NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

(No.)

CODE 410

DEFINITION

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

PURPOSE

This standard applies to all types of grade stabilization structures, including a combination of earth embankments and principal 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 designed to control the rate of flow or to regulate the water level in Structure for Water Control (587).

The purpose of this standard is 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

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

CRITERIA

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that will stabilize upstream head cutting.

Laws and Regulations. This practice must conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use, land disturbed by construction, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

Embankment dams. Class (a) dams that have a product of storage times effective height of the dam of 3,000 or more, those more than 35 ft. in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60 (TR-60).

Class (a) dams that have a product of storage times effective height of the dam of less than 3,000 and an effective height of 35 ft. or less shall meet or exceed the requirements specified for Pond (378), except as described in this standard.

The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.

Pond (378) size dams. If principal spillways are required, the minimum capacity of the principal spillway shall be that required to pass the routed design hydrograph expected from a 24-hour duration design storm of the frequency shown in Table 1.

If the effective height of the dam is less than 20 ft. and the auxiliary spillway has a stable grade throughout its length with no overfalls and has good vegetation along its reentry into the downstream channel, the principal spillway capacity may be reduced but can be no less than 80 percent of the 2-year frequency, 24-hour duration storm.

If criteria values exceed those shown in Table 1 or the storage capacity is more than 50 acre-ft., 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 principal spillway, regardless of size, may be considered in design flow of the auxiliary spillway. An auxiliary spillway is not required if the combination of storage and principal spillway discharge will handle the design storm. The embankment can be designed to meet the requirements for Water and Sediment Control Basins (638) rather than the requirements for Pond (378).

If an auxiliary spillway is required for a pond size structure it shall meet the requirements of Table 2 and the auxiliary spillway requirements of Pond (378).

Table 1. - Design criteria for establishing minimum capacity of the principal spillway for dams 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.		
----------acres---------		feet	Year
200	100	35 or less	2
400	200	20 or less	2
400	200	20 - 35	5
600	400	20 or less	5

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

Table 2. Minimum Auxiliary Spillway Capacity

			Min. design storm[2]	
Drainage area (ac)	Effective height of dam1 (ft)	Storage (ac-ft)	Frequency (Years)	Min. duration (Hours)
20 or less	20 or less	< than 50	10	24
All others		< than 50	25	24
All others		> than 50	50	24

1/. As defined under “Conditions where Practice Applies.”
2/. Select rain distribution based on climatological region.

Full-flow open structures. Full-flow open structures are those which must pass the design storm through the principal and auxiliary spillways without flooding the surrounding area. Examples are drop, chute, and box inlet drop spillways. These structures shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices, the National Engineering Handbook, and other applicable Natural Resources Conservation Service (NRCS) publications and reports. The minimum capacity shall be that required to pass the routed design hydrograph expected from a design storm of the frequency and duration shown in Table 3. If site conditions exceed those shown in Table 3, 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 four 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 3 or 4 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.

Island-type structures. Island-type structures are a special case of full-flow structure. For island-type structures, out of bank flooding can be tolerated. The minimum capacity of the principal spillway of an island-type structure, shall equal the capacity of the downstream channel or the 25-year frequency, 24-hour duration storm runoff, whichever is less. In no case shall it be less than 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 3 for total capacity without overtopping the headwall extensions of the mechanical spillway. Provisions 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 4. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions. If site condition values exceed those shown in Table 4, the 50-year frequency storm shall be used for minimum design of total capacity.

Landscape 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 and protected as necessary to prevent erosion.

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 3. 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.		Vertical drop	Principal spillway capacity	Total capacity
----------acres----------			Feet	year	year
1,200	450		5 or less	5	10
2,200	900		10 or less	10	25

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

Table 4. 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.		Vertical drop	Receiving channel depth	Total capacity
----------acres----------			Feet	feet	year
1,200	450		0 – 5	0 - 10	--5
1,200	450		5 – 10	10 - 20	10
2,200	900		0 – 10	0 - 20	25

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

General criteria. Earth embankment and auxiliary spillways of structures for which criteria are not provided under the standard for Pond (378) or in TR-60 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 3 or 4 without overtopping the embankment. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Discharge from the structure shall be sufficient that no crop damage results from flow detention.

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

Grade stabilization pond structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life.

Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

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.

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, nonvegetative coverings, such as, gravel or other mulches may be used.

CONSIDERATIONS

Effects on volumes and quality of runoff, deep percolation, and ground water recharge should be considered. Also consider changes in downstream erosion.

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 (O&M)

An O&M plan shall be prepared for use by the owner/operator. The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. The plan shall also provide for periodic inspection and repair or replacement of damage.