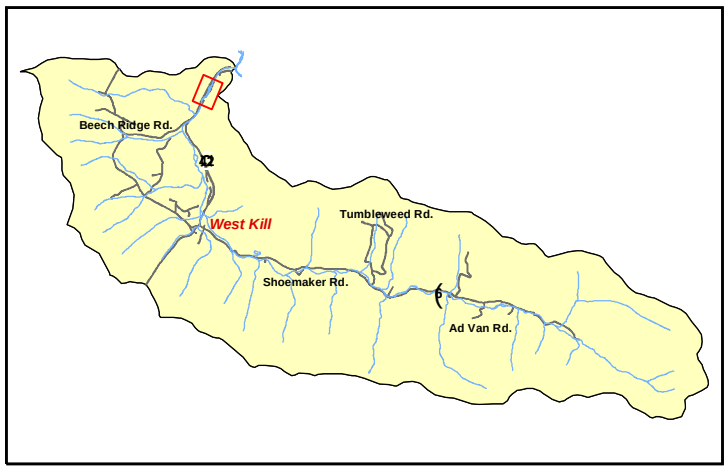


West Kill Management Unit 20

Stream Feature Statistics

43% of stream length is experiencing erosion
17% of stream length has been stabilized
20.9 acres of inadequate vegetation within the 300 ft. buffer
227 ft. of stream is within 50 ft. of the road
1 house located within the 100-year floodplain boundary

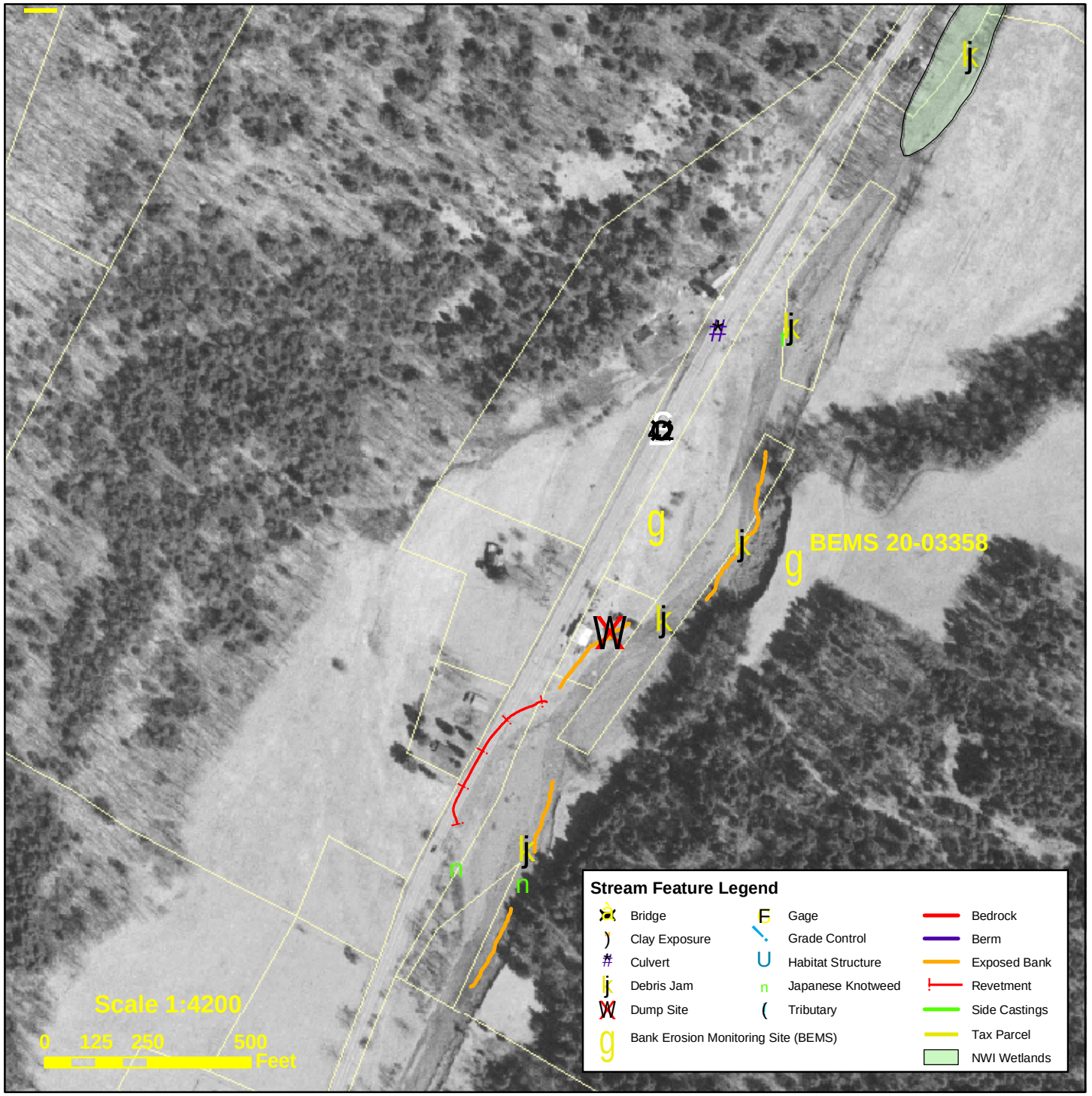


Figure 4.20.1 2004 aerial photography with stream feature inventory and tax parcels

Management Unit 20

Between Station 4778 and Station 2317

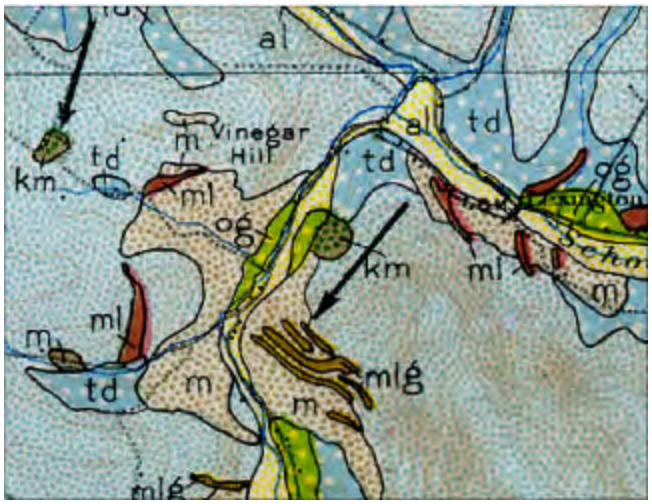
Management Unit Description

This management unit begins approximately 750 ft. downstream of the confluence of Roarback Brook, continuing approximately 2,461 ft., ending approximately 700 ft. upstream of the NYS Route 42 Bridge. The drainage area ranges from 30.7 mi^2 at the top of the management unit to 31.1 mi^2 at the bottom of the unit. The valley slope is 0.83%.

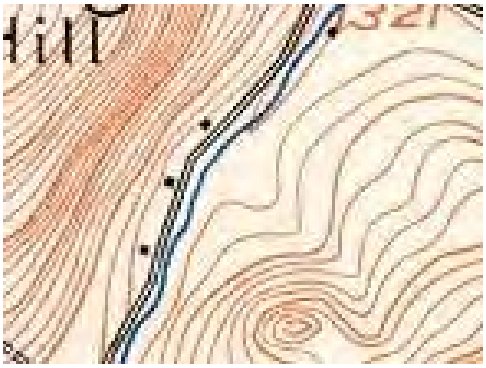
Summary of Recommendations Management Unit 20	
Intervention Level	Full Restoration throughout the management unit.
Stream Morphology	Restore equilibrium morphology.
Riparian Vegetation	Improve riparian vegetation throughout entire unit Eradicate knotweed.
Infrastructure	None
Aquatic Habitat	Watershed-wide study.
Flood Related Threats	Restore eroding banks.
Water Quality	Isolate fine sediment sources. Remove formerly buried refuse.
Further Assessment	Sediment transport modeling.

Historic Conditions

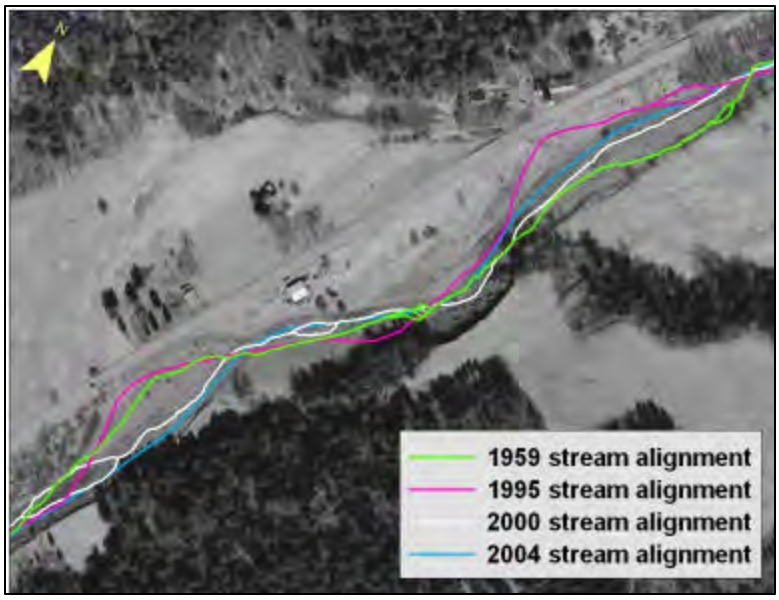
As the glaciers retreated about 12,000 years ago, they left their "tracks" in the Catskills. See Section 2.4 Geology of the West Kill Creek, for a description of these deposits.



Excerpt from Rich, 1935



Excerpt of 1903 USGS topographic map MU20



Historic Stream Channel Alignments in MU20

As seen from the historical stream alignments, the channel alignment has changed significantly over the years.

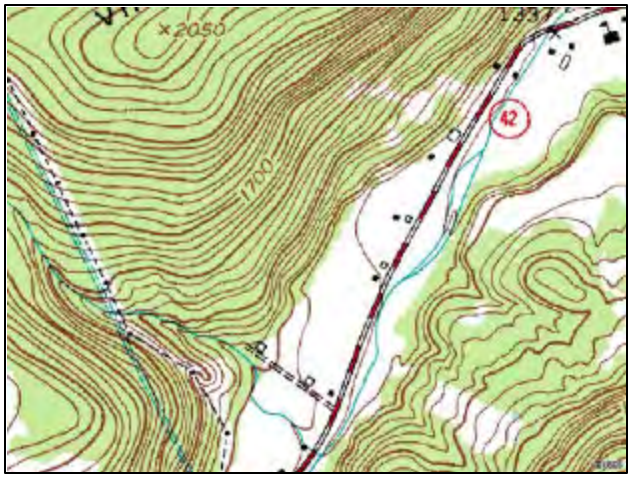
Stream Channel and Floodplain Current Conditions

Revetment, Berms and Erosion

The 2004 stream feature inventory revealed that 43% (1055 ft.) of the stream exhibited signs of active erosion along 2461 ft. of total channel length (Fig. 4.20.1). Revetment has been installed on 17% (406 ft.) of the stream. No berms were 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 4.20.2. "Left" and "right" references are oriented looking downstream. Italicized terms are defined in the glossary. This characterization is the result of surveys conducted in 2004 and 2005.

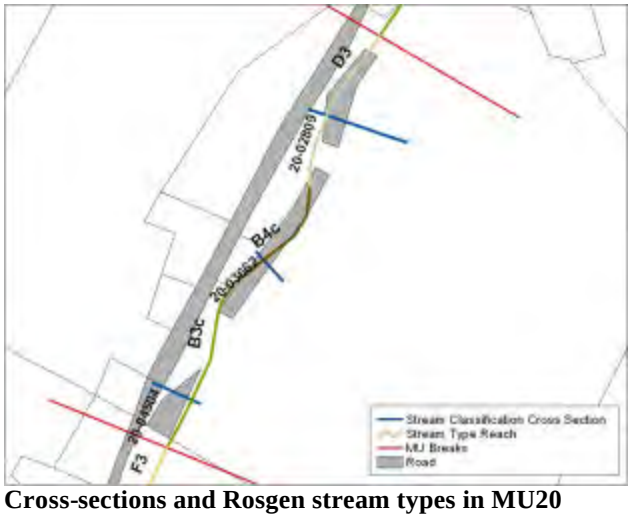


Excerpt from USGS topographic map, Lexington quadrangle

Emerging in Management Unit 20 fully onto the broad glacial / alluvial flat created by the confluence of the West Kill with Schoharie Creek less than a mile downstream, the channel conditions change radically from the previous unit. Bankfull channel width is nearly double, and water surface slope nearly half, of the averages upstream. While the entrenchment ratio used in morphological classification ranks as "Moderate", the large bankfull width means that even moderate entrenchment here offers sufficient floodplain area to moderate in-channel shear stress in large flow events. In fact, there is excess channel / floodplain connectivity through much of the unit. As a result, the unit is generally aggradational, and serves as a storage area for excess sediment supplied by the large slides just upstream. Aggradation, in turn, leads to *lateral migration*, or channel shifting, as the erosional force of flood flows is exerted on strambanks. This accounts for the high percentage of eroding streambanks in the unit, introducing substantial additional sediment. In the final reach of the unit, this excess sediment supply leads to channel *braiding*, with numerous channel threads.

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 a description of stream types).

Management Unit #20 begins with a 828 ft. reach of B3c stream type, as documented by a monumented cross-section at Station 4504. The channel is moderately *entrenched*, or somewhat confined within the stream banks during high flood events. The bankfull channel width is nearly double that of the reach upstream, channel slope is a very flat 0.4 % and the bed material is dominated by cobble, but with abundant gravel.



Cross-sections and Rosgen stream types in MU20

Aggradation

As the valley opens up and the extreme entrenchment that characterized the previous management unit moderates, higher flows develop excessive access to the floodplain (see Inset H, Fig. 4.20.2). Overwide channels lose their ability to transport the stream's *bedload*. Under these conditions streams often *aggrade*, or rise in stream bed elevation due to the excessive deposition, as is seen here. As a result of this aggradation, the bankfull width of the channel doubles here, producing potential thermal impacts on fish habitat during summer low flows.

These aggradational conditions and poor riparian vegetation have led to erosion of 219 ft. of the alluvial terrace on the right through toe scour. Although there was some evidence of revegetation of the bank face, initial development of a point bar on the left indicates that the site may be trending to a more sinuous morphology (see Inset D, Fig. 4.20.2) in response to the aggradational conditions.

Bank erosion, right

The land beyond the bank on the alluvial terrace is part of the Vinegar Hill Wildlife Preserve. This 394 acre NYSDEC site is apparently maintained in grassland and shrub-scrub as wildlife habitat.

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 both banks. On the right, a small isolated stand was documented near the water's edge, and on the left, a larger stand growing on the floodplain beneath a willow (undetermined Salix spp.) canopy.

Knotweed, right

Knotweed, left

The floodplain on the left has abundant willows, and this site presents an opportunity to observe competition between the two species. Both species thrive in floodplain conditions, but one, the willow, dramatically increases soil cohesion due to its deeper and denser root structure, and the other, because of its shallow root structure, actually encourages erosion. A program of eradication of Japanese knotweed throughout the West Kill valley is recommended.

Bank erosion on alluvial terrace, right

As the channel begins to bend gently to the left, large woody debris begins to be seen in this reach, with a large rootball and trunk lodged at the upstream end of another 180 ft. length of eroding bank, the result of toe scour on the right (see Inset C, Fig. 4.20.2).

Large woody debris, right

The large woody debris provides some obstruction at all flows, and may actually be encouraging the revegetation of this alluvial terrace bank, by directing the main flow to the left; some sedge is establishing at the toe.

Rip-rap along NYS Route 42

Across the channel, approximately 100 ft. of point bar and floodplain currently separate the active channel from the NYS Route 42 road embankment (Inset G, Fig. 4.20.2), which is protected by 406 ft. of dumped rip rap, in good condition. While a narrow band of the floodplain adjacent to the rip-rap is now well-vegetated, historic aerial photography indicates that the channel flowed against the road here before the 1996 flood.

Bank erosion

As the channel crosses over to flow against the alluvial terrace on the left, another 240 ft. length of erosion, again caused by toe scour, has exposed a formerly buried dumpsite in the floodplain (see Inset F, Fig. 4.20.2). The refuse appears to be old farm machinery and garbage, and should be removed.

Dump site exposed by erosion, left

As the channel crosses back over to the left at this dump site, a monumented cross-section (Station 3662) documents the change to a 750 ft. reach of B4c stream type, as the dominant bed material transitions to gravel and the bankfull width narrows.

Large woody debris, right

Throughout this reach, sedges are establishing at the toe of the banks, and large boulders are fairly abundant in the channel, some of which may be placed. At the tail of the point bar on the right, large woody debris has accumulated, but presents little obstruction of flows.

Eroding glacial terrace, right

As the channel flows up against the glacial terrace on the right bank (Inset B, Fig. 4.20.2) a high, 415 ft. section of erosion has been monumented as a Bank Erosion Monitoring Site (BEMS Station 20-3358). In a prioritization of twenty-one BEMS sites throughout the West Kill watershed (see Section 3.3, Watershed Inventory and Assessment), this site was ranked High Priority. The *thalweg*, or deepest part of the stream channel flows up against the high hillslope, which is stratified with multiple sand and silt layers, and is being undermined by toe erosion, leaving most of the stream bank unvegetated. The exposed *lodgement till* 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 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. Large mature trees continue to be introduced into the channel at the toe of the slope, as the failure enlarges upstream and downstream. The amount of sediment introduced here – including a substantial volume of fine gravel– as well as the obstruction caused by the woody debris, has produced aggradation at the downstream end of the failure, inducing lateral flow.

Debris jam

Aggradation

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 bank, regrading and then revegetation of the bank face, and establishment of channel geometry throughout the unit to more effectively convey the sediment load.

To ensure that any work at this site is not compromised by excessive sediment supply from upstream, this site should be designed and constructed as part of a comprehensive project including both Management Unit 19 and 20. Due to its valley morphology, MU20 is appropriately a sediment storage area; managing sediment transport and storage issues in a manner that won't exacerbate the instability of the hillslopes in the reaches just upstream will require additional assessment and modeling, as well as in-depth survey and design.

Culvert

Just downstream of the erosion, the glacial terrace wall bends sharply away from the channel on the right, and the right bank transitions to a much lower alluvial terrace. The aggradation continues, as the floodplain becomes even more connected on the left, where a small, unnamed tributary, draining the southeastern face of Vinegar Hill, enters. At the edge of the floodplain, the tributary crosses NYS Route 42 through a small, concrete, closed-bottom box culvert. This tributary ran subsurface through the floodplain at the time of the Inventory.

Knotweed, amid debris

The channel widens dramatically again here and transitions to a 883 ft. reach of D3 stream type, as documented by a monumented cross-section at Station 2804. D3 stream types are very sensitive to disturbance and have a poor potential for natural self-recovery without intervention. This stream type indicates that at bankfull flows, there are multiple channel threads, the ratio of stream width to mean depth is greater than 40, and the dominant bed material is cobble. Slope increases notably here at the downstream end of the aggradational setting.

Tree and woody debris on center bar

A mid-channel bar has developed around a live tree now standing in the middle of the channel, which has a large jam of woody debris lodged against it. Additional piles of woody debris have accumulated on the right bar. In total, these debris jams present a major obstruction at bankfull and higher flows. Several stands of Japanese knotweed grow among the debris piles.

At the end of the management unit, the multiple channel threads begin to converge into a narrower single channel, slope continues to increase and the floodplain narrows on the approach to the NYS Route 42 bridge crossing in the final management unit.

End of MU20

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).

Excess sediment supply from unstable reaches in the previous management unit produce aggradational conditions in Management Unit 20. The result has been lateral channel migration, which adds additional local sediment, further compounding the problem. Without intervention, these aggradational conditions are likely to continue, further destabilizing the upstream reaches by reducing the channel slope and increasing erosional pressure on the banks. There is a further risk that, at the downstream end of the aggradation in MU20, slopes will increase sufficiently to induce a headcut that will migrate headward, increasing entrenchment and further destabilizing the streambanks. The result is a feedback loop in the sediment transport processes in MU19 and MU20.

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 Herbaceous (48 %) followed by Forest (25 %). *Impervious* area (5%) within this unit's buffer is primarily the State Route 42, along with private residences and associated roads. Three occurrences of Japanese knotweed were documented in this management unit during the 2004 and 2005 stream inventories.

There are no 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).

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.

Twenty-seven potential planting sites were documented within this management unit (Fig. 4.20.4).

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

100-year floodplain boundary in Management Unit 20

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. 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 one house located within the 100-year floodplain boundary in this management unit. 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

A notably high percentage, 43% (1055 ft.), of the stream within this management is experiencing major erosion. There is one Bank Erosion Monitoring site in MU20 (BEMS 20-03358). The current channel morphology here is unlikely to self-recover in the near term, and is aggravating instability in the previous management unit. As a result, a comprehensive analysis and treatment of flood-related erosion risks in MU 19 and MU20 is recommended.

Infrastructure

Seventeen percent of the stream length in this management unit has been treated with some form of revetment. This revetment currently experiences little threat from high flows.

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 impaired throughout this management unit, with inadequate canopy cover, possible temperature barriers in a number of locations, low diversity of bedform 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 no significant clay exposures identified in the 2004 Inventory, because only lacustrine clay exposures were mapped in that inventory. Two clay-rich lodgement till exposures were 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 is one stormwater culvert in this management unit, but under lower flows, it appears to benefit from some natural filtration on its way through a vegetated floodplain.

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.

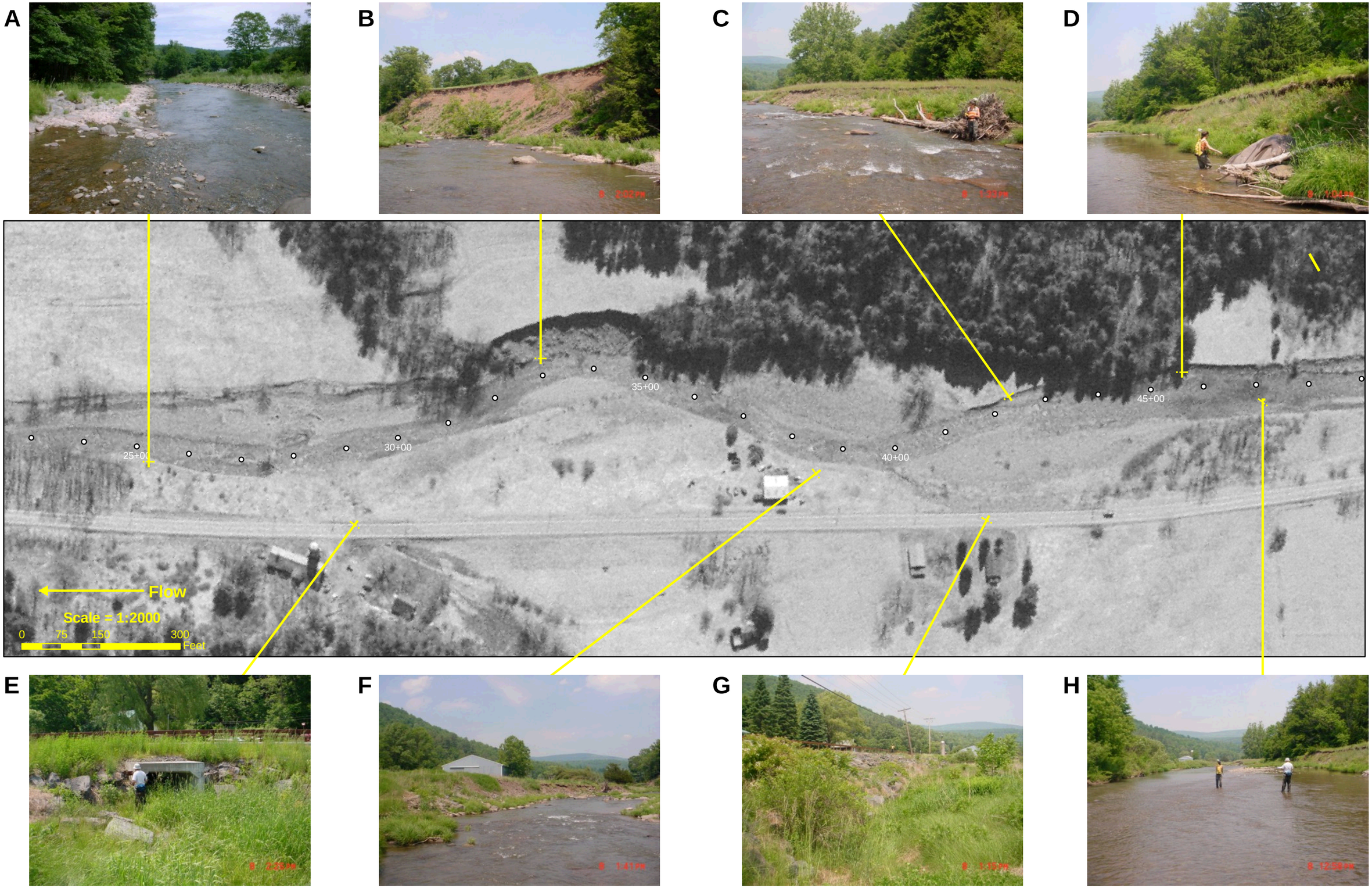


Figure 4.20.2 Management Unit 20 - 2004 aerial photography