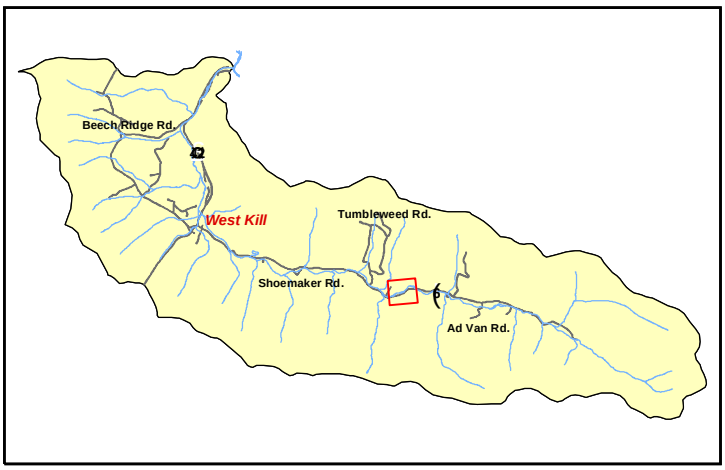


West Kill Management Unit 7

Stream Feature Statistics

15% of stream length is experiencing erosion
32% of stream length has been stabilized
14.8 acres of inadequate vegetation within the 300 ft. buffer
1,024 ft. of stream is within 50 ft. of the stream
4 houses located within the 100-year floodplain boundary

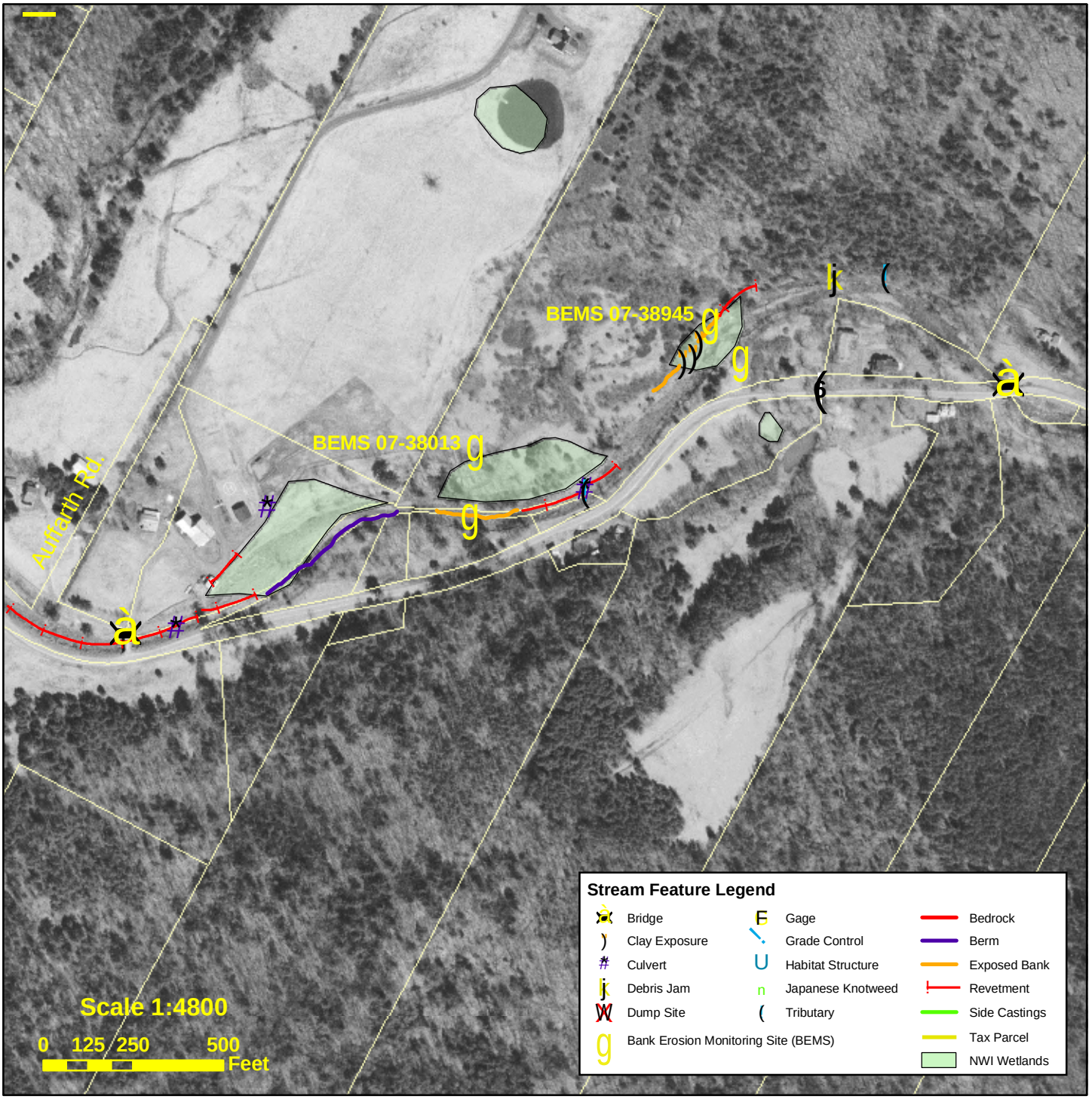


Figure 4.7.1 2004 aerial photography with stream feature inventory and tax parcels

Management Unit 7
Between 39851 and 36944

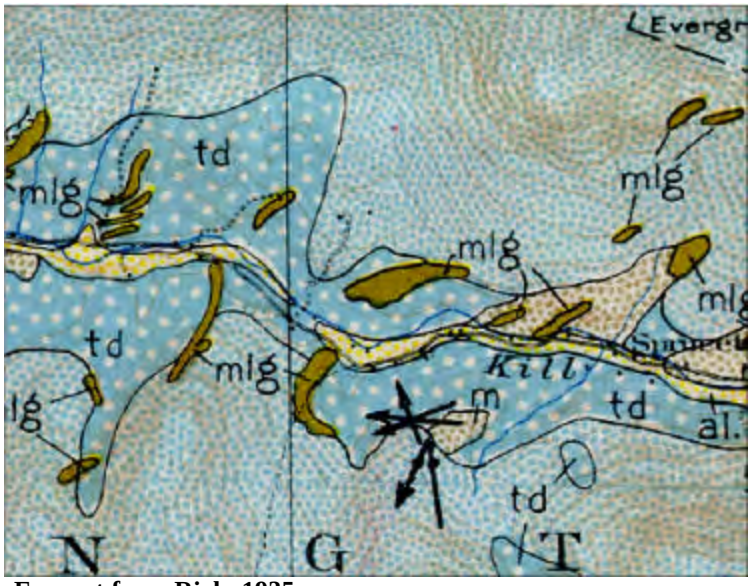
Management Unit Description

This management unit begins at the County Route 6 bridge at Station 39851, continuing approximately 2,907 ft. to the county bridge at Aufarth Road. The drainage area ranges from 10.8 mi^2 at the top of the management unit to 11.2 mi^2 at the bottom of the unit. The valley slope is 1.65%.

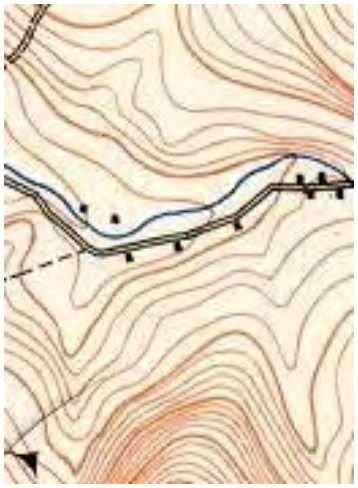
Summary of Recommendations Management Unit 7	
Intervention Level	Full Restoration at BEMS 06-40777 Assisted Self-recovery at aggradational sites.
Stream Morphology	Identify sources of excess sediment, improve sediment transport continuity and increase overall sediment transport capacity.
Riparian Vegetation	Potential plantings along aggradational reaches at the head and tail of the unit. Increase buffer width in downstream reaches, right.
Infrastructure	Interplanting of rip-rap installations.
Aquatic Habitat	Watershed-wide study. Investigate aggradational reaches for potential temperature and physical barriers.
Flood Related Threats	Mitigate inundation of garage near Aufarth Road.
Water Quality	Isolate fine sediment sources. Investigate stormwater management opportunities.
Further Assessment	Hydraulic study of bridge at Aufarth Road.

Historic Conditions

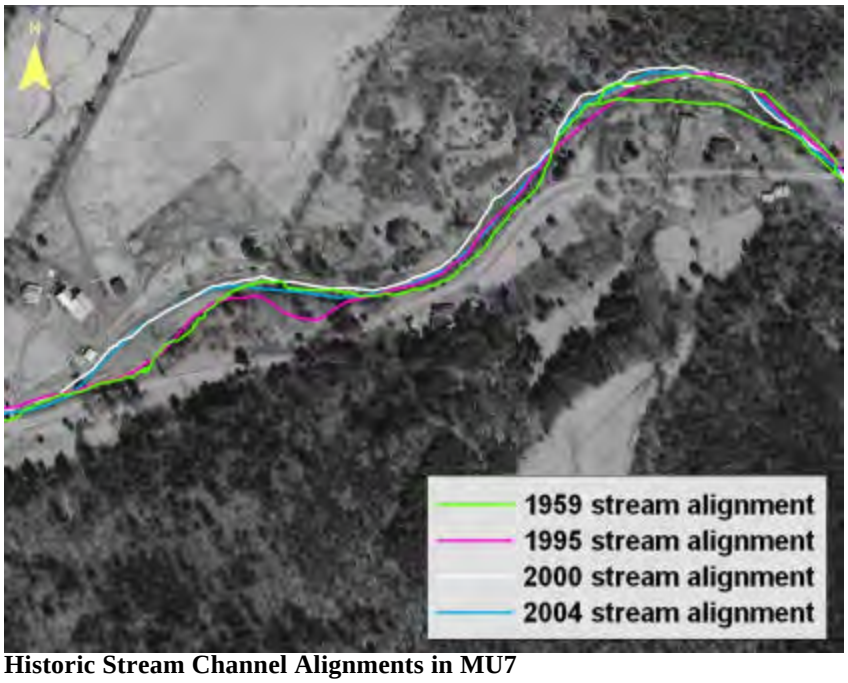
As the glaciers retreated about 12,000 years ago, they left their "tracks" in the Catskills. See Section 2.4, Geology of the West Kill Creek, for a description of these deposits.



Excerpt from Rich, 1935



Excerpt of 1903 USGS topographic map



Historic Stream Channel Alignments in MU7

As seen from the historical stream alignments, the channel alignment has changed significantly over the years with some areas exhibiting nearly 100 ft. of lateral channel migration during the period between 1995 and 2000.

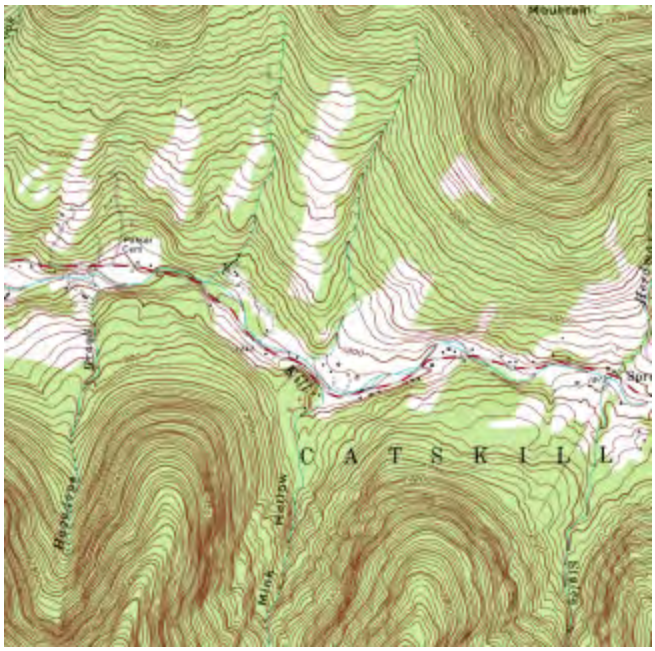
Stream Channel and Floodplain Current Conditions

Revetment, Berms and Erosion

The 2004 stream feature inventory revealed that 15% (433 ft.) of the stream length exhibited signs of active erosion along 2,907 ft. of total channel length. Revetment has been installed on 32% (920 ft.) of the stream length. One extensive berm, measuring 444 ft. long, 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 4.7.2. "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.

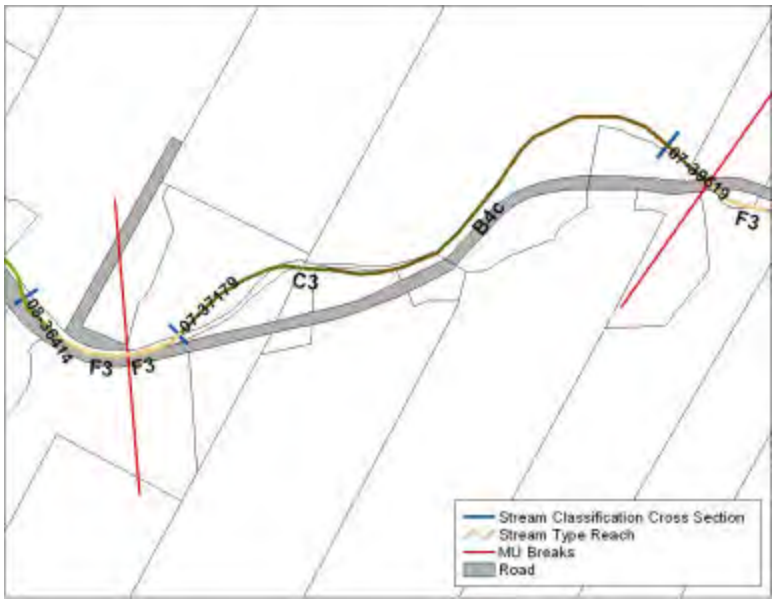


Excerpt of 1980 USGS topographic map

In Management Unit 7, the West Kill crosses to the north side of Spruceton Road, but remains relatively confined between the glacial terrace and the road. Sinuosity increases modestly, but the *floodplain* is pinched in places where the terrace and road converge, and the result is several exposures of glacial *till*. The low sinuosity, or curviness, and *beltwidth*, or the width of the stream corridor from outside-to-outside of meanders, are uncharacteristic of this valley slope, and due to the proximity of the channel to the northern valley terraces, the reach may be producing more sediment than it stores, through the entrainment of material scoured from the toe of these hillslopes, as well as from the bed of the stream in *incising*, or downcutting, reaches. Streams in valleys of this gradient tend to dissipate stream power laterally during high flows, with excess *shear stress*, or the force the stream exerts in the direction of its flow, often producing erosion of streambanks. In contrast, steeper streams often dissipate excess energy on the streambed, resulting in *incision*.

Stream morphology, or shape (i.e., slope, width and depth) changes several times in this unit, creating small reaches with differing morphologic characteristics, which are

classified as different *stream types* (See Section 3.2, Introduction to Stream Processes, for description of stream types).

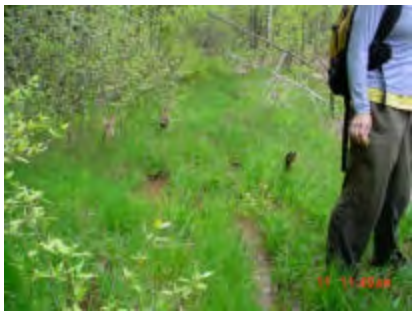


Cross-sections and Rosgen stream types in Management Unit 7

As entrenchment moderates coming out of the Greene County Route 6 bridge, Management Unit 7 (MU7) begins. A monumented cross-section (Station 39619) documents an approximately 1951 ft. long reach of B4c streamtype. The dominant bed material changes to gravel, and slope reduces to 0.9%.

Aggradation, as documented here at the time of the stream feature inventory, is a typical response to marked reductions in channel slope. Over widening, accelerated bar development and historic channel migration in the reaches below the bridge suggest that this process is on going, and has been for some time.

Aggradation downstream of bridge



Tributary, right

As the channel bends to the left, a small unnamed tributary enters from the right. The tributary flows across a well vegetated low floodplain, before spilling over a small shelf at the confluence. Knotweed was noted on the right bank near the tributary confluence. During the 2004 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. In the 2005 inventory, the number of stands throughout the management unit had increased to four. A program of eradication of Japanese knotweed throughout the West Kill valley is recommended.

Debris jam

A center bar begins near station 39300. A large debris jam is accumulating at the head of the center bar, promoting continued development of the center bar. The debris causes an obstruction only at high flow, while the low flow channels, at both the left and right, remain clear.

Headcut at convergence, looking upstream

The left and right channel threads converge at the tail of the center bar near station 39000 (Inset H, Fig. 4.7.2). A headcut is evident near the convergence of the two channel threads, with several exposures of clay in the reaches immediately downstream of the headcut.

Rip rap

Rip-rap toe protection has been installed in the lower third of the bend to the left. The rip-rap protects the toe of a previously eroded bank. The condition of the rip-rap is poor and continues to decline toward the downstream end of the installation.

Toe scour prevails at the downstream end of the rip-rap, resulting in significant bank erosion (Inset D, Fig. 4.7.2). This site is documented as a Bank Erosion Monitoring Site (BEMS 07-38945). 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. The *thalweg*, or deepest part of the stream channel flows up against portions of the hillslope here. The *glacial till* soils have a high silt and clay content, yielding a significant suspended sediment load during high flows. 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.

Bank Erosion, looking upstream

Clay Exposure

The photo above depicts the nature of the glacial till found in the eroded bank, and several other nearby clay exposures in both the bed and banks of this reach.

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 right bank, and revegetation of the bank face. In-depth survey and design would be required to plan a stream restoration project at this site.

Bank erosion, looking upstream

As Greene County Rte. 6 again begins to encroach on the stream corridor, and channel confinement increases, bank erosion is evident on the right bank (Inset C, Fig. 4.7.2). A small lateral bar at the toe of the erosion has begun to vegetate, improving the recovery potential of this bank exposure. This site was not documented as a Bank Erosion Monitoring Site.

Rip Rap, looking upstream

The stream continues to run adjacent to Greene County Rte. 6 for approximately 600 ft. Before the stream departs from the roadway, rip rap is found protecting the road embankment and a small parking area for the bed and breakfast on the opposite side of the road. The upstream portions of the rip-rap installation are older and appear to be made of material drawn from the stream channel. A gravel bar colonized by willows has formed at the toe of the older portion of the rip-rap. The newer section of the installation at the downstream end is made of angular quarry stone, and has no vegetation at its toe. Interplanting of this rip-rap installation is recommended to improve the longevity of the treatment while also enhancing the riparian buffer. Near the mid-point of the rip-rap, two 36 inch culvert pipes emerge from the left bank, conveying an unnamed tributary and road drainage under County Route 6 (Inset G, Fig. 4.7.2). The culverts are somewhat perched, but have adequate outfall protection.

Double culvert

Bank Erosion

As the channel begins to depart from County Route 6, at the downstream end of the rip-rap, 234 ft. of bank erosion is documented. Aggradation in this reach has formed a transverse bar, resulting in erosive cross currents, exacerbating the erosion problem at this low terrace. This site is documented as a Bank Erosion Monitoring Site (BEMS 07-38013). In a prioritization of twenty-one BEMS sites throughout the West Kill watershed (see Section 3.3, Watershed

Aggradation

Inventory and Assessment), this site ranked Low Priority. Continued monitoring of this site is recommended.

Increased bed elevations have been the result of aggradation in this reach, and the channel is now more connected to its floodplain than it was in the reach immediately upstream. Evaluation of LIDAR data, made available through a NYSDEC flood study, reveals a 700 ft. reach of C3 stream type.

Berm

A fairly old berm, made of side cast stream material, begins just down stream of the erosion, on the left. It confines the channel for approximately 444 ft., preventing flood water from accessing the terrace floodplain beyond the berm.

Culvert

A culvert, intended to convey upland drainage is documented on the right bank. The culvert outfall is perched on the hillslope, and flows down onto a bankfull bench. Though the outfall of this culvert is not badly eroded, rock outfall protection is recommended in order to preserve the stability of the bank.

Rip Rap, right

Approximately 100 ft. downstream of the culvert, rip-rap has been installed on the right bank (Inset B, Fig. 4.7.2). The rip-rap protects a garage located immediately at the top of the bank. The garage and its contents are threatened by both erosion and inundation in the event of a large flood event.

As the berm on the left ends, and County Route 6 draws close to the channel near Aufarth Road, rip-rap is found on the left bank at the back of a large cobble bar. This old rip-rap once protected County Route 6 when the West Kill was located in a now relic channel at the toe of the rip-rap.

Rip Rap, left

Rip Rap

As the channel approaches the Aufarth Road bridge, the channel becomes increasingly confined. A monumented cross-section (station 37179) documents a 256 ft. reach of F3 stream type. The channel slope increases to 1.7% and the stream bed material is dominated by cobble.

The Greene County Route 6 embankment, on the left of this confined approach, is protected by large angular rip-rap. The rip-rap continues downstream of the bridge, extending into Management Unit 8, and is in good condition. Gravel deposits upstream of bridges are commonly caused by inadequate sizing of the bridge opening. An undersized bridge opening causes water to back up upstream of the bridge, reducing stream velocity, which results in sediment deposition. In high stage, the floodwater may seek conveyance through alternative paths, forming new channels around the bridge constriction, as appears to have happened at this site. Additional *floodplain drainage*, using culverts set at the floodplain elevation under the north bridge approach, may help mitigate this problem. Even bankfull flows appear to be constricted by this bridge, and higher flows likely backwater, resulting in the upstream aggradation.


Aufarth Road Bridge

Recommendations in this area include interplanting of the rip-rap, enhancement of the riparian buffer on both the left and right floodplains, and hydraulic analysis of the bridge at Aufarth Road to determine its capacity to convey flood flows.

A culvert approximately 150 ft. upstream of the bridge conveys road drainage under Greene County Route 6, and outfalls onto the rip-rapped road embankment.

Aufarth Road marks the downstream end of Management Unit 7 (Inset A, Fig. 4.7.2).

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).

This management unit suffers from wide-spread sediment transport deficiencies. Bed load transported through Management Unit 6 exceeds the transport capacity of this management unit, resulting in channel aggradation, lateral migration and headcutting. Sediment transport equilibrium appears to return through the middle reaches of this unit before being once again disrupted by backwatering at the Aufarth Road bridge. Recommendations for Management Unit 7 include investigation of upstream sediment sources contributing to aggradation in the upper reaches, and hydraulic analysis of the bridge at Aufarth Road to quantify the backwater affect of high flows.

Riparian Vegetation

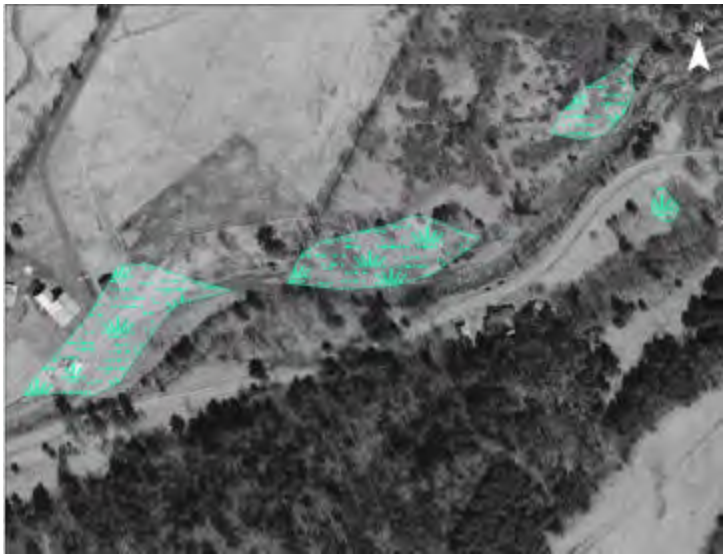
One of the most cost-effective methods for landowners to protect streamside property is to maintain or replant a healthy buffer of trees and shrubs along the bank, especially within the first 30 to 50 ft. of the stream. A dense mat of roots under trees and shrubs

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. 4.7.3). 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 (50 %) followed by Herbaceous (30 %). *Impervious* area (5 %) within this unit's buffer is primarily the Greene County Route 6, along with private residences and associated roads. Four occurrences of Japanese knotweed were documented in this management unit during the 2005 inventory.



National Wetland Inventory wetlands in MU7

There are four 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 upstream most wetland is 0.5 acres in size, and is classified as Riverine, Upper Perennial, Unconsolidated Shore, Temporarily Flooded (R3USA). The smallest wetland in this unit is 0.1 acres in size, and is classified as Palustrine, Unconsolidated Bottom, Semipermanently Flooded, Diked/Impounded (PUBFh). The wetland near the middle of the management unit is 1.2 acres in size, and is classified as Palustrine, Scrub-Shrub, Broad-Leaved Deciduous, Temporarily Flooded (PSS1A). The downstream most wetland is 1.5 acres in size, and is classified as Riverine, Upper Perennial, Unconsolidated Shore, Temporarily Flooded (R3USA).

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 (Fig. 13). 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.

Forty-two potential planting sites were documented within this management unit (Fig.4.7.4).

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

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

100-year floodplain boundary in Management Unit 5

identify areas prone to flooding. The current FIRMs indicate that there are 4 houses in this management unit within the 100 year floodplain. 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.

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, although 15% (433 ft.) of the stream length is experiencing major erosion, and 32% (920 ft.) has been stabilized.

There are two Bank Erosion Monitoring sites in MU7, and one (BEMS 07-38945) has extensive clay exposures and is contributing significant amounts of fine sediment to the stream. BEMS 07-3895 is ranked as a Medium Priority, and BEMS 07-38013 is ranked as a Low Priority.

Infrastructure

Thirty-two percent of the stream length in this management unit has been treated with some form of revetment. However, there are no immediate threats to roadways or bridges in this management unit.

Aquatic Habitat

It is recommended that a habitat study be conducted on the West Kill Creek, with particular attention paid to possible physical and 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.

Two areas of extensive aggradation, combined with weak riparian vegetation and canopy cover, make thermal barriers a special concern in this management unit. Fine sediment inputs from several clay exposures documented in the unit can lead to embeddedness and degrade spawning habitat.

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 three significant clay exposures documented in this management unit, which should be addressed through Full-Restoration.

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. Thirty-five percent of the stream lies within 50 ft. of a road. Opportunities should be investigated to construct small wetlands in the unit for stormwater treatment.

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 four 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 4.7.2 Management Unit 7 - 2004 aerial photography