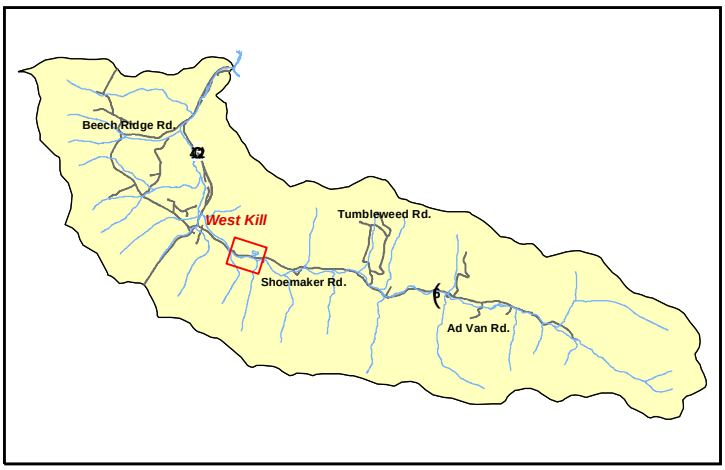


West Kill Management Unit 13

Stream Feature Statistics

40% of stream length is experiencing erosion
66% of stream length has been stabilized
11.1 acres of inadequate vegetation within the 300 ft. buffer
67 ft. of stream is within 50 ft. of the road
1 house located within the 100-year floodplain boundary

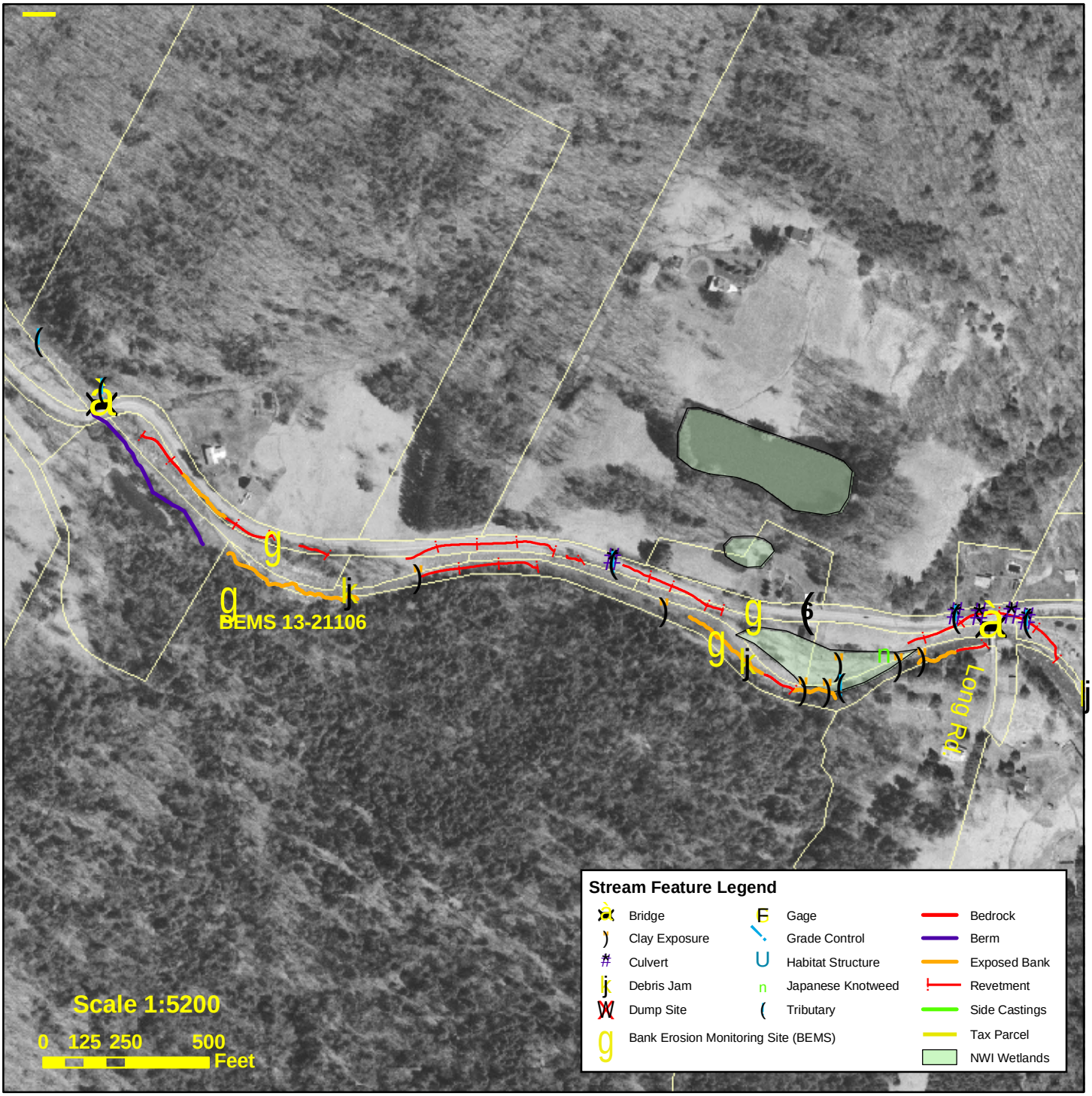


Figure 4.13.1 2004 aerial photography with stream feature inventory and tax parcels

Management Unit 13

Between Station 23489 and Station 20415

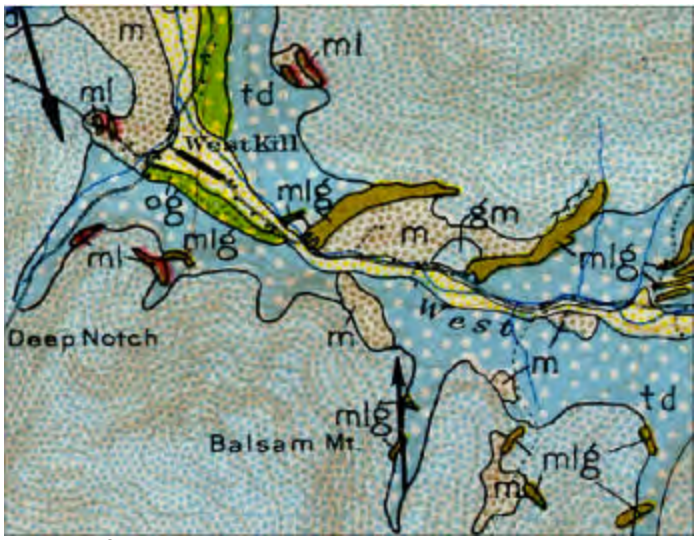
Management Unit Description

This management unit begins at the Long Road bridge crossing, continuing approximately 3074 ft. to the CR 6 Bridge. The drainage area ranges from 18.7 mi^2 at the top of the management unit to 19.6 mi^2 at the bottom of the unit. The valley slope is 1.65%.

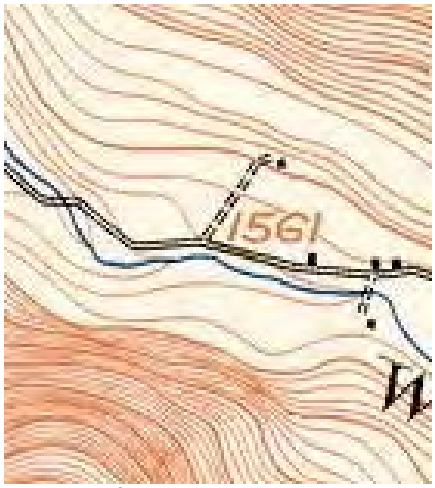
Summary of Recommendations Management Unit 13	
Intervention Level	Full Restoration throughout the unit.
Stream Morphology	Establish geomorphically appropriate channel dimensions, pattern and profile to the extent feasible.
Riparian Vegetation	Improve buffer function with riparian plantings Watershed wide Knotweed eradication program.
Infrastructure	Improve sediment transport continuity through installation of flood plain drains at Greene County Route 6 bridge.
Aquatic Habitat	Watershed wide study.
Flood Related Threats	Evaluate flood threats to the downstream hamlet originating in this unit.
Water Quality	Isolate sources of fine sediment through restoration.
Further Assessment	Geotechnical assessment of BEMS 13-21106.

Historic Conditions

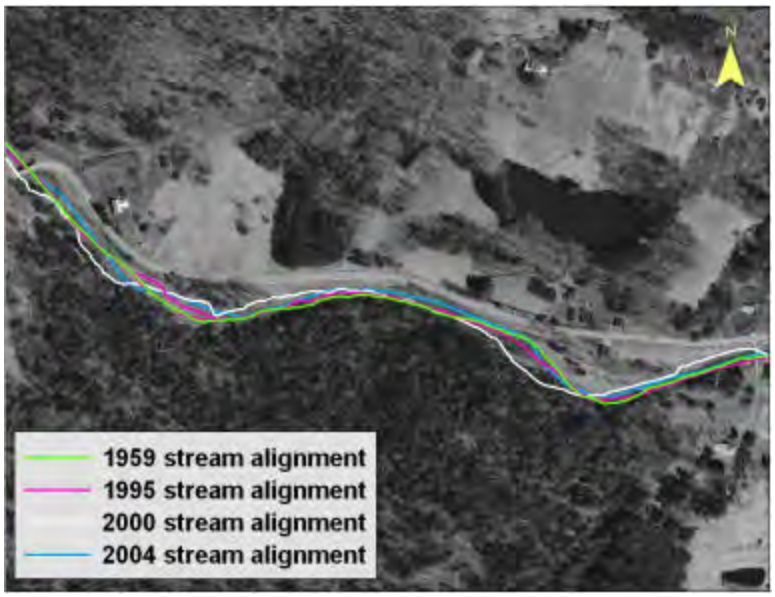
As the glaciers retreated about 12,000 years ago, they left their "tracks" in the Catskills. See Section 2.4 Geology of the West Kill Creek, for a description of these deposits.



Excerpt from Rich, 1935



Excerpt of 1903 USGS topographic map MU13



Historic Stream Channel Alignments in MU13

The channel through much of this unit is laterally controlled by the valley wall to the south, and Greene County Route 6 to the north. The narrow corridor allows minimal lateral adjustment of the channel, and any lateral adjustments impacting County Route 6 have been promptly suppressed. Lateral adjustment to the south is difficult to detect from aerial photography, due to the large volume of sediment that the valley wall will yield for every foot of bank retreat. As a result lateral migration is evident from the historical alignments only in reaches that are somewhat less confined. The magnitude of the migration, overall, is fairly minimal.

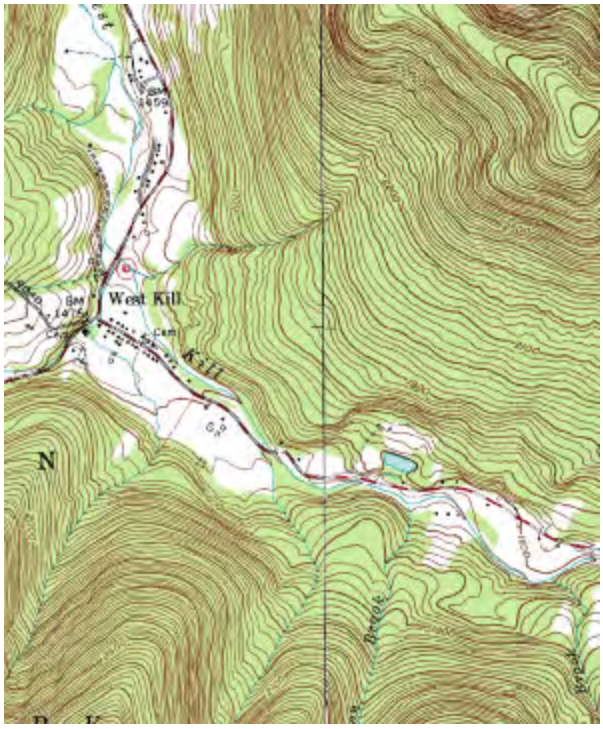
Stream Channel and Floodplain Current Conditions

Revetment, Berms and Erosion

The 2004 stream feature inventory revealed that 40% (1231 ft.) of the stream exhibited signs of active erosion along 3074 ft. of total channel length (Fig. 4.13.1). Revetment has been installed on a remarkably large 66% (2039 ft.) of the stream length. One berm, measuring 542 feet, was identified in this management unit at the time of the stream feature inventory.

Stream Morphology

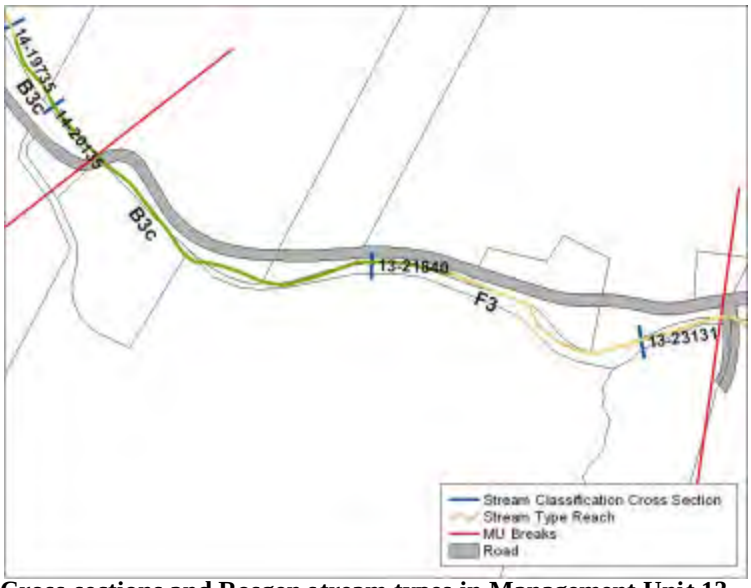
The following description of stream morphology references insets in the foldout Figure 4.13.2. "Left" and "right" references are oriented looking downstream. Stationing references proceed upstream, in feet, from an origin (Station 0) at the confluence with the Schoharie Creek at Lexington. Italicized terms are defined in the glossary. This characterization is the result of surveys conducted in 2004 and 2005.



Excerpt of 1980 USGS topographic

In Management Unit 13, the West Kill is confined between Greene County Route 6 and the glacial terrace at the valley wall to the south, as the valley becomes pinched near the confluence of Newton Brook. Glacial meltwater may have ponded behind an ice jam at this point, creating conditions for the development of lacustrine clay deposits, seen exposed in the channel bed and banks throughout this unit.

Stream morphology, or shape (i.e., slope, width and depth) changes several times in this unit (Fig. 5), creating small reaches with differing morphologic characteristics, which are classified as different *stream types* (See Section 3.2, Introduction to Stream Processes, for a description of stream types)



Management Unit #13 begins with a 1289 ft. reach of F3 stream type. The channel is *entrenched*, or confined within the stream banks during high flood events. The channel slope increases to 1.1% and the bed material is dominated by cobble.

Cross-sections and Rosgen stream types in Management Unit 13

Long Road bridge

Looking upstream

Looking downstream

The Long Road bridge marks the start of Management Unit 13. This bridge appears new and is in excellent condition. The span of this bridge is adequate to pass relatively high flows without channel constriction, but the channel meander just upstream of the bridge creates form roughness resulting in significant backwatering (Inset D, Fig. 4.13.2)

Rip-rap downstream of bridge, right

The right bank downstream of the bridge is reinforced with steel sheet pile at the toe, and rip-rap to the top of the bank. This treatment extends from above the bridge to approximately 275 ft. downstream of the bridge.

A perched culvert near the wing-wall of the bridge conveys road drainage under Greene County Route 6, and outfalls onto the rip-rap.

Culvert

Culvert

A second culvert under Greene County Route 6 conveys an unnamed tributary, and also outfalls onto the rip-rap.

Rip rap

The left bank downstream of the bridge is also rip-rapped for a distance of approximately 130 ft. The rip-rap appears to be new and is in good condition, however, the size of the stone is rather small for this setting.

Bank Erosion

Immediately downstream of the rip-rapped left bank, 128 ft. of bank erosion is observed. Riparian forest at the top of the bank may become threatened by continued erosion. A clay exposure at the toe of this bank is the first of five significant clay exposures identified between stations 23300 and 22900 (See Also Inset H, Fig. 4.13.2). Clay inputs into a stream are a serious water quality concern because they increase *turbidity*, degrade fish habitat, and can act as a carrier for other pollutants and pathogens.

Clay Exposure

Knotweed

During the 2004 and 2005 inventory, one stand of Japanese knotweed (*Fallopia japonica*), an invasive, exotic shrub species that can grow rapidly to crowd out more beneficial streamside vegetation, was observed here on the right bank. A program for eradication of Japanese knotweed throughout the West Kill valley is recommended. Just downstream of the knotweed, a monumented cross-section (Station 23131) verifies the F3 stream type.

Just before the channel bends to the right, Newton Brook joins the West Kill from the left. The tributary drains 0.5 mi^2 and has a quite steep, yet stable, approach through a well-forested floodplain.

Newton Brook confluence, left

Bank erosion, left

Immediately downstream of the tributary confluence, bank erosion is active on the left bank. This 148 ft. long slump failure has very high glacial till content. Two of the lacustrine clay exposures, mentioned above, lie at the toe of this failure. This failure has potential for significant woody debris introduction as sliding persists despite thick vegetation and root mat.

Rip-rap, left

Rip-rap has been installed for 103 ft. just downstream of the erosion, and is bounded on the downstream end by erosion as well. The rip-rap is intended to protect the toe of the slumping bank. The installation appears new, adequately sized, and in good condition.

Bank erosion, left

Down stream of the rip-rap, erosion continues for an additional 292 ft. The slump failure transitions to surficial terrace erosion. Clay rich glacial till is observed at the toe along the entire length of failure. This failure experiences extreme near bank stress, introduces excessive debris load, and has very low recovery potential (see Inset G, Fig. 4.13.2). This bank was significant enough to warrant detailed investigation as a Bank Erosion Monitoring Site (BEMS #12-22596). In a prioritization of twenty-one BEMS sites, throughout the West Kill watershed (see Section 3.3, Watershed Inventory and Assessment), this site ranked Medium Priority.

Bank erosion, left

A debris jam along this bank is evidence of the high volume of debris being introduced as a result of the undercutting of mature trees at the top of the bank. These trees span the channel, but create an obstruction at high flow (see Inset G, Fig. 4.13.2).

Debris Jam

Log Cribbing

As the channel again flows adjacent to Greene County Route 6, remnants of log cribbing in very poor condition are observed along approximately 335 ft. of the right bank. Rip-rap on the right bank has been installed to replace the center portion of the failing log cribbing. This steeply placed rock protects the Greene County Route 6 embankment, and is in good condition.

Rip-rap, right

Clay exposure, left

A glacial till exposure was documented on the left bank opposite the rip-rap. It is located at the toe of old healed erosion, with a lateral bar formed between the low flow channel and the exposure.

An unnamed tributary, culverted under Greene County Route 6, joins the West Kill from the right near station 22200. The tributary drains a pond on a residential area north of the road. Although the tributary is somewhat perched, the natural rock appears to provide adequate stabilization.

Tributary, right

Stacked Rock

A stacked rock wall stabilizes the road embankment just downstream of the tributary. The installation is old, and in poor condition. A narrow but well vegetated bench has formed at the toe of the stone wall.

Aggradation is noted immediately upstream of a significantly modified reach of channel. Gravel deposition, as seen here, is an expected channel response to marked changes in dimension, pattern, profile or roughness.

Aggradation

Rip-rap

In this case, rip-rap installed to stabilize Greene County Route 6 has modified the channel dimension, profile and roughness.

Damage to County Route 6 in 1996 and 1999 prompted rip-rapping of the entire channel cross-section along 450 ft. of the West Kill (Inset C, Fig. 4.13.2). The resulting channel has a reduced channel width and slope, and increased roughness, all contributing to a backwater condition in the reach immediately upstream. As a result, flow depths through the treatment during high flows were significantly increased, triggering a headcut at the outfall of the treatment. As the headcut migrates with future flow events, it is likely to destabilize the project, and threaten Greene County Route 6 once again. The coarse rock material used to line the channel also resulted in subsurface flow through the treatment during dry periods, forming a migration barrier and virtually eliminating aquatic habitat. Recommendations for this area include restoration of appropriate channel dimensions and slope, while not compromising the integrity of the structural measures installed to stabilize the adjacent roadway. Finer material should be applied to the channel to fill voids in the coarse rip-rap, and to promote surface flow through the treatment during low flows. Interplanting of the rip-rapped road embankment to enhance the longevity, aesthetic quality, habitat value and buffering capacity of the treatment is recommended.

Clay Exposure

At the downstream end of the rip-rapped channel, a clay exposure was documented at the toe of left bank and bed, on the approach to a hillslope failure. This failure is contributing a substantial volume of woody debris at the base of the left bank, creating significant obstruction at all flows.

Debris jam

Bank erosion, left

Along the outside of a bend back to the right, 474 ft. of extreme bank failure (see Inset E, Fig. 4.13.2) has been monumented as a Bank Erosion Monitoring Site (BEMS Station 13-21106). In a prioritization of twenty-one BEMS sites throughout the West Kill watershed (see Section 3.3, Watershed Inventory and Assessment), this site ranked High Priority, and rated as the second most severe erosion site in the West Kill watershed. The *thalweg*, or deepest part of the stream channel flows up against the glacial terrace here. The hillslope is being undermined by toe erosion, leaving large sections of the high bank unvegetated. The *exposed ice contact deposits* and *lacustrine* soils have a high silt and clay content, contributing sediment through both *wet and dry ravel* and yielding a significant suspended sediment load during high

Bank erosion, left

flows. The high volume of clay inputs into the stream from this site are a water quality concern, increasing *turbidity,* degrading fish habitat, and acting as a carrier for other pollutants and pathogens.


Bank erosion, left


Bank erosion, left

Full restoration is recommended for this site. This would likely involve establishment of a well-vegetated bench on the right with rock vanes to direct stream flows away from the left bank, and revegetation of the bank face. Geotechnical assessment, in-depth survey and design would be required to plan a stream restoration project at this site. A comprehensive engineer's report, West Kill Flood Mitigation Project, was prepared for this site, and is available at the Greene County Soil and Water Conservation District.


Bank erosion, left


Stacked Rock Wall

Proceeding downstream, set back on the bankfull bench on the right, 96 ft. of stacked rock wall retains the Greene County Route 6 embankment. The wall is in good condition. A forested buffer separates the wall from the channel, and debris on the bench suggests frequent inundation.

A second 160 ft section of stacked rock continues downstream, but in poor condition. The forested bench transitions to a vegetated point bar on the right.


Stacked Rock Wall


Bank erosion, right

As the channel straightens, 190 ft. of erosion is observed on the right bank where a section of the stacked rock wall has been undermined by toe scour, leaving the bank largely unvegetated. This was not monumented as a Bank Erosion Monitoring Site.

Downstream of the erosion, 178 ft. of stacked rock wall retain Greene County Route 6. There is no buffer between the bank and the road. Recommendations here include replacement of the lost revetment and planting of a riparian buffer using ecologically appropriate tree and shrub species between the road and the top of bank to enhance the function of the buffer, and improve fish habitat in this reach.

Stacked rock wall, right

Berm, left

Continuing downstream, an earthen berm was documented on the left. Sections of the berm have been retrofitted with flashboards mounted on salvaged rail road track stanchions, of which only remnants remain. A pond behind was noted behind the berm. Berms such as this, while created with the best of intentions, tend to raise flood elevations and increase the erosive power of the stream. It is recommended that the berms should be evaluated for their influence on floodplain connectivity and stream entrenchment, and that removal should be considered where there is significant deleterious impact.

Berm, left

Greene County Route 6 bridge

Management Unit 13 ends at the Greene County Route 6 bridge. The berm concentrates flood velocities on the bridge and inhibits flooding around, and increases stress on, the bridge. These conditions could threaten the stability of the bridge.

Route 6 bridge, looking downstream

Route 6 bridge, looking upstream

This bridge is scheduled for replacement. Recommendations for this site include coordination with the Greene County Highway Department to integrate replacement of the bridge into a comprehensive restoration, as proposed in the West Kill Flood Mitigation Project report, mentioned above.

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).

Throughout the unit, reaches are producing excess sediment supply due to hillslope erosion, exacerbated in part by aggradation, road encroachment and sediment transport discontinuity at the Greene County Route 6 bridge. More entrenched conditions in the upstream reaches of this management unit and excess sediment supply have resulted in reaches that are, alternately, under-effective and over-effective. Installation of flood plain drainage under bridge approach would likely reduce the backwater conditions and improve sediment transport continuity.

Riparian Vegetation

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. Mowed lawn does not provide adequate erosion protection on stream banks because it typically 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, which are adapted to our regional climate and soil conditions and typically require less maintenance following planting and establishment.

Some plant species that are not native can create difficulties for stream management, particularly if they are invasive. Japanese knotweed (*Fallopia japonica*), 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 of vegetation was conducted using aerial photography from 2005 and field inventories (Fig. 4.12.3). Japanese knotweed occurrences were documented as part of the stream feature inventory conducted during the summer of 2004, with additional occurrences identified in 2005.

In this management unit, the predominant vegetation type within the 300 ft. riparian buffer is Forest (63 %) followed by Herbaceous (22 %). *Impervious* area (5%) within this unit's buffer is primarily the Greene County Route 6, along with private residences and associated roads. One occurrence of Japanese knotweed was documented in this management unit during the 2004 and 2005 stream inventories.

National Wetland Inventory wetlands in MU13

There are 4 wetlands within this management unit mapped in the National Wetland Inventory (see Section 2.5, Wetlands and Floodplains for more information on the National Wetland Inventory and wetlands in the West Kill watershed). Wetlands are important features in the landscape that provide numerous beneficial functions including protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters, and maintaining surface water flow during dry periods (See Section 2.6 for wetland type descriptions and regulations). The most upstream wetland, which is 0.4 acres in size, is classified as *palustrine, unconsolidated bottom, permanently flooded, diked/impounded* (PUBHh). Moving downstream, the next wetland is 1.1 acres in size, and is designated *palustrine, scrub/shrub, broadleaved deciduous, temporarily flooded*, (PSS1A). Continuing downstream, the largest wetland in this management unit is 2.1 acres, the smallest wetland is 0.2 acres, and both are designated *palustrine, unconsolidated bottom, permanently flooded, diked/impounded* (PUBHh).

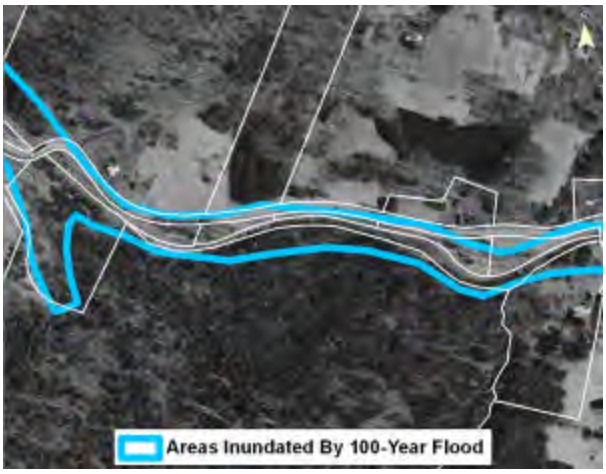
Areas of herbaceous (non-woody) cover present opportunities to improve the riparian buffer with tree plantings, to promote a more mature vegetation community along the streambank and in the floodplain. In November 2005, suitable riparian improvement planting sites were identified through a watershed-wide remote evaluation of current riparian buffer conditions and existing stream channel morphology. 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 long-term stream channel stability, 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 many cases, these sites can not be effectively treated with riparian enhancement alone, and full restoration efforts would include channel restoration components in addition to vegetative treatments.

Eighteen potential planting sites were documented within this management unit (Fig. 4.13.4). Recommendations for this site include planting native trees and shrubs along the edge of the stream bank and the upland area. Buffer width should be increased by the greatest amount agreeable to the landowners, but increasing the buffer width by at least 35 feet will increase the buffer functionality and improve stream bank stability while still allowing a significant lawn area.

Flood Threats

Inundation



100-year floodplain boundary in Management Unit 13

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. The NYS DEC Bureau of Flood Protection is currently developing new floodplain maps for the West Kill on the basis of recent surveys. These maps should be completed for the West Kill watershed in 2006.

According to this existing floodplain maps, there is 1 house located within the 100-year floodplain boundary in this management. The 100-year floodplain is that area predicted to be inundated by floods of a magnitude that is expected to occur once in any 100 year period, on the basis of a statistical analysis of the local flood record. Most communities regulate the type of development that can occur in areas subject to these flood risks. The current NFIP maps are available for review at the Greene County Soil & Water Conservation District office.

Bank Erosion

Most of the stream banks within the management unit are considered stable, but 40% (1231 ft.) of the stream length is experiencing major erosion, and their average height exceeds 23 feet. The notably high percentage of stream length that has been revetted indicates a history of instability. There are two Bank Erosion Monitoring sites in MU13, BEMS 13-22596 and 13-21106; They rank Medium and High Priority respectively.

Infrastructure

Sixty-six percent of the stream length in this management unit has been treated with some form of revetment, primary as protection for the Greene County Route 6 embankment.

Aquatic Habitat

It is recommended that a habitat study be conducted on the West Kill Creek, with particular attention paid to possible temperature barriers in aggrading sections, to the frequency of disturbance of the bed due to incision at numerous points in the system, and to embeddedness resulting from excessive entrainment of fine sediment.

Habitat was compromised throughout this management unit, with inadequate canopy cover, low diversity of bedform, physical and possible thermal barriers, and introduction of fine sediment from eroding banks.

Water Quality

Clay exposures and sediment from stream bank and channel erosion pose a potential threat to water quality in West Kill Creek. Clay and sediment inputs into a stream may increase *turbidity* and act as a carrier for other pollutants and pathogens. There were seven significant clay exposures identified in the 2004 Inventory, and 3 additional exposures identified in 2005,

Stormwater runoff can also have a considerable impact on water quality. When it rains, water falls on roadways and flows untreated directly into West Kill Creek. The cumulative impact of oil, grease, sediment, salt, litter and other unseen pollutants found in road runoff can significantly degrade water quality. There are three 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 numerous 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. No homeowners in this management unit made use of this program to replace or repair a septic system.

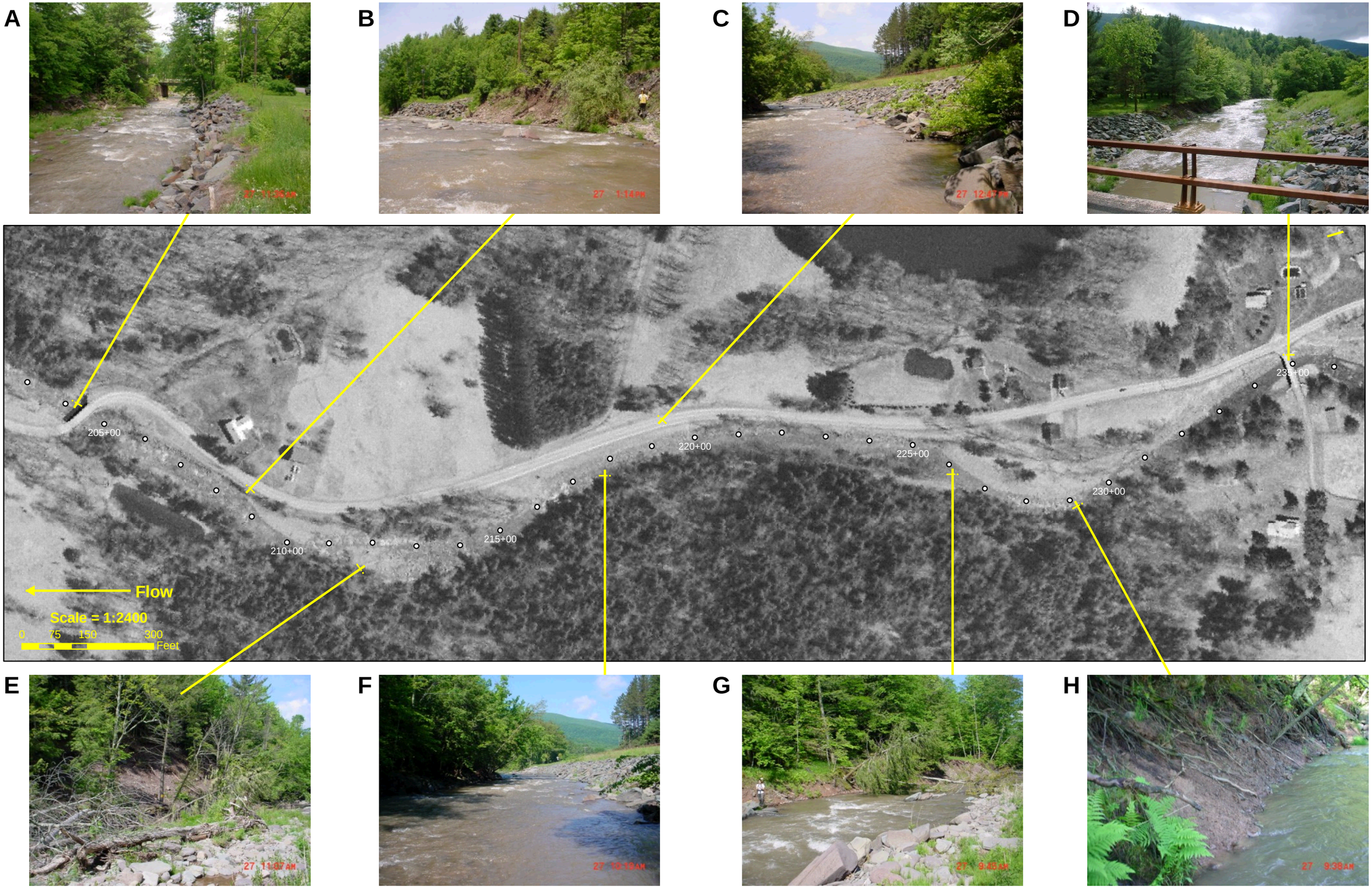


Figure 4.13.2 Management Unit 13 - 2004 aerial photography