NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

STRUCTURE FOR WATER CONTROL

(No.)
CODE 587

DEFINITION

A structure in a water management system that conveys water, controls the direction or rate of flow, maintains a desired water surface elevation or measures water.

PURPOSE

The practice may be applied as a management component of a water management system to control the stage, discharge, distribution, delivery or direction of water flow.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies wherever a permanent structure is needed as an integral part of a water-control system to serve one or more of the following functions:

- Convey water from one elevation to a lower elevation within, to or from a water conveyance system such as a ditch, channel, canal or pipeline designed to operate under open channel conditions. Typical structures are drops, chutes, turnouts, surface water inlets, head gates, pump boxes and stilling basins.
- Control the elevation of water in drainage or irrigation ditches. Typical structures are checks, flashboard risers and check dams.
- Control the division or measurement of irrigation water. Typical structures are division boxes and water measurement devices.
- Keep trash, debris or weed seeds from entering pipelines. Typical structures are debris screens and turbulent fountain screens.
- Control the direction of channel flow resulting from tides and high water or back-flow from flooding. Typical structures are tide and water management gates.
- Control the water table level, remove surface or subsurface water from adjoining land, flood land for frost protection or manage water levels for wildlife or recreation. Typical structures are water level control structures, flashboard risers, pipe drop inlets and box inlets.
- Convey water over, under or along a ditch, canal, road, railroad or other barriers. Typical structures are bridges, culverts, flumes, inverted siphons and long span pipes.
- Modify water flow to provide habitat for fish, wildlife and other aquatic animals. Typical structures are chutes, cold water release structures and flashboard risers.
- Provide silt management in ditches or canals. A typical structure is a sluice.
- Supplement a resource management system on land where organic waste or commercial fertilizer is applied.
- Create, restore or enhance wetland hydrology.

CRITERIA

General Criteria Applicable to All Purposes

Structures shall be designed on an individual job basis or applicable NRCS standard drawings shall be adapted, to meet site conditions and functional requirements. Designs shall be based upon site surveys, required hydraulic functions and site soils/foundation investigations. Structures not covered by Standard Designs/ Drawings shall be designed in accordance with current NRCS engineering handbooks and associated technical materials.

Provisions must be made for necessary maintenance. Care must be used to insure that the area's visual resources are not damaged. If watercourse fisheries are important, special precautions or design features may be needed to allow fish passage.

Vegetation complying with Critical Area Planting (342) shall be established on all disturbed earth surfaces. Where soil, climate or site specific conditions preclude establishing permanent vegetation, other protective means such as mulches or gravels shall be used.

The structure shall be fenced, if necessary, to protect the vegetation.

The water level upstream of water control structures shall not be raised on adjacent landowners without their permission.

Foundation. The extent of foundation investigations shall be based upon the size and importance of the structure, geology of the area, water table considerations and the initial findings of the investigations. **The foundation materials shall have adequate bearing strength to support the structure without undesirable and/or differential settlement unless specific structural design considerations and/or foundation treatment are included in the design for such conditions. The foundation materials shall have adequate resistance to prevent piping. Structure cutoffs, drainage and/or foundation treatment shall be included in the design as needed.**

Capacity. Structures shall have the capacity to carry the design flow with adequate freeboard, remain stable, control downstream erosion and keep the upstream and downstream water surfaces within the limits allowed.

Freeboard. The following minimum freeboard shall be provided:

Structure Type	Design Flow	Freeboard
Irrigation Ditch structure (e.g. checks, turn-outs, diversion boxes, drops of F< 4-feet)	6 cfs or less	4 inches
	6 to 15 cfs	6 inches
	15 to 50 cfs	9 inches
Inverted Siphon, Inlets & Outlets	Same as above plus 0.2 $V^2/2g$	

Where V = water velocity in pipe (fps)

Structural. Structures for water control shall be designed to withstand the anticipated loads from internal and external loading, hydrostatic uplift, surcharge loads, surface and impact loads, water pressure due to seasonally high water tables, frost and ice pressures. Refer to NRCS Technical Release 74, “Lateral Earth Pressures”.

Standard Drawings. The use of Idaho Standard Drawings numbered ID-SD-587A through ID-SD-587R shall be governed by the following limitations:

1. Depth of notch for drop structures shall not exceed four (4) feet.
2. Height of drop shall not exceed two (2) feet.
3. Length of crest shall not exceed four (4) feet.
4. Total height of any wall shall not exceed 4-1/2 feet except for pipe inlets where the width to height ratio is less than one (1).
5. The apron length for drop structures shall be not less than five times the flow depth over the crest at design flow.

When structure sizes exceed any of these limitations, hydraulic and structural computations are required to support the design.

Drop Structure Design. The crest elevation of drop structures in a system shall not be lower than the end sill elevation of the next upstream structure or the bottom of a stable ditch 300 feet upstream, whichever is closer. Exceptions are ditches in soils where a non-erosive velocity can be shown by design using a Mannings "n" coefficient no higher than 0.025. For installations where grade is permitted between structures, riprap, the greater of four (4) feet or one (1) apron length, shall be provided downstream of each structure.

The crest length should not be wider than the bottom width of the ditch. Table 1 can be used to select the structure crest length for various combinations of flow depth and capacity. The design notch depth for the structure shall include the required freeboard and water flow depth.

Apron widths should conform to the ditch bottom width immediately below the structure and shall not be narrower than the crest length.

For structures with two (2) feet or less drop, the apron length should not be less than the height of the drop plus three (3) times the depth of water above the crest. Apron length for structures with a drop greater than two (2) feet shall be

determined using National Engineering Handbook (NEH), Section 11, Drop Spillways, or from criteria contained in approved standard drawings.

TABLE I
Drop Structure Capacity* (cfs)

Flow Depth (Ft)	Crest Length (Ft)				
	1.0	1.5	2.0	2.5	3.0
0.5	1.2	1.75	2.33	2.9	3.5
1.0	3.3	4.95	6.6	8.25	9.9
1.5	6.1	9.1	12.1	15.2	---

Computed by $Q = 3.3\ LH^{3/2}$

At the high water line, the upstream headwall extensions shall extend into solid earth a horizontal distance equal to the cutoff requirements or one (1) foot, whichever is greater. The downstream wingwalls shall extend, at a minimum, to the normal high water line in the ditch.

For structures with a design flow of 15 cfs or less and a wall height above the apron of 4-1/2 feet or less, the combined length of the upstream cut-off and downstream toe wall below the apron shall be at least two (2) times the height of drop. This length shall be distributed between the upstream cut-off and toe wall. The toe wall shall extend not less than nine inches below the apron and the cut-off shall extend not less than one (1) foot below the apron.

Cut-off requirements for structures larger than 15 cfs or wall height greater than 4-1/2 feet or drop greater than two (2) feet shall be determined by using Lane's Theory of Creep in NEH, Section 11, or flow net procedures described in NRCS, Soil Mechanics Note 5, “Flow Net Construction and Use”.

Check Structure Design. The basic criteria for drop structures shall apply with the following exceptions:

For check structures with a design flow of 15 cfs or less and a wall height above the apron of three (3) feet or less, the combined length of upstream cut-off and downstream toe wall shall be two (2) times the design height of the check boards. This length below the apron shall be distributed between the upstream cut-off and the toe wall. The toe wall shall extend not less than nine inches below the apron and the cut-off shall extend not less than one (1) foot below the apron.

Division Box Design. The basic criteria for check and drop structures shall be used for determining headwall, cut-off and wingwall requirements. Additional criteria are as follows:

The cross-sectional area should provide for a flow velocity of about 1/2 foot/sec. The size should conform to existing or proposed ditches or pipelines and be adequate to safely distribute the design flow. Division boxes using pipe for distribution shall be proportioned in accordance with criteria for Pipe Inlet and Outlet Structures. Minimum entrance loss shall be computed as $1+v^2/2g$. where v = pipe velocity and g = 32.2.

If measuring devices are to be included in the design, the box dimensions shall meet the criteria for the measuring device used. The outlets for division boxes shall meet requirements for grade control structures or the outlet channel shall be riprapped where erosive velocities may occur.

Field Turnouts. Field turnouts shall have adequate capacity to supply the water for the area served. The maximum design ditch water surface shall provide for the required freeboard and water depth, plus head losses for the turnout for the type of ditch.

Turnouts shall be installed with a suitable cutoff and wingwalls.

When water velocity in the turnout exceeds three (3) feet/sec. or the outlet is not submerged, the outlet shall be protected with rock riprap, sod or other suitable material.

Materials. Structures may be constructed of aluminum, steel, reinforced concrete, rock, masonry, concrete blocks with reinforcing steel, concrete pipe, timber and fiberglass. All materials used in constructing structures for water control shall have the strength, durability and workability required to meet the installation and operational conditions required for the site.

Materials used must meet the applicable standard for the kind of materials used [i.e., concrete pipe shall meet the requirements of Irrigation Water Conveyance, Nonreinforced Concrete Pipeline (430CC), etc.].

The selection of the material to be used should take into account the following:

1. The required life of the structure.

2. The pH and salinity of the soil.

3. A cost comparison amortized to account for varying life spans.

Reinforced Concrete. Reinforced concrete structures, except for channel linings, shall have a minimum member thickness of six (6) inches. The minimum reinforcement for shrinkage and temperature rebar in six-inch members shall be 1/2 inch diameter steel reinforcing bars located on 12 inch centers each way. Designs for R/C structures shall conform to the requirements of NRCS, Technical Release 67, “Reinforced Concrete Design”. The minimum section thickness and reinforcement for channel linings shall be in accordance with NRCS, Far West States, Engineering Design Standards. The only exceptions shall be officially approved standard drawings.

Concrete Blocks. In general, the structural design of concrete block structures is the same as for reinforced concrete structures. Structures may be constructed of concrete block manufactured in accordance with ASTM criteria and using the procedures in NRCS Idaho Engineering Technical Note No. 3, "Design Considerations for Concrete Block Structures". Lightweight "Cinder Blocks" are not acceptable.

Metal. Metal used in structures shall meet the structural requirements of the job. The structure metal thickness will be determined for the specific loading conditions. However, for metal pipe riser type structures the minimum thickness shall be:

48 inch diameter and smaller 16 gage

54 inch diameter and larger 14 gage

All metal, aluminum or galvanized coated shall have a protective coating based upon the requirements of Steel Pipeline, (430-FF).

Timber. Wood used in structures shall meet the structural requirements of the job. Wood, except for redwood, cedar and larch, shall be treated with an environmentally safe preservative appropriate for the type of structure, use and species of wood used.

CONSIDERATIONS

When planning, designing and installing this practice, the following items should be considered:

- Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and ground water recharge.
- Potential for a change in the rate of plant growth and transpiration because of changes in the volume of soil water.
- Effects on downstream flows or aquifers that would affect other water uses or users.
- Effects on the field water table to ensure that it will provide a suitable rooting depth for the anticipated crop.
- Potential use for irrigation management to conserve water.
- Effects of construction on aquatic life.
- Effects on stream system channel morphology and stability as it relates to erosion, and the movement of sediment, solutes and sediment-attached substances carried by runoff.
- Effects on the movement of dissolved substances below the root zone and to ground water.
- Effects of field water table on salt content in the root zone.
- Short term and construction-related effects of this practice on the quality of downstream water.
- Effects of water level control on the temperatures of downstream waters and their effects on aquatic and wildlife communities.
- Effects on wetlands or water-related wildlife habitats.
- Effects on the turbidity of downstream water resources.
- Existence of cultural resources in the project area and any project impacts on such resources.
- Conservation and stabilization of archeological, historic, structural and traditional cultural properties when appropriate.

Design alternatives presented to the client should address economics, ecological concerns and

acceptable levels of risk for design criteria as it relates to hazards to life or property.

PLANS AND SPECIFICATIONS

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

The plan shall specify the location, grades, quantities, dimensions, materials and hydraulic and structural requirements for the individual structure. Provisions must be made for necessary maintenance. Care must be used to protect the surrounding visual resources. If watercourse fisheries are important, special precautions or design features may be needed to facilitate continuation of fish migrations.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be provided to and reviewed with the land manager. The plan shall be site specific and include, but not be limited to, the following: Structures will be checked and necessary maintenance, including removal of debris, shall be performed after major storms and at least semi-annually. Water level management and timing shall be adequately described wherever applicable.

REFERENCES

- King's Handbook of Hydraulics
- National Engineering Handbook, Sections 5, 6 and 11
- Engineering Field Handbook
- Engineering Design Standards, Far West States
- Technical Release 67, Reinforced Concrete Strength Design
- Technical Release 74, Lateral Earth Pressures