NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

GRASSED WATERWAY

(Ac.)

CODE 412

DEFINITION

A shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity using a broad and shallow cross section to a stable outlet.

PURPOSE

- To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding.
- To prevent gully formation.
- To protect/improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice is applied in areas where added water conveyance capacity and vegetative protection are needed to prevent erosion and improve runoff water quality resulting from concentrated surface flow.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct grassed waterways to comply with all federal, state, and local laws and regulations.

Capacity. Design the waterway to convey the peak runoff expected from the 10-year frequency, 24-hour duration storm. Increase capacity as needed to account for potential volume of sediment expected to accumulate in the waterway between planned maintenance activities. When the waterway slope is less than 1 percent, out-of-bank flow may be permitted if such flow will not cause excessive erosion. Ensure that the design capacity, at a minimum, will remove the water before crops are damaged.

Stability. Determine the minimum depth and width requirements for stability of the grassed waterway using the procedures in the NRCS National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 7, Grassed Waterways or Agricultural Research Service (ARS) Agriculture Handbook 667, Stability Design of Grass-Lined Open Channels. Base stability computations on the peak runoff expected from the 10-year frequency, 24-hour duration storm.

Ensure that the vegetation species selected are suited to the current site conditions and intended uses. Select species that have the capacity to achieve adequate density, height, and vigor within an appropriate time frame to stabilize the waterway.

The allowable effective stress on the soil may be estimated from the soil erodibility categories below, or may be calculated using site-specific soil properties.

- Easily Eroded: Very Fine Sandy Loam, Fine Sandy Loam, Coarse Sandy Loam, Coarse Sandy Loam, Sandy Loam, Very Fine Sand, Fine Sand, Coarse Sand, Sand, Loamy Very Fine Sand, Loamy Fine Sand, Loamy Coarse Sand, Loamy Sand, Silt loam (Plasticity Index < 12)
- Erodible: Silt loam (Plasticity Index >= 12), Silt, Loam, Sandy Clay Loam, Sandy Clay
- Erosion resistant: Clay loam, Silty clay loam, Silty clay, Clay

Design stress and design velocity shall not exceed the allowable effective stress and allowable velocity in Table 1 below, unless site-specific soil properties (soil type, plasticity index, and void ratio) are used to compute allowable effective stress. When allowable effective stress is computed using site-specific soil properties, design velocity shall not exceed

the allowable velocity in Table 1 by more than 20%.

Table 1 - Allowable stress and velocity

Soil Erodibility Category	Allowable Effective Stress (lbs/ft^2)	Allowable Velocity [1/] (feet/second)	
		Annually Vegetated, Retardance E	Permanently Vegetated, Retardance D
Easily Eroded	0.02	1.5	4.0
Erodible	0.03	2.0	4.5
Erosion resistant	0.05	2.5	5.0

[1/] Reduce allowable velocity 10 percent if a long duration flow is expected (such as from a pond or spring). Reduce allowable velocity 20 percent if it is difficult to establish or maintain good grass cover (80% minimum cover over the area) throughout the waterway.

Design velocity should be maintained or slightly increased for each succeeding downstream design reach of the waterway having similar cover. Design velocity may only be decreased for succeeding downstream reaches if a 100-foot transition zone is provided, and excessive sediment deposition is not expected. Reduction in velocity from one reach to the next shall not exceed 25 percent.

Annually vegetated waterways may be considered on gentle slopes of 0.6 percent or less. Design stress and velocity for an annually vegetated waterway shall be determined by using no vegetal cover and Retardance E.

Perennial grass sod must be established in permanently vegetated waterways. If field conditions allow, runoff from the contributing drainage area will be diverted from the waterway during the establishment period.

Width. Keep the bottom width of trapezoidal waterways less than 100 feet unless multiple or divided waterways or other means are provided to control meandering of low flows. Average top width of a waterway shall not be less than 20 feet, unless the waterway is located in an urban setting.

Side slopes. Where farm equipment must cross the waterway during farming operations, side slopes of 6:1 or flatter are recommended, but in no case shall side slopes be steeper than 4:1. Waterways may be parabolic or trapezoidal.

Depth. The capacity of the waterway must be large enough so that the water surface of the waterway is below the water surface of the tributary channel, terrace, or diversion that flows into the waterway at design flow. The minimum recommended depth is 1.0 foot. In urban settings, the minimum depth is 0.5 foot.

Provide 0.5 foot freeboard above the designed depth when flow must be contained to prevent damage. Provide freeboard above the designed depth when the vegetation has the maximum expected retardance.

When the design depth includes a permanent berm to complete the cross section, increase the total constructed depth to include a minimum of 0.5 foot of freeboard above the hydraulic design depth.

Drainage. When needed to establish or maintain vegetation on sites having prolonged flows, high water tables, or seepage problems, use Subsurface Drain (606), Underground Outlet (620), or other suitable measures in waterway designs.

Where drainage practices are not practicable or sufficient to solve these seepage problems, use conservation practice Lined Waterway or Outlet (468) in place of Grassed Waterway (412).

Spread out all excavated material away from the waterway in order to provide for free drainage into the waterway.

Outlets. Provide a stable outlet with adequate capacity to prevent ponding or flooding damages. The outlet can be another vegetated channel, an earthen ditch, a grade-stabilization structure, filter strip, or other suitable outlet.

Vegetative Establishment. Grassed waterways shall be vegetated according to NRCS Conservation Practice Standard Critical Area Planting (342). Species selected shall be suited to the current site conditions and intended uses. Selected species will have the capacity to achieve adequate density, height, and vigor within an appropriate time frame to stabilize the waterway.

Establish vegetation as soon as conditions permit. Use mulch anchoring, nurse crop, rock or straw or hay bale dikes, fabric or rock checks, filter fences, or runoff diversion to protect the vegetation until it is established.

Planting of a close growing crop, e.g. small grains or millet, on the contributing watershed prior to construction of the grassed waterway can also significantly reduce the flow through the waterway during establishment.

Provide livestock and vehicular crossings as necessary to prevent damage to the waterway and its vegetation.

Where subsoil will be exposed, stockpile the best available soil for spreading on the waterway after grading as specified in the construction details.

Temporary berms may be constructed alongside of the waterway to prevent runoff from entering the waterway until adequate vegetative cover is established. When the vegetation is established, the berms shall be removed in accordance with the operation and maintenance (O&M) plan; and the earthfill material blended in the field so that free drainage into the waterway is provided.

Waterway restoration. A waterway is considered to be nonfunctional when its age has exceeded the practice lifespan, and any of the following exists:

- The existing waterway has gully erosion exceeding 1 foot of depth in at least 25% of the waterway's length.
- The existing waterway has an unstable outlet that could be remedied by rebuilding the waterway with a different grade or cross section.
- The existing waterway has (1) a cross-sectional flow area with a capacity of less than 50 percent of the design discharge when full, or (2) a depth less than 0.5 foot.

Supporting data is to be prepared that clearly shows the waterway is or is not functional in accordance with the above criteria. Restored waterways shall be designed in accordance with this standard.

CONSIDERATIONS

Permanent berms along the waterway are permitted as part of the design depth and desirable when the waterway serves as an outlet for terraces or diversions to blend in with the ridge height.

Special consideration should be given to waterways that are being rebuilt or reshaped so the depth of the waterway is compatible with the existing terrace system.

Waterway designs may require the constructed bottom elevation to meet a specific elevation. Examples of this are waterways draining into or receiving flow from structures or waterways used as outlets for terraces or diversions to facilitate their improved alignment or paralleling. In these types of situations, construction tolerances for the flow line elevations shall be specified in the construction details.

Where environmentally-sensitive areas need to be protected from dissolved contaminants, pathogens, or sediment in runoff, consider establishment of an increased width of vegetation on the waterway above the flow area. Increasing the width of the waterway above the flow area will increase filtering of sediment and pathogens as well as increase infiltration of runoff and increase nutrient removal. Where sediment control is the primary concern, consider using vegetation in the waterway which can withstand partial burial and adding sediment control measures above the waterway such as residue management. Consider increasing the channel depth and/or designing areas of increased width or decreased slope to trap and store sediment to reduce the amount of sediment that leaves a field. Provide for regular cleaning out of the waterway when trapping sediment in this manner.

Tillage and crop planting often takes place parallel to the waterway, resulting in preferential flow – and resulting erosion – along the edges of the waterway. Consider installation of measures that ensure that runoff from adjacent areas will enter the waterway. Measures such as directing spoil placement or small swales can direct this preferential flow into the grassed waterway.

Avoid areas where unsuitable plant growth limiting subsoil and/or substratum material such as salts, acidity, root restrictions, etc. may be exposed during implementation of the practice. Where areas cannot be avoided, seek recommendations from a soil scientist for improving the condition or, if not feasible consider over-cutting the waterway and add topsoil over the cut area to facilitate vegetative establishment.

Avoid or protect if possible important wildlife habitat, such as woody cover or wetlands when determining the location of the grassed waterway. If trees and shrubs are incorporated, they should be retained or planted in the periphery of grassed waterways so they do not interfere with hydraulic functions. Medium or tall bunch grasses and perennial forbs may also be planted along waterway margins to improve wildlife habitat. Waterways with these wildlife features are more beneficial when connecting other habitat types; e.g., riparian areas, wooded tracts and wetlands. When possible, select species of vegetation that can serve multiple purposes, such as benefiting wildlife, while still meeting the basic criteria needed for providing a stable conveyance for runoff.

Water-tolerant vegetation may be an alternative to subsurface drains or stone center waterways on some wet sites.

Use irrigation in dry regions or supplemental irrigation as necessary to promote germination and vegetation establishment.

Wildlife habitat benefits can be provided by adding width of appropriate vegetation to the sides of the waterway. Care should be taken to avoid creating small isolated planting zones that could become population sinks where wildlife attracted to an area experience reproductive loss due to predation. Refer to Conservation Practice Standard 645, Wildlife Upland Habitat Management.

Consider including diverse legumes, forbs, and flowering plants such as milkweeds that provide pollen and nectar for native bees and other pollinators. In dry regions, these sites may be able to support flowering forbs with higher water requirements and thus provide bloom later in the summer.

The construction of a grassed waterway can disturb large areas and potentially affect cultural resources. Be sure to follow state cultural resource protection policies before construction begins.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for grassed waterways that describe the requirements for applying the practice according to this standard. As a minimum include:

- A plan view of the layout of the grassed waterway.
- Typical cross section(s) of the grassed waterway(s).
- Profile(s) of the grassed waterway(s).
- Disposal requirements for excess soil material.
- Site specific construction specifications that describe in writing the installation of the grassed waterway. Include specification for control of concentrated flow during construction and vegetative establishment.
- Vegetative establishment requirements.

A stormwater pollution prevention plan shall be prepared for all grassed waterways in which a Kansas Department of Agriculture, Division of Water Resources (DWR) permit is required for a channel change or stream obstruction. The landowner shall submit the plan with a permit application (called a Notice of Intent [NOI]) and permit fee to the Kansas Department of Health and Environment (KDHE) before construction begins.

OPERATION AND MAINTENANCE

Provide an operation and maintenance plan to review with the landowner. Include the following items and others as appropriate in the plan.

- Establish a maintenance program to maintain waterway capacity, vegetative cover, and outlet stability. Vegetation damaged by machinery, herbicides, or erosion must be repaired promptly.
- Correct erosion or silt deposition on annually vegetated waterways by removing the excess material or changing the vegetative cover if possible.
- Protect waterway from concentrated flow by using diversion of runoff or mechanical means of stabilization such as silt fences, mulching, haybale barriers and etc. to stabilize grade during vegetation establishment.
- Minimize damage to vegetation by excluding livestock whenever possible, especially during wet periods. Permit grazing in the waterway only when a

controlled grazing system is being implemented.

- Inspect grassed waterways regularly, especially following heavy rains. Fill, compact, and reseed damaged areas immediately. Remove sediment deposits to maintain capacity of grassed waterway.
- Avoid use of herbicides that would be harmful to the vegetation (including established forbs) or pollinating insects in and adjacent to the waterway area.
- Avoid using waterways as turn-rows during tillage and cultivation operations.
- Mow or periodically graze vegetation to maintain capacity and reduce sediment deposition. Mowing may be appropriate to enhance wildlife values, but must be conducted to avoid peak nesting seasons and reduced winter cover.
- Apply supplemental nutrients as needed to maintain the desired species composition and stand density of the waterway.
- Control noxious weeds.
- Do not use waterways as a field road. Avoid crossing with heavy equipment when wet.
- Lift tillage equipment off the waterway when crossing and turn off chemical application equipment.

REFERENCES

USDA, ARS. 1987. Stability design of grass-lined open channels. Agriculture Handbook 667.

USDA, NRCS. 2007. National Engineering Handbook, Part 650, Engineering Field Handbook, Chap. 7, Grassed waterways.