NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

SURFACE DRAINAGE, MAIN OR LATERAL

(ft.)

CODE 608

DEFINITION

An open drainage ditch constructed to a designed size and grade.

PURPOSES

This practice may be applied as part of a resource management system to support one or more of the following:

- Dispose of excess surface or subsurface water.
- Intercept ground water.
- Control ground water levels.
- Provide for leaching of saline of alkali soils.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to ditches primarily designed for disposal of surface and subsurface drainage water primarily collected by drainage field ditches and subsurface drains.

The practice provides minimum drainage requirements for multiple-purpose channels that provide drainage outlets for agricultural lands. Mains or laterals having a drainage area of more than 1 square mile must meet the channel stability requirements of NRCS National Engineering Technical Release, Design of Open Channels, TR-25. Field designed primarily designed to collect surface water are applicable to Conservation Practice Standard (607).

All lands to be drained shall be suitable for agriculture after installation of required drainage and other conservation practices.

An outlet for the drainage system must be available, either by gravity flow or by pumping. The outlet shall provide for the quantity and quality of water to be disposed of. Consideration shall be given to possible damages above or below the point of discharge that might involve legal actions.

CRITERIA

General criteria applicable to all purposes

The design and installation shall be based on adequate surveys and investigations.

Drainage requirements

Mains and laterals shall be located and designed to serve as integral parts of a surface or subsurface drainage system that meets the conservation and land use needs. The degree of drainage required by crops shall be determined and expressed in terms of drainage coefficients or depth and spacing of drains.

Capacity

The ditch capacity shall be adequate to provide for the removal of excess water, based on climatic and soil conditions and the needs of crops.

Required capacity shall be obtained by determining the watershed area; the required topographic, soil, and land use information; and use of the appropriate drainage coefficient curves.

Surface drainage main or laterals shall not be used to convey water from one watershed to another, unless due consideration has been

given to potential effects. Easements, agreements, etc., as needed, shall be obtained by the landowner/operator prior to construction activities.

The required capacity of mains and laterals for surface and subsurface drainage in irrigated areas shall be determined by evaluating site conditions, including irrigation water deliveries, irrigation canal or ditch losses, irrigation delivery system operation spills, soil stratification and permeability, deep percolation losses, field irrigation losses, and subsurface drain discharge.

Improved irrigation water management to decrease need for surface drainage shall be considered.

Capacity shall also be provided for the quantity of surface water runoff from both surface irrigation and storm events that is to be carried by the drainage mains and laterals.

Mains and laterals shall be designed with enough capacity to carry the required flows at the velocities that will be developed under the maximum probable retardance conditions.

Hydraulic grade line

The hydraulic grade line for drainage ditch design shall be determined from control points, including elevations of significant low areas served by the ditch and hydraulic grade lines of any tributary ditches and the outlet. If control point elevations are estimated rather than computed from survey data, the hydraulic grade line shall be no less than:

1. 1 foot below fields that will receive normal drainage from ditches draining more than 640 acres.
2. 0.5 foot for ditches draining 40 to 640 acres.
3. 0.3 foot for ditches draining less than 40 acres.

For lands to be used only for water-tolerant crops, such as trees and grasses, these requirements may be modified and the hydraulic grade line set at ground level. These provisions do not apply to channels where dikes contain flow.

The effects of hydraulic losses caused by culverts, bridges, or other obstructions in the channel section shall be considered.

Depth

Drainage ditches shall be designed deep enough to allow for normal sedimentation. If needed, the design depth and capacity may be increased to provide adequate subsurface drainage or for normal flow.

The increase shall be based on an evaluation of site conditions.

Ditches that serve as outlets for subsurface drains shall be designed for a normal water surface at or below the invert of the outlet end of the drain. The clearance between a subsurface drainage conduit invert and the ditch bottom shall be least 1 ft. for ditches that fill with sediment at a normal rate, except where lower values are specified for a job because of unusual site conditions. The normal water surface is the elevation of the flow during the expected peak flow period.

Cross section

The design ditch cross section shall be set below the design hydraulic grade line and shall meet the combined requirements of capacity, limiting velocity, depth, side slopes, bottom width, and, if needed, allowances for initial sedimentation. Side slopes shall be stable, shall meet maintenance requirements, and shall be designed on the basis of on-site conditions.

Velocity

Maximum permissible design velocity shall be based on site conditions and shall insure stability of the ditch bottom and side slopes. A desirable minimum velocity is 1.5 feet per second on flat grades. A channel cross section shall be selected on the basis of the depth and maintenance requirements, which will result in the desirable minimum velocity.

Mains and laterals shall be designed to develop velocities that are non-erosive for the soil materials through which they pass.

Local information on velocity limits, as approved by the NRCS State Conservation Engineer shall be used if available. If such information is not available, the maximum design velocity shall not exceed those shown in Table 1.

For checking designs to see that velocities do not exceed permissible values, a Manning's "n" no greater than 0.025 shall be used

Capacity design

Manning's formula shall be used in determining the design velocity, and the value of “n” shall be based on alignment, probable vegetative growth expected with normal maintenance, other roughness factors, and the hydraulic radius. Unless special site studies are available to justify other values, the following values of “n”, based on the hydraulic radius of the channel and assuming an aged channel with good maintenance and good alignment, shall be used in solving the Manning formula for mains and laterals when determining the design for required capacity:

Table 1

Hydraulic radius	n
Less than 2.5	0.040 - 0.045
2.5 to 4.0	.035 - .040
4.1 to 5.0	.030 - .035
More than 5.0	.025 - .030

For newly constructed ditches in fine-grained soils and sands, Manning’s “n” values shall be determined according to procedures in Chapter 6 of TR-25, and shall not exceed 0.025.

Stability

Characteristics of a stable ditch are:

1. The surface drainage field ditch neither aggrades nor degrades beyond tolerable limits.
2. The ditch banks do not erode to the extent that the ditch cross section is changed appreciably.

Stability checks that are flow related are not required if velocity is 2 ft/s or less.

Berms and spoil banks

Adequate berms shall be provided and shaped, as required, to provide access for maintenance equipment, to eliminate the need for moving spoil banks in future operations, to provide for work areas and facilitate spoil bank spreading, to prevent excavated material from washing or rolling back into ditches, and to lessen sloughing of ditch banks caused by heavy loads too near the edge of the ditch banks. The following minimum berm widths shall be provided, except where spoil is spread according to the engineering standard for spoil bank spreading:

Table 2

Ditch depth	Min. berm width
ft	ft
2-6	8
6-8	10
More than 8	15

If spoil material is to be placed in banks along the ditch rather than spread over adjacent fields, the spoil banks shall have stable side slopes. Provision must be made to channel water through the spoil and into the ditch without causing erosion.

Related structures and ditch protection

Mains and laterals shall be protected against erosion by chutes, drop structures, pipe drops, other suitable structures or grassed waterway, or specially graded channel entrances where surface water or shallow ditches enter deeper ditches.

Grade control structures, bank protection, or other suitable measures shall be used if necessary to reduce velocities and control erosion.

Culverts and bridges shall have enough hydraulic capacity and depth for drainage needs and to minimize obstruction to flow.

Capacities of pipe or drop structures generally shall be determined by use of the applicable drainage coefficients with the "island-type" of construction used to protect the structure from washout.

Each structure for an open ditch system shall be designed according to NRCS standards for the kind of structure and type of construction used.

CONSIDERATIONS

Water Quantity

1. Effects on the water budget components, especially with regard to effect on runoff, soil water, and water tables.
2. Potential changes in soil moisture that will affect the growth of desirable vegetation.
3. Effect on ground water recharge.

Water Quality

1. Effects on the detachment and transport of sediment and chemicals and dissolved and sediment-attached substances into water courses.
2. Effects on the salinity of drained soils and downstream water courses.
3. Effects on wetlands.
4. Effect on the quality of ground water.
5. Potential for changes in downstream water temperatures.
6. Effects on downstream visual quality.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing mains or laterals shall be in keeping with this standard and shall describe the requirements for constructing the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An Operation and Maintenance plan must be prepared for use by the landowner or operator responsible for irrigation field ditches operation and maintenance. The plan should provide specific instructions for operating and maintaining the irrigation field ditches to insure it functions properly. Minimum requirements to be addressed in the Operation and Maintenance Plan are:

1. Prompt repair or replacement of damaged components is necessary
2. Remove debris and foreign material from drainage ditches and other components that hinders system operation
3. Maintain good vegetative cover on all slopes and watercourses.

List items specific to the project on the Operation and Maintenance Worksheet.

REFERENCES

USDA NRCS, National Engineering Field Handbook, Chapters 3, 14.

USDA NRCS, Standard Drawings Handbook - Washington.

USDA NRCS, National Engineering Handbook,

Part 624, Drainage of Agricultural Lands.

ASCE No 70, Assessment and Management of Saline Soils.

USDA NRCS, National Engineering Technical Release, Design of Open Channels, TR-25, October 1977.

NRCS, WA
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Table 1 - Permissible Surface Drainage Field Ditch Velocities

	Velocity after aging of ditches carrying:		
	Clear water, no detritus	**Water transporting colloidal silts**	**Water transporting non-colloidal silts, sands, gravels, or rock fragments**
Original material excavated for field ditch	**ft/sec**	**ft/sec**	**ft/sec**
Fine sand (non colloidal)	1.50	2.50	1.50
Sandy loam (non-colloidal)	1.75	2.50	2.00
Silt loam (non-colloidal)	2.00	3.00	2.00
Alluvial silts when non-colloidal	2.00	3.50	2.00
Ordinary firm loam	2.50	3.50	2.25
Volcanic ash	2.50	3.50	2.00
Fine gravel	2.50	5.00	3.75
Stiff clay (very colloidal)	3.75	5.00	3.00
Graded loam to cobbles when non-colloidal	3.75	5.00	5.00
Alluvial silts when colloidal	3.75	5.00	3.00
Graded, silt to cobbles, when colloidal	4.00	5.50	5.00
Coarse gravel (non-colloidal)	4.00	6.00	6.50
Cobbles and shingles	5.00	5.50	6.50
Shales and hardpans	6.00	6.00	5.00