

Bank Erosion

Common Issues

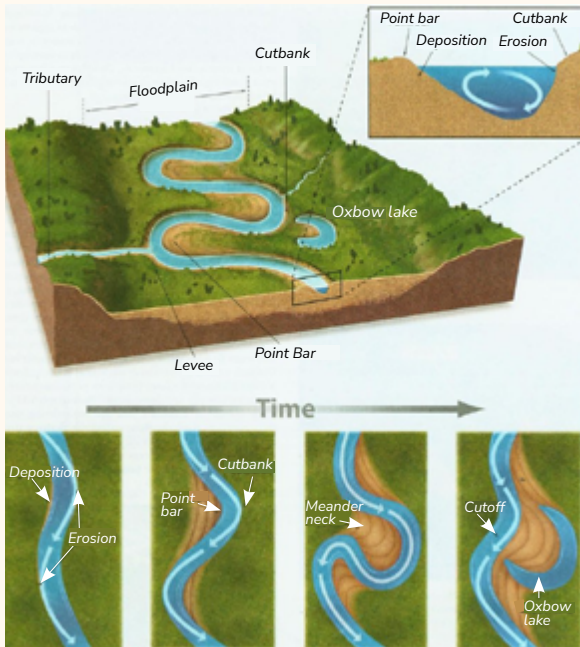
Bank erosion typically occurs on the outside bends of a river channel. Erosion can be concerning if infrastructure like roads, ditches, or buildings are close to where this process occurs. A particular concern is an avulsion, which is when the river establishes a new river channel, shortcutting a longer bend. Erosion may also impact the channel bed in some places, causing downcutting, or deepening, of the whole channel.

Questions to Consider

- Do the banks lack streamside vegetation? Is there evidence of past removal of riparian vegetation where the stream channel has migrated?
- Are livestock accessing banks at the outside bend of the river channel?
- Has bank stabilization or armoring (fortifying the river banks with materials) already been implemented? Has stabilization been implemented on an upstream or downstream property? If so, what types of materials were used?
- Is there a secondary channel that was cut off in the past but could be re-opened to reduce the velocity of water during high flows?
- Does the channel lack natural features that add complexity such as boulders, point bars, sand bars, cobble bars, instream woody material, or vegetation?
- Is the riverbed downcutting? Is the riverbed aggrading?
- While erosion may be problematic in one area, would it be acceptable in other locations?

Principles of River Health

Erosion and Deposition of Sediment are Natural Processes



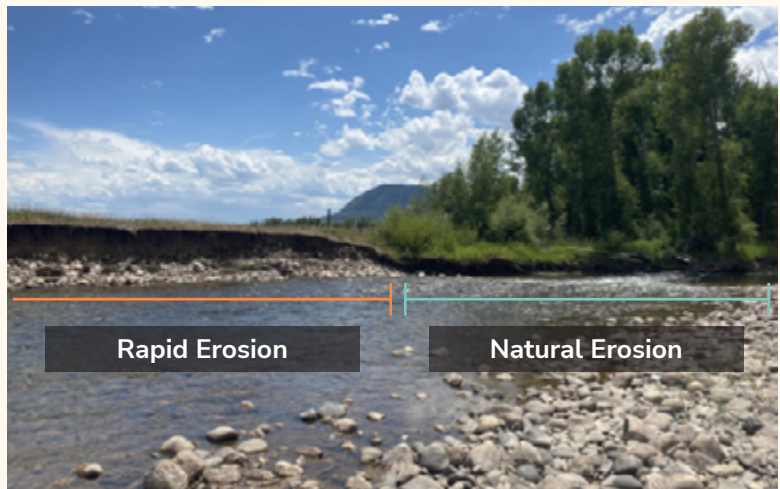
Meander migration, erosion, and deposition
Diagram courtesy of Paul Bierman and David Montgomery, *Key Concepts in Geomorphology*, 2020

Erosion and deposition are processes that occur as rivers channels move across the valley floor over time. Naturally functioning and healthy rivers are not static; rather, they migrate throughout the landscape, creating fresh surfaces and removing older ones. As shown in the diagram below, the river channel's energy erodes streambanks on outside bends, and those sediments are deposited on opposite inside bends to create sand and gravel point bars. These newly formed areas promote riparian vegetation regeneration, leading to healthier river habitats. This circuit of events—erosion and deposition—is essential for the health of the ecosystems along the river. Cottonwood and willow, for example, require newly created land in the form of fresh sandbars to successfully reproduce. If rivers cannot move because they are locked in place by human impact, then this dynamic sequence is stopped and riparian vegetation may age out and fail to regenerate.

Erosion Increases with Lack of Riparian Buffer

While erosion and deposition are natural processes, rapid or excessive erosion can become a problem both for the health of the river and for adjacent land uses. As river channels interact with areas that have been cleared of riparian forest, bank erosion becomes accelerated and exacerbated due to the absence of deep vegetation roots holding the soil together. This can lead to a loss of productive land and the undermining of existing infrastructure. The photo below shows a current example of these conditions in the Yampa Valley.

The intact riparian forest on the right side of the photo is undergoing healthy, natural erosion, creating gravel bars and undercutting cottonwood trees that then fall into the river and contribute to healthy habitat. Juxtaposed on the left side of the photo is a hayfield with no riparian buffer, where the bank erosion is much more pronounced and accelerated due to the lack of root structure holding the bank together. The field is losing productive agricultural land and a fence is falling into the river.



Streambanks erode more rapidly where they lack riparian vegetation
Photo by Kim Lennberg, Alba Watershed Consulting

Adverse Impacts of Historic Efforts to Reduce Bank Erosion

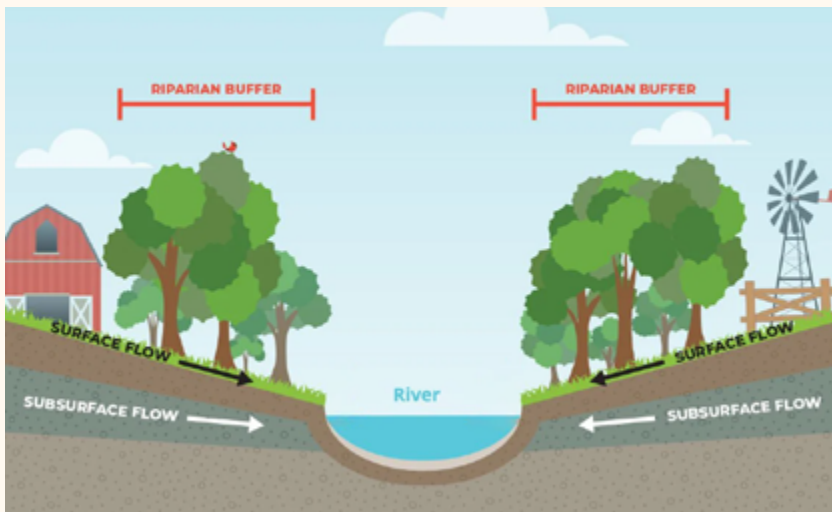
Although placing hard armoring and stabilization such as rock, riprap, or concrete is intended to stabilize riverbanks, it can instead lead to increased stream power and accelerated bank erosion. Similarly, loss of flow or blocking flow to side channels can also lead to increased erosion. Impacts from physical changes such as hard armoring are not isolated to the areas immediately adjacent to the bank stabilization and may be evident across the river, far downstream, and even upstream.

Recommended Practices or Actions

Many options are available for addressing rapid erosion on a particular property. Erosion is a natural process that occurs slowly and somewhat predictably in healthy riparian areas, so if possible, planting trees and shrubs along the banks of the river to create a riparian forest is the most desirable way to address erosion. The next option that can kick-start a riparian buffer is a willow toe treatment that uses willow cuttings to create an interlocking root system. When more protection or armoring is desired, other forms of streambank bioengineering, or using natural materials in addition to or instead of rock, riprap, or other “hard” materials, can be a good fit. These practices are described in more detail below.

Install Riparian Buffer

Protecting, maintaining, or creating a naturally vegetated riparian buffer is the best way to protect the land adjacent to the river channel and riparian area. Streambanks often collapse because they lack vegetation to slow erosion of the soil. The roots of the riparian vegetation, once established, protect the streambank and provide other benefits of riparian forests, such as wildlife habitat and improved water quality.



Riparian forest buffers are critical for stream health
Cross-sectional diagram by H2Ohio



Photo by Roddy Beall, Zenobia Consultants



*Willow toe, eight months after installation
Photo from the Colorado Stream Corridor Construction Manual*

Install Willow Toe

Where erosion is occurring along outside bends, intensive planting of dormant vegetative willow cuttings can be incorporated with streambank grading (along with the use of cobble or boulder materials to provide strength). Over time, the cuttings provide a dense root system that adds cohesion and stabilizes the bank. This treatment can provide long-term protection, wildlife and habitat benefits, and a healthy riparian buffer.

Install Post-Assisted Log Structures or Beaver Dam Analog Structures

For small streams or side channels, structures that mimic natural wood jams and beaver dams (called “beaver dam analogs”) can be an effective method for reducing stream power and reducing erosion. Instead of flowing swiftly through the channel and carrying sediment away, pooled water causes deposition of sediment, reversing the erosion process. Nature-based (i.e., low-tech) structures like these are not permanent, so they will often wash out in the spring and need to be replaced, but they are relatively inexpensive and meant to be taken over by beaver or rebuilt periodically. On a larger river, where handmade dams do not span the entire river, log structures can be placed in strategic locations to encourage deposition of sediment instead of rapid erosion. These temporary structures can be installed to redirect stream energy away from eroding banks. Where appropriate, structures can be placed to encourage erosion or bank movement in areas more suitable for that impact. These techniques work with the natural dynamism of the river, instead of locking the channel in place.



Post-assisted log structures redirect stream flow to reduce erosion and increase deposition where desired | Photo by Leaf Ninjas



*Beaver dam analogs cause pooling, reducing stream power and encouraging deposition
Photos courtesy of Joe Leonhard, The Nature Conservancy*

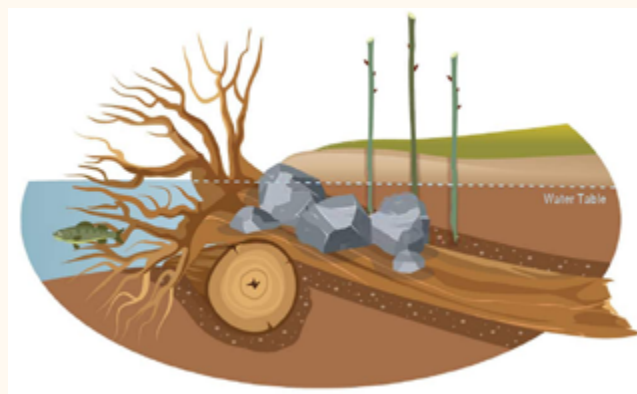
Install Vegetated Soil Lifts

Soil lifts are vertical layers of soil and native seeds wrapped with erosion control geotextile fabric (such as coir matting) and integrated with vegetation (such as willow stakes) to “build” or reconstruct stream banks that have been degraded. Soil lifts provide immediate and short-term structural support, allowing for root development and growth of vegetation, which ultimately provides long-term structural bank stabilization. As the erosion control fabric degrades, the bank is supported by maturing plants.



*Soil lifts during construction
Photo by Kim Lennberg, Alba Watershed Consulting*

Install Root Wads or Large Wood Complexes



*Conceptual cross-section of a river showing erosion control that creates structure and habitat
Diagram by The Watershed Center*

Large wood is a vital component of natural river systems and can be incorporated into riverbanks, the channel itself, or the adjacent floodplain as a restoration treatment. Depending on the application, purpose, and available materials, use of large wood can take the form of single logs, logs with their root systems intact (referred to as “root wads” or “root balls”), or engineered logjams (clusters of strategically placed logs), sometimes called “wood complexes.” Large wood is used for a variety of purposes, often to stabilize streambanks by slowing or redirecting stream currents through



Root wads and riparian forest restoration | Photo by Kim Lennberg, Alba Watershed Consulting

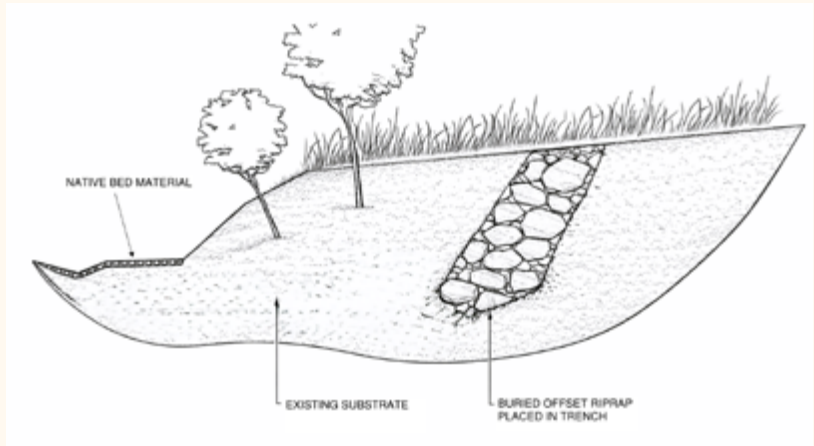
the addition of “roughness” to the channel, bank, or floodplain. If used on the floodplain, large wood can work to capture fine sediments, organic materials, and native seeds for riparian vegetation reestablishment. An engineered log jam consists of the deliberate placement of a matrix of wood to form structures at specific locations and is often used to direct flows away from critical infrastructure and protect banks. Large wood also provides microhabitats and cover for fish and other aquatic organisms.



*Toe wood and bankfull bench at Chuck Lewis State Wildlife Area
Photo by Ben Beall, Zenobia Consultants*

Protect Structures with Setback Riprap

Setback riprap is an engineered structure composed of buried large rocks placed away from the river channel to protect structures or infrastructure at risk of future erosion if the river continues to meander. In the short term, it allows room for flooding, erosion, and channel movement to occur naturally, but offers protection of important infrastructure if the channel migrates toward it. This treatment is an alternative to placing riprap along the bank or a berm at the channel's edge. Setback riprap is buried and covered with soil and revegetated in such a way that it is visually hidden in the landscape.



Conceptual cross section of a river showing setback riprap that allows for a natural streambank and riparian buffer while providing precautionary protection | Detail modified from Colorado Water Conservation Board Emergency Watershed Protection Program



Setback riprap is buried away from channel bank | Photo courtesy of Colorado Water Conservation Board

Install Boulder/Cobble Toe with Floodplain Bench



A boulder toe can be added to riparian plantings in high-risk areas where additional bank movement is unacceptable | Illustration by United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)

In an area where additional stream movement is not allowable for some reason, a boulder toe can provide erosion protection. This approach may introduce an unnatural material type that will have a long-term impact on natural river processes. As such, this technique can lead to long term degradation and should be used sparingly. To reduce impacts on overall river health, regrading the upper portion of the bank after toe installation creates a floodplain bench that allows flood energy to spread out and provides a flat area for additional vegetative plantings.

Install Engineered Grade Control Structures

Grade control structures are man-made river features designed to control the elevation of the riverbed while maintaining floodplain connectivity. Grade control structures can reduce the likelihood of erosion by directing flows away from banks. Grade control can also create beneficial habitats like pools for fish. The most common grade control structures incorporated into river restoration projects are cross vanes and J-hook vanes. Building grade control structures can be costly and may require permitting through the Division of Water Resources (DWR). Installing such structures should be carefully considered and properly engineered to consider upstream and downstream impacts. As these methods fundamentally alter the natural form of the river, they should be used only when deemed absolutely necessary or where they are necessary due to significant historical impacts to the river.



*Grade control structures can control river form
Photo by Kim Lennberg, Alba Watershed Consulting*

Additional Benefits of Implementing Recommended Practices

- Reducing stream power can reduce erosion on the property and for downstream neighbors
- Additional channel and floodplain roughness can mitigate potentially damaging floodwaters during spring runoff and large storms
- Increasing riparian vegetation can help anchor streambanks while also creating wildlife habitat and cooling surface water temperatures
- Encouraging sedimentation can build future pastureland

Reference and Resource Materials

A science-based journal article called [Bank Erosion as a Desirable Attribute of Rivers](#) describes why bank erosion is important for the healthy functioning of river ecosystems.

This [United States Department of Agriculture \(USDA\) Soil Bioengineering Webinar slide deck](#) presents techniques and case studies in successfully accomplishing streambank protection with bioengineering techniques.

[Colorado Stream Corridor Construction: A Guide for Contractors and Operators](#) was developed by the State of Colorado's Technical Assistance Team to improve the quality, function, and aesthetic of construction work in Colorado's stream corridors. It highlights best practices and innovative techniques in river restoration in Colorado.

[Living Streambanks: A Manual of Bioengineering Treatments for Colorado Streams](#) is a detailed manual of streambank bioengineering treatments that is focused on Colorado streams and rivers.

American Rivers authored [a review of restoration projects](#) that provides research and information on the use of low-tech process-based techniques in the restoration of riverscapes on headwater streams.

The USDA [Natural Resource Conservation Service \(NRCS\) Stream Restoration Planning and Design Field Guide](#) is a general field reference and training tool for stream corridor restoration and design.

The Watershed Center's [Regional Stream Stewardship and Recovery Handbook](#) provides a great resource with guidance and consideration for multiple strategies to address stream stewardship practices.