AEN-100

Building a Grade Stabilization Structure to Control Erosion

Steve Higgins, Donnie Stamper, and Sarah Wightman, Biosystems and Agricultural Engineering

Gully erosion creates large eroded channels that become problematic for many farms. Gullies form in natural drainage swales when vegetation in the swale is lost through overgrazing or tillage practices. They cause valuable soil to erode, and they form large channels that drain runoff into streams (Figure 1). This runoff can carry sediment, nutrients, and pathogens that can degrade the water quality.

Gullies also take up usable space and destroy farmland, often making the land unusable as grazing pasture or cropland (Figure 2) and interfering with farm operations such as mowing and harvesting.

There are many methods used to control gullies, but producers typically place roll bales in gullies, hoping to keep soil in place and stop further erosion (Figure 3). Roll bales are not effective and can actually make the erosion worse. To control erosion, the water must be directed to the center of the drainage way. Roll bales cause the water to move to the edge of the channel, eroding the banks and making the gully wider. Roll bales also degrade quickly, especially in the constant presence of flowing water.

If roll bales are placed in a gully within a pasture, livestock will be lured to the gully to eat the hay. This extra foot traffic can worsen the erosion, causing further loss of vegetation, roots, and soil. Congregating livestock also leave manure, which increases the nutrients and pathogens that could be picked up in runoff and carried to surface water. According to water quality specialists, this could be considered a conveyance of pollutants into the waters of the Commonwealth, and the landowner could be subject to a fine.

The best way to control gully erosion is to maintain vegetation in the area. Reducing livestock numbers and stocking rates can also prevent gully erosion. Reducing stocking rates can be accomplished by implementing a rotational grazing strategy (see UK Cooperative Extension publication Planning Fencing Systems for Intensive Grazing Management [ID-74]). If the slope of the gully is extremely steep and the erosion cannot be controlled by vegetation maintenance alone (Figure 4), a hardened structure needs to be installed. Types of structures used to control and prevent gully erosion include rock-lined channels, sediment traps, check dams, and grade stabilization structures. We recommend a grade stabilization structure, which can be placed outside the pasture, freeing up land and preventing injury to livestock by eliminating the unusable and dangerous gully. Grade stabilization structures can also be easily located in riparian areas that have already been excluded from livestock, which means that producers don't have to worry about animals walking across the large rock that is used to create the structure. A grade stabilization structure also takes up less space compared to rock-lined channels, which can remove available pasture from production and require additional fencing to exclude the structure.

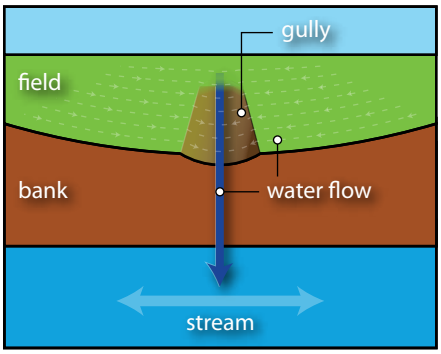

Figure 1. Gully erosion occurs when vegetation is removed from an area through which water flows. Sediment and other pollutants in runoff are then introduced to surface waters.

Figure 2. Eroded banks and washed-out soil make this gully unusable as good grazing pasture.

Figure 3. Many producers attempt to remedy gully erosion with roll bales of hay, but because it degrades quickly, hay does not solve the problem and can even make it worse by luring cows to graze in the gully.

Structure Design

Designing a grade stabilization structure can be complex and usually requires a detailed site investigation. For large structures (those passing more than 100 cfs (2.8 m3/s), storing more than 50 acre-ft (60,000m3), or standing more than 15 ft in total height), a qualified engineer familiar with hydraulics and experienced in structure design is required. Additional design guidance can be obtained from the local NRCS office.

How the Structure Works

Grade stabilization structures stabilize gullies by controlling the grade and the channel cutting in natural and artificial channels. The structure controls the flow of water and absorbs stream energy, but also makes the necessary elevation change between the channel (former gully) and the receiving surface water body to prevent erosion from occurring. A typical structure accomplishes this by using a series of closely placed posts and cattle panels to hold large rocks in place. This publication focuses on a structural design that uses wooden posts.

The design specifications in this publication require engineering calculations based on knowledge of soils and hydrology. Producers interested in remediating gully erosion with a grade stabilization structure should contact their local Natural Resources Conservation Service (NRCS) office for technical assistance and cost share opportunities.

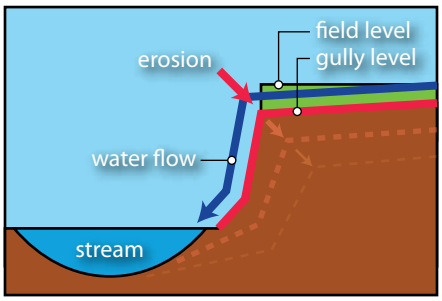

Figure 4. If not controlled, gully erosion will continue to increase in severity, causing a loss of soil and decrease in water quality.

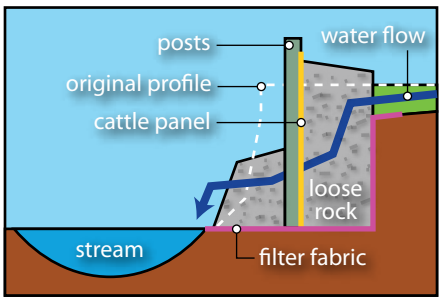

Figure 5. This grade stabilization structure is located between a gully and a stream to control the flow of water coming out of the gully and the elevation change.

Location

Grade stabilization structures can be located between a gully and the receiving water body (Figure 5) or as a series of structures in a channel. A prime location would be just before a stream confluence, where an elevation change can be used to lower the water from the gully to the main stream and erosion in the adjacent branch can be prevented.

Ideally, there should be 1.5 to 2 feet of soil in the bed of the existing gully to anchor the posts. Locate the structure on a straight section of the gully, with no curves within 100 feet.

Capacity

At a minimum, design the structure to control the runoff from a 10-year storm event or meet the channel's bankfull capacity, whichever is greater. Make sure you have enough bypass spillway capacity to prevent the structure from failing in larger storms. You should base this capacity on the structure's expected life and the economic impact and safety hazard posed if it were to fail. Larger structures cost more and may impose a greater safety hazard and therefore should be designed for a higher level of stability and safety.

Figure 6. Posts are installed to support the bank in a grade stabilization structure.

Figure 7. The posts are reinforced with geotextile fabric and rocks, which form a base for the soil.

Figure 8. Rocks are pushed up on both sides of the posts to collect soil runoff and filter water before it reaches the stream. Rocks also give newly established vegetation something to cling to.

Construction

Clear any existing vegetation from the construction area to eliminate the chance of water infiltration, which could cause damage to the footing. Place posts on 18-inch centers and drive them into the ground at least 1.5 to 2 feet (Figure 6). Then, attach cattle panels and geotextile fabric to the upstream side of the posts. Next, place riprap or shot rock over the geotextile fabric and around the posts to absorb the flowing water's energy and help hold the structure in place (Figure 7).

The rock berm should be placed about 2 feet higher than the grade of the gully so that it can intercept the water flow and absorb its energy (Figure 8). The rock should slope gradually to the center of the structure, which should be the high point of the berm so that if any water overflows, it will be centered and won't affect the structure's integrity. The outfall should have a gradual tapering of rock from the center of the posts extending approximately 6 feet. Once the rock is in place, posts should be cut so that they extend 6 inches above the rock (Figure 9). The overall drop in elevation should not

Figure 9. The completed grade stabilization structure prevents erosion by controlling the flow of water, absorbing stream energy, and controlling the elevation change.

exceed 6 feet. If constructed properly, the life span of the structure should be at least 30 years.

A grade stabilization structure is a best management practice, but remember that the best way to control gully erosion is to keep the area planted with vegetation. Filling in the gully with topsoil, planting and maintaining vegetation, and subsequently building a grade stabilization structure below the gully will slow erosion and preserve valuable pasture land. You may also need to fence livestock out of the area and intercept and divert runoff water above the gully to further prevent and control erosion.

Resources

The National Engineering Handbook (Section 11 - Drop Spillways and Section 14 - Chute Spillways), prepared by the USDA Soil Conservation Service (now Natural Resources Conservation Service [NRCS]), provides detailed, useful information on the design of grade stabilization structures. The handbook can be found online at the NRCS website: http://www.nrcs.usda.gov/technical/ENG/

References

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