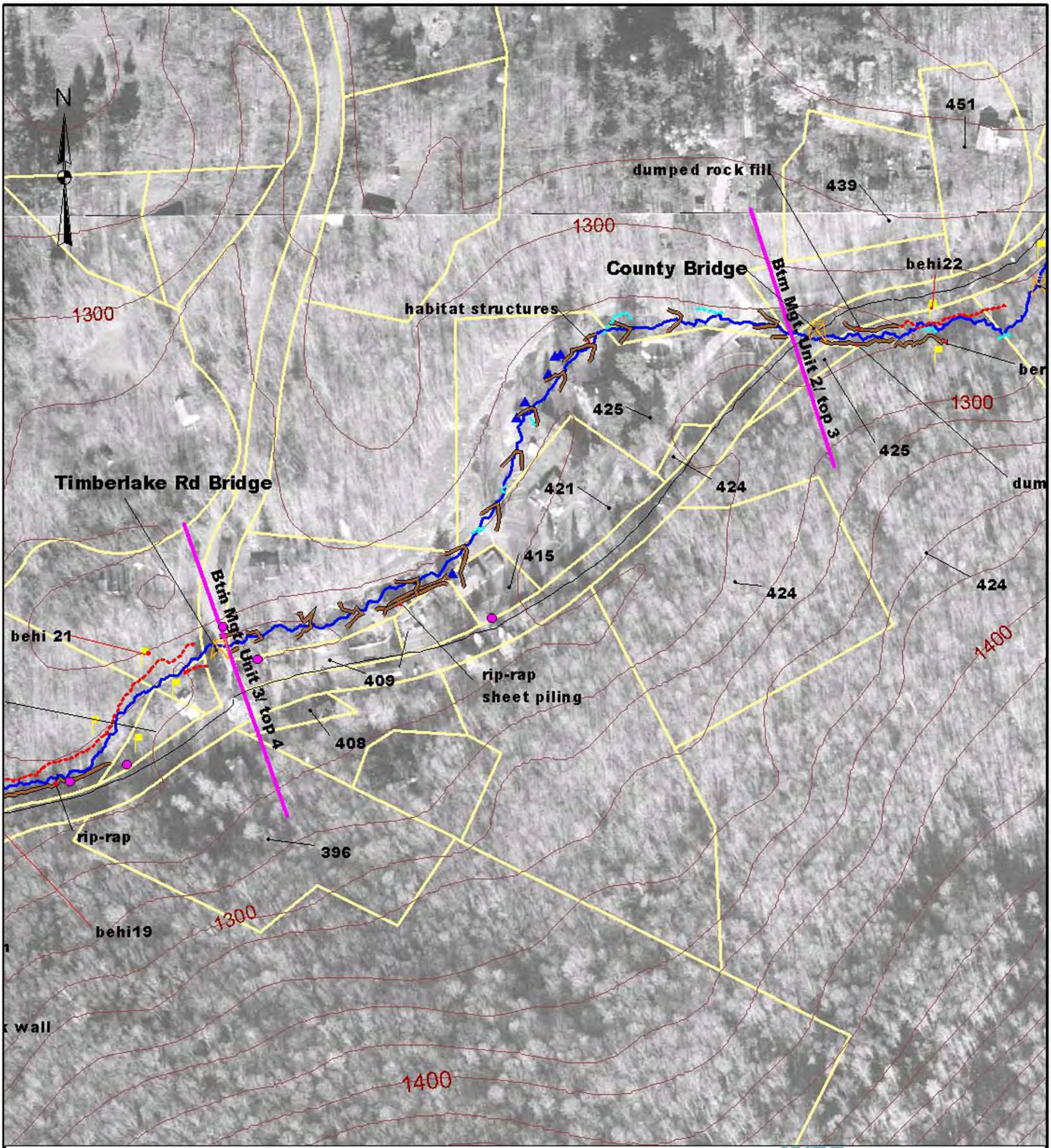

Broadstreet Hollow Management Unit 3

GIS Parcel, Contour and Wetland coverages are edited and provided by NYC DEP, 2000, UTM NAD 27, Zone 18 North, meters. Aerial Photography provided by UCSWCD & NYC DEP November 2001. All other coverages were developed using GPS in the UTM, Zone 18 North projection, NADCON (Conus), datum. GPS data collected 2001, by UCSWCD & NYC DEP SMP.

Note: G.I.S. data are approximate according to their scale and resolution. Data may be subject to error and are not a substitute for on-site inspection or survey. Parcel coverages are based on Ulster County Real Property tax maps 2000 and may not reflect actual surveyed property boundaries.

Contour Interval 20 feet

50 0 50 100 150 200 Feet

Scale 1:2,400

LEGEND

- 247 Street Address/911 code
- Greene parcels
- Ulster parcels
- Land fills
- Managment units
- Stream Center (Thalweg)
- Culvert
- Wetland
- Clay exposure
- Revetment
- Eroding bank
- Tributary
- Behi pin
- Bridge
- Broadstreet Hollow Road
- Knotweed

Broadstreet Hollow Management Unit 3

General Description:

Photo 1. Looking downstream, MU3 , spring 2002.

Management Unit 3 (MU3) is located in Greene County, NY, beginning at the outlet of County Bridge 3201230 near Regina's Way and continuing downstream approximately 1,150 feet to the inlet of Town Bridge 3201240 at Timber Lake Road. This management unit is the location of the Demonstration Stream Stability Restoration Project site ("demonstration project"), constructed in 2000 and 2001[1&2] (Photo 1).

Photo 2. Looking downstream at left bank eroded under the Torregrossa home, 1996, following the January flood event.

Sometime before the mid-1960s, the Broadstreet Hollow stream was straightened and pushed into the hillside in this area, most likely to accommodate the road and houses. During the January 1996 flood, the Broadstreet Hollow stream eroded dramatically in many locations throughout the valley. In this section, the stream moved approximately 30 feet laterally (sideways), back to within a few feet of its pre-1960s location, recovering its original structural shape, or *morphology* (Photo 2).

This development represented an imminent threat to life and property, hence making the site eligible for emergency repair work funding under the Emergency Watershed Protection Program, sponsered by the USDA-NRCS. While the program objectives were met, and the affected properties protected, glacial lake clays underlying the streambed were inadvertently exposed to a greater extent. (Photo 3).

Photo 3. Looking upstream, mid-MU3, showing glacial lake clay in stream bed and on hillslope to the left, 1997.

The Broadstreet Hollow Stream Management Plan includes provision for one restoration

Photo 4. Looking upstream, failing rip-rap along left bank opposite clay hillslope, mid-MU3, 1998.

project to demonstrate techniques that work with natural stream processes including flood capacity, sediment transport and vegetative management. This site was chosen for the demonstration project in 1997, following further erosion of the stream bed, failure of the hillslope, and ongoing damage to the repair work on the bank (Photo 4).

In the fall of 1999, flood conditions associated with Tropical Storm Floyd further degraded the stream channel. Rapid stream down-cutting, or *degradation*, along with saturation of the adjacent hillslope, accelerated the slope failure and opened up an underground spring.

Water moving under pressure (an *artesian* condition) through the clay layers underground produced a constant upwelling of muddy, or *turbid*, water (a "mud boil") as it came to the surface in the streambed (Photos 5 and 6). The turbid condition prevailed during both low and high flow conditions, with the stream remaining turbid from the project site down to the confluence with the Esopus Creek, about 3 miles downstream[5&13].

Photo 5. Close-up of artesian "mud boil" welling up through layers of clay in the Broadstreet Hollow stream bed, mid-MU3, winter 2000. Stream flow is from right to left.

Photo 6. Artesian "mud boil", early summer, 2000, showing clay hillslope on right bank, mid-MU3. Stream flow is from right to left.

I. Flood and Erosion Threats

A. Infrastructure and Private Property

There are eleven known property owners in MU3; seven of them contain or are bounded by the stream. The centerline of Broadstreet Hollow Road ranges from approximately 65 to 230 feet from the deepest part of the stream, or *thalweg*, in MU3.

Photo 7. Looking upstream at County Bridge 3201230, at the top of MU3.

Two County maintained bridges flank the top and bottom of MU3. The upstream bridge is on Broadstreet Hollow Road, just below the intersection with Regina's Way (Photo 7). This bridge was replaced following the flood of 1996, and is wide enough to accommodate both a low flow stream channel and to allow the stream to maintain a generally natural shape consistent with dimensions upstream and downstream.

Photo 8. Looking downstream at County Bridge 3201240, at the bottom of MU3.

The downstream bridge is constructed more narrowly than the natural stream both upstream and downstream from the bridge location (Photo 8).

A bridge that is too narrow can result in maintenance problems, both of the bridge itself as well as the stream channel or banks both upstream and downstream of the bridge. The constriction at the bridge can cause water to back up during floods, which can lead to increased erosion both upstream of the bridge, as the water swirls, or *eddies*, behind it, and as the water rushes through and eddies around the banks just downstream. This bridge shows evidence of such bank erosion both upstream and downstream of the bridge structure, as well as subsequent bank stabilization, or revetment work, to address ongoing instability. This bridge will likely have maintenance problems over time, unless it is reconstructed to accommodate the natural width of the stream[8].

MU3 Culverts

The largest of three culverts documented in MU3 during the stream assessment survey in 2001 provides a crossing for a small side stream, or tributary, under Broadstreet Hollow Road. This tributary enters the main stream in the lower half of MU3, just above the last home on the left bank (looking downstream). The other two corrugated metal culverts, one on each bank just upstream from the Timberlake Road bridge, were not running at the time of the survey. These culverts provide roadside ditch drainage for Broadstreet Hollow Road (left bank culvert) and Timberlake Road (right bank culvert).

B. History of Stream Work

The demonstration project comprising MU3 was designed to mitigate problems associated with stream *instability*, including stream bank and bed erosion, flood hazard and damages, poor water quality from silt and clay, degraded aquatic habitat, and adjacent hillslope failure. The project demonstrates the principles of natural channel design, using stable stream morphology and stream processes as a template to recreate a naturally sustainable stream channel.

Photo 9. Looking upstream from the bottom of MU3, Fall, 2002, showing plunge pool below a rock vane structure.

Thirteen boulder structures, or *cross vanes*, were installed in the stream to mimic the natural spacing of small waterfalls, or “steps”, and plunge pools (Photo 9). These features serve multiple functions, including dissipating stream energy (reducing erosion), preventing further down-cutting, providing a variety of fish habitat niches, and aerating the water (providing oxygen).

The channel shape was adjusted, including restructuring of bends, or meanders, and the recreation of the stream banks to mimic the low benches, or *discontinuous* floodplains, common in mountain streams [13] (Figure 5). Floodplains reduce flood velocity, increase absorption of floodwaters, encourage deposition of silt and fine sediments and decrease flood height, or *stage*, downstream. Most of Broadstreet Hollow stream floodplains consist of floodplain benches. Creation of floodplain benches adds to this valuable area. Structural re-vegetation, or *bioengineering*, of the stream side, or *riparian* area, greatly improves floodplain functions, and provides additional benefits for habitat and water quality (see Riparian Vegetation section). Due to space constraints in the lower portion of the reach, the project required a section of sheet piling to protect a home foundation. Bioengineering and instream channel structures were used to mitigate any increases in erosive power that may have resulted from water speeding up across the smooth surface of the sheet piling.

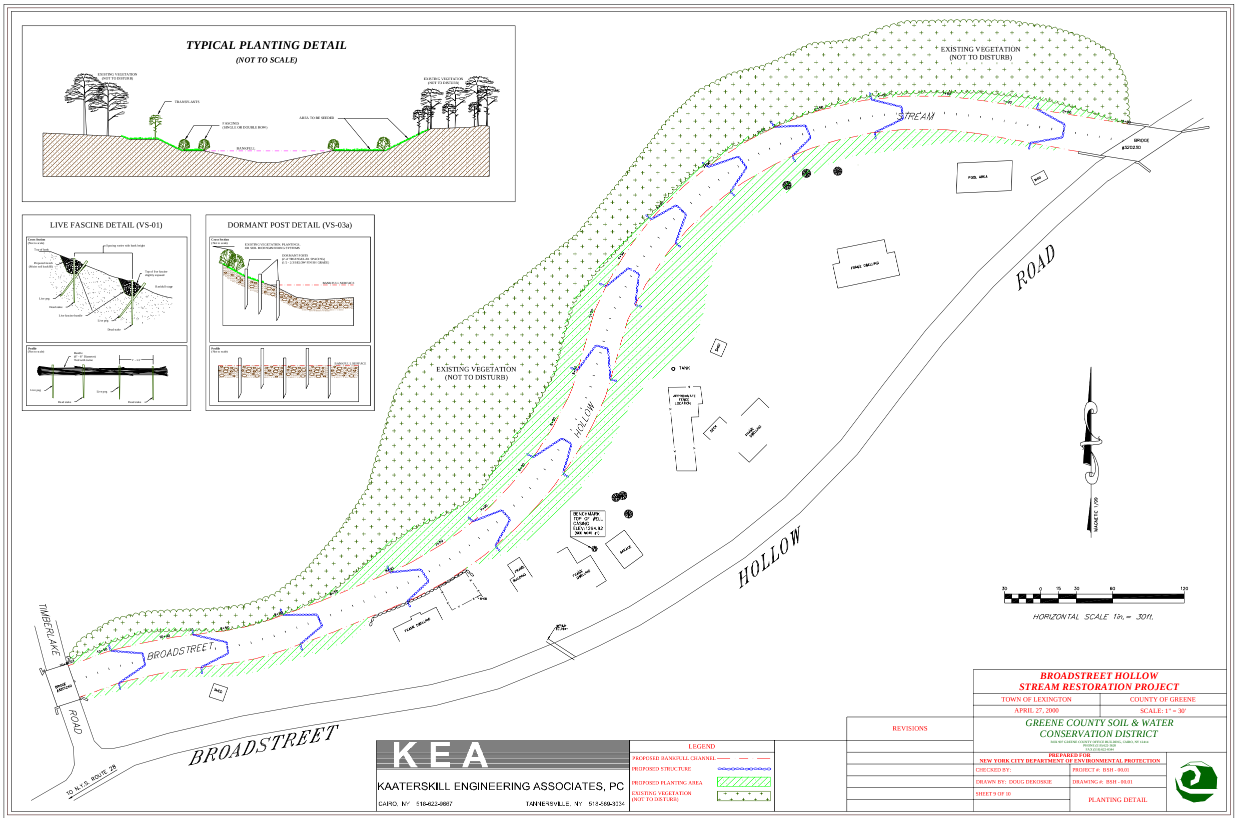

Figure.1 Design plan drawings for demonstration stream stability restoration project for MU3, 2000, showing vegetative planting (bioengineering) plan and spacing of rock vane structures. Drawing courtesy of Greene County Soil and Water Conservation District, NY.

The final restoration design included the installation of three groundwater relief wells in the center of the project reach (Photo 11). This was designed to force the groundwater through a piped outfall to the stream, instead of through layers of clay and up into the stream bed, thus keeping the water clear[13].

Photo 11. Groundwater relief well on the failing hillslope during construction, showing water from 30 feet down flowing up out of the ground under pressure. Note groundwater is clear before it comes in contact with the clay layers.

C. Exposed banks

No eroding or exposed banks were documented in MU3 at the time of the stream assessment survey in 2001. Ongoing monitoring of this reach will identify any bank erosion problems that may arise.

II. Water Quality

A. Sediment

At the time of the stream assessment survey in 2001, MU3 had approximately 140 feet (6%) exposed clay in the banks and channel bottom. This clay was likely left over from the construction process, or was a result of adjustment in the reach as it equilibrates through several flood events, and will likely stabilize itself over time. The demonstration project design included over-excavation of clay material in the streambed, and back filling with clean gravel and cobble materials similar to what occurs naturally in the stream (Photo 12)[5&13].

Photo 12. Excavation of a plunge pool below a cross vane during construction, 2000. Clay material in the stream bed was over-excavated and removed, and back filled with clean sediment to form the new stream bed.

B. Landfills/Dumping Sites

The stream assessment conducted in 2001 did not reveal any current *dumping sites* in or near the stream in MU3 that could contribute to water quality impairment from leaching of toxic materials.

C. Other Water Quality Issues

Investigation of other possible sources of contamination was not part of the stream assessment conducted in 2001. However, no evidence was found for *nutrient* or *pathogen* contamination in the stream (i.e., odors or discolored water). Any runoff from roadside ditches and culverts that may contain salts or other pollutants, or runoff containing fertilizer or other chemicals from lawn areas, were not specifically investigated. However, lack of well-vegetated streamside or riparian buffer areas could reduce the capacity of the stream banks to assimilate, or slow the input of, contaminants to the stream, especially before the riparian vegetation becomes fully established throughout the project area[7]. Most of MU3 is far from the road, but there may be direct runoff inputs from the bridge areas at the top and the bottom of the site, as well as from the tributary.

III. Stream Ecology

A. Aquatic habitat and populations

As part of the stream restoration demonstration project completed in MU3 in 2000, fish and aquatic insect population data have been gathered yearly since 1998 within the stable reference reach (MU1), the project site (MU3) and the control reach (MU17). These data show the Broadstreet Hollow self-supports, without stocking, populations of all three common trout species (rainbow, brook and brown) as well as a healthy and diverse community of aquatic insects[9].

B. Riparian Vegetation

Stream assessment conducted in 2001 did not investigate specific streamside (riparian) plant species or density condition, other than to note areas of insufficient or stressed vegetation that could affect stream stability, flooding or erosion threats, water quality or aquatic habitat for trout species. Based on these general, non-quantitative observations, riparian vegetation throughout MU3 appears to need continued augmentation to ensure establishment sufficient to provide the full benefits of a healthy riparian area.

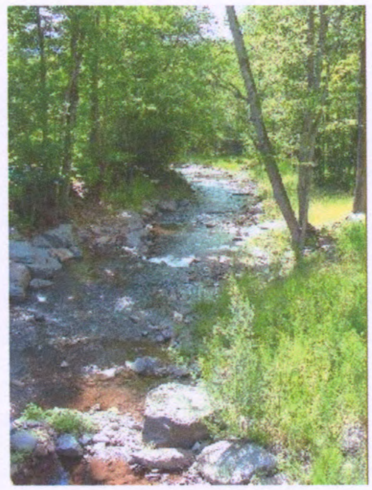

Photo 13. Looking downstream from the top of MU3, spring 2002, showing new riparian vegetation becoming established. Note mature trees left intact on both banks during construction of the project.

Following primary reconstruction of the stream channel, vegetation was reestablished on the floodplain and surrounding areas disturbed during construction activities (Photo 13). Techniques included live willow *fascines*, posts, live material transplants, bare root seedlings and potted trees/shrubs. Temporary soil stabilization was provided by spraying bare soil areas with a mix of seed and mulch material, or *hydro-seeding*, with a conservation grass seed mix. Planting was completed by the project contractor, GCSWCD staff and a wide range of volunteers including many local Broadstreet Hollow residents, and members of Trout Unlimited (Photo 14)[13].

Photo 14. Trout Unlimited volunteers assisting bioengineering efforts along the left bank of MU3, looking downstream, riparian planting day, May 18, 2002.

Establishing a functioning and self-sustaining riparian zone is very difficult, and can require a number of years and ongoing maintenance to achieve success. Under-vegetated areas in MU3 should continue to be vegetated or supplemented with a mixture of native riparian species to improve shade, cover and water temperature conditions for aquatic habitat[9], as well as to improve bank stability and reduce the need for future restoration work that could cause or increase stream ecosystem disturbances[3]. The development of the monitoring plan for vegetation is addressed in the Landowners Guide[11] and the Operation and Maintenance Plan[12] for the demonstration project site.

No *Japanese Knotweed* [7], a non-native, *invasive* plant was noted in this reach at the time of the assessment survey.

[1] Broadstreet Hollow Management Unit 3 Map
[2] Volume II Appendix 3.1.5 Management Unit 3 Workbook.
[3] Volume II Section 2.2 Watershed Management Recommendations
[4] Volume II Section 2.2.1-Monitoring Cross Section and Summary Tables
[5] Volume I Sections 3.2.1&2 Stream Processes, Morphology and Classification
[6] Volume I Section 3.5 Fisheries and Wildlife
[7] Volume I Sections 3.4 & Volume II 2.2.2 Riparian Vegetation Issues and Recommendations
[8] Volume II 2.0 Stream Stability Restoration Projects, Techniques and Contact Information & Appendices
[9] Volume I Sections 3.4 & Volume II 2.2.2 Riparian Vegetation Issues and Recommendations
[10] Section 3.2.4.2 Broadstreet Hollow Geology