Roadside Ditch Management Stabilization

1. Description

Roadside ditch management (RDM) stabilization is important to maintain proper water conveyance in ditches. If ditches are not stable, it can jeopardize the structure of the ditch, impacting water conveyance and water quality. Restoring an eroding ditch that was an active source of sediment decreases the amount of sediment exported to downstream waters. The practice involves stabilizing the side slopes and ditch channel and rapidly establishing dense vegetative cover to prevent further ditch erosion. Often referred to as" stabilized drainage way", this practice is frequently specified in most state erosion and sediment control manuals, new roadway and ditch construction criteria, and forest road design manuals.

Practitioners generally use a trapezoidal or parabolic ditch geometry to decrease erosion potential. These shapes will make routine mowing easier and reduce the potential for erosion. After any cleaning or excavation, stabilization measures—such as seeding, erosion control matting, or riprap— are important. Depending on factors such as velocity, slope, or drainage area, different types of stabilization methods are used. Check dams or wattles can be used to slow water flow through a steep ditch, decreasing the erosive forces. If the practices are successfully performed on an existing unstable ditch, sediment load reduction credit can be calculated for the ditch.

2. Practice Feasibility

2.1. Stabilization Feasibility

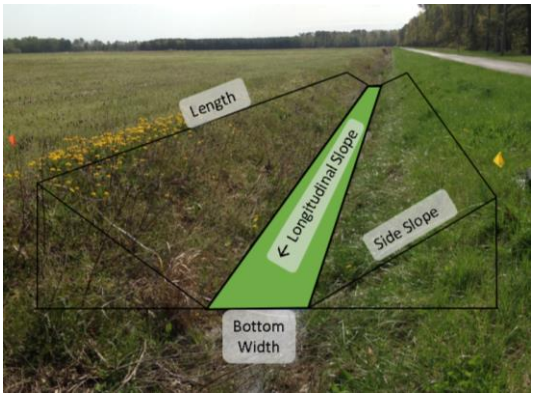
Depending on the site characteristics, stabilization methods may be applied. Key constraints include:

Existing Ditch Stability

- Only currently unstable ditches can receive credit after it is stabilized. Ditches are typically unstable due to existing ditch conditions or after ditch cleaning. Ditches that have high flow rates may need additional engineering outside the scope of this guidance. It is recommended that the velocity of flow from a 1-inch rainfall not exceed 3 feet per second for vegetated ditches. If the channel cannot handle the velocity of the incoming water, other types of lining can be used.

Available Space

- To ensure stability, a ditch should have a trapezoidal or parabolic bottom with side slopes 3:1 or flatter on the road side and side slopes 2:1 or flatter on the non-road side



Utilities

- For all roadside ditch projects, utilities may be a concern. If digging is necessary, call the local utility location services to mark the lines and consult local utility design guidance for the required horizontal and vertical clearance between utilities and the channels. Typically, utilities can cross grass channels if they are protected (e.g., double-casing) or are located below the channel invert.

3. Stabilization Methods

Stabilization generally requires little formal design elements to implement. Most of the methods have been established for erosion and sediment controls during construction. These methods can be used after ditch cleaning or on existing eroding ditches. One of the most cost-effective ways to implement these practices is to incorporate them into existing ditch maintenance, such as cleaning sediment from ditches (scraping), replacing culverts, or vegetation management. To receive credit for stabilizing a ditch, the ditch bed and side slopes must be fully vegetated with at least 95% cover or have other appropriate ditch lining to decrease soil erosion. Due to the variability of ditches, different methods may be needed to stabilize a ditch. Some common methods include:

- Minimum of 3:1 slope on the road side (2:1 on a non-road side)
- 2-foot wide ditch bottom elevation
- Inlet and outlet protection
- Trapezoidal or parabolic bottom
- Check dams

Stabilization should occur immediately after cleaning the ditch, including hydroseed or seed and mat the side slopes and bottom of the ditch. Inlet protection can be added to transitional areas, such as when concrete lining turn into a grass ditch or an agricultural pipe enters a ditch. Below are different ditch stabilization methods for different scenarios.

3.1. Ditch Stabilization Methods During Ditch Cleaning

When ditches need to be cleaned, activities should start on the upgrade section first and should not occur when substantial precipitation is predicted. If vegetation is removed during cleaning, it is important that there is sufficient time for the vegetation to regrow. The types of equipment used for cleaning and excavation also impact the stability of the ditch. If the equipment is not fit for the shape of

the ditch, it could lead to over-ditching (i.e. removing more of the ditch than necessary). Over-ditching should be avoided, as this increases ditch instability.

FIGURE 1: EXAMPLE OF OVERDITCHING- STEEP SIDE SLOPES

Other ditch stabilization best management practices during cleaning include:

- Wait until soils are dry before maintenance to decrease erosion. If excavation is necessary, ensure that stabilization will be successful (either through vegetation or other controls)
- Avoid maintenance 24 hours before or after a rain event. Cleaning and vegetation establishment should be scheduled for late spring/early summer for best results.
- Use erosion and sediment control BMPs to prevent erosion during maintenance
- Remove excavated soil from site.
- Heavy equipment should be operated on the paved road to minimize disturbance
- Seed immediately after cleaning (hydroseed, hydromulch, seed and matting)
- Use a seed mix that is fit for the site (shade, wet, sun tolerant)
- Use temporary erosion and sediment controls to decrease sediment leaving site before vegetation is established (filter log, check dam, erosion control matting, etc.)
- Maintain 3:1 or flatter side slopes

3.2. Ditch Stabilization Methods Using Vegetation

The majority of ditch stabilization methods will be using vegetation. The first step is to seed the unstable ditch with a tailored native species mix. This will provide above-ground vegetation with increased filtration and erosion control, a variety of root structures for infiltration, erosion control, and sequestering nutrients, and resources for pollinator species. Follow seeding with lightly raking or rolling into soil. The best time for seeding is in late fall to early winter. This timing allows for seed to cold-stratify naturally in place and germinate when conditions are right for each species. Seeds can be sown with a light layer of hydromulch (300 lbs/acre), then covered with second layer of hydromulch and tackfier at (900 lbs/acre) The first layer of hydromulch acts as a marker to where seeds have been applied, while the second layer helps to hold seed and slope in place. Another method is to sow seeds by hand, then cover with hydromulch or erosion control blanket as site conditions dictate.

Control weed height during the first growing season once vegetation reaches 18''–24" by trimming back to 6-inches to 8-inches tall 3–4 times as needed over the growing season. Control weed height during the second and third growing season by trimming back to 2" early spring, then maintaining at 12''–15" tall by trimming 3–4 times as needed over the growing season. Time the mowing to fit with recommended mowing windows as indicated for established ditch mowing. Strategic height reduction prevents weeds from becoming dominant and allows enough sunlight to reach natives, which is especially critical first season. Timing is also important for protecting Monarch butterflies. Herbicides should be applied during the correct prescribed time at rates identified on the label.

3.3. Ditch Stabilization Methods Using Ditch Lining

If vegetation is not able to survive the velocity of the water entering the ditch, other types of lining may be required. The stability of a ditch is based on the permissible velocity and allowable tractive force (shear stress) on the ditch lining.

$$\tau_d = \gamma ds$$

Where:
τd= shear stress in channel at maximum depth (lb/ft^2)
γ = unit weight of water (62.4 lb/ft^3)
d = depth of flow in channel (ft)
s= channel slope (ft/ft)

Examples of ditch lining include:

TABLE 1: LINING TYPE

Lining Type	Lining	Permissible Velocity (ft/sec)	Permissible Shear Stress (lbs/sq. ft)	Source
Vegetation	Long native grasses	4-6	1.2-1.7	[1]
	Short native and bunch grass	3-4	0.7-0.95	[1]
Rolled Erosion Control Products	Straw with net	1-3	1.5-1.65	[2]
	1-in Gravel	2.5-5	.33	[1]
	12-in d50 riprap	10-13	5.1	[1]
Hard Surface	Gabions	1-19	10	[1]

Refer to your local erosion and sediment control manual for more information on channel lining.

3.4. Procedures for Acceptance

Project acceptance is a visual inspection that takes place about 12 months after ditch stabilization methods have been implemented to make sure it is still working and meeting its landscaping objectives. If so, the practice is accepted by the local roads department and should be reported to the proper stormwater management authority. Post stabilization acceptance should also include as-built drawings or sketches showing

- Start and end of the ditch stabilization
- Width of unstable ditch
- Type of seed mix used
- Other types of stabilization techniques

The local approval authority should keep detailed inspection reports describing any needed maintenance. If any issues are found, identify a timeframe for repair and conduct a subsequent inspection to ensure completion of repairs.

A written inspection report is part of every inspection and should include:

- The date of inspection;
- Name of inspector;
- The condition of:
    - Vegetation
    - Side slopes
    - Main bed
    - Inlet and outlet
    - Check dams and erosion and sediment control practices, if applicable
    - Any other item that could affect the proper function of the stormwater management system
- Description of needed maintenance

4. Sediment and Nutrient Crediting Protocol

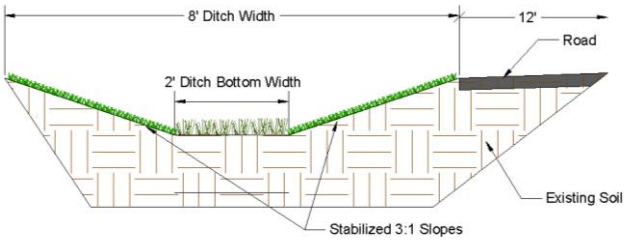
The Chesapeake Bay Program has sediment and nutrient credit protocols for various best management practices. Ditch stabilization is NOT a practice that has a protocol specifically for it; therefore, crediting methods from erosion and sediment control (ESC) are used [3]. The current credit for Level1 ESC is 74% for sediment only. Level 1 was chosen over Level 2 because it is unlikely that all the Level 2 ESC Practices will be performed with ditch stabilization. For ESC, nitrogen and phosphorus do not receive credit because there is evidence that the fertilizer used to establish vegetation could be a source of nutrients.

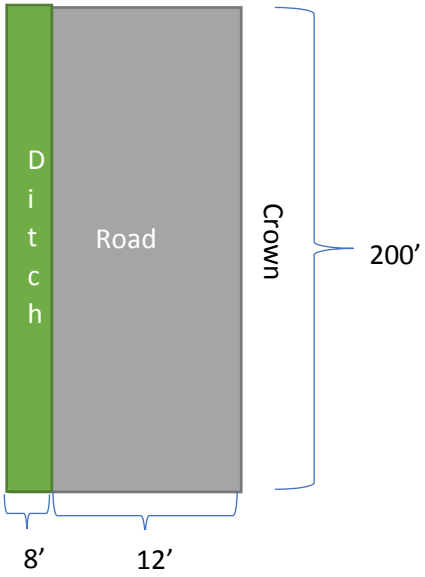
The following equation can be used to find the load reduction:

Removal rate (%) * Loading Rate (lb/acre/yr) * drainage area (acres) = Load Reduction (lb/yr)

The drainage area is the area of the stabilized ditch.

Credit Calculation Example





A ditch was stabilized after sediment was removed from the bottom. The ditch is 8' wide (total) and 200' long.

The loading rates can be found using the Chesapeake Assessment Scenario Tool (CAST) Model. For this example, the following loading rates are used:

TABLE 2: LOADING RATE FROM "FINAL MODEL DOCUMENTATION FOR THE MIDPOINT ASSESSMENT-5/11/2018" DOCUMENT *[4]*

Land Use	N (lbs/acre/year)	P (lbs/acre/year)	TSS (tons/acre/year)
Developed Non-regulated Turf (ditch)	11.19	0.86	0.47

With the drainage area of 8'*200' = 1600 sf (0.037 acres), the load reduction can be calculated:

Pollutant	Removal Rate from Level 1 ESC	Loading Rate from Table 6 (lb./acre/yr.)	Load Reduction (lb./yr.)
TSS	74%	940	74%*940*.037= 25.6

5. Maintenance and Visual Indicators

Routine maintenance checkups occur annually as part of regular maintenance visits and are used to immediately correct minor maintenance problems. The checkups are also used to provide quality control on maintenance activities and to determine whether the road crew needs to schedule a follow up visit to repair moderate maintenance problems.

TABLE 3: DEFINING NUMERIC TRIGGERS TO CLASSIFY DITCH STABILIZATION MAINTENANCE CONDITIONS

Defining Numeric Triggers to Classify Ditch Stabilization Maintenance Condition					
#	**INDICATOR**	**Pass**	**Minor**	**Moderate**	**Severe**
1	Inlet and outlet erosion	None	Some erosion	Erosion of 6" or less	Erosion of more than 6"
2	Bed erosion	None	Some rill erosion	Gully erosion of 6" or less	Gully erosion of more than 6"
3	Side slope erosion	None	Some erosion	Erosion occurring to less than 25% of slope surface	Erosion occurring to more than 25% of slope surface
4	Vegetation Cover	>95% cover	75-95% cover	50-75% cover	Less than 50% cover
5	Vegetative Maintenance	Well maintained, few weeds	Isolated areas need re-seeding or weeding	Needs major vegetation control and weed eradication	Needs major vegetation control or shrub/tree removal or replanting

6. Verification Procedures

Inspection of this practice is needed to verify that the ditch has been stabilized and the ditch is not a source of sediment and therefore can continue to receive its pollutant reduction credits, in the context of either a local or Bay-wide TMDL. The inspection should occur a minimum of once a year and include comparing the as-builts and field assessments. Verification uses a subset of the list of visual indicators that assess the hydrologic function and pollutant removal capability of the RDM practice, by answering three simple questions:

1. Does it still physically exist. i.e. can you find it and are the conditions and cover in the contributing drainage area still the same?
2. Is it still operating to reduce erosion as it was originally designed?
3. Is the maintenance condition sufficient to still support its pollutant reduction functions?

Table 6 below indicates specific visual indicators that are used to answer the questions above. A "severe" maintenance problem detected for one or more of these indicators, means that the facility fails and will lose pollutant removal credits unless it is brought back into compliance.

TABLE 4: PERFORMANCE VERIFICATION INDICATORS

	Visual Indicator	**Task/Investigation**
Pass	Ditch is vegetated in all areas, including inlet, outlet, side slopes, and main bed.	None.
Minor	Small amounts of bare dirt, most of the water in the ditch runs through vegetation, no impact to stream network.	Make note and check on next maintenance inspection.

Moderate	Moderate amounts of bare dirt, scouring in main bed, signs of sediment moving downstream.	Re-establish vegetation, determine if additional stabilization techniques are required to prevent erosion.
Severe	Little or no vegetation in ditch, actively eroding sediment.	Re-establish vegetation, side slopes, and add additional stabilization techniques.

References

[1] Marin County, [Online]. Available: https://www.marincounty.org/~/media/files/departments/pw/mcstoppp/residents/fischenichstabilitythresholds.pdf.

[2] USDA, [Online]. Available: https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17784.wba.

[3] Schueler T. et al, "Recommendations of the Expoert Panel to Define Removal Rates for Erosion and Sediment Control Practices," 14 4 2014. [Online]. Available: http://chesapeakestormwater.net/wp-content/uploads/downloads/2014/04/WQGIT-APPROVED-ESC-EXPERT-PANEL-REPORT_LONG-04142014.pdf.

[4] "Chesapeake Bay Program Phase 6 Watershed Model- Section 2 - Average Loads Final Model Documentation for Midpoint Assessment," 11 5 2018. [Online]. Available: https://cast.chesapeakebay.net/FileBrowser/GetFile?fileName=P6ModelDocumentation%2F2%20Average%20Loads%202018%2005%2022.pdf.