NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE, TIRE BALES

(No.)
Code 790

DEFINITION

A structure used to control the grade and head cutting in natural or artificial channels.

PURPOSE

- To stabilize the grade and control erosion in natural or artificial channels,
- To prevent the formation or advance of gullies, and
- To enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies only to structures:

- That have a product of storage (ac-ft) times the effective height (ft) of the dam of 1,000 or less,
- Where sudden breach or failure were to occur, damage would be limited to farm buildings, agricultural land, or township and county roads,
- In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion.

This standard applies to all types of grade stabilization structures, including a combination of earth embankments and mechanical spillways and full-flow or detention-type structures. This standard also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel. It does not apply to Structures for Water Control (587) or Dam, Diversion (348), designed to control the rate of flow or to regulate the water level in channels.

This standard applies to erosion control structures constructed of any combination of predominantly used tire bales along with natural materials such as rock, soil, brush, timber, posts, or woven wire.

CRITERIA

Potential effects of installation and operation of the well on cultural, historical, archeological, or scientific resources at or near the site shall be considered in planning.

Attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

Structures must be designed for stability under all anticipated operating conditions. The crest of the inlet must be set at an elevation that stabilizes upstream head cutting.

Earth embankment and emergency spillways of structures for which criteria are not provided under the standard for Pond (378) must be stable for all anticipated conditions. If earth spillways are used, they must be designed to handle the total capacity flow indicated in **Tables 2 or 3** without overtopping the structure. The foundation preparation, compaction, top width, and side slopes must ensure a stable structure for anticipated flow conditions. Discharge from the structure shall be sufficient that no crop damage results from flow detention.

Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

Tire bale structures are potentially hazardous and precautions must be taken to prevent injury or loss of life. Warning signs and/or fences shall be added as needed.

The design must consider the potential for tire bales to separate. Precautions must be taken to ensure bale integrity for the life of the structure.

The design must consider the potential for tire bales to float. The design must ensure that the bales are properly anchored.

Regardless of drainage area, the following documents should be considered in design:

- Available typical designs
- Engineering Field Manual, Chapter 10, "Gully Treatment"
- Forest Service Research Paper RM-169, Revised 1979 (Structures designed under these criteria shall be approved by the Resource Area Engineer.).

Tire Bale Structure on drainage areas less than 200 acres. The structure must be designed for stability after installation and shall be designed in accordance with:

- Hydrology or hydraulic computations are usually not necessary.
- The height of the structure is measured from the lowest point in the drainage way to the lowest point of the weir crest (notch).
- The maximum height of any structure, as defined above, shall not exceed 6 feet.
- The weir shall be designed to direct flows away from the gully banks, with the weir notch width being approximately equal to the current width of the gully bottom. The structure shall be designed to safely pass a minimum flow depth of 1 foot through the weir, without overtopping the structure.

Tire Bale Structure for drainage areas between 200 and 2,200 acres. The structure shall be designed in accordance with:

- Adequate hydrology and hydraulic computations shall be made to assure the stability of the structure for the proposed depth of flow over the weir.
- The height of the structure is measured from the lowest point in the drainage way to the lowest point of the weir crest (notch). The maximum height of any structure shall not exceed 15 feet.(For New Mexico Office of the State Engineer permit purposes, structure height is the difference in elevation between design top of structure and the lowest channel elevation along the downstream toe of the structure.)

Pond size dams. If mechanical spillways are required, the minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in **Table 1**, less any reduction because of detention storage.

The principal spillway capacity may be reduced to no less than 80 percent of the 2-year frequency, 24-hour duration storm if:

- The effective height of the dam is less than 15 feet,
- The auxiliary spillway has a stable grade throughout its length with no overfall, and
- It has good vegetation along its reentry into the downstream channel.

If the storage capacity is more than 50 acre-ft or the criteria values exceed those shown in **Table 1,** the 10-year frequency, 24-hour duration storm must be used as the minimum design storm.

Grade stabilization structures with a settled fill height of less than 15 ft and 10-year frequency, 24-hour storm runoff less than 10 acre-ft, shall be designed to control the 10-year frequency storm without overtopping. The mechanical spillway, regardless of size, may be considered in design and an auxiliary spillway is not required if the combination of storage and mechanical spillway discharge will handle the design storm. The embankment can be designed to meet the requirements for Water and Sediment Control Basin (638) rather than the requirements for Pond (378).

Full-flow open structures. Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices, the National Engineering Handbook, and other applicable NRCS publications and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in **Table 2**, less any reduction because of detention storage. If site conditions exceed those shown in **Table 2**, the minimum design 24-hour storm frequency is 25 years for the principal spillway and 100 years for the total capacity. Structures must not create unstable conditions upstream or downstream. Provisions must be made to insure reentry of bypassed storm flows.

Toe wall drop structures can be used if the vertical drop is 4 ft or less, flows are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or as specified in **Table 2 or 3**, as

applicable, less any reduction because of detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

Table 1

Design criteria for establishing minimum capacity of the principal spillway for structures with storage capacity of less than 50 acre-feet

Maximum drainage area for indicated rainfall*			Effective height of dam	Frequency of minimum design, 24-hour duration storm
0-3 in.	3 - 5 in.	5+ in.		
----------acres----------			ft	years
400	200	100	**15 or less**	**2**
600	400	200	**15 or less**	**5**

* In a 5-year frequency, 24-hour duration storm

Island-type structures. If the mechanical spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the mechanical spillway should carry at least the 2-year, 24-hour storm or the design drainage curve runoff. The minimum auxiliary spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in **Table 2** for total capacity without overtopping the headwall extensions of the mechanical spillway. Provision must be made for safe reentry of bypassed flow as necessary.

Side-inlet drainage structures. The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in **Table 3**. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions. If site condition values exceed those shown in **Table 3**, the 50-year frequency storm shall be used for minimum design of total capacity.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. If climatic conditions preclude the use of vegetation, non-vegetative coverings such as gravel or other mulches may be used.

CONSIDERATIONS

If the area is used for livestock, the structures, earthfill, vegetated spillways, and other areas, should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

Effect on volumes and rates of runoff, evaporation, deep percolation and ground water recharge.

Effect of the structure on soil water and resulting changes in plant growth and transpiration.

Ability of structure to trap sediment and sediment-attached substances carried by runoff.

Effect of structure on the susceptibility of downstream stream banks and stream beds to erosion.

Effect of the structure on the movement of dissolved substances to ground water.

Effect on visual quality of downstream water resources.

In highly visible public areas and those associated with recreation, careful considerations should be given to landscape resources. Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

Table 2

Design criteria for establishing minimum capacity of full-flow open structures

Maximum drainage area for indicated rainfall*				Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.	5+ in.	Vertical drop	Principal spillway capacity	Total capacity
----------acres----------			Ft	year	year
1,200	**450**	**250**	**5 or less**	**5**	**10**
2,200	**900**	**500**	**10 or less**	**10**	**25**

*In a 5-year frequency, 24-hour duration storm.

Table 3

Design criteria for establishing minimum capacity of side-inlet, open weir, or pipe-drop-drainage structure

Maximum drainage area for indicated rainfall*				Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.	5+ in.	Vertical drop	Receiving channel depth	Total capacity
----------acres----------			Ft	Ft	year
1,200	**450**	**250**	**0 – 5**	**0 - 10**	**--**
1,200	**450**	**250**	**5 – 10**	**10 - 20**	**10**
2,200	**900**	**500**	**0 – 10**	**0 - 20**	**25**

*In a 5-year frequency, 24-hour duration storm.

PLANS AND SPECIFICATIONS

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Provisions shall be made for operations and maintenance requirements and may include a formal plan for more complex designs.

The following actions shall be carried out to ensure the practice functions as intended throughout its expected life of 10 years. These actions include normal repetitive activities in the application and use of the practice (operation), repair, and upkeep.

The structure and all of its components will be inspected periodically, protected, and restored as needed to maintain the intended purpose from adverse impacts such as rodent holes, vehicular traffic, seepage, erosion, broken cables, cracked concrete, or woody vegetation.

REFERENCES

Forest Service Research Paper RM-169, Revised 1979

NRCS Technical Release No. 60 (TR-60)

NRCS Engineering Field Manual for Conservation Practices

NRCS FOTG, section IV

NRCS National Engineering Handbook,