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June 30, 2024

<u>Via Electronic Mail</u>

Courteny Morehouse
Berkshire Regional Planning Commission
1 Fenn St., Suite 201
Pittsfield, MA 01201

Re: North Branch Hoosic River assessment at former site of Briggsville Dam

Dear Ms. Morehouse:

This letter discusses a geomorphic assessment of the North Branch Hoosic River in Briggsville, MA just upstream of the former site of the Briggsville Dam removed in 2010 (Figure 1). Ongoing erosion on the right bank of the river (looking downstream) (Figure 2) was initiated by record flooding during Tropical Storm Irene in 2011 (Web citation 1) that occurred shortly after completion of the dam removal. The erosion is of concern to a nearby condominium complex whose front lawn, on a slightly lower surface, becomes smaller with each passing flood as the erosion progresses. The assessment was undertaken to determine the possible causes of erosion and to identify bank stabilization solutions that can simultaneously enhance habitat along this section of the river. The assessment consisted of a site visit on April 8, 2024 and a review of online topographic maps, aerial photographs, and past studies as discussed in further detail below.

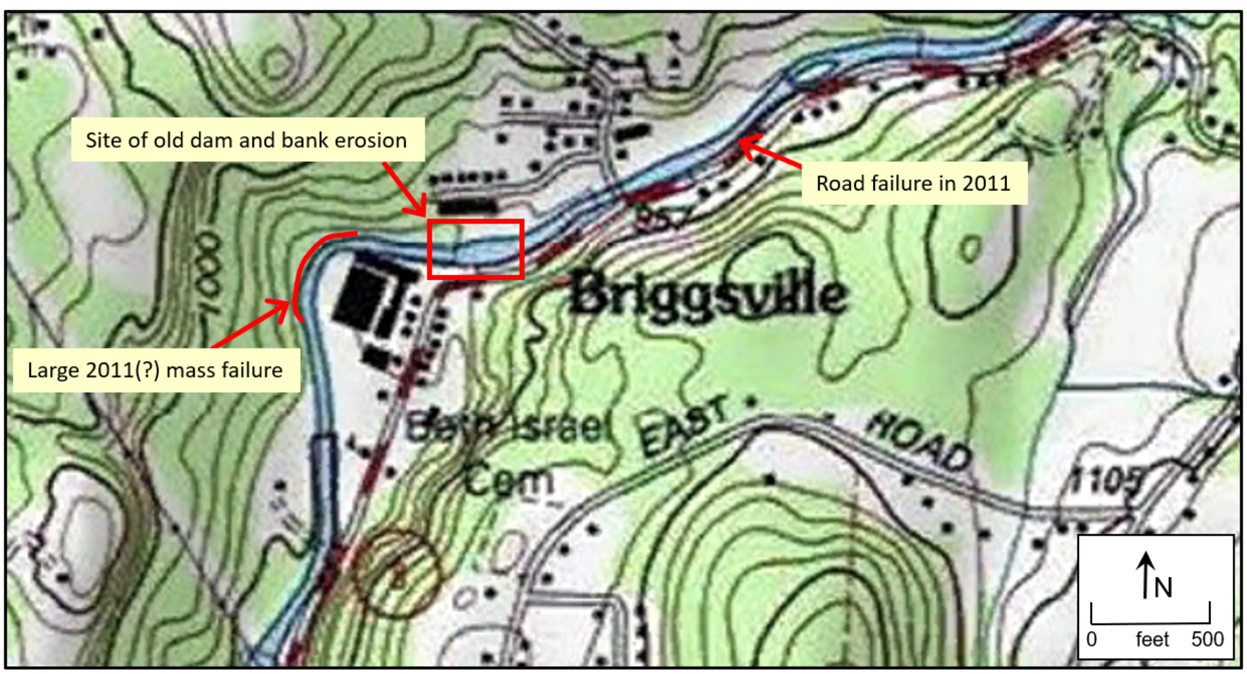


Figure 1. Location of the former Briggsville Dam and ongoing erosion as well as other sites mentioned in text.

Figure 2. Bank erosion on right bank of North Branch Hoosic River just upstream of former Briggsville Dam. Note condominium complex (yellow building) in background.

Physical setting and causes of erosion

The 15-foot-high 145-foot-long Briggsville Dam was removed to open up 30 miles of high quality habitat to benefit Eastern brook trout and other coldwater species at a time when the dam owner was facing expensive repairs to the aging structure (Figure 3; Web citation 2). An earthen berm on the right bank downstream of the dam was not removed as part of the dam removal (Figure 4) and separates the river from a now forested swale that may have originally served as a tailrace downstream of the dam. As part of the dam removal, sediment that had accumulated in the impoundment to the top of the dam was partially removed to form a graded channel and an inset floodplain such that no steep drop existed at the dam following the removal (Figure 5).

Figure 3. Removal of the Briggsville Dam in 2010. (From Web citation 2)

Figure 4. Earthen berm (faced with large boulders in the trees) downstream of the former dam.

Figure 5. Looking upstream through the old dam site at the excavated channel and inset floodplain constructed upstream of the former dam prior to Tropical Storm Irene. (From Web citation 3)

Tropical Storm Irene caused record flooding on the North Branch Hoosic River in August 2011 and led to severe bank erosion that damaged Route 8 just 0.2 mi upstream of the former dam site (Figure 1; Web citation 3). In addition, a large mass failure occurred relatively recently at the sharp bend in the river downstream of the dam and is assumed to have occurred during Tropical Storm Irene (Figure 6). Glacial clay present along the stream bottom suggests the river may have been temporarily dammed by the landslide. The flooding also largely infilled with coarse sediment the excavated channel upstream of the removed dam, forming a large mid-channel gravel bar that has diverted the majority of flow towards the right bank with a secondary side channel present on the left bank along Route 8. Formation of the mid-channel bar also eroded away the constructed floodplain and initiated the ongoing bank erosion (Figures 2 and 7).

Figure 6. Portion of mass wasting area at sharp bend downstream of former dam (see Figure 1).

Figure 7. Deposition in constructed channel diverted flow towards the right bank and initiated ongoing bank erosion. View looking upstream.

Long before the dam removal, the North Branch Hoosic River was artificially manipulated in other ways that may be contributing to the erosion of the right bank upstream of the former dam site (Figures 2 and 7). Although the valley bottom is narrow, the presence of a straight channel flowing directly against the higher valley side slopes near the former Briggsville Dam is suggestive of artificial channel straightening. Straightened channels result in energized flows (due to shortening of the channel) and artificially sharp bends (where two separately channelized segments join) such as at the location of (and likely related to) the large mass failure downstream of the former dam (Figures 1 and 6). The channel straightening was almost certainly accompanied with artificial filling of the floodplain when the mill buildings and associated infrastructure were built, thus constricting more flow to the channel before floods are able to spread across the full width of the valley bottom. The eroding bank upstream of the former dam is itself composed of artificial fill as evidenced by the poorly sorted unstratified mix of cobbles and fine sediment with pipes and other historic artifacts eroding out of the bank (Figure 8). The fill may have been placed in portions of what was once a larger impoundment with the bank erosion into that fill exposing remnants of an older dam that may have contained that larger impoundment (Figure 9). Relatively uncompacted artificial fill is generally more susceptible to erosion than more compacted native soils.

Figure 8. The eroding right bank upstream of the former dam is composed of artificial fill.

Figure 9. A short portion of an older dam has been exposed by erosion of the right bank.

The section of channel adjacent to the eroding bank appears steeper than nearby sections upstream and downstream. This steep section may represent a headcut that may slowly migrate upstream as the channel bed adjusts to the lower base level resulting from the removal of the former 15-foot high Briggsville Dam. Lowering of the channel bed may further destabilize the eroding bank and extend the erosion further upstream. Currently, the channel bed has naturally armored itself with large rock that, in one location, forms a boulder weir across the main channel (Figure 10), essentially freezing the headcut in place as long as the boulders remain immobile during future floods. Alternatively, continued bank erosion could outflank the boulders in the channel and allow the headcut to migrate further upstream.

Figure 10. A natural V-shaped boulder weir has developed along the eroding bank and is currently preventing the further advancement of a headcut that could continue to undermine and destabilize the eroding bank.

Bank stabilization options

Three bank stabilization options for the eroding right bank (Figure 2) are considered here: 1) construction of boulder deflectors along the eroding bank; 2) construction of boulder weirs across the channel; and 3) removal of the earthen berm and artificial fill. The pros and cons of each option are considered based on an analysis of six factors related to each stabilization technique: 1) appropriateness for the site; 2) durability and effectiveness; 3) consistency with natural processes; 4) temporary construction impacts; 5) habitat enhancement; and 6) potential impacts elsewhere (i.e., across channel and downstream) (Table 1). The chosen option will need to undergo a more thorough design phase to estimate costs, determine permitting requirements, and support grant applications for implementation funds. Owners of the condominium units and other stakeholders should be engaged throughout the decision-making process to gauge their response to the temporary and long-term impacts of each stabilization option.

Construction of boulder deflectors

Boulder deflectors deflect flow away from an eroding bank and redirect the strongest currents toward the center of the channel; flow velocities are reduced near the bank and deposition ultimately occurs along the bank toe (Table 1). Individual deflectors consist of a low line of boulders (not more than one-third the bankfull height) angled slightly upstream, so flow passing over the boulders is redirected away from the eroding bank (Appendix 1). The boulders exposed at the surface typically rest on footer boulders set below the stream grade to prevent undermining by bed scour. While the boulders should be large enough to resist movement by the expected design forces, rootwads with the attached log buried in the channel bed can be used to further support the boulders and create habitat (Appendix 1). Deflectors typically slope down from the bank into the channel, but should not extend more than one-third of the channel's bankfull width to prevent negatively impacting the opposite bank. Several deflectors (at least four are proposed for the site in Briggsville) built in series along the bank are needed to effect stabilization. The redirected flow passing over the deflectors will begin to spread out immediately downstream of the deflectors and potentially impinge again on the eroding bank. Consequently, a single deflector at the upstream end of the eroding bank would not be sufficient to stabilize the bank. The portions of the bank between deflectors can be further stabilized using log structures to further reduce the erosive force of flows between the boulder deflectors and encourage more sediment deposition along the bank toe.

STABILIZATION APPROACH	PROS	CONS
Boulder deflectors		
Appropriateness for site	- Sediment deposition between structures likely at bank toe	- High outflanking risk where each deflector joins bank of uncompacted fill
Durability and effectiveness	- Will reduce flow velocities at bank toe if remain intact	- Undermining and outflanking a significant concern
Consistency with natural processes	- Consistent with natural boulder substrate	- Deflectors are not a structure typically seen in nature
Temporary construction impacts	- No trees need to be removed for construction	- Excavation into and adjacent to artificial fill may cause significant collapse of bank
Habitat enhancement	- Pools at tip of structures; deposition between structures could narrow channel	- Flow velocities reduced along bank but limited velocity refuge elsewhere
Potential impacts elsewhere	- Unlikely to impact opposite bank that is already heavily armored along Route 8	- No significant reduction in flow velocities downstream, so existing concerns remain
Boulder weirs		
Appropriateness for site	- Will redirect flow towards center of channel and away from erodible bank	- High outflanking risk where each deflector joins bank of uncompacted fill
Durability and effectiveness	- If footer boulders large enough & set deep enough, weirs should function properly	- Continued deposition in area could once again redirect flow toward right bank
Consistency with natural processes	- Mimics natural structures already forming in area	- Weirs crossing mid-channel bar unnatural w/ intent to freeze instabilities in place
Temporary construction impacts	- No trees need to be removed for construction	- Significant excavation of channel bed; bank collapse possible as w/ deflectors
Habitat enhancement	- Pools formed in center of channel by focused flow; flow complexity across channel	- Flow velocities reduced along banks but limited velocity refuge elsewhere
Potential impacts elsewhere	- Roughness created by structures will reduce erosive force downstream slightly	- Redirecting flow towards Route 8 could have unintended consequences
Earthen berm and fill removal		
Appropriateness for site	- Removes unnatural constraints to river flow	- Lower lawn level for condominium residents
Durability and effectiveness	- More resiliency as channel will have freedom to adjust to changing conditions	- Stabilization still required on backside of floodplain to ease landowner concerns
Consistency with natural processes	- Elimination of constricting berm will reduce deposition and size of mid-channel bar	- Forest regrowth will take years or area could be repurposed as lawn
Temporary construction impacts	- Limited or no in-stream work would be required	- Large mature trees growing on berm would need to be removed
Habitat enhancement	- Velocity reduction in main channel and creation of side channel habitat	- Loss of some forest canopy for many years
Potential impacts elsewhere	- Restored floodplain will reduce erosive forces and flood peaks downstream	- Relatively small area being treated so positive improvements will be minimal

Table 1. Some pros and cons of the three stabilization options considered.

Deflectors at the Briggsville site are likely to induce sediment deposition effectively at the toe of the eroding bank given the considerable amount of sediment deposited around logs and other obstructions in the area (Figure 11). However, boulder deflectors are prone to damage from undermining of the footer boulders by bed scour or lateral outflanking around the back end of the structures where they tie into the bank (Table 1). Both problems are valid concerns at the Briggsville site. The steep channel bed upstream of the former dam is currently maintained by large boulders armoring the channel bed (Figure 10) but if that armor layer is mobilized, then bed scour will occur rapidly as the bed slope adjusts to the lower river level resulting from the dam removal. While the footer boulders can protect against minor bed scour created by the structure itself, footer boulders cannot protect against the significant bed lowering related to the dam removal.

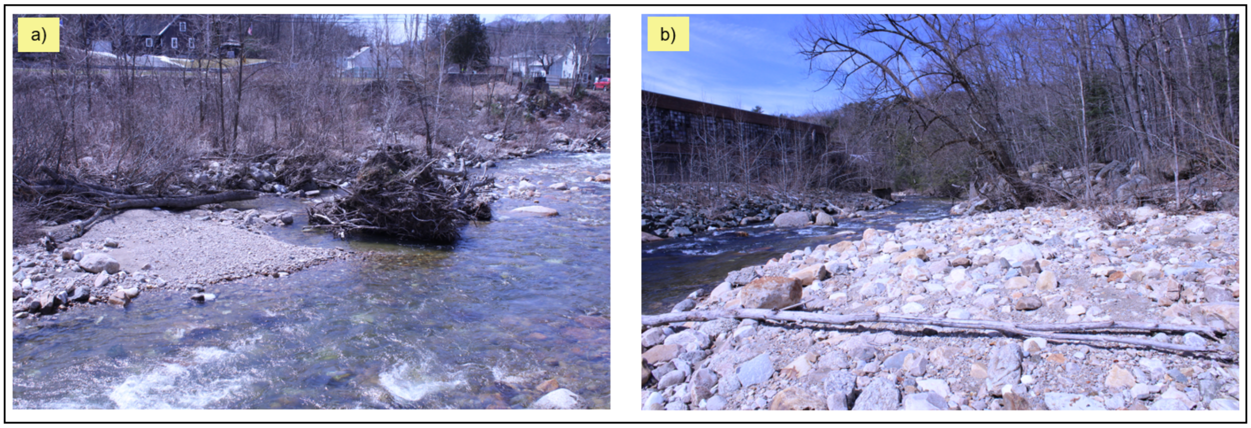


Figure 11. The river is sensitive to deposition near the former dam site as evidenced by a) sand and gravel accumulating around a large root wad along the margins of the mid-channel bar and b) a large cobble bar formed downstream of the remnant dam protruding from the right bank (see Figure 9).

Lateral outflanking of deflectors is also a significant risk at the Briggsville site given that the eroding bank along which the deflectors will be built is composed of uncompacted artificial fill (Figure 8). Scour is most severe where softer materials are in contact with harder materials such as boulders. While this problem could be mitigated by baffling the flow's energy with logs and brush anchored over the contact between the boulders and loose fill, the excavation into the uncompacted fill that will be required along much of the bank to both anchor these protective logs and to set the footer boulders of the deflectors could cause significant collapse of the loose fill and compromise the integrity of the structures from the outset.

Construction of boulder weirs

Constructed boulder weirs are typically V-shaped structures (with the point of the "V" at the upstream end) that cross the entire width of the channel, focusing water into the center of the channel and reducing flow velocities along the banks. Both arms of the weir are angled upstream and essentially represent two extended boulder deflectors built on opposite river banks that join in the center of the channel. A series of three or four weirs across the channel along the length of the eroding bank will not only stabilize the eroding bank like the deflectors but will also serve as grade controls that will inhibit downcutting along the steepened section of channel upstream of the former dam (Appendix 1). The constructed weirs will replicate, strengthen, and extend the natural armoring already resisting further downcutting of the channel (Figure 10). The weirs proposed for the Briggsville site would actually be extended structures, representing two weirs joining on the mid-channel bar separating the main channel near the eroding bank and the smaller side channel flowing along Route 8 (Appendix1). By setting the elevation of the weirs in the side channel slightly lower than in the main channel, a portion of the flow could be diverted away from the eroding bank and refocus some of the river's erosive force along the left bank that is already heavily armored along Route 8.

The concerns of undermining and outflanking discussed above with respect to deflectors also apply to weirs (Table 1). By continuing the weirs across the mid-channel bar, outflanking of the weirs along the heavily armored left bank is unlikely. However, the other end of the weirs would terminate on the right bank of fill and be subject to the same enhanced scouring around the hard boulders as the deflectors (see above). While undermining of the weirs by bed scour is less likely than the deflectors given that the boulders will fully cross the channel, excavating large footer boulders deep enough into the coarse channel substrate may prove difficult. Furthermore, like the deflectors, excavation near the right bank could lead to significant collapse of the unconsolidated artificial fill.

Removal of earthen berm and artificial fill

The eroding right bank upstream of the former dam, as described above, is composed of artificial fill (Figure 8). Investing considerable funds to stabilize the eroding bank may not be advisable given that the uncompacted nature of the fill increases the risk of outflanking. Restoring the natural floodplain that existed prior to dam construction through removal of the earthen berm (Figure 4), artificial fill (Figures 2, 7, and 8), and remnant of old dam (Figure 9) provides a more sustainable approach for reducing erosive forces in the immediate area as well as further downstream (Appendix 1). The berm and fill are currently artificially constraining floods such that they impart a greater erosive force on the channel margins and more quickly convey flows downstream, potentially increasing the risk of large mass failures as has occurred in the past (Figures 1 and 6). By removing these constraining features, floodplain flow could be restored on the right bank, reducing erosive forces on the left bank along Route 8 and further downstream where considerable infrastructure and high unstable banks are present. Restoring the floodplain would also be beneficial to aquatic organisms by reducing flow velocities in the channel and providing side-channel habitat on the restored floodplain.

Removal of the artificial fill would address the bank erosion by greatly reducing the height of the bank; the current bank height did not exist prior to dam construction and placement of the fill. The final height of the floodplain and remaining bank will have to be determined in a later project design phase, but erosive forces on the remaining low bank will be greatly reduced by allowing flows to access the restored floodplain. While erosion of the low bank is still possible, allowing the river to migrate across the floodplain would provide greater resiliency during large flood events and minimize erosive forces and flood peaks downstream (Table 1). Given the presence of the condominiums on the higher surface (Figure 2), the back side of the lowered floodplain surface would need to be stabilized to ensure significant channel migration does not initiate erosion of the higher surface. The use of a log crib wall filled with large rock could be used for stabilization to provide both habitat and a greater peace of mind to residents potentially concerned about the risk of erosion closer to the condominiums (Appendix 1). However, erosion along the backside of the floodplain is unlikely to ever be a severe threat for at least three reasons. First, the slope rising to the level of the condominiums is composed of native less erosive materials compared to the currently eroding bank of artificial fill (Figure 2). Second, the erosive forces of flow on the floodplain will not be as strong as those currently present in the confined channel. Finally, removal of the earthen berm downstream (Figure 4) will reduce or eliminate the backwatering of flood flows that led to the deposition of the mid-channel bar and subsequent flow diversion into the now eroding right bank (Figure 7). If the berm is removed, sediment will more readily pass through the area, the size of the mid-channel bar will be reduced over time, and redirection of flow towards the right bank will be less likely.

From a technical perspective, the most significant drawback to removing the earthen berm is the removal of the large mature trees presently growing on the berm (Figure 4). Regrowth of trees would take many years, but potentially shortened with the replanting of larger trees immediately after berm removal. Perhaps a more significant issue with berm and fill removal is public resistance to the dramatic change in the surroundings. Currently, the condominiums are only slightly higher than the top of the artificial fill surface that is eroding along the river's edge. After fill removal, the restored floodplain would be several feet lower. The floodplain could still be used as a lawn and playground, as is the case today, with steps built to access the lower surface. The restored floodplain would be inundated more frequently than the currently higher surface, but would only be inaccessible a few days each year during larger flow events.

In conclusion, channel constraints that remain (i.e., the earthen berm) following the 2010 dam removal have caused significant channel deposition upstream of the former dam and the initiation of erosion along the right bank into artificial fill (Figure 7). While stabilization of the current bank is possible, construction would be difficult given the loose unconsolidated fill and channel constraints would remain in place such that erosive forces and flood peaks downstream would not be reduced. Removal of the earthen berm (Figure 4) and artificial fill (Figure 2) would greatly transform the site in a way that might be initially unpopular among local residents, but represents the most sustainable way of reducing the erosive forces at the site while also improving aquatic habitat. Since this approach is also the most consistent with natural processes and the most likely to reduce flood hazards to downstream infrastructure, grant funds for implementation could be more readily secured from environmental or hazard mitigation programs. If you have any questions regarding the results of this geomorphic assessment, feel free to contact me at any time at 207-491-9541 or jfield@field-geology.com.

Sincerely,

John Field, PhD

Encs.

Web citations

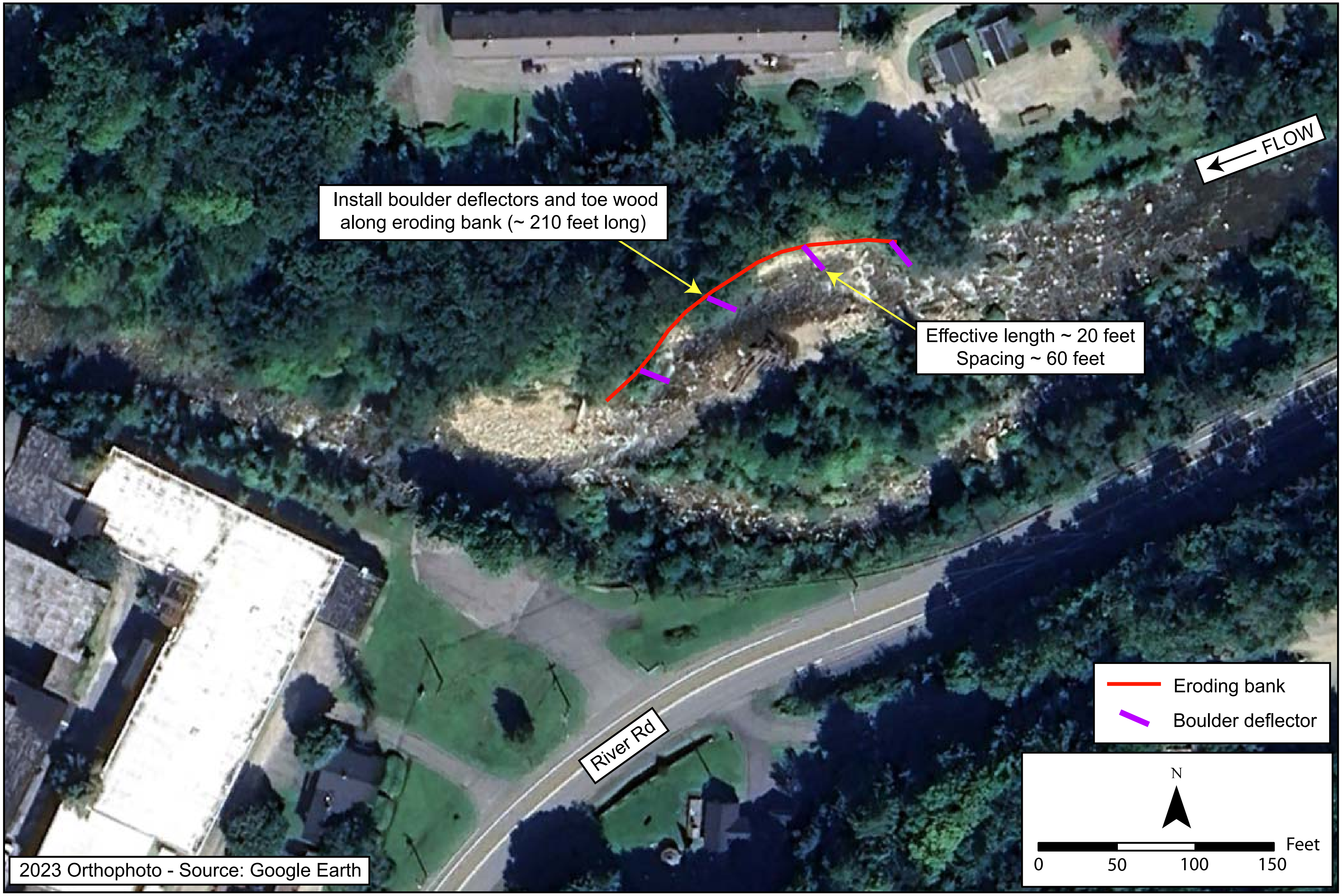
Web citation 1:
https://nwis.waterdata.usgs.gov/ma/nwis/peak/?site_no=01332000&agency_cd=USGS& (Accessed June 30, 2024).

Web citation 2: https://www.usda.gov/media/blog/2010/12/01/dam-removal-enhances-massachusetts-wildlife-habitat (Accessed June 30, 2024)

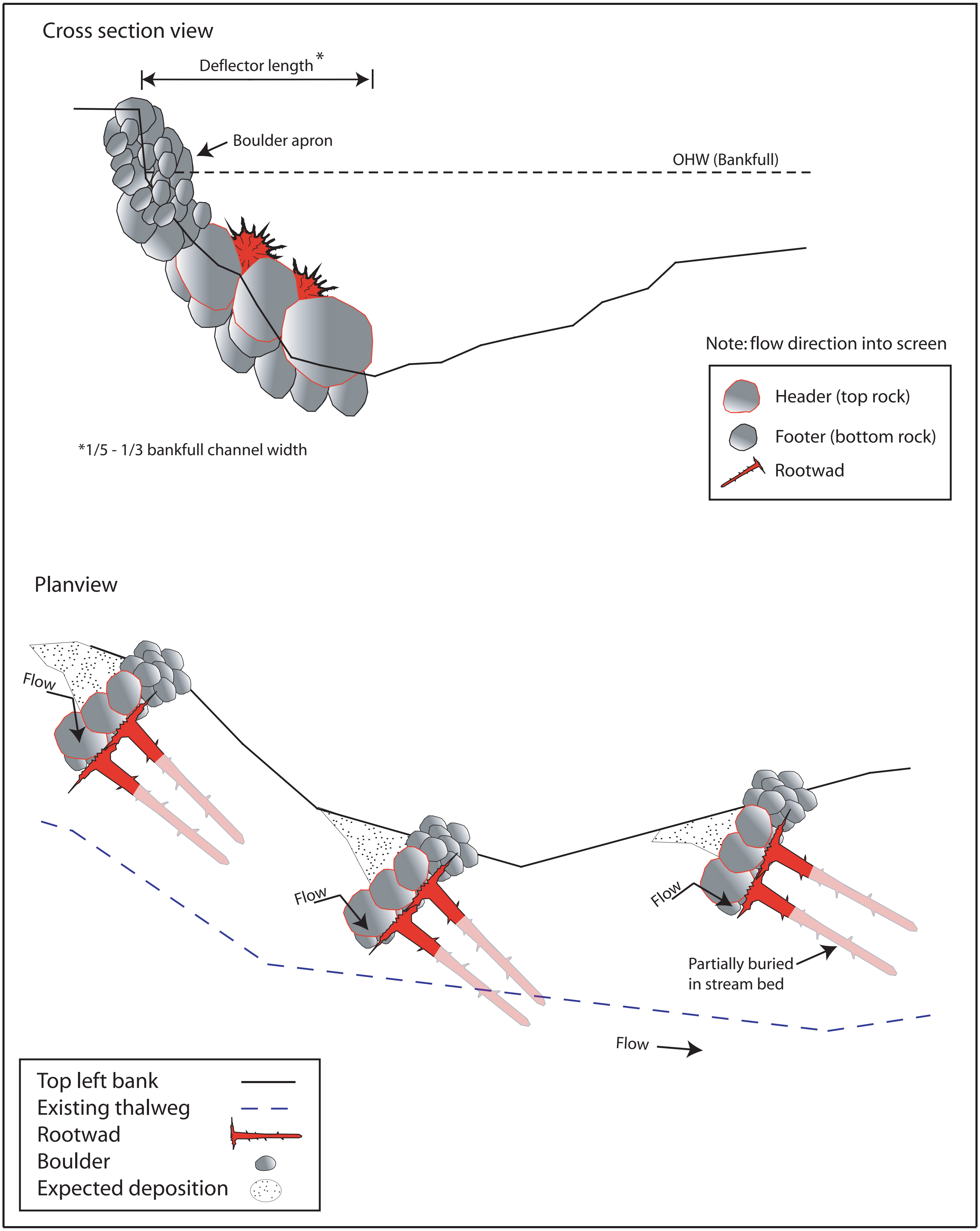
Web citation 3: https://streamprojects.wordpress.com/2010/12/10/briggsville-dam-removal-north-branch-hoosic-river-clarksburg-ma/#jp-carousel-209 (Accessed June 30, 2024)

APPENDIX 1

(Concept designs of bank stabilization alternatives)

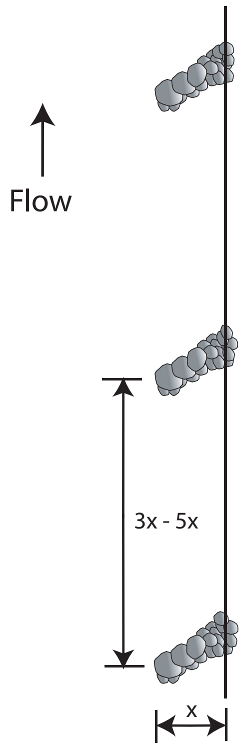


Conceptual design plan view - Boulder deflectors and toe wood.

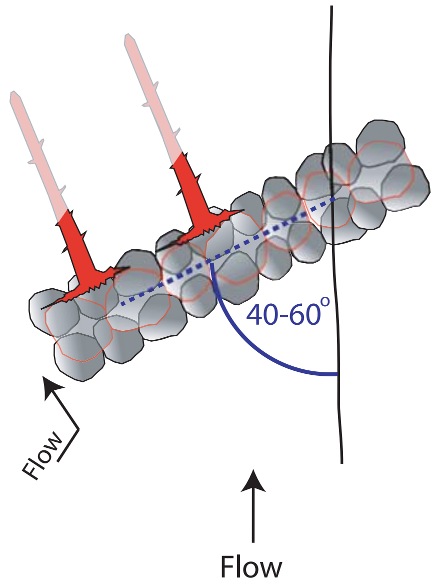


Boulder deflector design typical - sheet 1.

Planview spacing detail

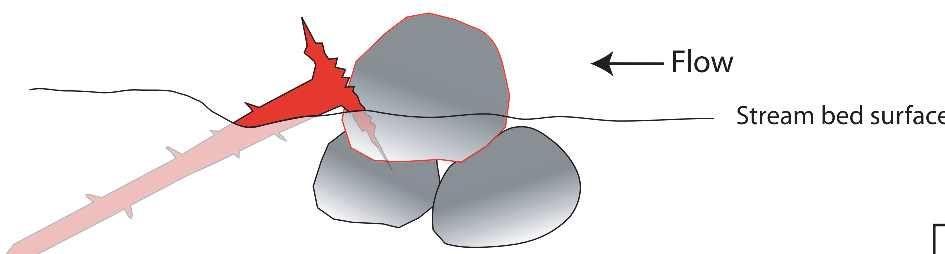


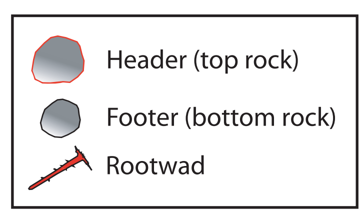
Planview angle detail



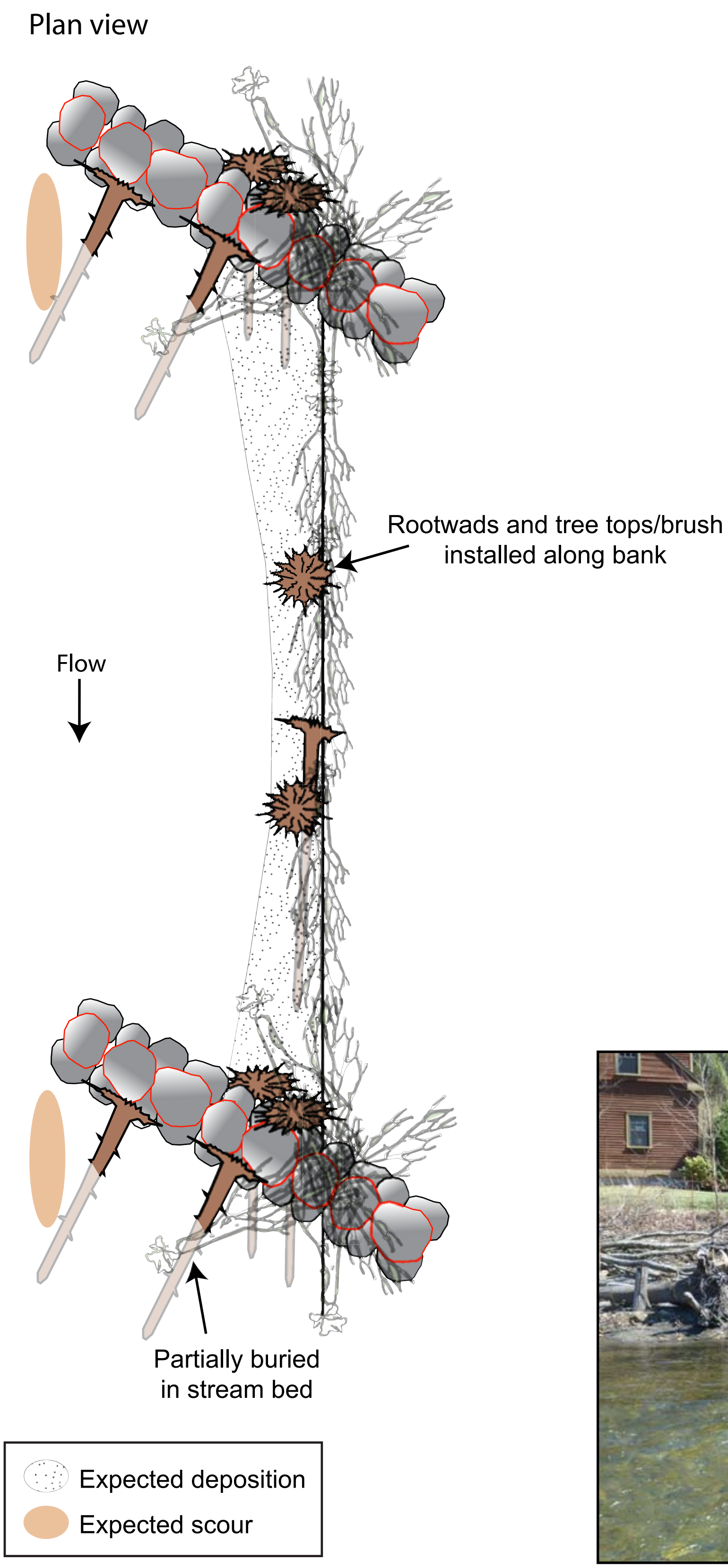
Example photo

Side view detail



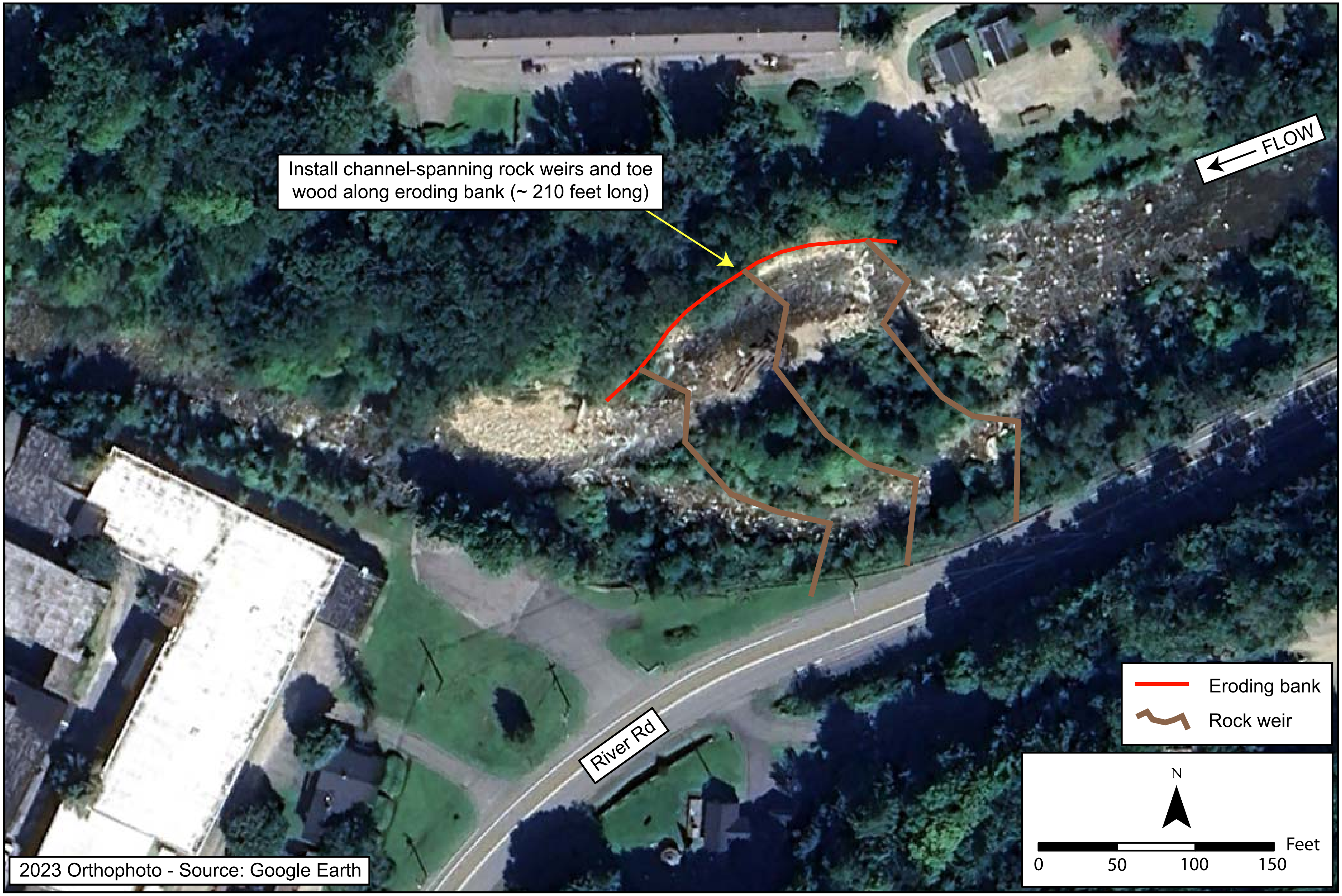


Boulder deflector design typical - sheet 2.

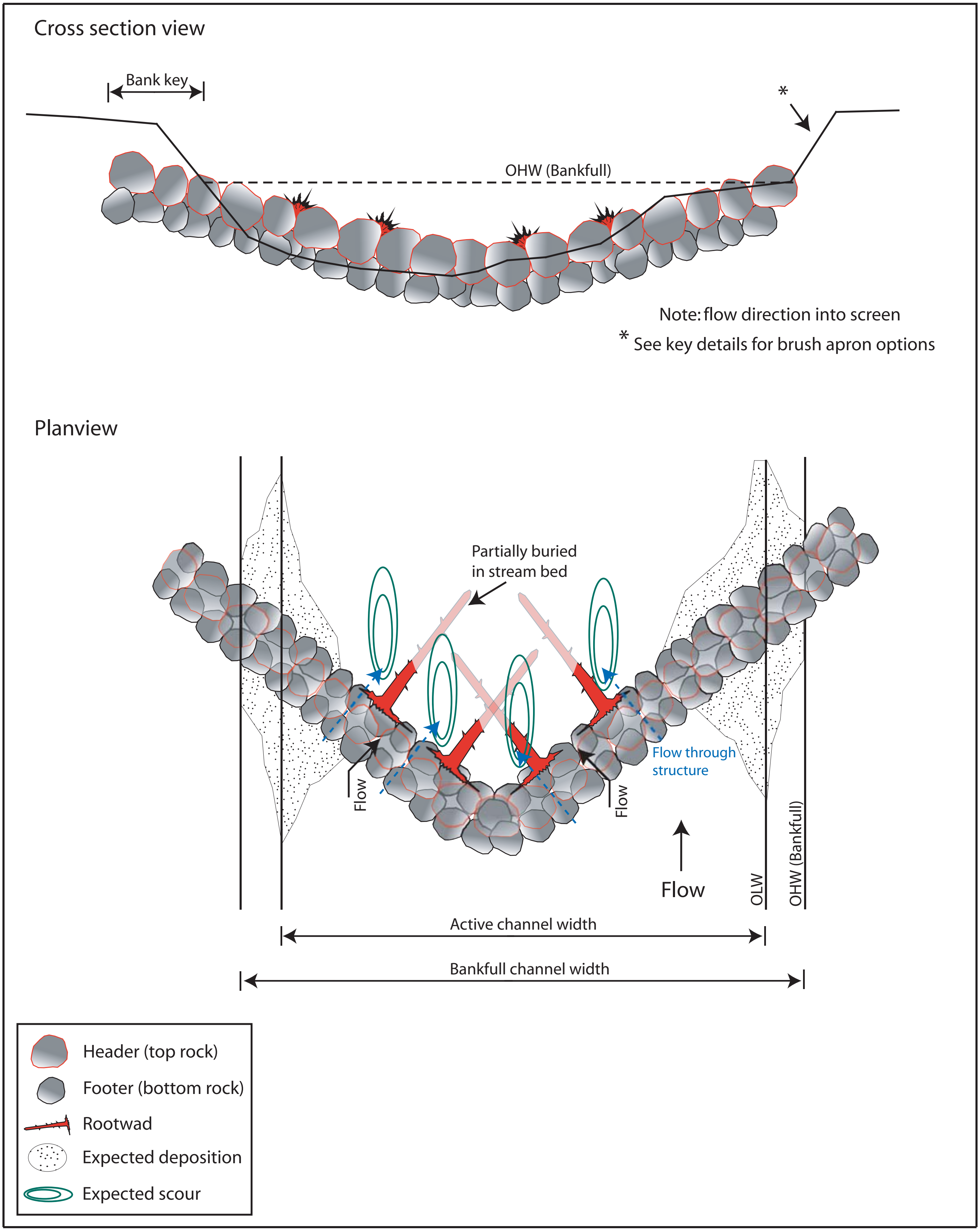



Example of boulder deflector

Boulder deflector design typical - sheet 3.

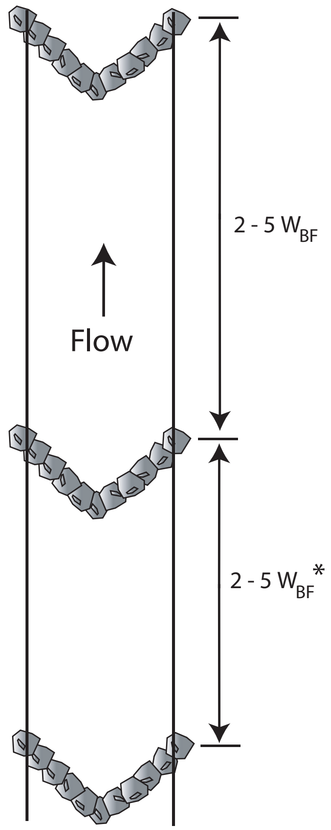


Conceptual design plan view - Rock weirs and toe wood.



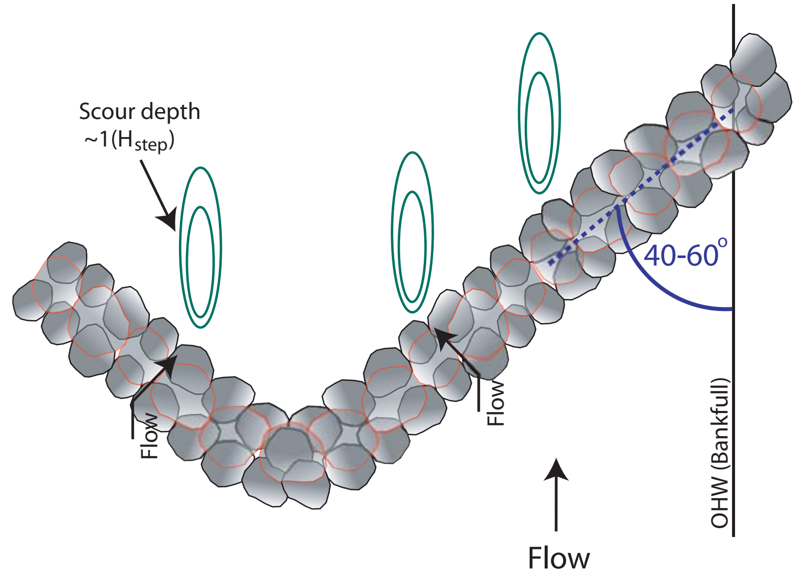
Porous rock weir design typical - sheet 1.

Planview spacing detail



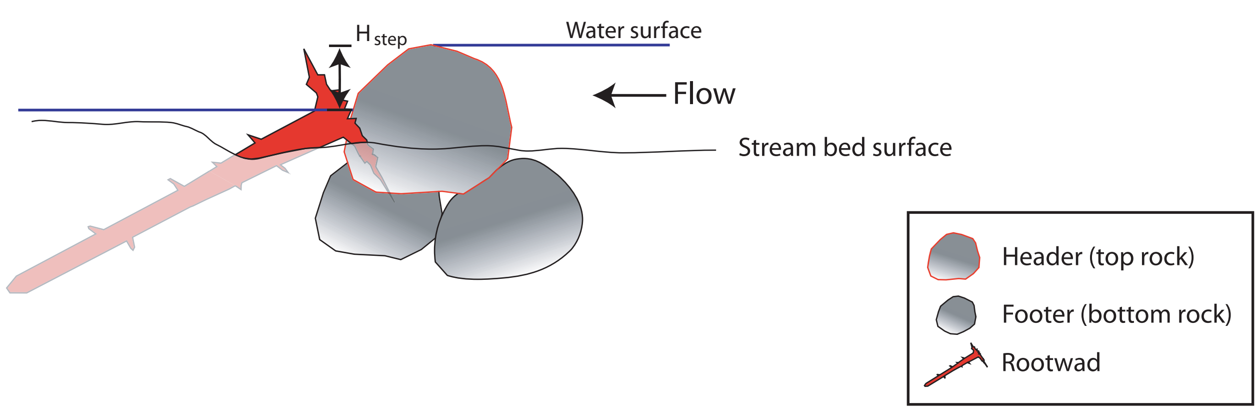
*Higher channel gradient requires closer structure spacing

Planview angle detail

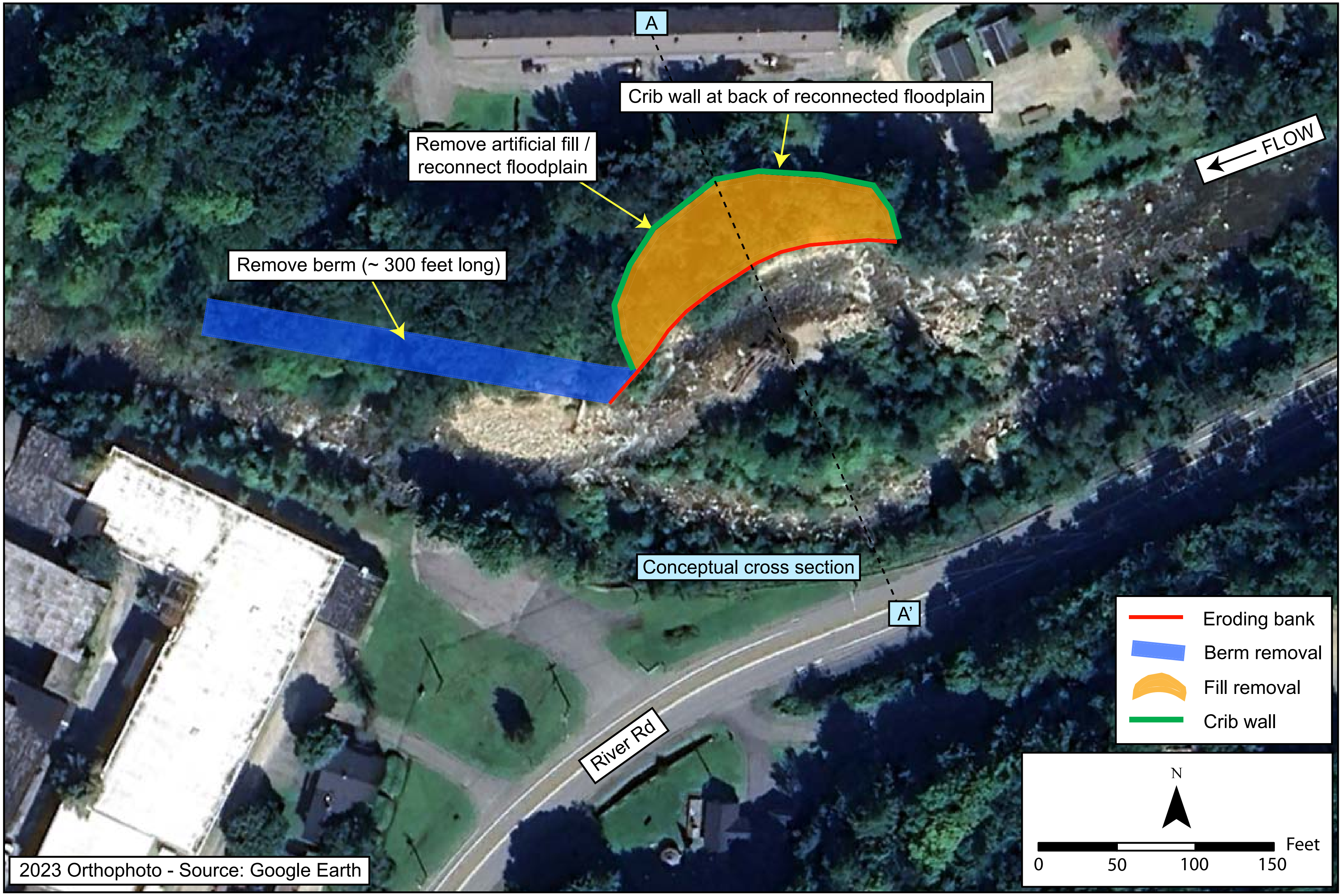


Example photo

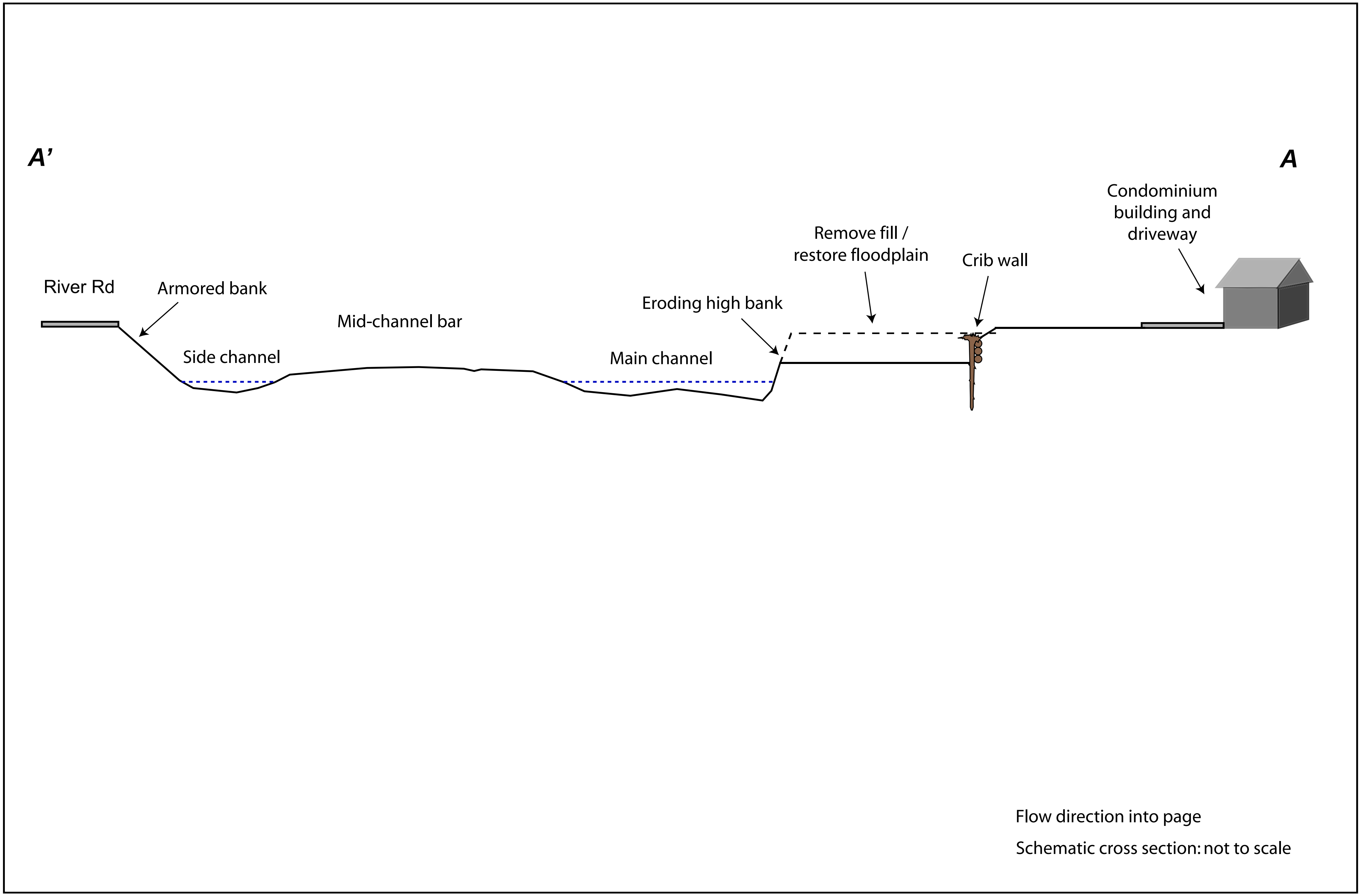
Side view detail



Porous rock weir design typical - sheet 2.

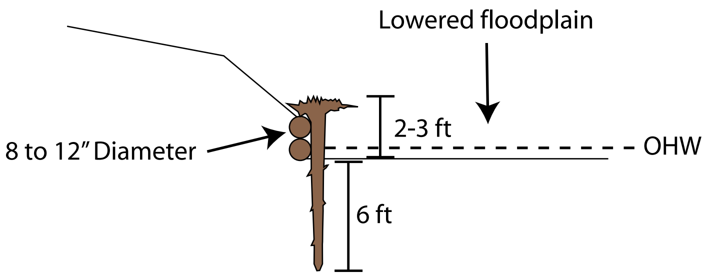


Conceptual design plan view - Remove berm and artificial fill.



Conceptual design cross section - Remove berm and artificial fill.

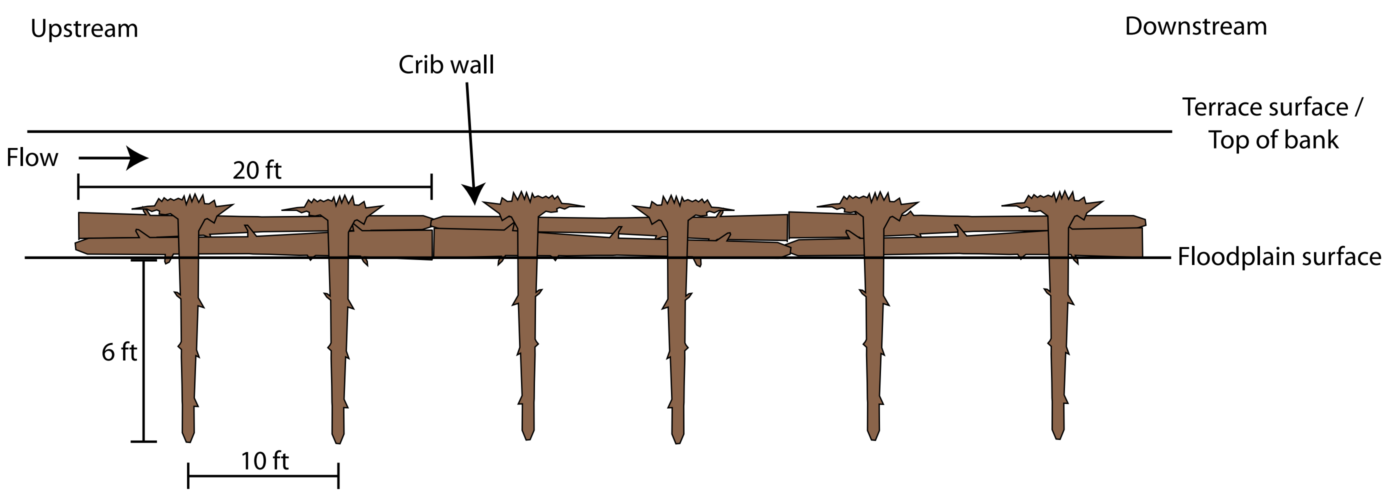
Cross section view



Note: flow direction into page

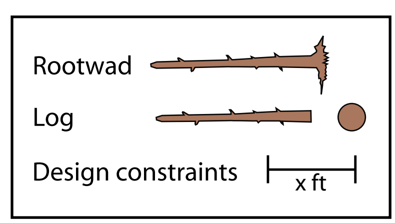
Example photo

Longitudinal view



Note: Schematic - Not to scale

*Only a portion of treatment area displayed to show detail



Log crib wall design typical - floodplain application.