAM CORRIDOR AREA – Upland Impacts

1. **Upland Impacts Component –** Land Cover / Use
    a. Forest
    b. Shrub
    c. Pasture
    d. Crop Field
    e. Residential
    f. Industrial/Commercial
    g. Urban

2. **Upland Impacts Component –** Surface Water Impacts (quantity)
    a. Road ditch outlet
    b. Diversion / Waterway outlet
    c. Natural drainage way
    d. Stormwater outlet

ASSESSMENT TOOLS

REFERENCES

1. **Stream Corridor Restoration – Principles, Processes, and Practices.** Federal Interagency Stream Restoration Work Group, October 1998

STREAM CORRIDOR – An Overview

Stream Stability (*from Post-Flood Emergency Stream Intervention Training Manual)*

The definition of a stable stream is: "The tendency of a stream to maintain its cross-section, plan form and profile geometry over time, effectively transporting its water and sediment supply without aggrading (building up), degrading (down-cutting), or adjusting laterally (eroding its banks)." (Rosgen, 1996)

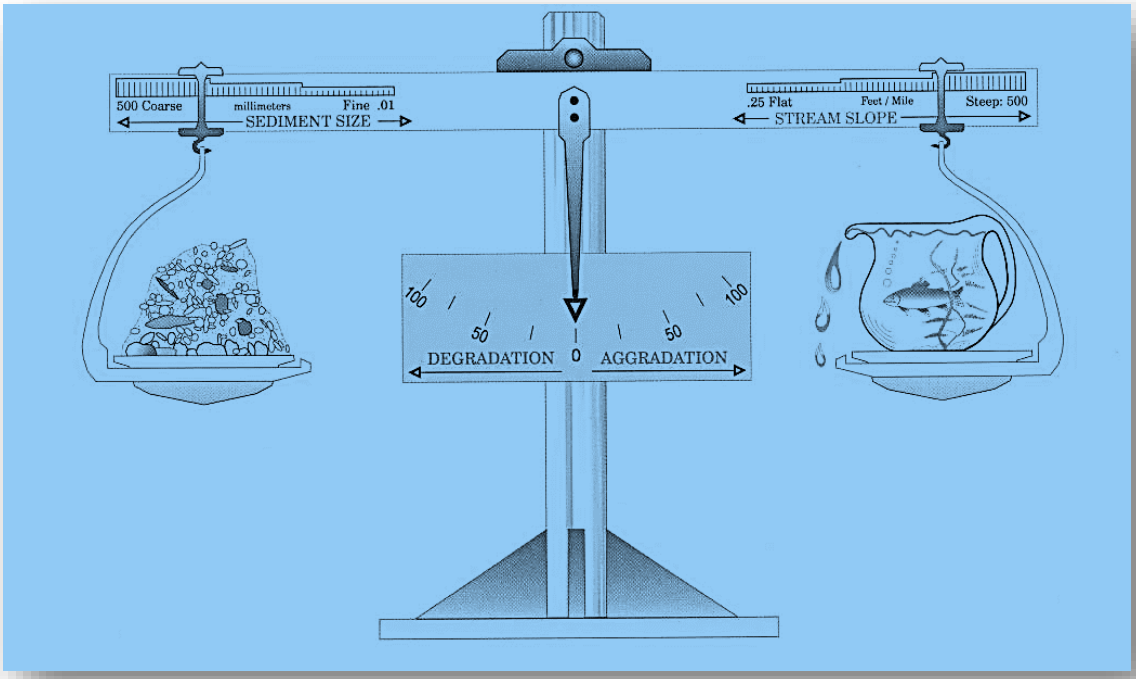
Streams that are in balance with their landscapes adapt a form that can pass the water and sediment through both small and large floods, regaining their previous form after the flood passes. In many situations, however, stream reaches become unstable when some management activity has upset that balance, altering the stream's ability to move its water and sediment effectively.

The form of a stream that is considered "stable" varies with topography. When it is in balance with mountainous terrain, a stable stream will look different than one that is in balance with rolling hills or broad floodplains. Stable streams are less likely to experience bank erosion, water quality and habitat problems. A number of factors can change the stability of streams, such as changes in flow input, sediment, and land use. Channelization of the stream and placement of berms, culverts and bridges can also have a negative impact on stream stability.

Sediment Balance

Sediment discharge has long been recognized as one of the primary variables that determine the characteristics of a stream. **Figure 2.5** below illustrates the relationship between a set of four primary physical variables (sediment size, sediment load, stream discharge and stream slope) and two opposing processes (stream bed aggradation and degradation) that determine stream sediment and channel characteristics and balance. The figure suggests that a change in one of four physical variables will trigger a response in the two process variables. This in turn creates changes in stream characteristics. See **Figure 2.5a** and **Figure 2.5b**. Streams are said to be in equilibrium when the volume of water is enough to transport the available sediment without building up in the channel (also known as aggradations) or cutting down the channel bed (known as degradation). Streams will adjust their shape, size and slope in order to transport the sediment.

LOAD **DISCHARGE**



STREAM EFFECT

Figure 2.5 Sediment Balance (Sediment LOAD) x (Sediment SIZE) is proportional to (Stream SLOPE) x (Stream DISCHARGE) **(Rosgen, 1996)**

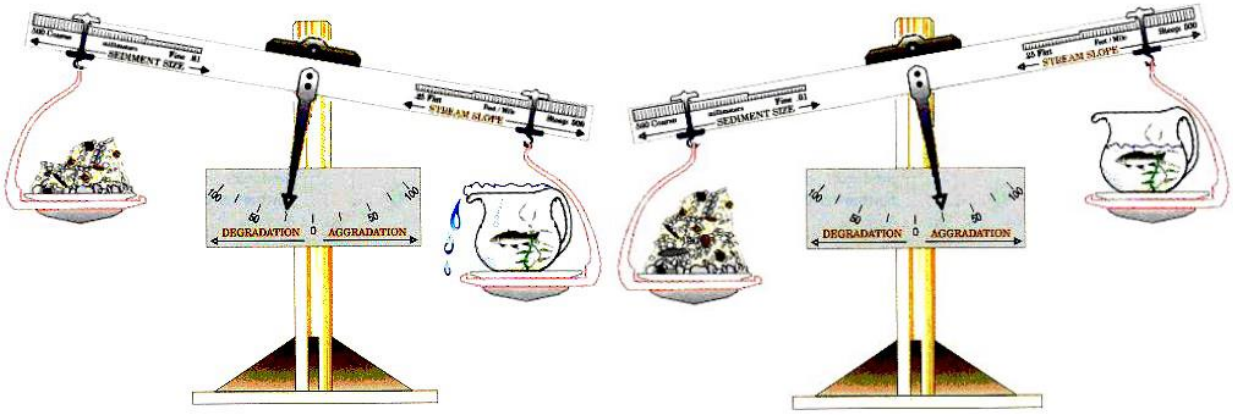


Figure 2.5a If the supply of sediment decreases or the supply of water increases, the stream will begin to erode the stream bed or degrade. (After Rosgen, 1996)

Figure 2.5b If the supply of sediment increases or the supply of water decreases, the stream will begin to fill in with gravel or aggrade. (After Rosgen, 1996

Stream Features

The features of a stream are described in terms of their planform dimensions, their longitudinal dimensions, and their cross-sectional dimension.

The overhead or "planform" view of the stream focuses on the path that the stream follows within its valley (**Figure 2.6**). Stream managers speak of a stream's sinuosity as they describe the coverage the stream meanders across the valley. Sinuosity is related to slope and energy. A stream that has sinuosity has a longer distance than a stream that is straight. The associated elevations will also differ whereas the greater the sinuosity the lower the average slope. The sinuosity of a stream is generally greater at the lower

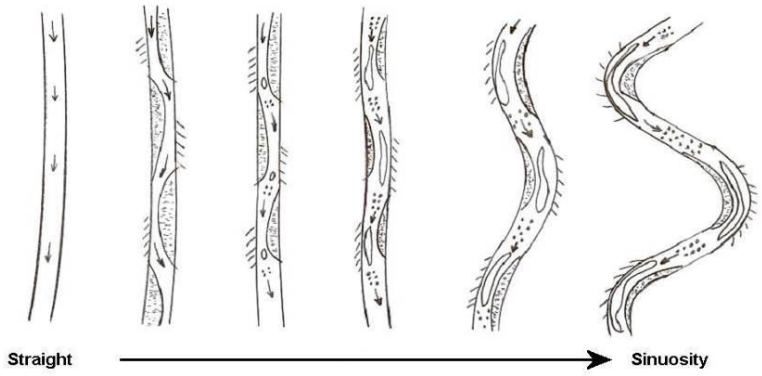


Figure 2.6 Planform of a Stream with Increasing Sinuosity (After Keller, 1972)

end of the valley, closer to the mouth of the watershed.

Longitudinal dimensions of a stream are used to describe how the stream changes from the top of the watershed to the mouth of the stream. The most important factor is the slope of the stream. Slope is a critical contributor to the energy of the stream. The energy of water flowing down a slope is needed to move sediment. A stream's slope can vary from high gradient (slope greater than 4%) to medium gradient (2%-4%) to low gradient (less than 2%) (see **Figure 2.7**). The slope of the stream typically is greatest at the top of the watershed (high gradient stream) and gradually declines as the stream flows down the valley (medium gradient stream) and makes its way to the bottom of the watershed (low gradient streams).

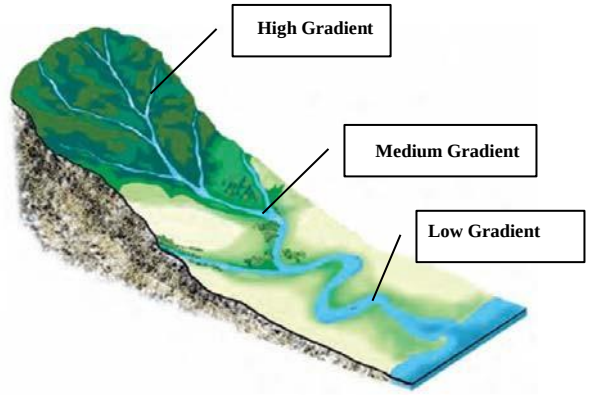


Figure 2.7 Stream's slope from high gradient to low

In terms of its cross-sectional dimension, a stream has a primary channel that conveys most of the flow throughout the year. Secondary conveyance of flow is the floodplain. Floodplains are the flat area of a stream system located above the top of the stream bank that is inundated with slower flowing water during and following flood flow events. Flood flows in some streams sections may not rise over the top of the banks and therefore may lack or are disconnected from their historic floodplain. Such stream channels are commonly called entrenched channels (**Figure 2.8**). Maximum depth is the distance from the top of the water at bank full elevation to the deepest part of the channel. If at twice maximum depth the stream cannot access its floodplain, it is considered to be entrenched.

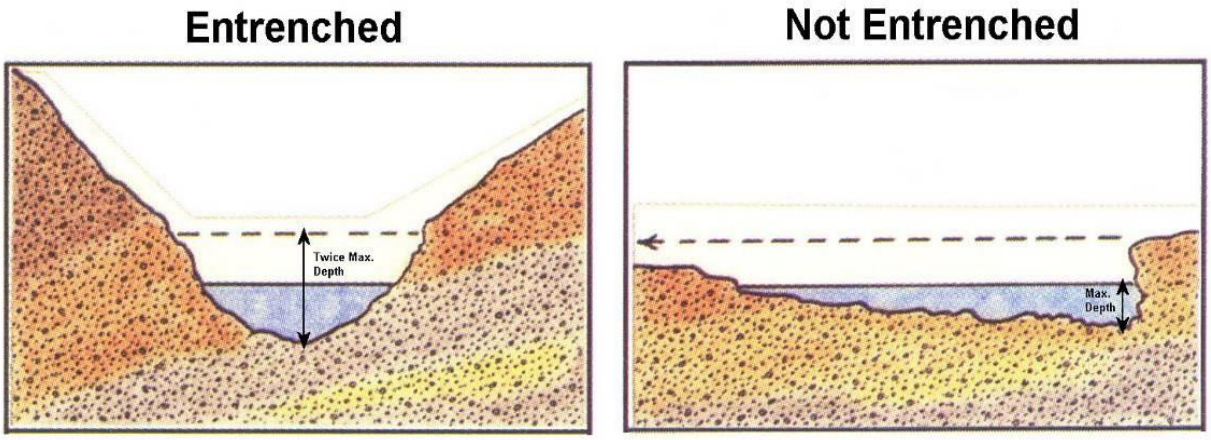


Figure 2.8 Shows entrenched channel (After Rosgen, 1996)

"The floodplain is defined as the flat area bordering a stream, constructed by the river in the present climate and inundated during periods of high flow" (Leopold, 1997). The floodplain is a critical component of stream function. The floodplain serves as an energy dissipater and depository of finer sediments during high flows. **Figure 2.9** shows a typical cross section of a stream system with bank full and floodplain. Notice that a bank full event is not considered a flood event until it over tops the banks. Bank full happens on average, every 1.2 to 2.0 years. This discharge, from relatively frequent storms, is largely responsible for the shape of the stream channel within the floodplain.

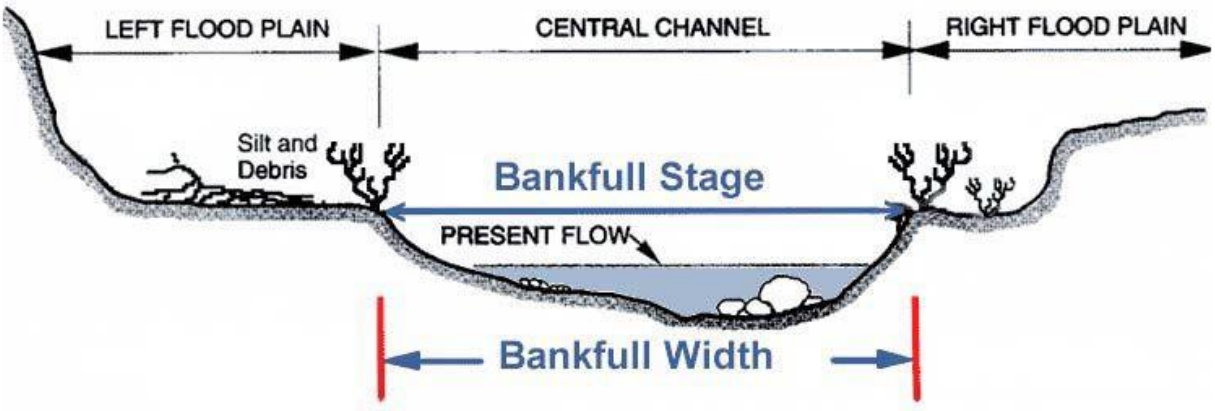


Figure 2.9 Shows a typical cross section of a stream system (After Newbury & Gaboury, 1993))

Assessing the Stream Corridor

As mentioned previously above, the Stream Corridor Components - active stream channel; the stream channel banks; the floodplain; the riparian zone; and the immediate areas upland that directly impact the corridor – work together to provide stream function and stability. While each of the components are handled separately in the assessment sheets, impacts on one or more of the components often has a direct impact on the other components. For example a disconnected or non-functional floodplain may be the cause of both bank and bed erosion. Another example may be where excessive surface water from an upland source is destabilizing stream corridor riparian areas and/or stream banks. Therefore, before any diagnostic conclusions and planning recommendations are made and pursued, it is highly recommended to complete the assessment of the entire corridor and make determinations of the cause of loss of stream corridor function.

Assessing the Channel

As described above, a stream channel in its functional form will be capable of transporting both water flows, typical for its contributing watershed, as well as the normal sediment loads received from upstream that are a result of natural geologic processes. Modifications to this stable form can result in the channel becoming unstable, causing it to either aggrade (deposit excess amounts of bedload) or degrade (increasing its depth). Examples of such activities include:

- excavation of the channel
- blockages to the channel by debris, culverts, bridges or other crossings
- disconnection from accessing its floodplain during high flows through the creation of berms or deepening the channel through dredging
- increasing the amount of water entering the channel or decreasing the time it takes water to reach the channel from its contributing watershed
- adding an unnatural supply of sediment from construction, tillage or bank failures upstream

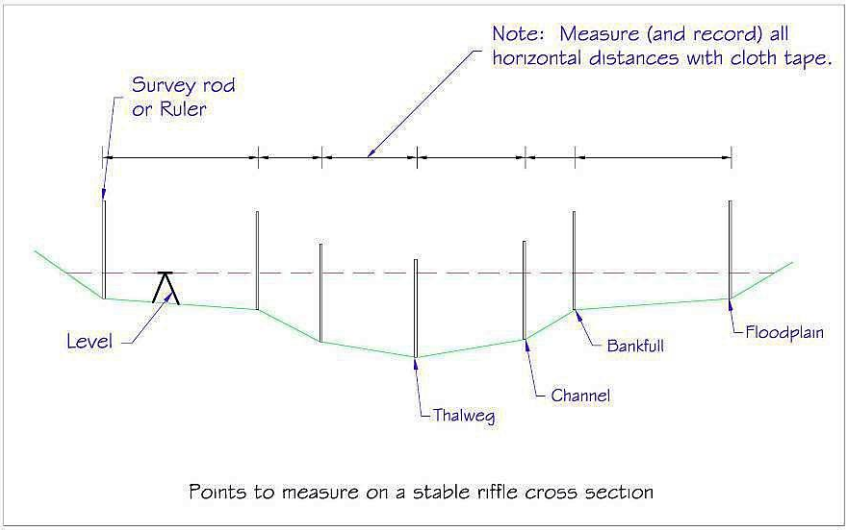
To assess the relative functionality of the channel, two tools are available that provide a generalized guide for determining the cross-sectional features needed by the stream, based on the size of the watershed. These are the USGS StreamStats program for NY (Appendix A) and the stream dimension tables provided as part of the Post Flood Emergency Stream Intervention Program, (Appendix B). Both these sources provide the estimated width of the channel at "bankfull," the depth of the channel at the "bankfull" elevation, and the floodplain width needed to accommodate normal flood flow elevations. Watershed size at the location being assessed can be determined through the USGS StreamStats program described in appendix A or through downloading the color-coded topographic maps from the DEC website at https://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1294 . It is important to note that both these tools are based on regional "models" and as such are only useful for approximation and general evaluation when attempting to identify critical functionality of the channel.

In conducting a visual assessment of the stream channel, begin by determining if there is a single or multiple channel. In attempting to identify the "bankfull" elevation, look for physical indicators consistent with the stream type being considered. In most streams, this is usually the point where

there is a break in the stream bank slope in the active channel that identifies the beginning of the floodplain. Changes in the size material (gravel, sand, etc.) that indicates a change in flow velocity are also good indicators. Once the bankfull elevation is identified, a quick survey as indicated in the diagram below will provide measurements that can be compared to the measurements indicated in the tables referenced above.

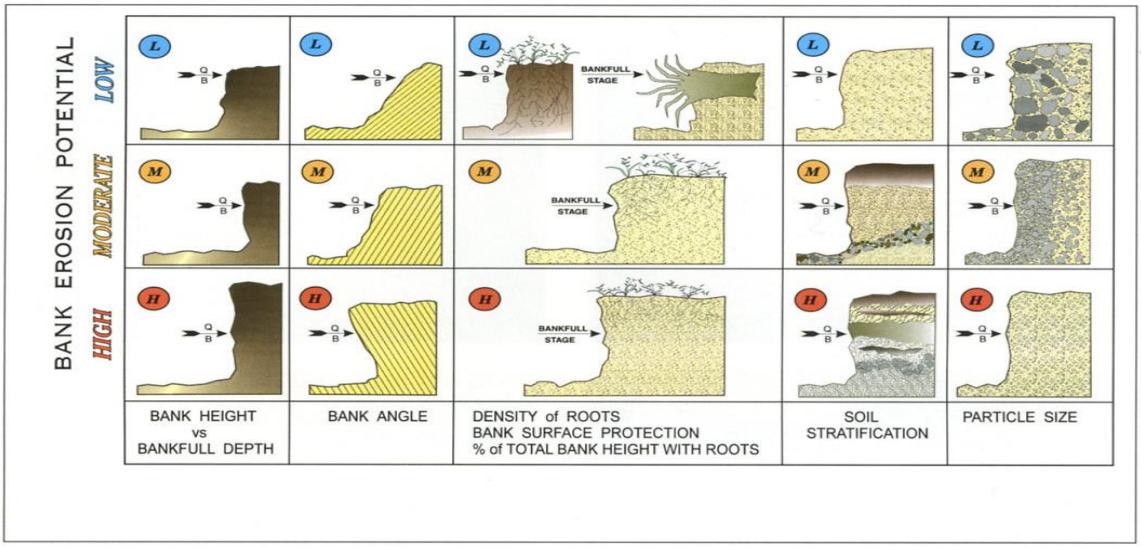
Things to consider in assessing the channel are:

- Unnatural pattern that may indicate straightening or other modification
- Excessive deposition of bedload
- Excess scour, down-cutting in bed elevation or incision
- Loss of longitudinal features such as pools and riffles



Points to measure on a stable riffle cross section

Assessing the Stream Banks



Stream bank stability is a reflection of many variables. The velocity of the stream flow – calculated and measured as "sheer stress" - is governed by the cross section of the stream discussed above and the hydrology and hydraulics of the channel. The physical shape of the bank, the resistance to the sheer stress of the materials as shown in the diagram above are also critical components. There exists predictive models such as the Bank Erodibility Hazard Index (BEHI) that help determine the potential for bank failure.

Assessing the Floodplain

For most streams, the proper width and elevation of their floodplains are critical in providing stability and resiliency to flooding events. A proper- sized floodplain connected to a stream channel will reduce sheer stress on the channel banks, store flood waters and reduce downstream flooding.

Things to consider in assessing the functionality of the floodplain include:

- Functional width based on drainage area
- Vegetative cover
- Obstructions that block or concentrate flow
- Signs of scour, erosion or avulsions or evidence of former channel locations

Assessing the Riparian Area

Riparian areas are the areas adjacent to stream channels that function as transitional areas between the stream and uplands. Riparian areas may or may not include flood plains and associated wetlands, depending on the valley form of the stream corridor. Riparian areas are among the most biologically diverse habitats of landscapes and are sources of wood, leaves, and organic matter for the stream. These areas provide important habitat and travel corridors for numerous plants, insects, amphibians, birds, and mammals. Well-established and connected riparian areas perform critical functions for maintaining healthy, resilient stream ecosystems. The capacity for riparian areas to sustain these functions depends in part on the quality and quantity of the riparian vegetation and how it interacts with the stream ecosystem.

Things to consider in assessing the functionality of the riparian area include:

- Proper width to provide stream stability, habitat and water quality functions
- Vegetative cover type, health and diversity
- Signs of exotic and invasive species

Assessing the Contributing Upland Area

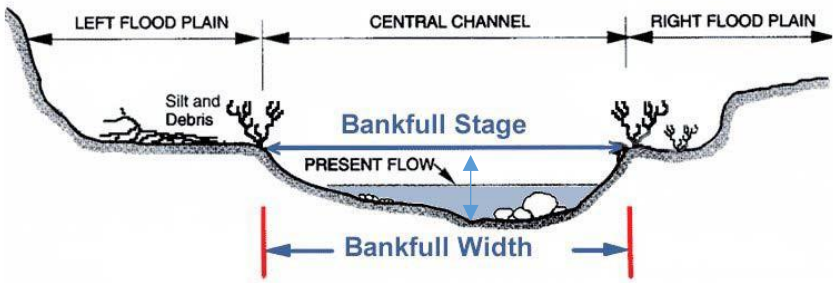
Runoff from above the stream corridor has a critical influence on the stability and health of the components of the corridor. Pollution in the form of sediments, nutrients and other materials can impact on the health and viability of the vegetation and terrestrial and aquatic wildlife. Stormwater flows are often collected and discharged into the stream corridor without consideration for impacts on bank stability or stable outlets.

Things to consider in assessing the impacts of areas above the stream corridor include:

- Type of land use/cover and expected quality and quantity of runoff
- Sources of concentrated flows of stormwater runoff and how they impact on bank and channel stability
- Stability of outlets
- Stormwater discharge impacts on stream corridor vegetation

Stream Corridor Assessment – Stream Channel

Utilizing appropriate values from either USGS Stream Stats or NY ESI stream channel tables, compare and evaluate the following: bankfull elevation, width and depth; floodplain widths (left & right banks combined). Actual suggested observations related to a divergence from these values are included, as well as planning and design suggestions.



Channel Component	Level of Concern (1-4)	Items of Concern	Observations, Evaluation & Recommendation [1] *Planning & design considerations by qualified individual* [2]*Planning & design considerations by qualified engineer*
Bankfull Width	1	*80 to 120 % of recommended width*	- Little or no bank erosion. Channel appears to have good connection to floodplain. Continued monitoring
	2	*70 to 80 % of recommended width*	- Potential for bank erosion, some bank erosion observed. Channel may be disconnected with floodplain. Check stream banks condition and conduct detail cross section. [2]May consider stabilization practices
		120 to 130% of recommended width	- Potential for bedload deposition, some excess bedload deposits. Survey stream bed slope. Check for obstructions downstream or source of sediment upstream
	3	*60 to 70% of recommended width*	- Stress on bed and banks causing eroded banks and incising channel. [2]May require grade control, bank stabilization or channel resizing

		130 to 150% of recommended width	- Significant bedload deposition occurring, causing stream channel migration above normal. [2]May require channel resizing and in-channel structures.
	4	*<60% of recommended width*	- Severe stress on bed and banks causing eroded banks and incising channel. [2]Practices to be considered include resizing channel, grade control, bank stabilization
		>150% of recommended width	- Severe bedload deposition occurring, causing stream channel migration above normal. [2]May require channel resizing and in-channel structures
Bankfull Depth	1	*90 to 110 % of recommended depth*	- Minor bank erosion may be observed. Continued monitoring
	2	*80 to 90 % of recommended depth*	- Channel may demonstrate inability to transport bedload. More frequent engagement of floodplains. Channel may need resizing to re-establish transport ability. Check for sources of excess sediment upstream.
		110 to 120% of recommended depth	- Potential for bank erosion and bed incision. Check stream banks condition and conduct detail cross section. [2]Determine hydrology and hydraulics to calculate sheer stress on bed and banks. [2]May need to consider channel grade control/stabilization.
	3	*70 to 80% of recommended depth*	- Stream demonstrating inability to transport bedload. More frequent out of channel out-of-channel flooding. [2]May require channel resizing to re-establish transport ability. Check for sources of excess sediment upstream or evidence of history of channel modification.
		120 to 140% of recommended depth	- Stress on bed and banks causing eroded banks and incising channel. [2]May require grade control, bank stabilization and channel resizing.
	4	*<70% of recommended depth*	- Channel demonstrating inability to transport bedload and water during bankfull or higher events. Significant bedload deposition

		>140% of recommended depth	occurring causing stream channel migration above normal. [2]May require channel resizing and in-channel structures. - Severe stress on bed and banks causing eroded banks and incising channel. [2]Practices to be considered include resizing channel, grade control, bank stabilization
Floodplain Width *Note – floodplain width greater than 100% - no concern*	1	*> 75% of recommended width*	- Floodplain appears stable. Little or no evidence of floodplain erosion. Stream banks with little or no erosion. Continued monitoring
	2	*60 – 75% of recommended width*	- Some stress on channel bed and banks during high flows with bank and floodplain erosion noted. [1]May need to widen floodplain.
	3	*50 to 60% of recommended width*	- Scour on floodplains may be apparent, causing damage. Stream banks may experience higher stress causing erosion. [1]May need to widen floodplains to proper width.
	4	*< 60% of recommended width*	- Scour on floodplains and potential avulsions. Stream channel may experience bed and bank erosion. [1]Need to consider re-establishment of floodplain width.
Channel Obstructions a. Culvert b. Bridge c. Crossing d. Gravel e. Wood f. Other	1	*Minor obstructions or deposits obstructing < 10% of bankfull channel width*	- Some flow in bankfull channel diverted around obstruction with little or no impacts on channel pattern or banks. Continue monitoring.
	2	*Obstructions or deposits restricting channel bankfull width by 10 to 20%*	- Stream flow diverted around obstruction or in case of crossing, restricted from normal bankfull width. Scour in channel, diverting flows into banks or modifying pattern observed. [1]May need to remove or modify obstruction. [2]In case of crossing may need to consider stabilizing banks and channel below crossing.
	3	*Obstructions or deposits restricting channel bankfull width by 20 to 30%*	- Stream flow diverted around obstruction or in case of crossing, restricted from normal bankfull width. Notable scour in channel, diverting flows into banks or modifying pattern observed. Property

			damage or loss being experienced after each significant storm event. [1]May need to remove or modify obstruction. [2]In case of crossing may need to consider stabilizing banks and channel below crossing.
	4	*Obstructions or deposits restricting channel bankfull width > 30%*	- Considerable obstruction causing channel to migrate into banks, serious channel scour due to restrictions in cross section, increased stream velocities, unstable banks, potential avulsions and loss of property. [2]Removal or modification of obstruction needs to be considered along with possible channel redesign or in case of crossing, modification and or stabilization practices.
Channel Slope	1	*Consistent with valley grade/ slope*	- Stream channel at proper cross sectional dimensions at bankfull width. Well connected to floodplain. Good longitudinal bed features for stream type. Continue monitoring.
	2	*Sections of channel inconsistent with valley grade/slope*	- Some evidence of past channel modifications. Some incision or deposition in channel observed. Check for channel modification or obstruction upstream and downstream. [2]May need to consider practices to restore channel grade and stabilization.
	3	*Channel reach inconsistent with valley grade/slope. Minor head cuts or deposition observed.*	- Evidence of channel modification. Incision or deposition in channel observed. Stream banks and pattern are impacted and resulting erosion observed. Check for channel modification or obstruction upstream and downstream. [2]Consideration of practices to restore grade and elevation of channel and stabilization.
	4	*Channel reach inconsistent with valley grade/slope. Considerable head cuts or deposition.*	- Evidence of channel modification. Significant incision or deposition in channel causing failing bank stability and stream pattern changes. Channel is deepening or widening. Riparian property loss as a result of impacts. [2]Consideration of practices to restore proper cross section and grade.
Channel Pattern	1	*Single channel. Pattern consistent with valley and stream type.*	- Continue monitoring.

	2	*Single channel. Some bends over tight*	- Bank erosion observed on outside of bends. Accelerated deposition on outside of bends above bankfull elevations. Possible obstructions. Check for signs of channelization. [1]Consider removal of deposition to proper elevations. [1]Removal of obstructions. [2]Potential need for bank stabilization practices.
	3	*Multiple channels. Pattern inconsistent with valley type and stream type. Channel over straight or bends too tight.*	- In most stream types, multiple channels demonstrate over widening and deposition. Accelerated deposition or obstructions resulting in change in pattern and forcing channel into opposite banks. Considerable bank erosion. Check for signs of channelization - straightening of channel, widening, etc. [2]May need to consider design and reconstruction of stable channel pattern and profile, removal of deposition/obstructions, and stabilization practices.
	4	*Multiple channels. Tortuous curves. Overly straight pattern. Pattern significantly inconsistent with valley and stream type.*	- Multiple channels indication of over widening and deposition observed. Accelerated deposition or obstructions resulting in change in pattern and forcing channel into opposite banks and causing significant loss of land bordering stream channel. Considerable bank erosion. Check for signs of channelization - straightening of channel, widening, etc. [2]Consider design and reconstruction of stable channel pattern and profile, removal of deposition/obstructions, and stabilization practices.
Channel Avulsions	1	*Floodplain Scour*	- Slight floodplain scour, rills, slight channel formation observed. Check adequacy of channel cross section and floodplain width. Check for obstructions in channel and floodplain. [1]May need to remove obstructions. [2]May need to consider resizing channel and/or floodplain to proper dimensions.
	2	*New channel within stream corridor*	- Secondary stream channel developed after high water event within floodplain. Check adequacy of channel cross section and floodplain

			width. Check for obstructions in channel and floodplain. [1]May need to remove obstructions. [2]May need to consider resizing channel and/or floodplain to proper dimensions.
	3	*New channel in floodplain – no structures threatened*	- Main stream channel developed after high water event within floodplain. No structures are impacted. Check adequacy of channel cross section and floodplain width. Check for obstructions in channel and floodplain. [1]May need to remove obstructions. [2]May need to consider resizing channel and/or floodplain to proper dimensions, blocking and filling avulsion channel.
	4	*New channel in floodplain – structures threatened*	- Main stream channel developed after high water event within floodplain. Structures are impacted and/or threatened. Check adequacy of channel cross section and floodplain width. Check for obstructions in channel and floodplain. [1]May need to remove obstructions. [2]Will need to consider blocking and filling of avulsion channel, resizing original channel and/or floodplain to proper dimensions.
Habitat Quality ***Considerations include:*** • ***Barriers to passage*** • ***Types of cover*** • ***Bedload embeddedness*** • ***Stream channel morphology*** • ***Cover such as wood, pools, over-hanging vegetation, large rock, aquatic plants, riffles***	1	*Some habitat present. No passage obstruction*	- Stream bed features somewhat consistent with stream type. Bedload features consistent with other reaches. Some deposition of finer or coarser materials than upstream or downstream. Check for evidence of channel modifications in past. Check channel cross sectional dimensions. Continue monitoring.
	2	*Limited habitat present. No passage obstruction*	- Lack of stream bed features consistent with reaches upstream or downstream of similar stream type. Deposition of fine materials filling voids and covering coarser bed materials. Little or no cover. Check for evidence of channel modifications. Check channel cross sectional dimensions. [2]May need to resize channel cross section and add habitat features in design. [1]May need to address riparian vegetation deficiency.

	3	*Limited habitat present. Passage obstruction*	- Lack of stream bed features consistent with reaches upstream or downstream of similar stream type. Deposition of fine materials filling voids and covering coarser bed materials. Little or no cover. Passage obstruction of < 2 feet due to minor dam or stream crossing outlet drop. Check for evidence of channel modifications. Check channel cross sectional dimensions. [2]May need to resize channel cross section and add habitat features in design. [2]May need to design transition from outlet of obstruction or consider removal/replacement. [1]May need to address riparian vegetation deficiency.
	4	*Little or no habitat present. Significant passage obstruction*	- Lack of stream bed features consistent with reaches upstream or downstream of similar stream type. Deposition of fine materials filling voids and covering coarser bed materials. Little or no cover. Passage obstruction of > 2 feet due to minor dam or stream crossing outlet drop. Check for evidence of channel modifications. Check channel cross sectional dimensions. [2]May need to resize channel cross section and add habitat features in design. [2]May need to design transition from outlet of obstruction or consider removal/replacement. [1]May need to address riparian vegetation deficiency.

Typical Stream Channel Practices for consideration (not all-inclusive)

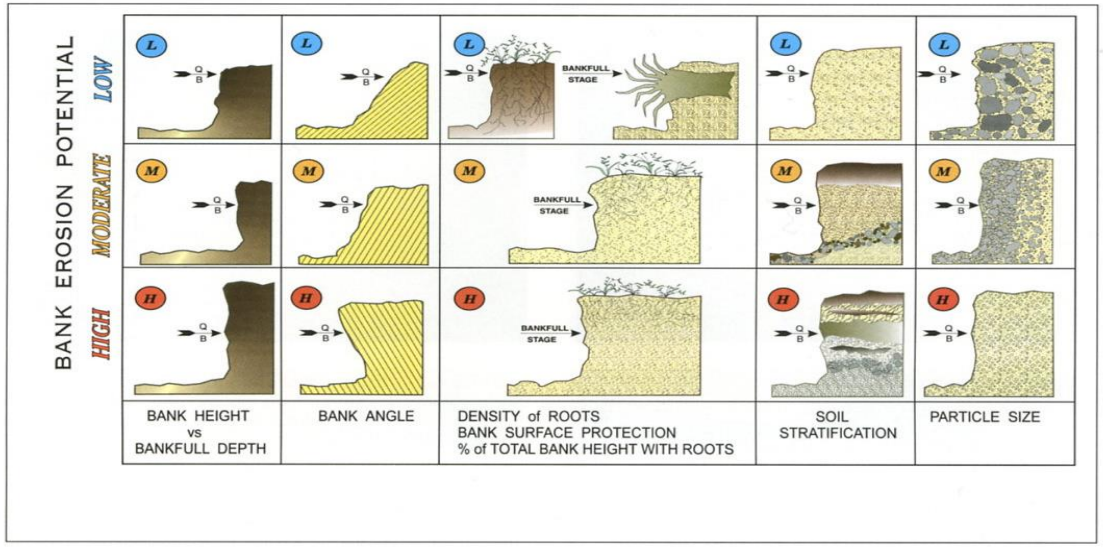
- NY NRCS Standard 326 - Clearing and Snagging
- NY NRCS Standard 342 - Critical Area Planting
- NY NRCS Standard 395 - Stream Habitat Improvement and Management
- NY NRCS Standard 396 - Aquatic Organism Passage
- NY NRCS Standard 410 - Grade Stabilization Structure
- NY NRCS Standard 500 - Obstruction Removal
- NY NRCS Standard 578 - Stream Crossing

- NY NRCS Standard 580 - Streambank and Shoreline Protection
- NY NRCS Standard 582 - Open Channel
- NY NRCS Standard 584 - Channel Bed Stabilization

Stream Corridor Assessment – Stream Bank Stability

Based on Bank Erosion Hazard Index

(BEHI)



Bank Component	Level of Concern (1-4)	Items of Concern	Observations, Evaluation & Recommendation [1] *Planning & design considerations by qualified individual* [2]*Planning & design considerations by qualified engineer*
Bank Height at Bankfull vs. Bank Height	1	*At or near bankfull elevation*	- Little or minor bank erosion may be observed. Continued monitoring
	2	*10 to 30% of bank height above bankfull elevation*	- Potential for bank erosion and bed incision. Check stream banks condition and conduct detail cross section. [2]May need to consider channel grade control/stabilization and/or bank stabilization.
	3	*30 to 50% of bank height above bankfull elevation*	- Stress on bed and banks causing eroded banks and incising channel. [2]May require grade control, bank stabilization and channel resizing.

	4	*> 50% of bank height above bankfull elevation*	- Severe stress on bed and banks causing eroded banks and incising channel. [2]Practices to be considered include resizing channel, grade control, and bank stabilization.
Bank Angle	1	*0 to 20%*	- Bank angle stable. Well vegetated. Little or minor bank erosion may be observed. Continued monitoring
	2	*20 to 60%*	- Bank angle fairly stable. Some evidence of difficulty holding vegetation. Some potential erosion. [1]Consider regrading to stable angle and vegetating.
	3	*60 to 90 %*	- Bank angle unstable. Erosion of bank through collapsing or surface erosion. Vegetation sparse. Check channel cross section for proper dimensions. [1]May need to regrade and vegetate bank. [1]May need to consider bank stabilization geo product.
	4	*>90%*	- Bank toe undermined. Considerable bank wasting/failure. No vegetation. Check cross section for proper dimensions. [2]Consider bank regrading and bank stabilization practices.
Bank Root Density ***(of total bank height)***	1	*80 to 100%*	- Good vegetative root zone for almost entire bank. Little or minor bank erosion may be observed. Continued monitoring
	2	*50 to 80%*	- Vegetative root zone covers more than half of bank depth. Some bare soil demonstrating soil loss/erosion. [1]May need to consider replanting with appropriate plant species. Check bank angle to assure stable soil conditions before planting.
	3	*30 to 50%*	- Vegetative root zone limited and providing reduced protection. Check cross section for proper dimensions. [2]If bare soil non-resistant to bank sheer stress, consider bank stabilization.

	4	*<30%*	- Vegetative root zone limited and providing reduced protection. Check cross section for proper dimensions. [2]If bare soil non-resistant to bank sheer stress, consider bank stabilization.
Bank Soil Stratification	1	*Bank layers resistant to stream sheer stress*	- Layers of bank materials consist of bedrock, boulders and other materials. Little or minor bank erosion may be observed. Continued monitoring
	2	*Bank layers resistant to stream sheer stress below bankfull but materials above bankfull less resistant*	- Some evidence of erosion above bankfull. [1]May need to consider vegetative or stabilization practices.
	3	*Bank layers mix of resistant and non-resistant materials*	- Bank layers mix of stone and/or soil-sand-silt. Some bank failure due to undermining of non-resistant materials. [2]May need to consider bank stabilization practices.
	4	*Bank layers consist of erosive materials*	- Bank failure and material loss due to erosion. [2]Consider bank stabilization practices.
Bank Particle Size	1	*Bedrock*	- No bank erosion may be observed. Continued monitoring
	2	*Boulders*	- Little erosion may be observed. If bank erosion is concern, determine proper stream cross section and stream bank sheer stress and adequacy of boulder size to provide adequate protection.
	3	*Cobble / Gravel*	- Bank erosion may be observed due to non-cohesive nature of materials. Check proper stream cross section and stream bank sheer stress. [2]May need to consider resizing channel and/or bank protection practices.
	4	*Sand/Silt/Clay/Loam*	- Bank materials exhibit little erosive resistance. In the absence of vegetative cover may show considerable erosion. Check proper

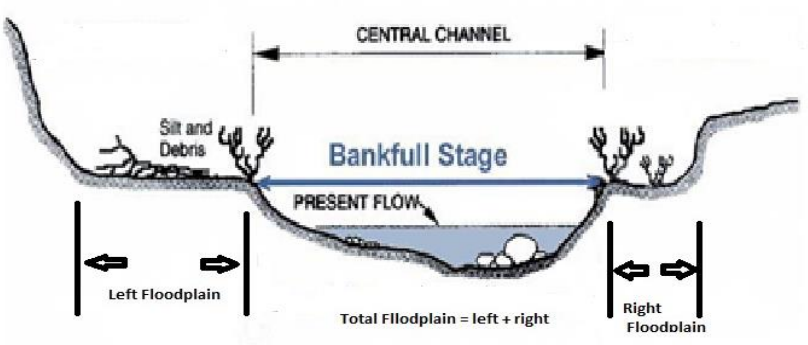
			stream cross section and stream bank sheer stress. [2]May need to consider resizing channel and/or bank protection practices

Typical Stream Channel Practices for consideration (not all-inclusive)

- NY NRCS Standard 326 - Clearing and Snagging
- NY NRCS Standard 342 - Critical Area Planting
- NY NRCS Standard 410 - Grade Stabilization Structure
- NY NRCS Standard 490 - Tree/shrub Site Prep
- NY NRCS Standard 500 - Obstruction Removal
- NY NRCS Standard 578 - Stream Crossing
- NY NRCS Standard 580 - Streambank and Shoreline Protection
- NY NRCS Standard 582 - Open Channel
- NY NRCS Standard 584 - Channel Bed Stabilization
- NY NRCS Standard 578 - Crossing Stream
- NY NRCS Standard 612 - Tree/Shrub Establishment

Stream Corridor Assessment – Floodplain

Utilizing the ESI tables, determine the proper floodplain elevations and width for providing adequate, functional and stable stream access.



Floodplain Component	Level of Concern (1-4)	Items of Concern	Observations, Evaluation & Recommendation *[1]Planning & design considerations by qualified individual* *[2]Planning & design considerations by qualified engineer*
Floodplain Elevation	1	*Below bankfull elevation.*	- Deposition in channel causing aggradation. More frequent flooding of floodplains. Potentially some deposition or scour observed in floodplains. Check for obstructions in floodplains. Continue monitoring. [2]May need to restore channel cross section and depth.
	2	*< 2 feet above bankfull elevation*	- Minor bank erosion may be observed. Continued monitoring. If stream banks exhibit severe erosion, [1]may need to consider restoration of proper floodplain elevation or [2]stream channel grade control.

	3	*2 to 3 feet above bankfull elevation*	- Bank erosion and stream bed incision may be observed. Check stream banks condition and conduct detail cross section. [1] Consider restoring proper floodplain elevation. [2]Determine hydrology and hydraulics to calculate sheer stress on bed and banks. [2]May need to consider channel grade control/stabilization.
	4	*> 3 feet above bankfull elevation*	- Severe stress on bed and banks causing eroded banks and incising channel. [2]Practices to be considered include resizing channel, grade control, bank stabilization and proper floodplain elevation restoration.
Floodplain Width	1	*75 to 90 % of recommended width*	- Higher flow velocities during flood events may cause scour in floodplain. Some minor stream bank erosion may be observed. Continue monitoring.
	2	*60 to 75 % of recommended width*	- Higher flow velocities during flood events creating scour and rill erosion in floodplain. Stream bank erosion and channel incision may be observed. [1]Consider restoring proper floodplain width. [2]May need to consider stream channel grade control and/or bank stabilization in conjunction with floodplain width restoration.
	3	*50 to 60 % of recommended width*	- Higher flow velocities during flood events creating erosion in floodplain, possible avulsions. Stream bank erosion and channel incision observed. [1]Consider restoring proper floodplain width. [2]May need to consider stream channel grade control and/or bank stabilization in conjunction with floodplain width restoration.
	4	*< 50% of recommended width*	- Higher flow velocities during flood events creating erosion in floodplain, possible avulsions. Severe stream bank erosion and channel incision observed. [1]Consider restoring proper floodplain width. [2]May need to consider stream channel grade control and/or bank stabilization in conjunction with floodplain width restoration.

Floodplain Cover/Land Use	1	*75 to 90% cover. No tillage or bare soil exposed*	- Floodplain at proper width and elevation will have little or no observed scour or erosion after flooding event. Continue monitoring. [1]Consider establishing vegetation in area that are exposed.
	2	*50 to 75% cover. Minimal tillage or bare earth exposed*	- Floodplain at proper width and elevation may demonstrate scour or erosion (rill and sheet) of topsoil. [1]Consider conservation tillage, cover crops or other permanent stabilization.
	3	*25 to 50% cover. Conventional tillage with cover crop/residuals. Considerable bare earth exposed*	- Floodplain at proper width and elevation will demonstrate scour or erosion (rill and sheet) of topsoil. May observe some channelization in floodplain. [1]Consider conservation tillage, cover crops or other permanent stabilization.
	4	*Little or no cover*	- Floodplain at proper width and elevation will demonstrate scour or erosion (channel, rill and sheet) of topsoil. [1]Consider conservation tillage, cover crops or other permanent stabilization.
Floodplain Obstructions • **Berms/dikes** • **Buildings** • **Debris** • **Other**	1	*Floatable debris. <10% permanent obstructions*	- Some scour in immediate area of obstructions may be noted. [1]Consider removal of obstructions and continue monitoring.
	2	*Floatable debris. 10 to 25% permanent obstructions*	- Scour in immediate area of obstruction may be noted along with possible channelization around permanent structures. [1]Consider removal of obstructions. [2]May need to mitigate permanent obstructions for restoration of flood flows.
	3	*Floatable debris. 25 to 50% permanent obstructions*	- Scour, rill and channel erosion in floodplain observed. Stream bank erosion and channel incision observed. [1]Consider removal of berms, gravel piles, fill and other obstructions. [2]May need to consider stream channel grade control and/or bank stabilization in conjunction with floodplain width restoration. [2]May need to mitigate permanent obstructions for restoration of flood flows.

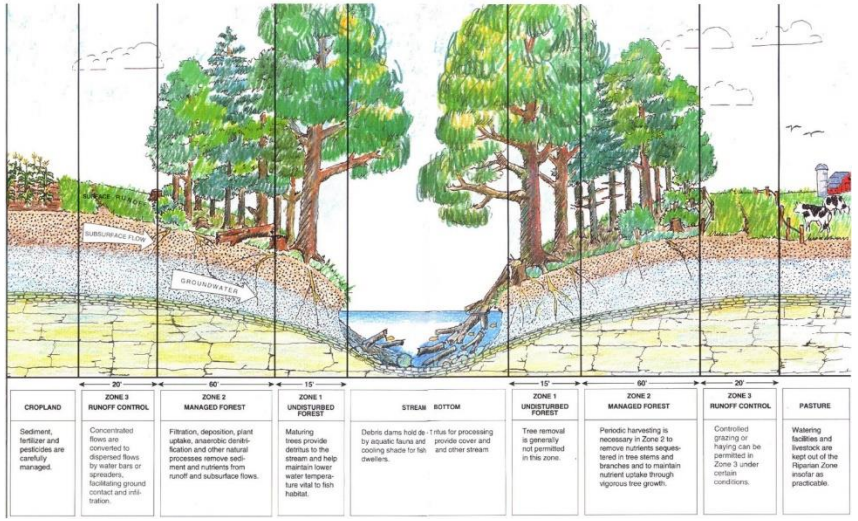
	4	*>50% of floodplain obstructed.*	- Scour, rill and channel erosion in floodplain observed along with possible avulsions. Stream bank erosion and channel incision observed. [1]Consider removal of berms, gravel piles, fill and other obstructions. Consider reconstruction of floodplain where possible to regain width lost to permanent obstructions such as buildings and roads. [2]May need to consider stream channel grade control and/or bank stabilization in conjunction with floodplain width restoration. [2]May need to mitigate permanent obstructions for restoration of flood flows.
Floodplain Invasives	1	*< 10 % Invasives*	- [1]Consider selective spot control.
	2	*10 to 20% Invasives*	- [1]Consider selective spot control.
	3	*20 to 40% Invasives*	- [1]Consider broad area control.
	4	*>40% Invasives*	- [1]Consider broad area control and replanting.

Typical Stream Channel Practices for consideration (not all-inclusive)

- NY NRCS Standard 342 - Critical Area Planting
- NY NRCS Standard 362 - Diversion
- NY NRCS Standard 390 - Riparian Forest Buffer
- NY NRCS Standard 391 - Riparian Herbaceous Buffer
- NY NRCS Standard 453 - Land Reclamation Landslide Treatment
- NY NRCS Standard 466 - Land Smoothing
- NY NRCS Standard 468 - Lined Waterway or Outlet
- NY NRCS Standard 490 - Tree/shrub Site Prep
- NY NRCS Standard 500 - Obstruction Removal
- NY NRCS Standard 612 - Tree/Shrub Establishment
- NY NRCS Standard 644 - Wetland Wildlife Habitat Mgt.
- NY NRCS Standard 666 - Forest Stand Improvement

Stream Corridor Assessment – Riparian Area

Riparian Assessment based on reference - Part 614 Stream Visual Assessment Protocol Version 2 National Biology Handbook, Subpart B—Conservation Planning, USDA - NRCS



When considering the health and function of the riparian area, determine the functions of the three riparian zones (see figure):

- Zone 1 (streamside) which provides water temperature reductions and both aquatic and terrestrial habitat values
- Zone 2 (intermediate) which provides surface and groundwater filtration
- Zone 3 (upland) which provides surface filtration of sediment, nutrients and other pollutants.

When evaluating riparian areas, consider evaluating/ranking each side of the stream separately.

Riparian Area Component	**Level of Concern (1-4)**	**Items of Concern**	**Observations, Evaluation & Recommendation** *[1] Planning & design considerations by qualified individual* *[2]Planning & design considerations by qualified engineer*
Riparian Width/Quantity ***Consider appropriate widths based on:*** • ***Slope*** • ***Upland land use*** • ***Filtration needs***	1	*Natural plant community extends >1.5 and <2 bankfull widths and covers the entire floodplain for the length of property. Some breaks in riparian area. Moderate slopes*	- Some surface flow through breaks in riparian area. [1]Consider replanting areas of breaks.
	2	*Natural plant community extends 1 to 1.5 bankfull width and only covers 50 to 75% of floodplain.*	- Evidence of surface flows through riparian vegetation gaps. Potential for sediment, nutrients and other pollutants to reach stream from upland land use. [1]Consider design and planting of adequate riparian area.

	3	*Significant gaps in riparian vegetation. Moderate slopes Natural plant community <1 bankfull width and/or less than 35 feet and covers < 50% of floodplain. One side of stream with little or no native riparian vegetation. Moderate to severe slopes*	- Significant gaps in natural vegetation along stream banks on one or two sides of stream. Evidence of sediment, nutrient and other pollutants reaching stream from upland land use. [1]Consider design and planting of adequate riparian area.
	4	*Natural plant community absent from one or both sides of stream. Moderate to severe slopes*	- Evidence of sediment, nutrient and other pollutants reaching stream from upland land use. Limitations to habitat corridor along stream. Potential for thermal pollution of stream. Observed runoff channels from upland to stream. Potential for floodplain scour and/or erosion. May observe stream bank erosion. [1]Need for design and planting of adequate riparian area.
Riparian Cover ***Consider stream classification (cold water vs. warm water) in determining level of concern. Consider 3 riparian zones and vegetative needs of each.***	1	*75 to 90% of water surface shaded.*	- Percent of stream shaded/canopy cover when sun directly overhead. Continue monitoring.
	2	*50 to 75% of water surface shaded.*	- Percent of stream shaded/canopy cover when sun directly overhead. [1]Consider age and species of riparian area zones and design and planting of appropriate vegetative covers.
	3	*25 to 50% of water surface shaded*	- Percent of stream shaded/canopy cover when sun directly overhead. [1]Consider age and species of riparian area zones and design and planting of appropriate vegetative covers.
	4	*< 25% of water surface shaded*	- Percent of stream shaded/canopy cover when sun directly overhead. [1]Consider age and species of riparian area zones and design and planting of appropriate vegetative covers.

Riparian Quality	1	*Good natural and diverse vegetation with composition, density and age structure appropriate to site and riparian zone. Little evidence of concentrated flows. Some evidence of exotic or invasive species.*	- Appropriate vegetation for filtration, habitat and stream quality needs. [1]May need to conduct selective invasive control. Continue monitoring.
	2	*Limited vegetative diversity and structural layers for each riparian zone. Exotic and invasive species 10 to 30% cover.*	- May observe evidence of disturbance or activities in riparian zone that have modified effectiveness. May observe evidence of concentrated runoff through riparian zones. [1]Consider design, planting and maintenance of riparian areas. [1]Consider exotic and invasive control.
	3	*Natural vegetation limited. Exotic and invasive species 30 to 50% cover. Riparian zones limited or non-existent*	- Evidence of concentrated flows running through riparian areas. Invasive species common. Significant disturbance or activities on riparian area. [1]Consider design, planting and maintenance of riparian areas. [1]Consider exotic and invasive controls. [2]May need to consider surface water control above and through riparian area.
	4	*Little or no natural vegetation. Exotic and invasive species > 50% cover.*	- Evidence of concentrated flows running through riparian areas. Invasive species common. Significant disturbance or activities on riparian area. [1]Consider design, planting and maintenance of riparian areas. [1]Consider exotic and invasive controls. [2]May need to consider surface water control above and through riparian area.
Riparian Slope	1	*0 to 10%*	- Potential for sheet flow through buffer. Consider adequate width and quality of buffer. Minimal width at 35 feet.
	2	*10 to 20%*	- Potential for sheet flow and some concentrated flows. Consider adequate width and quality of buffer. Minimal width at 35 to 50 feet.

	3	*20 to 30%*	- May observe concentrated flows. Consider adequate width and quality of buffer. Minimal width of 50 to 100 feet.
	4	*> 30%*	- May observe concentrated flows. Consider adequate width and quality of buffer. Minimal width 100+ feet.

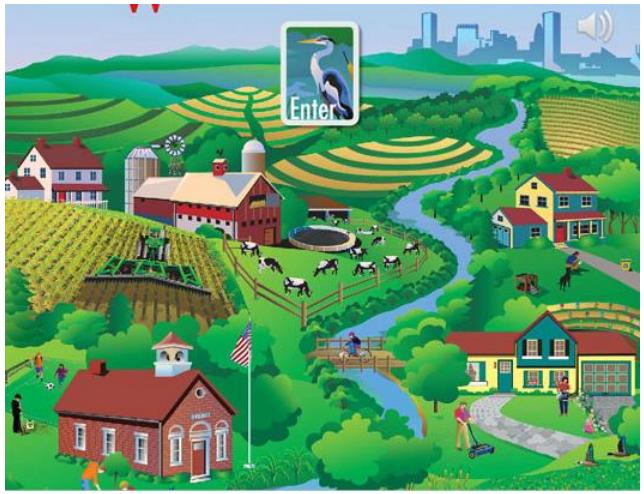
Typical Stream Channel Practices for consideration (not all-inclusive)

- NY NRCS Standard 326 - Clearing and Snagging
- NY NRCS Standard 342 - Critical Area Planting
- NY NRCS Standard 362 - Diversion
- NY NRCS Standard 390 - Riparian Forest Buffer
- NY NRCS Standard 391 - Riparian Herbaceous Buffer
- NY NRCS Standard 393 - Filter Strip
- NY NRCS Standard 412 - Grassed Waterway
- NY NRCS Standard 453 - Land Reclamation Landslide Treatment
- NY NRCS Standard 466 - Land Smoothing
- NY NRCS Standard 468 - Lined Waterway or Outlet
- NY NRCS Standard 490 - Tree/shrub Site Prep
- NY NRCS Standard 500 - Obstruction Removal
- NY NRCS Standard 570 - Stormwater Runoff Control
- NY NRCS Standard 582 - Open Channel
- NY NRCS Standard 587 - Structure for Water Control
- NY NRCS Standard 601 - Vegetative Barrier
- NY NRCS Standard 606 - Subsurface Drainage
- NY NRCS Standard 607 - Surface Drain, Field Ditch
- NY NRCS Standard 608 - Surface Drain, Main or Lateral
- NY NRCS Standard 612 - Tree/Shrub Establishment
- NY NRCS Standard 620 - Underground Outlet
- NY NRCS Standard 638 - Water and Sediment Control Basin

- NY NRCS Standard 644 - Wetland Wildlife Habitat Mgt.
- NY NRCS Standard 646 - Shallow Water Development and Management
- NY NRCS Standard 647 - Early Successional Habitat Development/Mgt.
- NY NRCS Standard 656 - Constructed Wetland
- NY NRCS Standard 657 - Wetland Restoration
- NY NRCS Standard 658 - Wetland Creation
- NY NRCS Standard 659 - Wetland Enhancement
- NY NRCS Standard 666 - Forest Stand Improvement

Stream Corridor Assessment – Upland Impacts

In conducting any risk analysis for a stream corridor, it is important to consider the upland contributions and impacts to those stream corridor components. Both quality and quantity of runoff can be the cause of compromising and ultimate failure of the stream corridor.



Upland Component	Level of Concern (1-4)	Items of Concern	Observations, Evaluation & Recommendation [1] *Planning & design considerations by qualified individual* [2]*Planning & design considerations by qualified engineer*
Land Cover / Use • **Forest** • **Shrub** • **Pasture** • **Crop** • **Livestock** • **Residential** • **Industrial** • **Urban**	1	*Land cover/use primarily vegetative with little potential for pollutants*	- Continue monitoring.
	2	*Land cover/use has some potential for adding pollutants to stream corridor*	- Residential development, cropland or pasture have potential for adding sediment, nutrients or other pollutants. [1]Consider riparian / floodplain width and zoned vegetative cover to check for appropriate filtration values. [1]May need to design and plant appropriate riparian zones and vegetation.
	3	*Land use/cove has potential for adding significant pollutants to*	- Residential, urban and industrial development; cropland or pasture; and livestock concentrations have potential for adding sediment,

		stream corridor. Riparian vegetation filtration value questionable.	nutrients or other pollutants. [1]Consider riparian / floodplain size and zoned vegetative cover to check for appropriate filtration values. [1]May need to design and plant appropriate riparian zones and vegetation.
	4	*Land use/cover is adding pollutants into stream corridor. Riparian vegetation inadequate to filter.*	- Residential, urban and industrial development; cropland or pasture; and livestock concentrations are adding sediment, nutrients or other pollutants. [1]Check riparian / floodplain size and zoned vegetative cover to check for appropriate filtration values. [1]Need to design and plant appropriate riparian zones and vegetation. [2]May need to consider design and implementation of additional filtration practices.
Surface Water Impacts (quantity) • **Road ditch outlet** • **Diversion / Waterway outlet** • **Natural drainage way** • **Stormwater outlet**	1	*Upland water concentrations outlets into stream corridor in sheet flow. Some riparian vegetation compromised*	- Upland water sources out letting into stream corridor. Saturated conditions but no concentrated flows causing erosion. Some limitation/impacts to riparian vegetation. Continued monitoring.
	2	*Upland water concentrations outlet into stream corridor causing channel(s) formation through riparian zone. Some riparian vegetation compromised*	- Concentrated water outlets creating eroded channels through riparian zones. Some stream bank erosion where outlet to stream channel. [2]Consider outlet stabilization and/or distribution where flow enters stream corridor. [2]May need outlet stabilization at stream channel and bank stabilization.
	3	*Multiple upland water concentrations contribute significant water that outlets into stream corridor causing multiple channels through riparian zone. Saturated conditions limit riparian vegetation. Moderate riparian slopes*	- Concentrated water outlets creating eroded channels through riparian zones. Stream bank erosion where outlet to stream channel. Saturated soil limits vegetation. Riparian areas with moderate slopes exhibiting unstable conditions for vegetation. [2]Consider outlet stabilization and/or distribution where flow enters stream corridor. [2]May need to intercept and collect outlets and carry in designed channel to stable outlet to stream. [2]May need outlet stabilization at stream channel and bank stabilization.

	4	*Multiple upland water concentrations contribute significant water that outlets into stream corridor causing multiple channels through riparian zone. Saturated conditions limit riparian vegetation. Severe riparian slopes*	- Concentrated water outlets creating eroded channels through riparian zones and/or saturating steep banks causing bank failure. Stream bank erosion where outlet to stream channel. Saturated soil limits vegetation. Riparian areas with steep slopes exhibiting unstable conditions for vegetation. [2]Consider outlet stabilization and/or distribution where flow enters stream corridor. [2]May need to intercept and collect outlets and carry in designed channel to stable outlet to stream. [2]May need outlet stabilization at stream channel and bank stabilization.

Typical Stream Channel Practices for consideration (not all-inclusive)

- NY NRCS Standard 326 - Clearing and Snagging
- NY NRCS Standard 342 - Critical Area Planting
- NY NRCS Standard 362 - Diversion
- NY NRCS Standard 390 - Riparian Forest Buffer
- NY NRCS Standard 391 - Riparian Herbaceous Buffer
- NY NRCS Standard 393 - Filter Strip
- NY NRCS Standard 412 - Grassed Waterway
- NY NRCS Standard 453 - Land Reclamation Landslide Treatment
- NY NRCS Standard 466 - Land Smoothing
- NY NRCS Standard 468 - Lined Waterway or Outlet
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- NY NRCS Standard 657 - Wetland Restoration
- NY NRCS Standard 658 - Wetland Creation
- NY NRCS Standard 659 - Wetland Enhancement
- NY NRCS Standard 666 - Forest Stand Improvement

Stream Corridor Assessment Summary Report

Farm Name			
Contact Name			
Address			
Phone			
Evaluator			**Phone:**
Date Prepared		**Date Delivered**	**Reach ID**

Worksheet Name and Number	Level of Concern (1-4)	Items of Concern	Evaluation & Recommendations
1. Stream Channel • Bankfull width • Bankfull depth • Floodplain width • Obstructions • Channel Slope • Channel Pattern • Avulsions • Habitat			
2. Stream Banks • Bank height • Bank angle • Bank root density • Bank Soil Stratification	**Left / Right**		

• Bank Materials			
3. Floodplain • Elevation • Width • Obstructions • Invasives			
4. Riparian Zone • Width / Quantity • Cover • Quality • Slope	**Left / Right**		
5. Upland Area • Land cover/use • Surface water impacts	**Left / Right**		

Notes & Comments:

Progressive Planning Components:

Stream Corridor

- NY NRCS Standard 326 - Clearing and Snagging
- NY NRCS Standard 342 - Critical Area Planting
- NY NRCS Standard 362 - Diversion
- NY NRCS Standard 390 - Riparian Forest Buffer
- NY NRCS Standard 391 - Riparian Herbaceous Buffer
- NY NRCS Standard 393 - Filter Strip
- NY NRCS Standard 395 - Stream Habitat Improvement and Management
- NY NRCS Standard 396 - Aquatic Organism Passage
- NY NRCS Standard 410 - Grade Stabilization Structure
- NY NRCS Standard 412 - Grassed Waterway
- NY NRCS Standard 453 - Land Reclamation Landslide Treatment
- NY NRCS Standard 466 - Land Smoothing
- NY NRCS Standard 468 - Lined Waterway or Outlet
- NY NRCS Standard 490 - Tree/shrub Site Prep
- NY NRCS Standard 500 - Obstruction Removal
- NY NRCS Standard 570 - Stormwater Runoff Control
- NY NRCS Standard 578 - Stream Crossing
- NY NRCS Standard 580 - Streambank and Shoreline Protection
- NY NRCS Standard 582 - Open Channel
- NY NRCS Standard 584 - Channel Bed Stabilization
- NY NRCS Standard 587 - Structure for Water Control
- NY NRCS Standard 578 - Crossing Stream
- NY NRCS Standard 601 - Vegetative Barrier
- NY NRCS Standard 606 - Subsurface Drainage
- NY NRCS Standard 607 - Surface Drain, Field Ditch
- NY NRCS Standard 608 - Surface Drain, Main or Lateral
- NY NRCS Standard 612 - Tree/Shrub Establishment
- NY NRCS Standard 620 - Underground Outlet
- NY NRCS Standard 638 - Water and Sediment Control Basin
- NY NRCS Standard 644 - Wetland Wildlife Habitat Mgt.
- NY NRCS Standard 646 - Shallow Water Development and Management
- NY NRCS Standard 647 - Early Successional Habitat Development/Mgt.
- NY NRCS Standard 656 - Constructed wetland
- NY NRCS Standard 657 - Wetland Restoration
- NY NRCS Standard 658 - Wetland Creation
- NY NRCS Standard 659 - Wetland Enhancement
- NY NRCS Standard 666 - Forest Stand Improvement

Minimum factors to be considered

- ✓ Degree of impairment, threat to areas of concern, and level of intervention needed
- ✓ Stream Reach hydrology and hydraulics
- ✓ Estimated/calculated stable cross section (width, depth, cross sectional area, floodplain width) at bankfull
- ✓ Calculated sheer stress at bed and banks
- ✓ Reach valley slope
- ✓ Stream bed longitudinal features, slope and historic pattern
- ✓ Physical barriers to channel and structural obstructions in stream corridor to be protected and limit design
- ✓ Riparian zone(s) slope, width, vegetation, animal access/exclusion
- ✓ Location and appropriate design for stream crossings
- ✓ Source and type of upland surface discharge and appropriate stable outlet
- ✓ Level of survey, design and/or engineering needed for practice(s)
- ✓ Operation and maintenance considerations for selected practice(s)

General References:

1. **Post-Flood Emergency Stream Intervention Training Manual.** NY DEC, 2013

2. **Applied River Morphology**. Wildland Hydrology Consultants, 1996, Dave Rosgen

3. **Stream Visual Assessment Protocol**. USDA-Natural Resources Conservation Service, 1998. National Water and Climate Center Technical Note 99-1

4. **Stream Corridor Restoration – Principles, Processes, and Practices.** Federal Interagency Stream Restoration Work Group, October 1998

5. **Part 654 Stream Restoration Design National Engineering Handbook.** USDA-NRCS, August 2007, Chapter 3

6. **Technical Supplement A - Stream Corridor Inventory and Assessment Techniques**. USDA-NRCS, 210–VI –NEH, 2007

7. **Incised Channels – Morphology, Dynamics and Control.** S.A. Schumm, M.D. Harvey, and C.C. Watson, 1984

8. **Integrated Riparian Evaluation Guide (Levels I, II, and III).** USDA Forest Service, 1992. T. Collis

9. **Preliminary Investigation (PI) for Stream Riparian Areas.** USDA Natural Resources Conservation Service

10. **Procedures for Using the Oregon Stream Habitat Data Sheet.** USDA Natural Resources Conservation Service, 1998. Biology Technical Note No. 12

11. **Rapid Stream Assessment Protocol (RSAT) Field Methods – Appendix A.** J. Galli, Sr., 1996 Department of Environmental Programs, Metropolitan Washington Council of Governments

12. **Riparian Area Management – Greenline Riparian-Wetland Monitoring.** USDI Bureau of Land Management, 1993. TR 1737-8. National Applied Resources Sciences Center

13. **Riparian Area Management – Inventory and Monitoring of Riparian Areas.** USDI Bureau of Land Management, 1989. TR 1737-3. National Applied Resources Sciences Center

14. **Stream Corridor Assessment Survey.** Maryland Department of Natural Resources, 2000. K. Yetman, Watershed Restoration Division, Chesapeake and Coastal Watershed Services

15. **Stream Inventory Handbook – Level I and II.** USDA Forest Service, 1996

16. **Stream*A*Syst – A Tool to Help You Examine Stream Conditions on Your Property.** Oregon State University, Extension Service

17. **New York State Prohibited and Regulated Invasive Plants.** NYS Dept. Environ. Conservation & Department of Ag & Markets, September 10, 2014

18. **A Function-Based Framework for Stream Assessment & Restoration Projects.** EPA 843-K-12-006, May 2012

19. **AEM Tier 2 Worksheet – Stream & Floodplain Management.** NYS Dept. of Ag and Markets, July 2012

20. **Agricultural Environmental Management Information Sheet – Stream and Floodplain Management.** NYS Dept. of Ag and Markets, July 2012

APPENDIX A

How to Use USGS New York Streamstats web tool

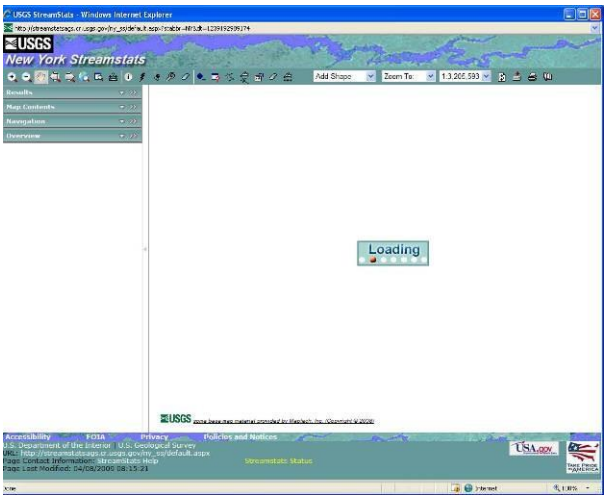
How to use the USGS New York StreamStats Web Tools to Calculate Watershed Area (WA)

Acquiring the watershed area in square miles (area upstream of a location on a stream) is key for using the Regional Tables of Hydraulic Geometry for determining the bankfull dimensions of a channel. Until recently, the time needed to calculate watershed area was a major impediment to using the tables. USGS has recently developed an excellent tool for this calculation and it is openly available on the internet.

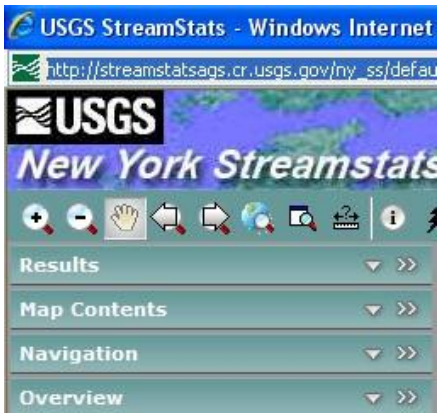
To use this tool you will need high speed internet access. Even with high speed internet access, this program can be slow to load. If the process hangs up in loading mode, get out and reconnect to the site. Patience is needed.

Step 1: Navigate to the USGS StreamStats page for New York. This is the current link to the site: http://streamstatsags.cr.usgs.gov/ny_ss/index.htm

When you connect to the site the program will start up and you will get this "loading" screen.



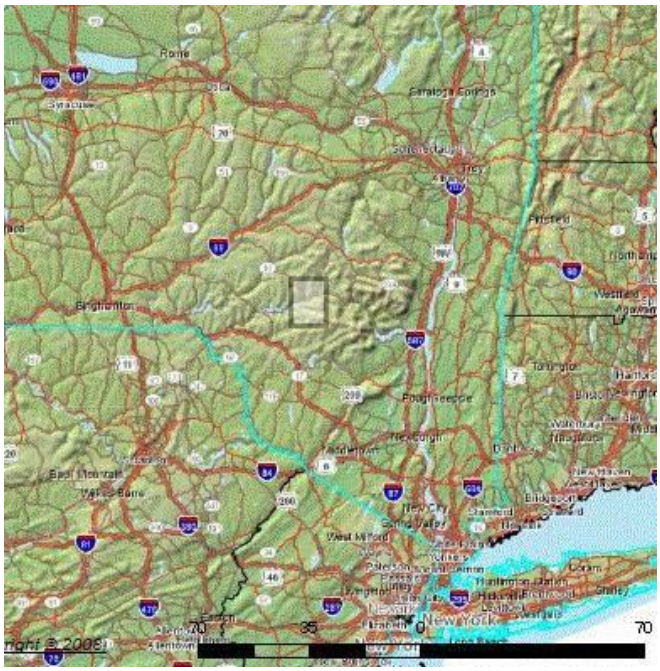
Step 2: Zoom to the area of interest



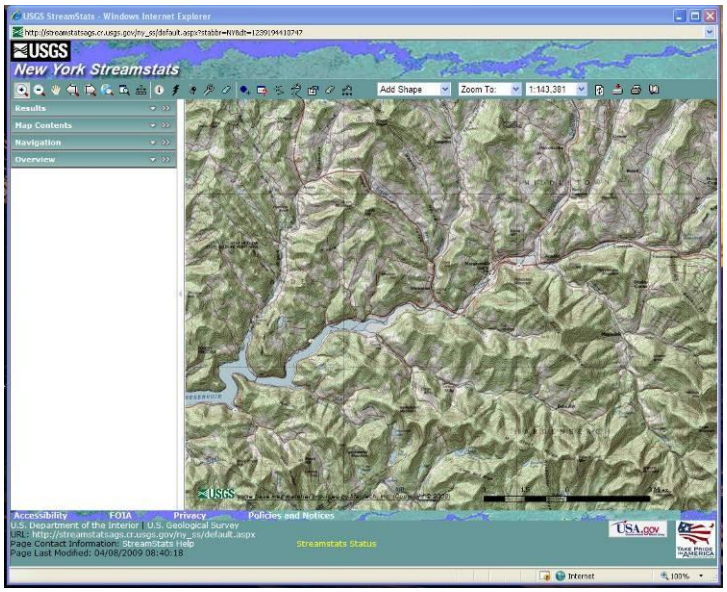
Select the zoom in button in the upper left of the screen. Zoom in is the magnifier glass icon with the plus sign in the center. Single click on the icon will activate this tool.

To zoom in you are going to create a drag box. Hold down the left mouse button on a point on the map to the north and west of the area of interest, and while keeping the button held down, move the mouse to the south and east so that a box is created around the area of interest. Release the left mouse button to complete the box (see the gray area in the image to the left). The program will zoom in to the extent of the box.

This will be your first zoom in extent.

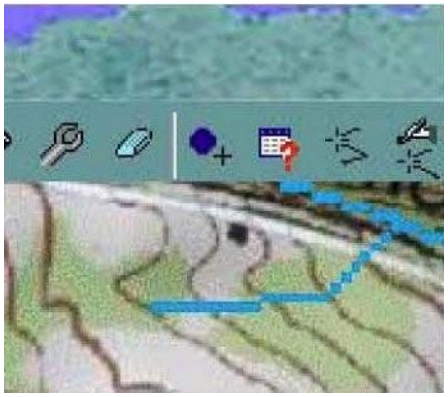


You will probably have to repeat this process until you get fully zoomed into the project site. With the site centered in the map frame you can also use the scale pull down to set the scale to about 1:10,000. This scale will enable you to accurately use the point delineation tool. *Don't zoom in too far as the application may hang up in the loading mode.*

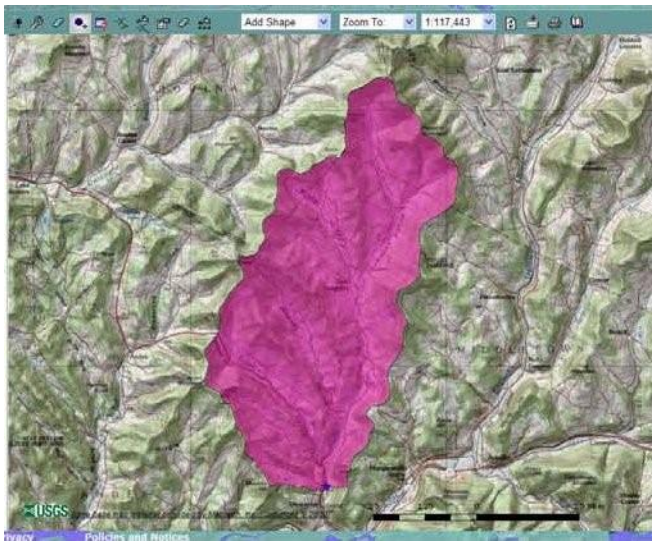


Step 3: Use the Watershed delineation from a point tool to select the location of interest

Use the button with the grey dot and plus sign to select the point on the stream where you wish to calculate the watershed area.

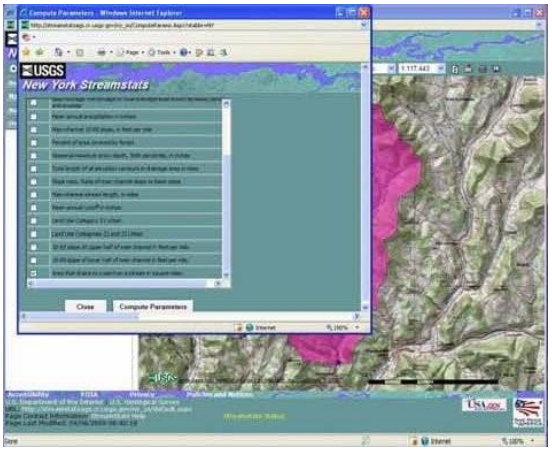


Single click on the icon to make it active. You will note that the stream appears as a series of connected light blue cells (pixels). Select the cell on the stream that you wish to be the lowest point on the watershed. This is also called the "pour point". You will determine the total upstream area contributing flow to this point on the stream. The program will then outline the watershed area contributing flow to this point.



Step 4: Calculate Watershed Area

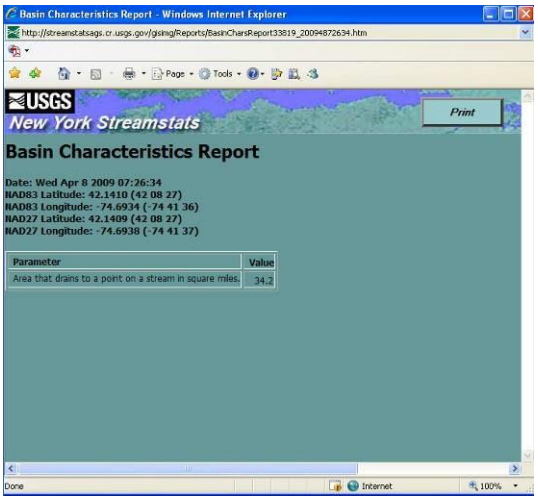
Use the Basin Characteristics icon (rectangular box with red question mark located to the right of the point delineation icon) to generate a report of the basin's characteristics. To use the tool simply single click the icon and a check box will appear on your screen.



The tool will calculate numerous statistics for the basin. To save time, uncheck all of the boxes except the box labeled "Area that drains to a point on a stream in square miles" Then left mouse button click on "Compute Parameters"

The program will compute the area.

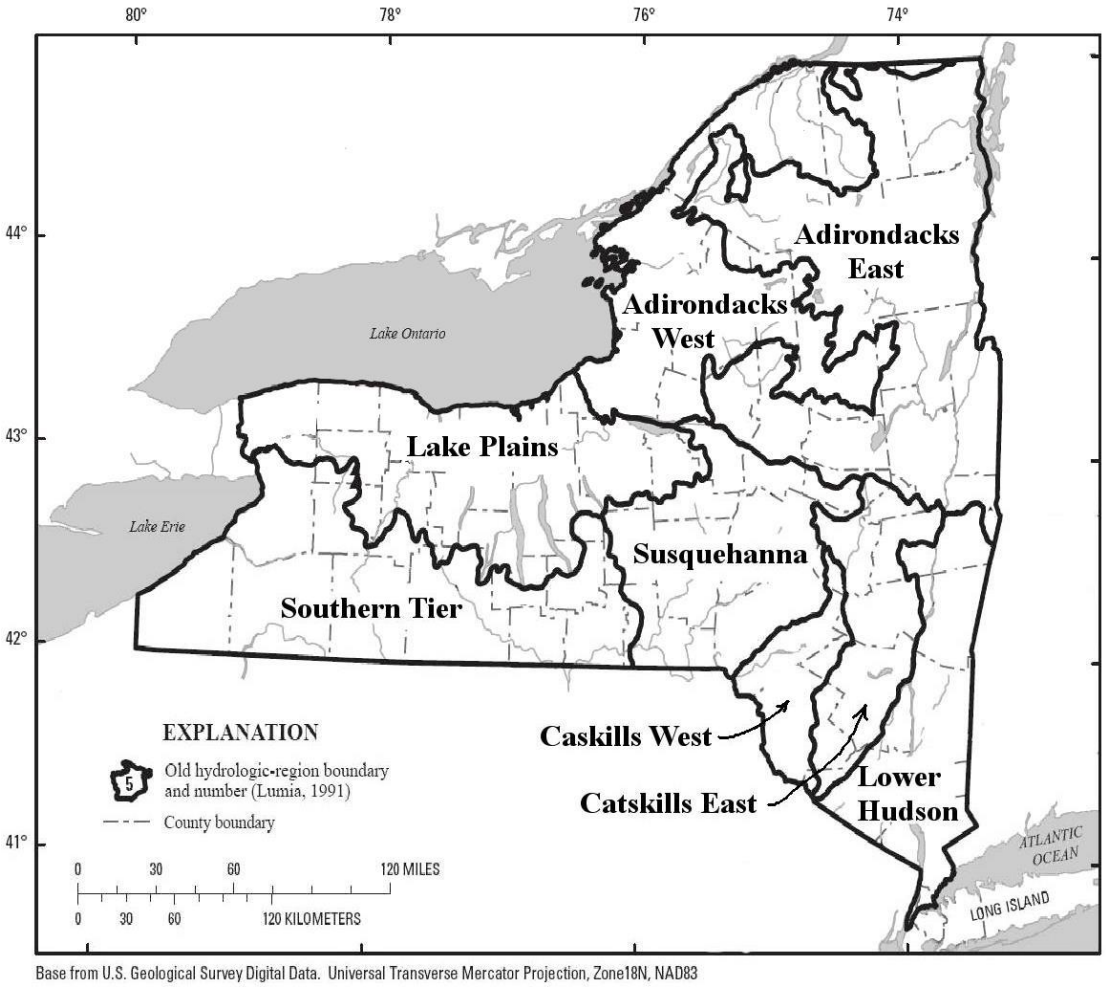
There are numerous help screens available for use with this tool. To access the instructions left click on the top bar (aqua blue area near where the USGS agency block). A window will open with a table of contents located on the left. Click on the User Instructions hyperlink to access the instructions.



Many thanks to Martyn Smith and the GIS staff at USGS Troy office for their efforts to create this excellent application. We especially acknowledge the contributions of Barry Baldigo, Fisheries Biologist of USGS who helped make this application available for our use.

APPENDIX B

Bank-full Hydraulic Geometry Tables for Selected Hydrologic Regions



Hydrologic Regions in New York State

HYDROLOGIC REGION 1 (WESTERN ADIRONDACKS)

Bank-full Hydraulic Geometry vs. Drainage Area for Selected Hydrologic Regions

				Construction Dimensions					
DA (sq. mile)	Bankfull Area (sq. ft)	Bankfull Width (ft)	Bankfull Depth (ft)	channel bank side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1	22.3	21.5	1.1	3:1	1.3	3.9	6.9	21.5	47.3
2.5	42.1	30.0	1.4	3:1	1.7	5.2	9.8	30.0	65.9
5	68.1	38.5	1.8	3:1	2.2	6.5	12.8	38.5	84.7
7.5	90.3	44.6	2.1	3:1	2.5	7.4	14.9	44.6	98.1
10	110.2	49.5	2.3	3:1	2.7	8.1	16.6	49.5	108.9
12.5	128.7	53.6	2.4	3:1	2.9	8.7	18.1	53.6	118.0
15	146.1	57.3	2.6	3:1	3.1	9.2	19.4	57.3	126.1
17.5	162.5	60.6	2.7	3:1	3.2	9.7	20.6	60.6	133.3
e20	178.3	63.6	2.8	3:1	3.4	10.1	21.7	63.6	139.9
22.5	193.5	66.4	3.0	3:1	3.5	10.5	22.7	66.4	146.0
25	208.2	68.9	3.1	3:1	3.6	10.9	23.6	68.9	151.7
27.5	222.4	71.4	3.2	3:1	3.7	11.2	24.5	71.4	157.0
30	236.3	73.6	3.2	3:1	3.8	11.5	25.3	73.6	162.0
32.5	249.8	75.8	3.3	3:1	3.9	11.8	26.1	75.8	166.8
35	263.0	77.9	3.4	3:1	4.0	12.1	26.8	77.9	171.3
37.5	275.9	79.8	3.5	3:1	4.1	12.4	27.5	79.8	175.7
40	288.5	81.7	3.6	3:1	4.2	12.7	28.2	81.7	179.8
42.5	300.9	83.5	3.6	3:1	4.3	12.9	28.9	83.5	183.8
45	313.1	85.3	3.7	3:1	4.4	13.2	29.5	85.3	187.6
47.5	325.0	87.0	3.8	3:1	4.5	13.4	30.1	87.0	191.3
50	336.8	88.6	3.8	3:1	4.5	13.6	30.7	88.6	194.9

HYDROLOGIC REGION 2 (EASTERN ADIRONDACKS)

Bank-full Hydraulic Geometry vs. Drainage Area for Selected Hydrologic Regions

				Construction Dimensions					
DA (sq. mile)	Bankfull Area (sq. ft)	Bankfull Width (ft)	Bankfull Depth (ft)	channel bank side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1	22.3	21.5	1.1	3:1	1.3	3.9	6.9	21.5	47.3
2.5	42.1	30.0	1.4	3:1	1.7	5.2	9.8	30.0	65.9
5	68.1	38.5	1.8	3:1	2.2	6.5	12.8	38.5	84.7
7.5	90.3	44.6	2.1	3:1	2.5	7.4	14.9	44.6	98.1
10	110.2	49.5	2.3	3:1	2.7	8.1	16.6	49.5	108.9
12.5	128.7	53.6	2.4	3:1	2.9	8.7	18.1	53.6	118.0
15	146.1	57.3	2.6	3:1	3.1	9.2	19.4	57.3	126.1
17.5	162.5	60.6	2.7	3:1	3.2	9.7	20.6	60.6	133.3
e20	178.3	63.6	2.8	3:1	3.4	10.1	21.7	63.6	139.9
22.5	193.5	66.4	3.0	3:1	3.5	10.5	22.7	66.4	146.0
25	208.2	68.9	3.1	3:1	3.6	10.9	23.6	68.9	151.7
27.5	222.4	71.4	3.2	3:1	3.7	11.2	24.5	71.4	157.0
30	236.3	73.6	3.2	3:1	3.8	11.5	25.3	73.6	162.0
32.5	249.8	75.8	3.3	3:1	3.9	11.8	26.1	75.8	166.8
35	263.0	77.9	3.4	3:1	4.0	12.1	26.8	77.9	171.3
37.5	275.9	79.8	3.5	3:1	4.1	12.4	27.5	79.8	175.7
40	288.5	81.7	3.6	3:1	4.2	12.7	28.2	81.7	179.8
42.5	300.9	83.5	3.6	3:1	4.3	12.9	28.9	83.5	183.8
45	313.1	85.3	3.7	3:1	4.4	13.2	29.5	85.3	187.6
47.5	325.0	87.0	3.8	3:1	4.5	13.4	30.1	87.0	191.3
50	336.8	88.6	3.8	3:1	4.5	13.6	30.7	88.6	194.9

HYDROLOGIC REGION 3 (LOWER HUDSON)

Bank-full Hydraulic Geometry vs. Drainage Area for Selected Hydrologic Regions

				Construction Dimensions					
DA (sq. mile)	Bankfull Area (sq. ft)	Bankfull Width (ft)	Bankfull Depth (ft)	channel bank side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1	39.8	24.0	1.7	3:1	2.4	7.1	4.9	24.0	52.8
2.5	63.1	31.4	2.0	3:1	2.7	8.2	7.5	31.4	69.0
5	89.4	38.4	2.3	3:1	3.1	9.2	10.0	38.4	84.5
7.5	109.7	43.2	2.5	3:1	3.3	9.8	11.8	43.2	95.1
10	126.7	47.0	2.7	3:1	3.5	10.4	13.1	47.0	103.4
12.5	141.8	50.2	2.8	3:1	3.6	10.8	14.3	50.2	110.4
15	155.4	52.9	2.9	3:1	3.7	11.1	15.3	52.9	116.4
17.5	167.9	55.4	3.0	3:1	3.8	11.5	16.2	55.4	121.8
e20	179.6	57.6	3.1	3:1	3.9	11.7	17.0	57.6	126.6
22.5	190.6	59.6	3.2	3:1	4.0	12.0	17.8	59.6	131.1
25	200.9	61.4	3.3	3:1	4.1	12.2	18.5	61.4	135.2
27.5	210.8	63.2	3.3	3:1	4.1	12.4	19.1	63.2	139.0
30	220.2	64.8	3.4	3:1	4.2	12.6	19.8	64.8	142.5
32.5	229.3	66.3	3.4	3:1	4.3	12.8	20.3	66.3	145.9
35	238.0	67.8	3.5	3:1	4.3	13.0	20.9	67.8	149.1
37.5	246.4	69.2	3.6	3:1	4.4	13.2	21.4	69.2	152.1
40	254.5	70.5	3.6	3:1	4.4	13.3	21.9	70.5	155.0
42.5	262.4	71.7	3.6	3:1	4.5	13.5	22.4	71.7	157.8
45	270.1	72.9	3.7	3:1	4.5	13.6	22.8	72.9	160.5
47.5	277.5	74.1	3.7	3:1	4.6	13.8	23.3	74.1	163.0
50	284.8	75.2	3.8	3:1	4.6	13.9	23.7	75.2	165.5

HYDROLOGIC REGION 4 (CATSKILLS EAST)

Bank-full Hydraulic Geometry vs. Drainage Area for Selected Hydrologic Regions

				Construction Dimensions					
DA (sq. mile)	Bankfull Area (sq. ft)	Bankfull Width (ft)	Bankfull Depth (ft)	channel bank side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1	17.9	17.1	1.1	3:1	1.4	4.3	4.3	17.1	37.6
2.5	36.5	26.1	1.4	3:1	1.8	5.4	7.6	26.1	57.3
5	62.5	35.9	1.8	3:1	2.2	6.5	11.4	35.9	78.9
7.5	85.7	43.2	2.0	3:1	2.4	7.3	14.3	43.2	95.0
10	107.1	49.3	2.2	3:1	2.6	7.9	16.8	49.3	108.5
12.5	127.4	54.6	2.4	3:1	2.8	8.4	18.9	54.6	120.2
15	146.8	59.4	2.5	3:1	2.9	8.8	20.9	59.4	130.7
17.5	165.5	63.8	2.6	3:1	3.1	9.2	22.7	63.8	140.4
e20	183.5	67.8	2.7	3:1	3.2	9.6	24.3	67.8	149.2
22.5	201.1	71.6	2.8	3:1	3.3	9.9	25.9	71.6	157.6
25	218.3	75.2	2.9	3:1	3.4	10.2	27.4	75.2	165.4
27.5	235.1	78.5	3.0	3:1	3.5	10.5	28.8	78.5	172.8
30	251.5	81.7	3.1	3:1	3.6	10.8	30.1	81.7	179.8
32.5	267.7	84.8	3.2	3:1	3.7	11.0	31.4	84.8	186.6
35	283.5	87.8	3.3	3:1	3.7	11.2	32.6	87.8	193.1
37.5	299.1	90.6	3.3	3:1	3.8	11.5	33.8	90.6	199.3
40	314.5	93.3	3.4	3:1	3.9	11.7	35.0	93.3	205.3
42.5	329.7	96.0	3.5	3:1	4.0	11.9	36.1	96.0	211.1
45	344.7	98.5	3.5	3:1	4.0	12.1	37.2	98.5	216.7
47.5	359.5	101.0	3.6	3:1	4.1	12.3	38.2	101.0	222.2
50	374.1	103.4	3.7	3:1	4.2	12.5	39.2	103.4	227.5

HYDROLOGIC REGION 4a (CATSKILLS WEST)

Bank-full Hydraulic Geometry vs. Drainage Area for Selected Hydrologic Regions

				Construction Dimensions					
DA (sq. mile)	Bankfull Area (sq. ft)	Bankfull Width (ft)	Bankfull Depth (ft)	channel bank side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1	7.2	9.1	0.8	2:1	1.0	2.1	2.5	9.1	20.0
2.5	16.3	15.0	1.1	3:1	1.6	4.8	2.7	15.0	33.0
5	30.4	21.9	1.4	3:1	1.9	5.6	5.3	21.9	48.1
7.5	43.6	27.3	1.6	3:1	2.1	6.2	7.4	27.3	60.0
10	56.4	31.9	1.8	3:1	2.2	6.7	9.2	31.9	70.2
12.5	68.9	36.0	1.9	3:1	2.4	7.2	10.9	36.0	79.3
15	81.1	39.8	2.0	3:1	2.5	7.5	12.4	39.8	87.6
17.5	93.0	43.3	2.2	3:1	2.6	7.9	13.8	43.3	95.3
e20	104.8	46.6	2.3	3:1	2.7	8.2	15.1	46.6	102.5
22.5	116.5	49.7	2.3	3:1	2.8	8.5	16.3	49.7	109.2
25	128.0	52.6	2.4	3:1	2.9	8.8	17.5	52.6	115.7
27.5	139.3	55.4	2.5	3:1	3.0	9.0	18.7	55.4	121.9
30	150.6	58.1	2.6	3:1	3.1	9.3	19.8	58.1	127.8
32.5	161.8	60.7	2.7	3:1	3.2	9.5	20.8	60.7	133.5
35	172.9	63.2	2.7	3:1	3.2	9.7	21.9	63.2	139.0
37.5	183.9	65.6	2.8	3:1	3.3	9.9	22.9	65.6	144.3
40	194.8	67.9	2.9	3:1	3.4	10.1	23.8	67.9	149.5
42.5	205.6	70.2	2.9	3:1	3.4	10.3	24.8	70.2	154.5
45	216.4	72.5	3.0	3:1	3.5	10.5	25.7	72.5	159.4
47.5	227.1	74.6	3.1	3:1	3.6	10.7	26.6	74.6	164.2
50	237.8	76.7	3.1	3:1	3.6	10.9	27.5	76.7	168.8

HYDROLOGIC REGION 5 (SUSQUEHANNA)

Bank-full Hydraulic Geometry vs. Drainage Area for Selected Hydrologic Regions

				Construction Dimensions					
DA (sq. mile)	Bankfull Area (sq. ft)	Bankfull Width (ft)	Bankfull Depth (ft)	channel bank side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1.0	10.8	13.5	0.8	3:1	1.1	3.2	3.5	13.5	29.7
2.5	23.0	20.4	1.2	3:1	1.5	4.4	5.8	20.4	44.8
5.0	40.6	27.8	1.5	3:1	1.9	5.6	8.3	27.8	61.2
7.5	56.7	33.4	1.7	3:1	2.2	6.5	10.2	33.4	73.4
10.0	71.8	38.0	1.9	3:1	2.4	7.2	11.8	38.0	83.5
12.5	86.3	42.0	2.1	3:1	2.6	7.7	13.2	42.0	92.3
15.0	100.3	45.5	2.3	3:1	2.7	8.2	14.5	45.5	100.2
17.5	113.9	48.8	2.4	3:1	2.9	8.7	15.7	48.8	107.4
20.0	127.1	51.8	2.5	3:1	3.0	9.1	16.8	51.8	114.0
22.5	140.0	54.6	2.6	3:1	3.2	9.5	17.8	54.6	120.2
25.0	152.7	57.3	2.7	3:1	3.3	9.9	18.8	57.3	126.0
27.5	165.2	59.8	2.8	3:1	3.4	10.2	19.7	59.8	131.5
30.0	177.5	62.2	2.9	3:1	3.5	10.5	20.6	62.2	136.8
32.5	189.5	64.4	3.0	3:1	3.6	10.8	21.4	64.4	141.8
35.0	201.5	66.6	3.1	3:1	3.7	11.1	22.2	66.6	146.6
37.5	213.2	68.7	3.2	3:1	3.8	11.4	23.0	68.7	151.2
40.0	224.9	70.7	3.2	3:1	3.9	11.7	23.7	70.7	155.6
42.5	236.4	72.7	3.3	3:1	4.0	11.9	24.4	72.7	159.9
45.0	247.8	74.6	3.4	3:1	4.1	12.2	25.1	74.6	164.1
47.5	259.0	76.4	3.5	3:1	4.1	12.4	25.8	76.4	168.1
50.0	270.2	78.2	3.5	3:1	4.2	12.6	26.5	78.2	172.0

HYDROLOGIC REGION 6 (SOUTHERN TIER)

Bank-full Hydraulic Geometry vs. Drainage Area for Selected Hydrologic Regions

				Construction Dimensions					
DA (sq. mile)	Bankfull Area (sq. ft)	Bankfull Width (ft)	Bankfull Depth (ft)	channel bank side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1	17.6	16.9	1.0	3:1	1.4	4.1	4.3	16.9	37.2
2.5	32.3	24.8	1.3	3:1	1.6	4.8	7.6	24.8	54.6
5	51.1	33.2	1.5	3:1	1.8	5.5	11.0	33.2	73.0
7.5	66.8	39.3	1.7	3:1	2.0	6.0	13.6	39.3	86.5
10	80.8	44.3	1.8	3:1	2.1	6.4	15.8	44.3	97.6
12.5	93.7	48.7	1.9	3:1	2.2	6.7	17.6	48.7	107.1
15	105.7	52.6	2.0	3:1	2.3	7.0	19.3	52.6	115.6
17.5	117.1	56.1	2.1	3:1	2.4	7.2	20.8	56.1	123.4
e20	127.9	59.3	2.2	3:1	2.5	7.4	22.2	59.3	130.4
22.5	138.2	62.3	2.2	3:1	2.5	7.6	23.6	62.3	137.0
25	148.2	65.1	2.3	3:1	2.6	7.8	24.8	65.1	143.2
27.5	157.9	67.8	2.3	3:1	2.6	7.9	25.9	67.8	149.1
30	167.3	70.3	2.4	3:1	2.7	8.1	27.1	70.3	154.6
32.5	176.4	72.7	2.4	3:1	2.7	8.2	28.1	72.7	159.9
35	185.2	75.0	2.5	3:1	2.8	8.4	29.1	75.0	164.9
37.5	193.9	77.2	2.5	3:1	2.8	8.5	30.1	77.2	169.8
40	202.3	79.3	2.6	3:1	2.9	8.6	31.0	79.3	174.4
42.5	210.6	81.3	2.6	3:1	2.9	8.7	31.9	81.3	178.9
45	218.7	83.3	2.6	3:1	2.9	8.8	32.8	83.3	183.2
47.5	226.7	85.2	2.7	3:1	3.0	8.9	33.7	85.2	187.4
50	234.5	87.0	2.7	3:1	3.0	9.0	34.5	87.0	191.5

HYDROLOGIC REGION 7 (LAKE PLAINS)

Bank-full Hydraulic Geometry vs. Drainage Area for Selected Hydrologic Regions

				Construction Dimensions					
DA (sq. mile)	Bankfull Area (sq. ft)	Bankfull Width (ft)	Bankfull Depth (ft)	channel bank side slope	D (ft)	3D (ft)	X (ft)	TW (ft)	Min. FP (ft)
1	15.9	10.8	1.5	2:1	2.3*	4.6*	1.3*	10.8	23.8
2.5	29.0	16.4	1.8	2:1	3.2*	6.4*	1.7*	16.4	36.1
5	45.7	22.6	2.0	2:1	3.4*	6.8*	3.3*	22.6	49.7
7.5	59.6	27.2	2.2	3:1	3.5*	10.2*	3.7*	27.2	59.8
10	72.0	31.0	2.3	3:1	3.5	10.6	4.9	31.0	68.2
12.5	83.4	34.3	2.4	3:1	3.5	10.5	6.7	34.3	75.5
15	94.0	37.3	2.5	3:1	3.5	10.5	8.1	37.3	82.1
17.5	104.0	40.1	2.6	3:1	3.5	10.6	9.4	40.1	88.1
20	113.5	42.6	2.7	3:1	3.6	10.7	10.6	42.6	93.7
22.5	122.6	44.9	2.7	3:1	3.6	10.8	11.7	44.9	98.9
25	131.4	47.2	2.8	3:1	3.6	10.9	12.7	47.2	103.8
27.5	139.8	49.3	2.8	3:1	3.7	11.0	13.7	49.3	108.4
30	148.0	51.3	2.9	3:1	3.7	11.1	14.6	51.3	112.8
32.5	156.0	53.2	2.9	3:1	3.7	11.2	15.4	53.2	117.0
35	163.8	55.0	3.0	3:1	3.7	11.2	16.3	55.0	121.1
37.5	171.4	56.8	3.0	3:1	3.8	11.3	17.1	56.8	125.0
40	178.8	58.5	3.1	3:1	3.8	11.4	17.8	58.5	128.7
42.5	186.0	60.1	3.1	3:1	3.8	11.5	18.6	60.1	132.3
45	193.2	61.7	3.1	3:1	3.9	11.6	19.3	61.7	135.8
47.5	200.1	63.3	3.2	3:1	3.9	11.7	20.0	63.3	139.2
50	207.0	64.8	3.2	3:1	3.9	11.7	20.7	64.8	142.6

APPENDIX C

GLOSSARY

100-year flood – A large, but infrequent, flood event that has a 1% chance of occurring in any given year (occurs, on average, once every 100 years).

100-year floodplain – Areas adjacent to a stream or river that are subject to flooding during a storm event that has a 1% likelihood of occurrence in any given year (occurs, on average, once every 100 years). Most municipalities require a floodplain development permit for new development within areas mapped as the 100-year floodplain.

aggradation (aggrading) – The general and progressive buildup of a streambed due to sediment deposition. Aggradation occurs when the channel is supplied with more sediment load than it is capable of transporting.

alluvial fan – A fan-shaped deposit of material at the place where a stream issues from a steep valley onto a plain or broad valley with a low slope.

avulsion – Where the stream is no longer in its original channel.

bankfull – Bankfull flow is the channel forming discharge**.** *"The bankfull stage corresponds to the discharge at which the channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing the work that results in the average morphologic characteristics of the channel." (Dunne and Leopold, 1978)*

bankfull depth – The measurement of stream depth at bankfull elevation.

bankfull width – The measurement of stream width at bankfull elevation.

base flow – The portion of stream flow that comes from groundwater seepage into the channel; constitutes the natural dry weather flow in the stream.

bedload – Sediment that is transported in a stream by rolling, sliding, or jumping on or near the streambed.

berm – A mound of earth or other materials, usually linear, constructed along a stream, road or other area. Berms are often constructed to protect land from flooding or eroding, or to control water drainage. Some berms are constructed as a byproduct of a stream management practice whereby streambed sediment is pushed out of the channel and mounded on (and along the length of) the streambank – these berms are frequently breached by the stream and

should not be relied on for flood control. Streamside berms often interfere with other stream processes such as floodplain function, and can exacerbate flood-related erosion or stream instability.

braided channel (braided stream) – A stream that has flow in several channels, which successively meet and divide. Braiding occurs when sediment is deposited within the channel area.

buffer – See riparian buffer.

channel – A natural or artificial watercourse with a definite bed and banks that conveys continuously or periodically flowing water.

channelization – Straightening or deepening of a natural stream channel or otherwise disconnecting a stream from its natural floodplain.

check dam – A low dam constructed across a channel to decrease the stream flow velocity (by reducing the channel gradient), minimize channel scour, and promote sediment deposition.

cluster development – The use of a site design that incorporates open space into a development site. The open space can be used for recreation or preserved as naturally vegetated land.

cross section (steam) – Is the measurement of the area contained in stream channel at bankfull elevation.

culvert – A pipe or closed conduit for the free passage of surface drainage water. Culverts are typically used by highway departments to control water running along and under the road, and to provide a crossing point for water from roadside drainage ditches to the stream, as well as for routing tributary streams under the roads. Landowners also use culverts to route roadside drainage ditch water under their driveways.

debris – Floating or submerged material, such as logs, vegetation, or trash, transported by a stream.

degradation (degrading or down cutting) – The general and progressive lowering of a channel due to downward erosion of the streambed over a relatively long channel length. A degrading stream may have high, unstable banks and be disconnected from its floodplain.

deposition – The accumulation or laying down of matter by a natural process.

dike (levee) – An embankment to confine or control water, often built along the banks of a river or stream to contain over bank flow and prevent inundation of floodplain development.

discharge (stream flow) – The rate of flow passing a fixed point in a stream, expressed as a volume of water per unit time, usually cubic feet per second (cfs).

dynamic equilibrium – A stream system that has achieved a balance in transporting its water and sediment loads over time without aggrading (building up), degrading (cutting down), or migrating laterally (eroding its banks and changing course). A stream in dynamic equilibrium resists flood damage, resists erosion, and provides beneficial aquatic habitat.

entrenchment – A measurement of a stream's relationship with its valley and surrounding land forms and can be defined as a vertical containment of the stream.

embeddedness – The degree to which an object is buried in steam sediment. Embeddedness is generally defined as the degree to which sand and silt (fines) surround or cover the larger gravel, cobble and boulder-sized material in riffle areas.

erosion – The detachment and movement of soil or rock fragments by water, wind, ice, or other geological agents. In streams, erosion is a natural process that can be accelerated by poor stream management practices.

floodplain (see also 100-year floodplain) – Any flat or nearly flat lowland bordering a stream that is periodically inundated by water during floods. The floodplain acts to reduce the velocity of floodwaters, increase infiltration, reduce streambank erosion, and encourage deposition of sediment. Vegetation on floodplains greatly improves these functions.

floodway – That portion of the floodplain required to store and discharge floodwaters without causing potentially damaging increases in flood heights and velocities.

grade (gradient) – The slope of a stream, measured along the length of the stream channel.

grade stabilization (grade control) – The use of hard structures in a channel to prevent headcutting or degradation (lowering of the channel grade).

gravel bar (see also point bar) – An elevated deposit of gravel located within a stream channel and lacking permanent vegetation.

groundwater – Water beneath the earth's surface, found at varying depths, where every space between soil or rock particles is filled with water.

headcut – A marked change in the slope of a streambed, as in a "step" or waterfall, that is unprotected or of greater height than the stream can maintain. Increased potential for erosion

at this location causes the headcut to move upstream, eventually reaching an equilibrium slope.

hydraulics – The applied science that deals with the behavior and flow of liquids. When used in reference to a stream, hydraulics refers to the processes by which water flows within the channel.

hydrologic cycle – The global circulation of water in the air, on land, and in the sea.

hydrology – The science that deals with the occurrence and movement of water in the atmosphere, upon the surface, and beneath the land areas of the earth. In reference to a particular stream, the hydrology is the amount and timing of water flow into the stream.

impervious – Those surfaces that cannot effectively infiltrate rainfall and snow melt (e.g. rooftops, pavement, sidewalks, driveways, etc.). Impervious cover causes an increase in the volume of surface runoff.

incised stream or incision – A stream in which degradation (erosion of the streambed) has caused deepening of the channel to a point where the stream is no longer connected to its floodplain.

infiltration – The process of water percolating into the soil.

instability (unstable) – An imbalance in a stream's capacity to transport sediment and maintain its channel shape, pattern, and profile.

intermittent stream – A stream or portion of a stream that flows in a well-defined channel during the wet seasons of the year, but not the entire year.

invasive plant – A species of plant that is not native to a region and has the ability to compete with and replace native species in natural habitats. Invasive plants present a threat when they alter the ecology of a native plant community.

kinetic energy – Energy of motion. The kinetic energy of a stream is equal to one-half the mass of water, times the square of the velocity at which the water is moving.

levee – See dike.

longitudinal dimensions – morphological adjustments that a stream makes to reflect conditions in a specific valley. These may include slope, sinuosity, steps, pools, riffles, etc.

meander – Refers to both the winding pattern of a stream ("meander bends") and to the process by which a stream curves as it passes through the landscape (a "meandering stream").

A meandering stream channel generally exhibits a characteristic process of bank erosion and point bar deposition associated with systematically shifting meanders.

National Flood Insurance Program – Federal program that makes available subsidized flood insurance in those jurisdictions within which the local government regulates development in identified flood hazard areas. Local regulations must be at least as stringent as federal standards.

natural stream design – A stream restoration method that uses data collection, modeling techniques, and stable or reference channels in the design of ideal channel configurations.

nutrients – Essential chemicals, including nitrogen and phosphorous, that are needed by plants and animals for growth. Excessive amounts of nutrients can lead to degradation of water quality and algal blooms.

pattern (of a stream channel) – The shape of a stream as seen from above or on a map.

planform - The view of the stream that focuses on the path that the stream follows within its valley

peak flow – The maximum stream flow from a given storm condition at a specific location.

point bar – A stream deposition feature usually found on the inside of a bend; consists of sand, gravel, or other sediment and lacks permanent vegetation.

pool – A stream feature in which water is deeper and slower than in adjacent areas. Pools typically alternate with riffles along the length of a stream channel.

potential energy – Energy that results from gravitational pull on an object. The potential energy in a stream is equal to the weight of water times the elevation of a specified point relative to the mouth of the stream.

profile – The shape of a stream drawn along the length of its channel to show both the streambed and the water surface.

riffle – A stream feature in which water flow is shallow and rapid compared to adjacent areas. Riffles typically alternate with pools along the length of a stream channel.

riparian – The area of land along a stream channel and within the valley walls where vegetation and other land uses directly influence stream processes.

riparian buffer (or stream buffer) – Zone of variable width along the banks a stream that provides a protective natural area along the stream corridor.

riparian rights – The rights of an owner whose land abuts water.

riprap – Broken rock placed on a streambank or other surface to protect against scouring and erosion.

rock vanes – Rock structures built below the water level to control the direction of flow within a stream.

root wad – Streambank stabilization technique in which a one or more tree trunk is embedded in the streambank with the root mass facing the flow to dissipate energy.

roughness (hydraulic roughness) – In a stream, roughness refers to the frictional resistance to flow.

runoff – See surface runoff.

scour – The process by which the erosive action of flowing water removes material from the bed or banks of a stream.

sediment – Solid material, both mineral and organic, that is being transported or has been moved by air, water, gravity, or ice from its site of origin (streambank or hillside) to the place of deposition (in the stream channel or on the floodplain).

sheer stress – Measure of the force that makes the sediment move.

skidding – Short-distance dragging of logs or felled trees from the stump to a point of loading or processing.

skid trail – Rough travel ways for logging machinery. Logs are often dragged over the skid trail surface.

stable stream (see also dynamic equilibrium) –The tendency of a stream to maintain its cross-section, plan form and profile geometry over time, effectively transporting its water and sediment supply without aggrading (building up), degrading (down-cutting), or adjusting laterally (eroding its banks). (Rosgen, 1996).

storm flow – The portion of stream flow that comes from surface runoff and constitutes the main component of high stream flows during rainy weather.

storm hydrograph – A graph of stream discharge against time for a single storm event.

stormwater – Surface runoff; generally referred to as stormwater when the surface runoff is from developed areas.

stormwater management – The use of structural or non-structural practices that are designed to reduce stormwater runoff and mitigate its adverse impacts on property, natural resources, and the environment. Structural practices involve construction of systems that provide short-term storage and treatment of stormwater runoff. Non-structural techniques use natural measures to reduce pollution levels, do not require extensive construction efforts, and/or promote pollutant reduction by eliminating the pollutant source.

stream – A natural watercourse with a definite bed and banks that conducts continuously or periodically flowing water.

streambed (bed) – The bottom of a stream channel bounded by banks.

streambank (bank) – The sides of a stream channel between which the flow is normally confined.

stream corridor – The stream components that act in concert to provide the functions needed to manage normal and flood flow events and transport both sediment and water in a stable manner. It includes the stream channel, the stream banks, the floodplain, the riparian areas and contributing upland areas.

stream restoration – The process of converting an unstable, altered, or degraded stream corridor, including the adjacent riparian zone and flood-prone areas to its natural stable condition considering recent and future watershed conditions.

stream stabilization – The in-place stabilization of a severely eroding streambank and/or streambed. Although stabilization techniques address the immediate problem, they may not restore the system's dynamic equilibrium.

surface runoff (see also stormwater) – The portion of precipitation or snow melt that reaches the stream channel by flowing over the land surface.

thalweg –

transpiration – The process by which water taken up by plants is returned to the atmosphere by evaporation from leaves.

"triage"(approach to stream assessment) – A process for moving from recognition of a stream problem to selection of an appropriate intervention, based on a relatively quick assessment of the problem, the causes, and the urgency of the situation.

tributary – A stream that feeds into another stream; usually the tributary is smaller in size than the main stream.

velocity – In streams, the speed at which water is flowing, usually measured in feet per second.

water bar – A shallow trench or diversion ditch that diverts surface runoff from roads, fire breaks, or skid trails into a dispersion area. Water bars are used to disperse flow, minimize erosion, and enhance conditions for re-vegetation.

watershed – A unit of land on which all the water that falls (or emanates from springs) collects by gravity and runs off via a common outlet (stream).

wetland – An area that is permanently or periodically saturated by water with vegetation adapted for life under those soil conditions, such as swamps, bogs, fens, and marshes.