

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
GRADE STABILIZATION STRUCTURE

(No.)

CODE 410

DEFINITION

A grade stabilization structure is a structure used to control the grade in natural or constructed channels.

PURPOSE

The purpose of a grade stabilization structure is to stabilize grade, reduce erosion, or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where channels require a structure to stabilize the grade or to control gully erosion.

CRITERIA

Laws and Regulations. The investigation, design, and installation of the conservation practice must comply with all applicable governmental regulations, laws, permits, licenses, and registrations. The landowner is responsible for obtaining all permits and rights.

General Criteria.

Set the crest of the inlet at an elevation that will stabilize the channel and prevent upstream head cutting.

All components, such as, earth embankments 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.

Design earthen embankments and auxiliary spillways to handle the total capacity flow indicated in Tables 1 or 2 without overtopping any embankment. The foundation preparation, compaction, top width, and side slopes must ensure a stable earthen embankment for anticipated flow conditions.

Provide a minimum sediment storage capacity equal to the expected life of the structure, or provide for periodic cleanout.

Provide measures necessary to prevent serious injury or loss of life such as protective guardrails, warning signs, fences, or lifesaving equipment.

Seed or sod the exposed surfaces of earthen embankments, earth spillways, borrow areas, and other areas disturbed during construction in accordance with NRCS Conservation Practice Standard (CPS) *Critical Area Planting* (Code 342). If climatic conditions preclude the use of seed or sod, use NRCS CPS *Mulching* (Code 484) to install inorganic cover material such as gravel.

Embankment dams. Low hazard (Class a) dams that have a product of storage times the effective height of the dam of 3,000 ac-ft² or more, those more than 35 ft in effective height, and all significant (Class b) and high hazard (Class c) dams must meet or exceed the criteria specified in Engineering Technical Release TR-210-60, Earth Dams and Reservoirs.

Low hazard (Class a) dams that have a product of storage times the effective height of the dam of less than 3,000 ac-ft² and an effective height of 35 ft or less must meet or exceed the requirements specified in NRCS CPS *Pond* (Code 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.

Storage is the capacity of the reservoir in acre-feet below the elevation of the crest of the

lowest auxiliary spillway or the elevation of the top of the dam if there is no open channel auxiliary spillway.

Pond sized dams. If principal spillways are required, the minimum capacity of the principal spillway must convey the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 3, less any reduction from detention storage. For dams with effective height less than 20 ft, a stable auxiliary spillway with no overfalls, and good auxiliary spillway vegetation along its reentry into the downstream channel, the designer may reduce the principal spillway capacity to no less than 80 percent of the 2-year frequency, 24-hour duration storm. For dams with a storage capacity more than 50 acre-ft or criteria values exceeding those shown in Table 3, use the 10-year frequency, 24-hour duration storm as the minimum design storm.

If an auxiliary spillway is required for a pond size structure it shall meet the requirements of Table 4 and the auxiliary spillway requirements of Pond (378).

Small pond-sized dams. For dams with an effective height of less than 15 ft and 10-year frequency, 24-hour storm runoff volume less than 10 acre-ft, the designer may use the requirements of NRCS CPS *Water and Sediment Control Basin (Code 638)*. Design the grade control structure to control the peak flow from the 10-year frequency, 24-hour duration storm without overtopping. If the combination of storage and principal spillway discharge will handle the design storm, an auxiliary spillway is not required.

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. Design drop, chute, and box inlet drop spillways to the requirements in the National Engineering Handbook, Part 650, Engineering Field Handbook and other applicable NRCS publications and reports. Provide a minimum capacity to pass the peak flow expected from a design storm of the frequency and duration shown in Table 1, less any reduction from detention storage. If site conditions exceed those shown in Table 1, design the minimum principal spillway capacity for the 25-year frequency (24-hour duration)

storm and design the minimum total capacity for the 100-year frequency (24-hour duration) storm. Structures must not create unstable conditions upstream or downstream. Install provisions for 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 1/3 of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts must meet the requirements of the responsible road authority or as specified in Table 1 or 2, as applicable, less any reduction from 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. Design the minimum capacity of the principal spillway equal to the capacity of the downstream channel. In no case shall the principal spillway capacity be less than the 2-year frequency, 24-hour storm. Design the minimum auxiliary spillway capacity equal to that required to pass the peak flow expected from a 24-hour duration storm of the frequency shown in Table 1 for total capacity without overtopping the headwall extensions of the principal spillway. Make provision for safe reentry of bypassed flow as necessary.

Side-inlet, open weir, or pipe-drop drainage structures. Table 2 provides 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. Design the minimum principal spillway capacity equal to the design drainage curve runoff for all conditions. If site condition values exceed those shown in Table 2, use the 50-year frequency, 24-hour duration storm for minimum design of total capacity.

CONSIDERATIONS

Provide sufficient discharge to minimize crop damage from water detention.

In highly visible public areas and those associated with recreation, give careful consideration to landscape resources.

Landforms, structural materials, water elements, and plant materials should complement their surroundings visually and functionally. Shape excavated material and cut slopes to blend with the natural topography. Shape shorelines and create islands to add visual interest and wildlife habitat. Form and finish exposed concrete surfaces to add texture, reduce reflection, and to alter color contrast. Select sites to reduce adverse impacts or create desirable focal points.

Consider the effect of the grade control structure on aquatic habitat. For channels supporting fish, consider the effect of the structure on fish passage.

In natural channels, consider the effect of the grade control structure on fluvial geomorphic conditions.

Provide fences to protect structures, earth embankments, and vegetated spillways from livestock. Near urban areas, provide fencing as appropriate to control access and exclude traffic.

Table 1. - Design criteria for establishing minimum capacity of full-flow open structures.

Maximum drainage area for indicated rainfall in a 5-year frequency, 24-hour duration storm		Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.		Principal spillway capacity	Total capacity
-----acres-----		<i>ft</i>	<i>yr</i>	<i>yr</i>
1,200	450	0 - 5	5	10
2,200	900	0 - 10	10	25

Table 2. - Design criteria for establishing minimum capacity of side-inlet, open weir, or pipe-drop drainage structure.

Maximum drainage area for indicated rainfall in a 5-year frequency, 24-hour duration storm		Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.		Receiving channel depth	Total capacity
-----acres-----		<i>ft</i>	<i>ft</i>	<i>yr</i>
1,200	450	0 - 5	0 - 10	5
1,200	450	5 - 10	10 - 20	10
2,200	900	0 - 10	0 - 20	25

Table 3. - 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 in a 5-year frequency, 24-hour duration storm		Effective height of dam	Frequency of minimum design, 24-hour duration storm
0-3 in.	3 - 5 in.		
-----acres-----		ft	Yr
200	100	0 - 35	2
400	200	0 - 20	2
400	200	20 - 35	5
600	400	0 - 20	5

Table 4. – Minimum Auxiliary Spillway Capacity

Drainage area (ac)	Effective height of dam (ft)	Storage (ac-ft)	Min. design storm ¹	
			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. Select rain distribution based on climatological region.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for installing grade stabilization structures that describe the requirements for applying the practice according to this standard. As a minimum, include the following items in the plans and specifications:

1. A plan view of the layout of the grade stabilization structure and appurtenant features.
2. Typical profiles and cross sections of the grade stabilization structure and appurtenant features as needed.
3. Structural drawings, as needed.
4. Seeding requirements, as needed.
5. Safety features.
6. Site specific construction requirements.

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OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. As a minimum, include the following items in the operation and maintenance plan:

1. Require periodic inspections of all structures, earthen embankments, spillways, and other significant appurtenances.
2. Require prompt repair or replacement of damaged components.
3. Require prompt removal of sediment when it reaches pre-determined storage elevations.
4. Require periodic removal of trees, brush, and invasive species.

5. Require periodic inspection of safety components and immediate repair if necessary.
6. Require maintenance of vegetative protection and immediate seeding of bare areas as needed.

REFERENCES

USDA Natural Resources Conservation Service. Engineering Technical Releases, TR-

210-60, Earth Dams and Reservoirs. Washington, DC.

USDA Natural Resources Conservation Service. National Engineering Handbook, Part 628, Dams. Washington, DC.

USDA Natural Resources Conservation Service. National Engineering Handbook, Part 650, Engineering Field Handbook. Washington, DC.