Management Unit 5

Greene County - Town of Hunter
Cross Section 90 to Cross Section 107

Management Unit Description

This management unit begins at the private bridge at Cross Section 90 and continues approximately 3,143 ft. to Cross Section 107. The drainage area ranges from 7.5 mi^2 at the top of the management unit to 8.2 mi^2 at the bottom of the unit. The valley slope is 3.2% and water surface slope is 2.6%.

Generally, stream conditions in this management unit show signs of stress. The unit is laterally controlled for much of its length by the valley form, with a very constricted stream corridor. Residential encroachment and historic channel and infrastructure management appear to have exacerbated naturally high entrenchment conditions, and set the stage for incision. Management efforts between cross-sections 97 and 101 should focus on grade control and bank stabilization using *natural channel design* principles. Overwide reaches should be addressed with vegetated bank treatments, and where appropriate, in-channel plantings to encourage narrowing of the active channel. Replacement or maintenance of the private bridge at the downstream end of the unit should reflect the *morphological* and sediment transport requirements of the unit. GCSWCD will provide technical assistance for bridge replacement and maintenance in the unit. Although abundant for brown and rainbow trout, habitat is generally of low quality.

Summary of Recommendations Management Unit 5	
Intervention Level	Full Restoration/Assisted Self-Recovery
Stream Morphology	Address entrenchment and grade control between cross-sections 97 and 101 (BEMS# 11-13) Address sediment transport issues at private stream crossing
Riparian Vegetation	Riparian plantings at the four identified planting sites (PS #21-24) Encourage narrowing and deepening of channel through plantings at identified planting site (PS #22)
Infrastructure	Replacement of private road crossing at end of management unit with a geomorphically appropriate bridge design
Aquatic Habitat	None
Flood Related Threats	Resurvey National Flood Insurance Program (NFIP) maps to more accurately reflect the active stream channel Stabilize banks between cross-sections 97 and 101 as part of natural channel restoration (BEMS# 11-13)
Water Quality	None
Further Assessment	Ongoing monitoring of bank erosion monitoring sites #11,12,13 Monitor clay exposures in the management unit

Historic Conditions

The F.W.Beers 1867 Atlas of Greene County shows a cooperage, or barrel making operation, in this management unit.

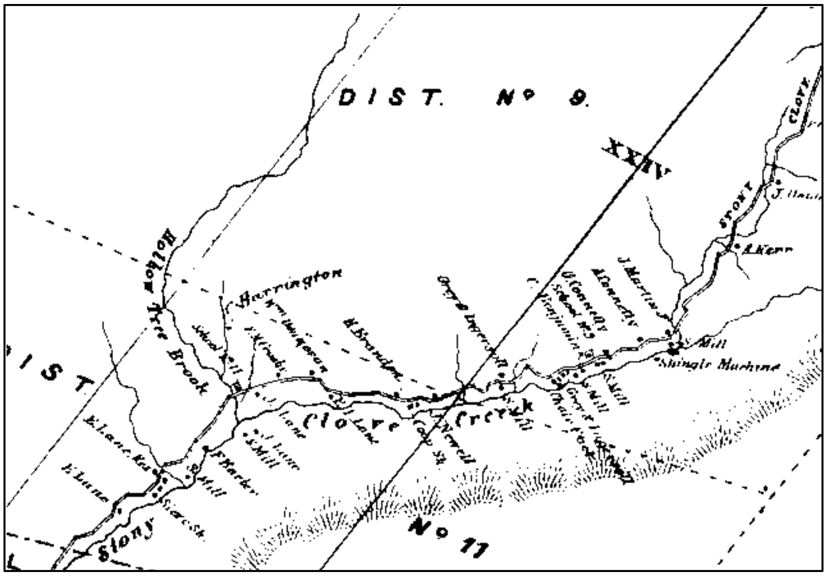


Figure 2 Excerpt from F.W. Beers 1867 Atlas of Greene County

The valley floor was substantially cleared of hemlock stands by the late 1800s, and much of the remaining forest cover by the early decades of the 20th Century. Such deforestation likely led to gullying of small streams, and a considerable sediment load delivered into Stony Clove Creek from its tributaries.

Figure 3 View from railroad line, across Stony Clove Creek and NYS Route 214 in the vicinity of Management Unit 5 - Courtesy of the Gale Collection

Historical stream channel alignments indicate that most of the stream channel within this management unit has remained laterally stable (Fig. 4). As revealed by this 1959 aerial photograph, the stream channel downstream from the Wright Road bridge was at one time split into two channels. The stream rejoined into one channel approximately 400 ft. downstream. This split does not appear in the next available aerial photographs taken in 1980.

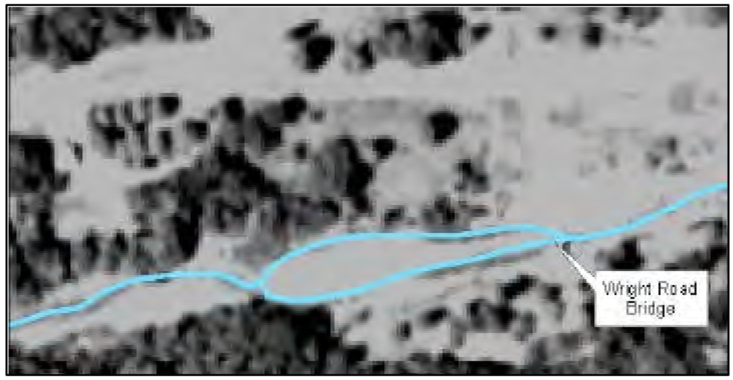


Figure 4 - 1959 aerial photograph with stream alignment

There is, however, evidence of historical and ongoing vertical instability in the unit. According to available NYS DEC records there have been nine stream disturbance permits issued in this management unit area. Three of these permits were issued after the 1996 flood event. A permit was issued to Sheldon Awand, to replace the rip-rap, on his property on the right bank, just upstream from the Wright Rd. bridge (Inset C). Across the Stony Clove Creek on the left bank, Dianne Martin was issued a permit to install rip-rap on an eroded stream bank and redistribute gravel to restore stream flows to the pre-flood channel. The third permit was issued to Anne Mullen-O'Kelly, to make repairs and remove gravel that accumulated upstream from the bridge at the end of the management unit (Inset A).

The bridge at the end of the management unit has been damaged repeatedly by high flow events. In addition to1996 flood event, permits to repair this bridge were also issued in 1984 (2), 1995, 1997, and 1999 (2).

Stream Channel and Floodplain Current Conditions

Revetment, Berms and Erosion

The 2001 stream feature inventory revealed that 7% (443 ft.) of the stream banks exhibited signs of active erosion along 3,143 ft. of total channel length (Fig. 1). Revetment has been installed on 14% (847 ft.) of the stream banks. A berm has been created on 7% (410 ft.) of the stream banks.

Stream Morphology

The following description of stream morphology references insets in the foldout Figure 29. "Left" and "right" references are oriented looking downstream, photographs are also oriented looking downstream unless otherwise noted. Italicized terms are defined in the glossary. This characterization is the result of a survey conducted in 2001.

Stream morphology, or shape (i.e., slope, width and depth) changes frequently in this unit, creating small reaches with differing morphologic characteristics, which are classified as different *stream types* (See Section 3.1 for stream type descriptions).

The unit is laterally controlled for much of its length by the valley form, with a very constricted stream corridor. This confinement, combined with high channel gradients, has led to channel incision and accompanying bank erosion throughout much of this management unit. At the downstream end of the unit, a private stream crossing presents unique sediment transport issues.

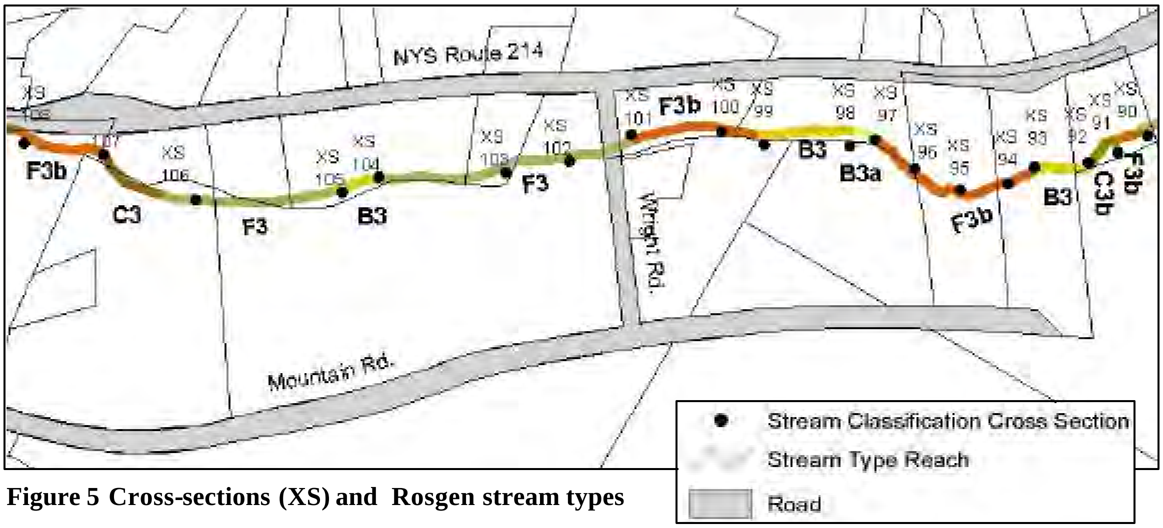


Figure 5 Cross-sections (XS) and Rosgen stream types

Management unit #5 begins with a short 21 ft. reach of F3 stream type. The channel is *entrenched*, or confined within the stream banks during high flood events, which can result in *degradation*. This reach, however, appears stable with its current morphology, exhibiting a gentle 1.7% slope and its cobble size bed material.

As channel slope steepens to 2.2%, stream type adjusts to F3b for the next 85 ft. of stream (Fig. 6). This reach remains entrenched.

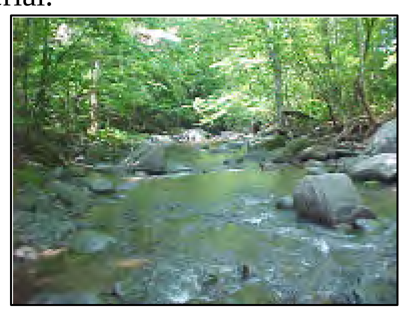


Figure 6 Cross-section 91 Stream Type F3b

Continuing downstream, the stream reconnects with its floodplain for a 93 ft. of C3b stream (Fig. 7). Although there are many scattered boulders, dominant channel bed material remains cobble.

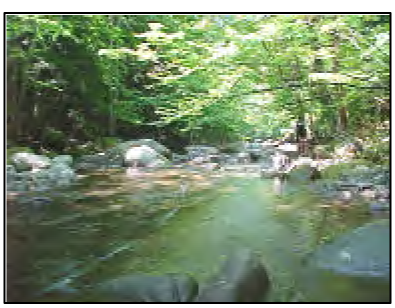


Figure 7 Cross-section 92 Stream Type C3b

As the stream becomes moderately entrenched, limiting its ability to overspill its banks, stream type transitions into B3 for the next 155 ft. of stream (Fig. 8).

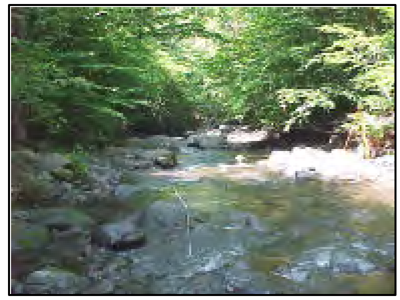


Figure 8 Cross-section 93 Stream Type B3

Figure 9 Tributary

Two tributaries enter in this reach. The first, shown in Figure 9, enters the Stony Clove Creek from the left bank at the very top of the reach. This tributary is rated D under the NYS DEC best usage classification system. This is the lowest classification, indicating the water is only suitable for fishing. The second is a drainage tributary, which enters just downstream from the first tributary, from the middle of the right stream bank through a PVC pipe. This probably drains the upland residential area.

Continuing downstream, the channel once again becomes entrenched, transitioning to F3b stream type (Fig. 10). The overall slope of this reach increases dramatically to 3.9%. The reach consists of a series of steep *cascades* each followed by a *run*. There is an abundance of large boulders in this reach but dominant stream channel material remains cobble. This 513 ft. reach is fairly stable until bank erosion monitoring site #12, near the end of the reach.

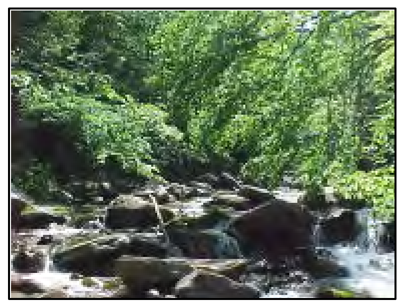


Figure 10 Cross-section 97 Stream Type F3b Looking Upstream

From the end of this reach to the Wright Road bridge, the stream shows indications of extreme instability. Monitoring at bank erosion monitoring site #12 (Inset H & Fig. 11) focuses on the left bank. During high flow events, this bank is subject to severe erosion due to the entrenchment of the stream channel. Adding to the instability of this reach, a *headcut* is migrating upstream between erosion sites #11 and #12, causing channel *incision*. Although the top of this bank is heavily forested, the bank angle is over-steep, and vegetation appears to be disconnected from the water table. Erosion is active and numerous trees continue to be undercut. The morphology of this section in unstable and revegetation alone will not be sufficient to stabilize the bank. It is recommended that grade control be established throughout the reach to achieve more effective flood conveyance, and stream banks be graded and vegetated.

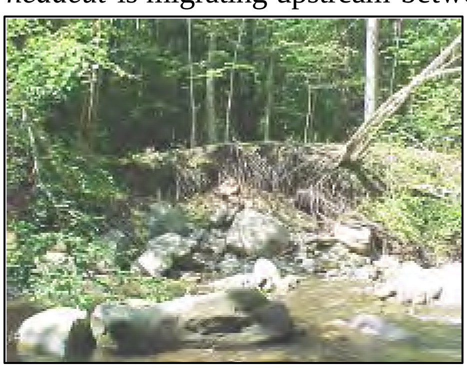


Figure 11 Bank erosion site #12

The Bank Erodibility Hazard Index (*BEHI*) score of site #12 is ranked "High", the third highest prioritization category in terms of its vulnerability to erosion. Previous geologic mapping did not identify lodgement till or glacial lake clays at this site, and none were identified during the stream feature inventory. This bank erosion site is considered a medium priority for restoration because of its threat to infrastructure downstream but has a small eroding area (768 ft^2) and does not threaten water quality.

As the stream turns out of the meander bend, it becomes moderately entrenched and slope increases dramatically to 7.7%, for this short 69 ft. B3a stream reach (Fig. 12). Stream bank erosion continues along bank erosion monitoring site #11 on the left bank (Inset G). This twelve ft. high bank is exposed to high *shear stress*, or stream force during high flow events. This high stress has undercut the stream bank, causing the vegetation on the top of the bank to collapse.

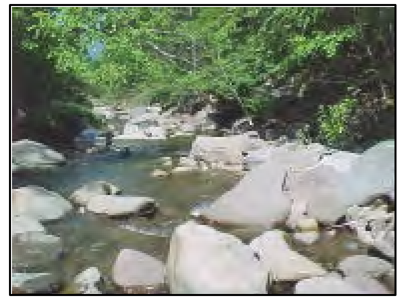


Figure 12 Cross-section 98 Stream Type B3a

The BEHI score of site #11 is ranked "High", the third highest prioritization category in terms of its vulnerability to erosion. This bank erosion site is considered a medium priority for restoration because of its threat to infrastructure downstream but has a small eroding area (1006 ft^2) and does not threaten water quality.

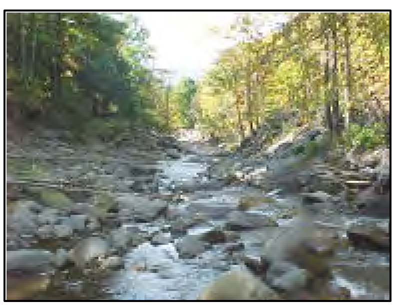


Figure 13 Cross-section 99 Stream Type B3

Proceeding downstream, channel slope decreases but remains steep at 3.8%, as the stream type changes to B3 for the next 335 ft. reach (Fig. 13). The reach is characterized by steep cascades and pools. There is an abundance of large boulders in this reach but the dominant stream channel material remains cobble.

Stream bank erosion continues along the left bank to bank erosion monitoring site #13 (Inset F & Fig. 14). The stream reach is moderately entrenched with a 14 ft. high, devegetated left bank and 9 ft. high, rip-rapped right bank. The channel has incised into the streambed here. This incision has disconnected the channel from its former floodplain, and the stream is now widening to try to create a new floodplain within the entrenched condition. The rip-rap installed on 283 ft. of the right stream bank now has small trees growing through it, increasing the resistance of this side of the channel to erosive flood currents (Inset D). Downstream from this rip-rap a short section of the bank is experiencing erosion at a gap in the revetment.

Figure 14 Bank erosion site #13 right bank

The BEHI score of site #13 left and right bank is ranked "High", the third highest prioritization category in terms of its vulnerability to erosion. Previous geologic mapping did not identify lodgement till or glacial lake clays at this site, and none were identified during the stream feature inventory. This bank erosion site is considered a medium priority for restoration because of its threat to infrastructure downstream but has a small eroding area (2102 ft^2) and does not threaten water quality.

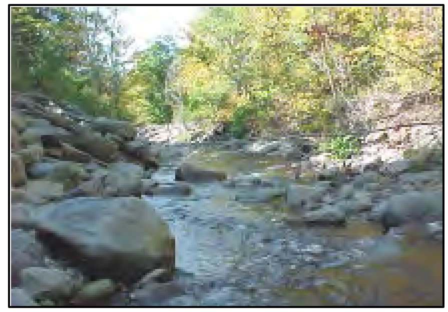


Figure 15 Cross-section 100
Stream Type F3b

As the channel becomes more entrenched and slope decrease to 2.3%, stream type changes into F3b for the next 350 ft. of stream (Fig. 15). This reach has high banks on both sides, and has experienced severe erosion during past flood events. In efforts to protect their homes, both stream banks have been heavily armored with rip-rap by the landowners.

As shown in the figure 15, there is 102 ft. of rip-rap on the left bank at the upstream end of this reach. Further downstream, on the outside meander bend, on the right stream bank, is another 304 ft. of rip-rap (Inset C). Stream corridor geologic mapping by Rubin (1996) identified exposures of lodgement till along this reach (See Section 2.4, Geology of the Stony Clove Creek, for a description of these deposits). It is likely that the rip-rap covers such exposures. Stream bank erosion often occurs on the outer banks of streams where velocity is greatest. This reach will continue to experience erosion problems if the entrenchment and shear stress are not reduced.

Figure 16 Cross-section 102
Stream Type F3

As the stream approaches the Wright Road bridge (Inset B), the slope flattens to 1.7%, as the stream transitions into F3 stream type (Fig. 16). This Greene County bridge (BIN#3201070) was heavily damaged in the 1996 flood event. The Federal Emergency Management Agency (FEMA) provided $201,893 to replace this bridge. The new bridge appears have adequate horizontal and vertical clearance to safely pass high flow events.

The reaches from cross-section 97 through 101 are trending toward increased instability, and without intervention, are unlikely to return to a stable form without significant consequence to adjacent residences. Access and dewatering difficulties complicate restoration efforts here. Full restoration is recommended at this site to mitigate potential flood-related erosion hazards. Restoration design should address both grade control and bank stability issues.

The 700 ft. stream reach downstream from the bridge remains entrenched with an overwide, shallow stream channel. On the right bank, set back approximately 70 ft. from the active stream channel is a 410 ft. long berm, which appears to be made from *side castings*. As shown in the historical channel instability section, the stream channel was once spilt in this reach and the berm was directly along one of the stream channels (Fig. 4). This stream channel has been abandoned. Normally, berms prevent flood waters from spilling into the floodplain, which increases the stream velocity and causes *degradation.* Since this berm is set back significantly from the stream bank, it does not appear to be causing any problems.

Proceeding downstream, the channel becomes moderately entrenched and slope increases slightly to 2.1% for a short 134 ft. reach of B3 stream type (Fig. 17).

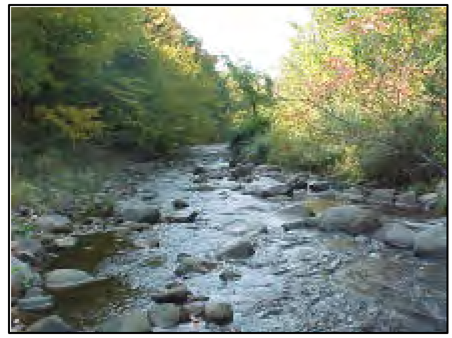


Figure 17 Cross-section 105 Stream Type B3

At the end of this reach, the stream reverts back to a F3, as the stream once again becomes entrenched and the slope decreases to 1.7% (Fig. 18). This 467 ft. reach has an overwide channel and is shallow. Overwide channels are considered unstable because they often *aggrade*, which eventually causes bank erosion by increasing stream velocity against the stream bank. Overwide channels also provide poor fish habitat due to filling of deep pools and warmer water temperatures.

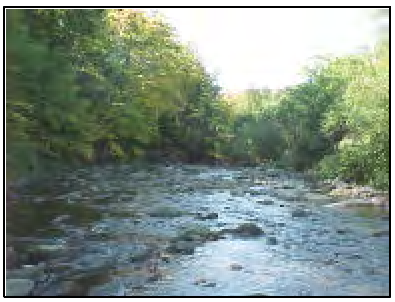


Figure 18 Cross-section 106 Stream Type F3

At the top of this reach, on the left bank, is a clay exposure, confirming Rubin's 1996 geologic mapping of lodgement till here (Fig. 19). Clay inputs into a stream are of serious water quality concern because they can increase *turbidity,* degrade fish habitat, and act as a carrier for other pollutants and pathogens.

Figure 19 Clay Exposure

As the channel reconnects with its floodplain, stream type changes to C3 for the last 184 ft. reach in this management unit (Fig. 20). The channel begins to narrow and the slope remains consistent at 1.8%. At the top of this reach, there is another clay exposure located on the left bank.

Figure 20 Cross-section 107 Stream Type C3

At the end of this reach, the stream splits into two channels as it must pass a private stream crossing owned by the homeowners on the left side of the stream (Inset A). The majority of the stream passes through the culvert bridge on the right side of the stream at low flows. The remaining stream flow flows straight and falls into two smaller culverts which pass under the road crossing just above the stream grade level (Fig. 21). Higher flows spill directly across the roadway, rendering it impassable and requiring significant maintenance after flood flows ebb.

Figure 21 Culvert under road crossing

This overflow also occurs during smaller rain events, when debris clogs the two smaller culverts. This road crossing causes channel instability downstream by dividing channel forming flows and creating a barrier to sediment transport. Replacement of this road crossing with a single bridge, with an opening adequate to pass high flows, could alleviate this problem. Unfortunately, this is a very costly option not typically feasible for many private landowners.

Sediment Transport

Streams move sediment as well as water. Channel and floodplain conditions determine whether the reach aggrades, degrades, or remains in balance over time. If more sediment enters than leaves, the reach aggrades. If more leaves than enters, the stream degrades (See Section 3.1 for more details on Stream Processes).

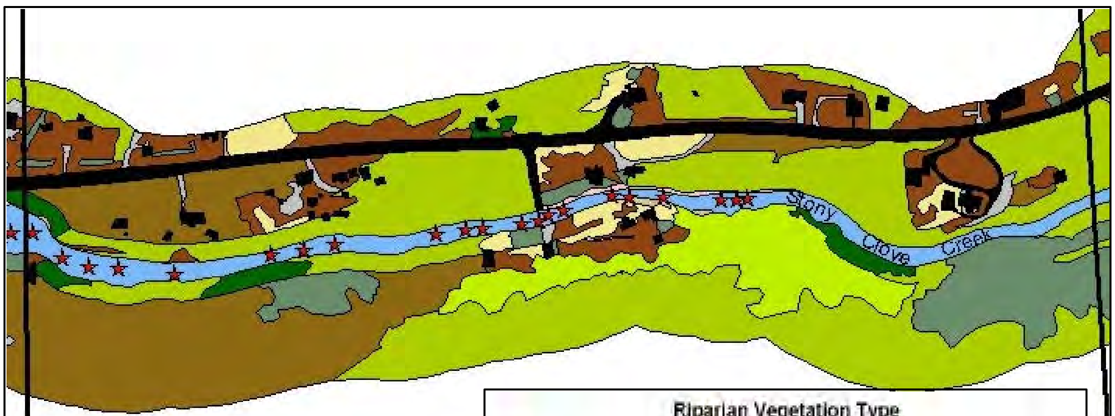
Much of this management unit appears to be vertically unstable, with excess sediment transport capacity. The resulting incision is currently migrating upstream, destabilizing banks, and increasing the sediment load delivered downstream. Restoration activities in this management unit could therefore have beneficial impacts both upstream and downstream. Sediment transport should also be addressed at the stream crossing in Figure 21.

<u>Riparian Vegetation</u>

One of the most cost-effective methods for landowners to protect streamside property is to maintain or replant a healthy buffer of trees and shrubs along the bank, especially within the first 30 to 50 ft. of the stream. A dense mat of roots under trees and shrubs bind the soil together, and makes it much less susceptible to erosion under flood flows. Grass does not provide adequate erosion protection on stream banks because it has a very shallow rooting system. Interplanting with native trees and shrubs can significantly increase the working life of existing rock rip-rap placed on streambanks for erosion protection. *Riparian*, or streamside, forest can buffer and filter contaminants coming from upland sources or overbank flows. Riparian plantings can include a great variety of flowering trees and shrubs native to the Catskills. Native species are adapted to regional climate and soil conditions and typically require little maintenance following installation and establishment.

Plant species that are not native can create difficulties for stream management, particularly if they are invasive. Japanese knotweed (*Polygonum cuspidatum*), for example, has become a widespread problem in recent years. Knotweed shades out other species with it's dense canopy structure (many large, overlapping leaves), but stands are sparse at ground level, with much bare space between narrow stems, and without adequate root structure to hold the soil of streambanks. The result can include rapid streambank erosion and increased surface runoff impacts.

An analysis is of vegetation was conducted using aerial photography from 2001 and field inventories (Fig. 22 & Appendix A). Japanese knotweed occurrences were documented as part of the MesoHABSIM aquatic habitat inventory conducted during the summer of 2002 (Appendix B).



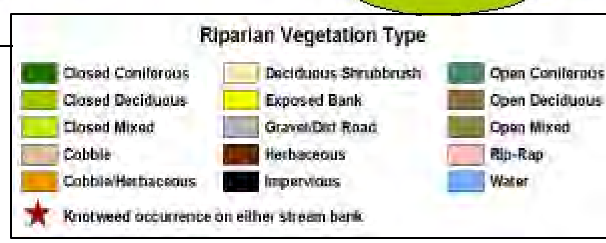


Figure 22 Riparian vegetation map Management Unit 5

The predominant vegetation type within the 300 ft. riparian buffer is forested (76%) followed by herbaceous (12%). The areas of herbaceous (non-woody) vegetation present opportunities to improve the riparian buffer with plantings of more flood-resistant species. *Impervious* area (7%) within this unit's buffer is primarily the NYS Route 214 roadway and private residences.

In June 2003, suitable riparian improvement planting sites were identified through a watershed-wide field evaluation of current riparian buffer conditions and existing stream channel morphology (Fig. 23). These locations indicate where plantings of trees and shrubs on and near stream banks can help reduce the threat of serious bank erosion, and can help improve aquatic habitat as well. In some cases, eligible locations include stream banks where rock rip-rap has already been placed, but where additional plantings could significantly improve stream channel stability in the long-term, as well as biological integrity of the stream and floodplain. Areas with serious erosion problems where the stream channel requires extensive reconstruction to restore long-term stability have been eliminated from this effort. In most cases, these sites can not be effectively treated with riparian enhancement alone, and full restoration efforts would include re-vegetation components. Four appropriate planting sites were documented within this management unit.

Figure 23 Planting sites location map for Management Unit 5

Planting site #21 (no photo available) is located on the right bank at the Zahartos residential property. This property has grass planted to the edge of the stream bank with some trees along the bank. Additional tree and shrub plantings are recommended to increase the density of the upland stream buffer.

Planting site #22 is an in-channel planting area located between cross-section 103 and 104 (Fig. 24). This reach of stream channel is overwide and shallow. Overwide channels are considered unstable because they often aggrade, which eventually causes bank erosion by increasing the stream velocity against the stream bank. Overwide channels also provide poor fish habitat due to generally warmer water temperatures and a lack of deep pools. Willows have begun to establish along the right bank. There is some apparently inactive erosion on the left bank which should be treated with willow and other native plantings. If not planted, this reach should be monitored to determine the stream's capacity to re-vegetate on its own.

Figure 24 Planting Site #22 looking upstream

Planting site #23 (no photo available) is located on the right bank at the series of red & white cabins along NYS Route 214. This property has a large grass lawn planted to the edge of the stream bank. Japanese Knotweed is prevalent along the right bank. Additional tree and shrub plantings are recommended to increase the density of the upland stream buffer. It is also recommended to remove the Japanese Knotweed, which is an invasive non-native species. Japanese Knotweed does not provide adequate erosion protection because it has a very shallow rooting system.

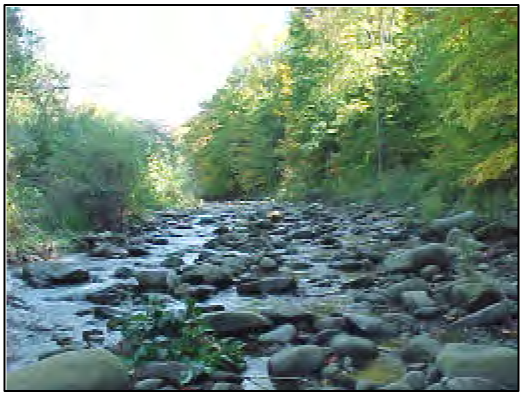


Figure 25 Planting Site #24 looking upstream

Planting site #24 is an in-channel planting area beginning between cross-sections 105 & 106 and ending at the bridge at the end of the management unit (Fig. 25). This reach of stream is overwide and shallow. Overwide channels are considered unstable because they often aggrade, which eventually causes bank erosion by increasing the stream velocity against the stream bank. Overwide channels also provide poor fish habitat due to generally warmer water temperatures and a lack of deep pools.

In-channel plantings of native willows and sedges is recommended along the toe of each bank. These plantings may allow the stream to narrow into a more stable morphology. Japanese Knotweed and *Multiflora Rose* (*Rosa multiflora*) are prevalent along the right bank. It is recommended to remove these species, which are invasive non-native species. Japanese Knotweed does not provide adequate erosion protection because it has a very shallow rooting system.

Flood Threats

Inundation

As part of its National Flood Insurance Program (NFIP), the Federal Emergency Management Agency (FEMA) performs hydrologic and hydraulic studies to produce Flood Insurance Rate Maps (FIRM), which identify areas prone to flooding. Initial identification for these maps was completed in 1976. Some areas of these maps may contain errors due to stream channel migration or infrastructure changes over time.

Figure 26 100-year floodplain boundary in Management Unit 5

To address the dated NFIP maps, the NYS DEC Bureau of Flood Protection is currently developing floodplain maps, using a new methodology called Light Detection And Ranging (LIDAR). LIDAR produces extremely detailed and accurate maps, which will indicate the depth of water across the floodplain under 100-year and other flood conditions. These maps should be completed for the Stony Clove Watershed in 2004.

According to the NFIP maps, there are eighteen houses located within the 100-year flood boundary in this management unit (Fig. 26). The current NFIP maps are available for review at the Greene and Ulster County Soil & Water Conservation District offices.

Bank Erosion

The majority of stream banks within the management unit are relatively stable, with only 7% of the stream banks experiencing erosion. There are three bank erosion sites, totaling 443 ft. in length, in this management unit.

All three of the bank erosion sites (Insets F,G,H) in this management unit are located above the Wright Road Bridge. Future erosion at these sites is a serious concern to the two private residences just upstream from the bridge. While rip-rap currently installed at these locations may provide temporary relief from erosion, these measures are likely to require on-going maintenance or transfer erosion problems to upstream or downstream areas. These erosion sites share a common cause, and should be addressed in a single restoration project.

Infrastructure

Bridges are highly susceptible to damage because they require the stream to pass through a narrow area during flood events. Bridge openings should be should be sized to eliminate backwater effects through at least bankfull stage, and to be able to convey most flood flows without significant damage. Culvert drainage in the floodplain under bridge approaches can also help reduce the risk of bridge failure, while lowering flood elevations and minimizing sediment deposition upstream of the bridge.

The history of stream disturbance permits in this management unit indicates that the private bridge at the end of this management unit has been severely damaged in past flood events. During high flow events the stream flows over the road crossing, often causing damage. This overflow also occurs during smaller rain events, when debris clogs the two smaller culverts. This road crossing causes stream instability downstream due to the spilt channel. This road crossing should be replaced with a single bridge, with an adequate opening able to pass high flows. Figure 27 shows the bridge rendered impassable during a moderate flow event.

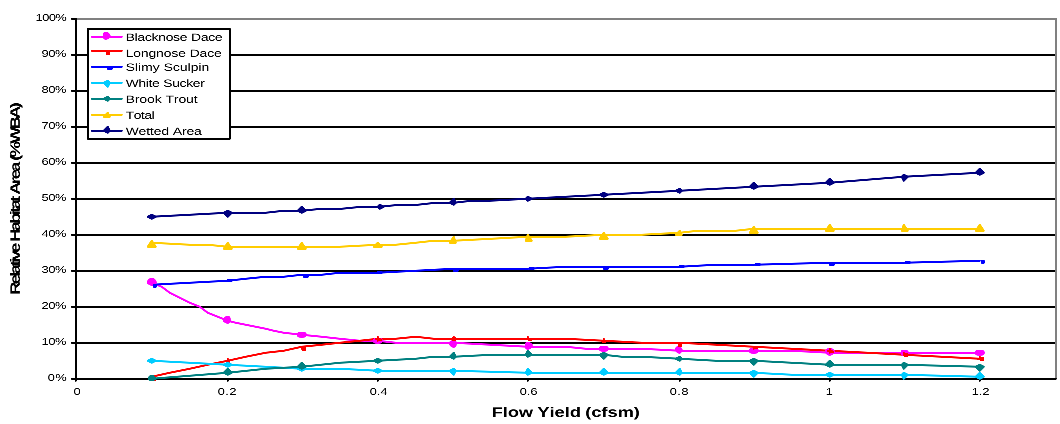
Figure 27 Road Crossing March 21, 2003 (967cfs)

Although approximately 140 ft. of the stream is located within 50 ft. of NYS Route 214, there are no serious flood threats to this roadway.

Aquatic Habitat

Aquatic habitat was analyzed for each management unit using Cornell University Instream Habitat Program's model called MesoHABSIM. This approach attempts to characterize the suitability of instream habitat for a *target community* of native fish, at the scale of individual stream features (the "meso" scale), such as riffles and pools. Habitat is mapped at this scale for a range of flows. Then the suitability of each type of habitat, for each species in the target community, is assessed through electrofishing. These are combined to predict the amount of habitat available in the management unit as a whole. The habitat rating curves in the figure below depict the amount of suitable habitat available at different flows. See Appendix B for a more detailed explanation of methods.

Management Unit #5 consists mostly of fast flowing, shallow habitats (riffles, glides and rapids) with abundant boulders, but almost no woody debris. *Wetted area* is only about half of the bankfull wetted area across all measured flows, increasing slightly with flow. Therefore, as flow increases, it generally becomes deeper and faster, turning into runs. The hydro-morphological units are also larger than those in Management Unit #4. Nevertheless, the overall habitat stays at a relatively constant level, covering the majority of wetted area. As flows get faster, the habitat becomes less suitable for blacknose dace. White sucker and brook trout habitat stay at very low levels, though the latter's habitat increases slightly at flows close to 0.6 cfsm. Similar to previous sections, brown and rainbow trout have very little prime habitat, but plentiful low quality habitat. Improving overhead cover in the unit with joint plantings installed at rip-rap revetments would enhance habitat quality. (See general recommendations for aquatic habitat improvement in Section 6.6)



Rating curve for relative habitat area versus flow for Management Unit 5

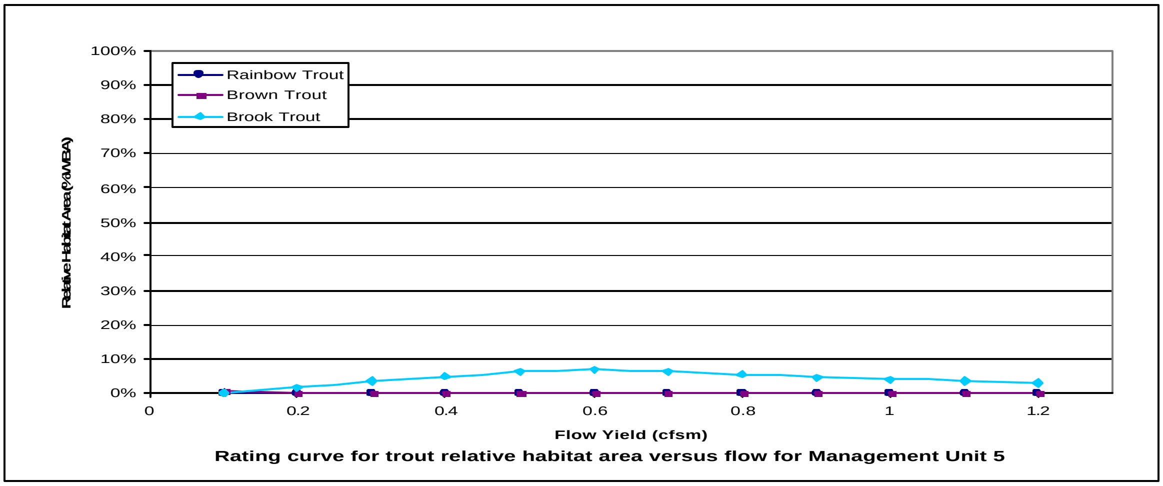


Figure 28 MesoHABSIM habitat rating curves for Management Unit 5

Water Quality

Clay exposures and sediment from stream bank and channel erosion pose a significant threat to water quality in Stony Clove Creek. Clay and sediment inputs into a stream may increase *turbidity* and act as a carrier for other pollutants and pathogens. There are currently two clay exposures along the left stream bank in the lower half of the management unit. Although these sites are not presently contributing large amounts of clay into the stream, if this bank begins to erode it would likely expose larger clay deposits. These sites should be monitored for potential increases in exposure area and susceptibility to *entrainment* over time.

Stormwater runoff can also have a considerable impact on water quality. When it rains, water falls on roadways and flows untreated directly into Stony Clove Creek. The cumulative impact of oil, grease, sediment, salt, litter and other unseen pollutants found in road runoff can significantly impact water quality. There are no stormwater culverts in this management unit.

Nutrient loading from failing septic systems is another potential source of water pollution. Leaking septic systems can contaminate water making it unhealthy for swimming or wading. There are many houses located in close proximity to the stream channel in this management unit. These homeowners should inspect their septic systems annually to make sure they are functioning properly. Each household should be on a regular septic service schedule to prevent over-accumulation of solids in their system. Servicing frequency varies per household and is determined by the following factors: household size, tank size, and presence of a garbage disposal. Pumping the septic system out every three to five years is recommended for a three-bedroom house with a 1,000-gallon tank; smaller tanks should be pumped more often.

The New York City Watershed Memorandum of Agreement (MOA) allocated 13.6 million dollars for residential septic system repair and replacement in the West-of-

Hudson Watershed through 2002. Eligible systems included those that were less than 1,000-gallon capacity serving one- or two-family residences, or home and business combinations (CWC, 2003). Two homeowners in this management unit made use of this program to replace or repair their septic systems.