NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

SUBSURFACE DRAIN, (FEET)

Code 606

DEFINITION

A conduit, such as corrugated tile or pipe installed beneath the ground surface to collect and/or convey drainage water.

PURPOSE

The purpose of subsurface drainage is to:

1. Improve the soil environment for vegetative growth, reduce erosion, and improve water quality by:
   a. regulating water table and ground water flows,
   b. intercepting and preventing water movement into a wet area,
   c. relieving artesian pressures,
   d. removing surface runoff,
   e. leaching of saline and sodic soils
   f. serving as an outlet for other subsurface drains, and
   g. Regulating sub-irrigated areas or waster disposal areas.
2. Collect ground water for beneficial uses.
3. Remove water from heavy use areas, such as around buildings, roads, and play areas; and accomplish other physical improvements related to water removal.
4. Regulate water to control health hazards caused by pests such as flukes, flies, or mosquitoes.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to areas having a high water table where benefits of lowering or controlling ground water or surface runoff justify installing such a system.

This standard applies to areas suitable for the intended use after installation of required drainage and other conservation practices. The soil shall have enough depth and permeability to permit installation of an effective and economically feasible system. The drainability and treatment of saline and alkali soils shall be considered where this is a problem.

In areas where an outlet is available, either by gravity flow or by pumping, the outlet shall be adequate for the quantity and quality of effluent to be disposed. Consideration shall be given to possible damages above or below the point of discharge.

All drainage shall be in accordance with the Iowa Drainage Law.

ENVIRONMENTAL CONSIDERATIONS

Due consideration shall be given to the maintenance of wildlife habitat. The landuser will be advised if wetlands will be affected and that current NRCS wetland policy will apply. (See Part 506, NCPM.)

Septic tanks and other waste disposal systems will not be connected directly to drain systems. Subsurface drains will not be outletted into wells or sinkholes.

CRITERIA

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

OUTLETS

Open Ditch. Natural channels or constructed ditches used as outlets shall provide free outlets for subsurface drains within a

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reasonable time after a major storm peak flow. The outlet channel should be deep enough to permit subsurface drain laterals to be placed at optimum depth for the soil to be drained. The flow line of the main at the outlet should be at least one foot above the normal low water flow in the channel, except this clearance may be reduced when sedimentation of the outlet channel is not anticipated and little water flows in the channel a few hours after a storm.

Existing Subsurface Main Used as an Outlet.

When the outlet is a county, mutual, or private drain, it shall have sufficient depth to permit laterals to be placed at a minimum depth of three feet. Any mutual or private drain shall be in good condition if it is to serve as an outlet for new drains. The required capacity of existing mains is as follows:

1. If adequate surface drainage does not exist and underground outlets must be used to drain potholes, the main shall have capacity to remove runoff from the entire watershed area of the pothole at the rate of ¼ inch in 24 hours.
2. If adequate surface drainage does exist naturally or has been constructed, the main shall have capacity to remove drainage water from only the area within the watershed which needs subsurface drainage at the rate of ¼ inch in 24 hours.

Capacity. The drainage coefficient (rate of water removal in inches per 24 hours) for new mains and laterals is selected according to the degree of existing surface drainage.

If adequate surface drainage does not exist and surface inlets must be used to drain potholes, the subsurface drain shall have capacity to remove runoff from the entire watershed of the pothole at the rate of ½ inch in 24 hours. This capacity shall be provided whether or not the surface inlets are initially installed. An exception may be made for small potholes when surveys are available to accurately determine the volume of the potholes. In this case, capacity to remove 3/8 inch per 24 hours from the land area which needs subsurface drainage plus the capacity to remove the volume of the potholes in 24 hours is sufficient.

If adequate surface drainage does exist naturally or has been constructed to drain depressed areas, the subsurface drain shall have capacity to remove drainage water from only the area within the watershed which needs tile drainage at the rate of 3/8 inch per 24 hours.

On areas where no ponding exists, but surface drainage is limited by grades less than 0.2 percent, capacity shall be provided for the area needing subsurface drainage at the rate of ½ inch for 24 hours.

Size. The diameter of clay or concrete drain tile required for a known acreage of land can be determined from tile drainage chart, “acres drained by various sizes of clay or concrete drain" attached to this specification.

The size of corrugated plastic drainage tubing required to drain a known acreage can be determined from drainage chart, “acres drained by various sizes of plastic drainage tubing", attached to this specification. The use of corrugated plastic drainage tubing will be limited to fifteen-inch diameter or smaller.

The required size of subsurface drains made of other materials can be calculated using Manning's Formula and Chapter 3, EFM.

Subsurface drains larger than that indicated by the chart should be used when conditions indicate possible overloading or unusual loss of capacity. Overloading of subsurface drains may occur due to ground water movement from lower depths upward into the drainage field or from an indefinite collection area of sidehill seepage. Unusual loss of capacity may occur due to misalignment, nonuniform grade, and sedimentation.

Minimum size drains shall be as follows:

1. Six-inch for draining unstable peat and muck soils which are more than four feet deep, when segmented, non-flexible, subsurface drain materials are used. When flexible, non-segmented conduits

are used, the size may be reduced to five-inch.

2. Five-inch for draining non-cohesive loess and sandy soils or soils which contain pockets or layers of sand in the upper five feet.

3. Five-inch for collecting spring or sidehill seepage water from an area of more than one acre (0.4 ha). (Drain size should be determined on the basis of estimated flow, if possible).

4. Four-inch for draining stable and cohesive soils. The maximum length of four-inch drain on the upper end of a line is limited to 1,800 feet for clay or concrete tile or 1,500 feet for plastic tubing if the design grade is flatter than 0.4 percent.

Depth, Spacing, and Location. Depth and spacing of laterals shall be in accordance with recommendations set out in the Iowa Drainage Guide.

The minimum depth of cover over mains and laterals shall be two feet and minimum depth of laterals shall be three feet in mineral soils. This minimum depth shall apply to normal field levels and may exclude sections where mains or laterals cross under road or railroad ditches or minor depressions. Where these conditions exist and it is impractical to place additional fill over the top of the line, the subsurface drain shall be a metal pipe or other conduit of equal or greater durability, strength, and resistance to exposure and impact.

The minimum depth of cover in organic soils shall be 30 inches for normal field levels, as defined above, after initial subsidence. Structural measures shall be installed if it is feasible to control the water table level in organic soils within the optimum range of depths.

Depth of mains should be designed so that the laterals can be joined to the main with a center-to-center or higher connection. A minimum difference in elevation of 0.3 foot between the flowlines of the main and of the lateral is desirable. Flowline-to-flowline connection is permissible when unavoidable.

Minimum Velocity and Grade. In areas where sedimentation is not a hazard, the minimum grades shall be based on site conditions and a velocity of not less than 0.5 ft/sec. If a hazard exists, a velocity of not less than 1.4 ft/sec shall be used to establish the minimum grades if site conditions permit. Otherwise, provisions shall be made for preventing sedimentation by use of filters or by collecting and periodically removing sediment from installed traps, or by periodically cleaning the lines with high-pressure jetting systems or cleaning solutions, as specified in the plans.

Minimum permissible grades shall be in accordance with recommendations set forth in the Iowa Drainage Guide.

Maximum Grade and Protection. On sites where topographic conditions require that drain lines be placed on steep grades and design velocities will be greater than indicated under "Maximum Velocity Without Protective Measures," special measures shall be used to protect the conduit. These measures shall be specified for each job according to the particular conditions of the job site. The protective measures shall include one or more of the following:

1. Selecting rigid butt end pipe or tile with straight smooth sections and square ends to obtain tight fitting joints.

2. Wrapping open joints of the pipe or tile with tar-impregnated paper, burlap, or special fabric-type filter material.

3. Placing the conduit in a sand and gravel envelope or blinding with the least erodible soil available.

4. Sealing joints or using a watertight pipe or nonperforated continuous tubing.

5. Enclosing continuous perforated pipe or tubing with fabric-type filter material or properly graded sand and gravel.

Maximum Velocity Without Protection.

Velocities by soil textures are:

Soil Texture	Velocity	
	ft.	m/s
Sand and sandy loam	3.5	1.0
Silt and silt loam	5.0	1.5
Silty clay loam	6.0	1.8
Clay and clay loam	7.0	2.1
Coarse sand or gravel	9.0	2.7

Maximum permissible flow velocities in drains with protective measures will be in accordance with the Iowa Drainage Guide.

Materials. Subsurface drains include conduits of clay, concrete, bituminized fiber, metal, plastic, or other materials of acceptable quality.

The conduit shall meet strength and durability requirements of the site. All conduits shall meet or exceed the minimum requirements indicated in Standard 606, NHCP.

Foundation. If soft or yielding foundations are encountered, they shall be stabilized and the lines shall be protected from settlement by adding gravel or other suitable materials to the trench, by placing the conduit on a plank or other rigid supports or by using long sections of perforated or watertight pipe having adequate strength to ensure satisfactory subsurface drain performance.

Loading. The allowable loads on subsurface drain conduits shall be based on the trench and bedding conditions specified for the job. A factor of safety of not less than 1.5 shall be used in computing the maximum allowable depth of cover for a particular type of conduit.

Heavy-duty corrugated plastic drainage tubing shall be specified if the soil is rocky, if cover over the tubing is expected to exceed ten feet, or trench widths are expected to exceed two feet. (This refers to trench widths in the area of the tubing and at least one foot above the top of the tubing.) Heavy duty tubing will also be used under terrace fills.

For rigid type conduits, the allowable conduit depths may be determined from the Iowa Drainage Guide.

Filters and Filter Material. Suitable filters shall be used around conduits if they are needed because of site conditions to prevent sediment accumulation in the conduit. The need for a filter shall be determined by the characteristics of the soil materials at drain depth and the velocity of flow in the conduit.

Not less than three inches of filter material shall be used for sand-gravel filters. The filter shall be designed to prevent the material in which the installation is made from entering the conduit. Not more than ten percent of the filter material shall pass the No. 60 sieve.

Artificial fabric or mat-type filter materials may be used, provided that the effective opening size, strength, durability, and permeability are adequate to constantly filter the soil to protect subsurface drain operation throughout the expected life of the system.

Envelopes and Envelope Material. Envelopes shall be used around subsurface drains if they are needed for proper bedding of the conduit or to improve the characteristics of flow of ground water into the conduit.

Materials used for envelopes do not need to meet the gradation requirements of filters, but they shall not contain materials that will cause an accumulation of sediment in the conduit or that will render the envelope unsuitable for bedding of the conduit. Envelope materials shall consist of sand-gravel, organic, or other compressible material. Sand-gravel envelopes shall all pass a 1 ½ inch sieve; 90 to 100 percent shall pass a ¾ inch sieve; and not more than ten percent shall pass a No. 60 sieve. Where organic or other compressible materials are used, they shall be used only around a rigid wall conduit and above the centerline of flexible tubing. All organic or other compressible material shall be of a type that will n

Placement and Bedding. All subsurface drains, whether flexible conduit such as plastic or bituminized fiber or rigid conduits such as clay or concrete, shall be laid to a

neat line and grade. The conduit shall be placed and bedded as described in subsurface drain construction specifications (page 606-7) except that:

1. Rigid drainage conduits, such as clay or concrete drain tile, do not need the 90 degree V-groove in the trench bottom.
2. The V-groove shall not be used for flexible conduits exceeding eight inches in diameter, because the void under the conduit will create a potential path for soil erosion. A semicircular or trapezoidal groove shaped to fit the conduit shall be used for flexible conduits exceeding eight inches in diameter.

Auxiliary Structures and Protection. Structures installed in drain lines must not unduly impede the flow of water in the system. Their capacity shall be no less than that of the line or lines feeding into or through them. The use of internal couplers for corrugated plastic tubing shall be allowed. The use of connection, junction boxes, surface and blind inlets, and relief wells will be in accordance with the Iowa Drainage Guide.

If the drain system is to carry surface water flow, surface water inlets shall have a capacity of no less than that required to provide the maximum design flow in the drain line or lines.

The capacity of a relief well system shall be based on the flow from the aquifer, the well spacing, and other site conditions and shall be adequate to lower the artesian waterhead to the desired level.

Junction boxes, manholes, catch basins, and sand traps shall be accessible for maintenance. A clear opening of not less than two feet shall be provided in either circular or rectangular structures.

The size of relief wells is generally based on the available equipment rather than on hydraulic consideration. Such wells shall not be less than four inches in diameter.

The drain system shall be protected against velocities exceeding those provided under “Maximum velocity without protection” and against turbulence created near outlets, surface inlets, or similar structures.

Continuous or closed-joint pipe shall be used in drain lines adjoining the structure where excessive velocities will occur.

Junction boxes shall be installed if more than two main drains join or if two main drains join at different elevations.

If surface water is to be admitted to subsurface drains, inlets shall be designed to exclude debris and prevent sediment from entering the conduit. Lines flowing under pressure shall be designed to withstand the resulting pressures and velocity of flow. Auxiliary surface waterways shall be used where feasible.

If not connected to a structure, the upper end of each subsurface drain line shall be capped with a tight-fitting cap of the same material as the conduit or other durable materials.

The outlet shall be protected against erosion and undermining of the conduit, against entry of tree roots, against damaging periods of submergence, and against entry of rodents or other animals into the subsurface drain. A continuous section of pipe without open joints or perforations shall be used at the outlet end of the line and shall discharge above the normal elevation of low flow in the outlet ditch. Corrugated plastic tubing is not suitable for the outlet section.

Continuously submerged outlets shall be permitted for water table control in organic and sandy soils if planned and designed according to the standard for Regulating Water in Drainage Systems (554).

The outlet pipe and its installation shall conform to the following requirements:

1. If burning vegetation on the outlet ditch bank is likely to create a fire hazard, the material from which the outlet pipe is fabricated shall be fire resistant. If the likelihood is great, the outlet pipe shall be fireproof.
2. Two-thirds of the pipe shall be buried in the ditch bank, and the cantilever section

shall extend to the toe of the ditch side slope or the side slope shall be protected from erosion. The minimum length of the pipe shall be 16 feet.

3. If ice or floating debris may damage the outlet pipe, the outlet shall be recessed to the extent that the cantilevered part of the pipe will be protected from the current in the ditch.
4. Headwalls used for subsurface drain outlets shall be adequate in strength and design to avoid washouts and other failures.

Watertight conduits strong enough to withstand the expected loads shall be used if subsurface drains cross under irrigation canals or other ditches. Conduits under roadways shall be designed to withstand the expected loads. Shallow subsurface drains through depressed or low areas and near outlets shall be protected from damage by farm machinery and other equipment and freezing and thawing.

Where acid water from existing or abandoned mines is discharged, outlets shall be non-corrosive plastic pipe conforming to the requirements for principal spillways for Pond (378). All other appurtenances to the tile system shall also be made from non-corrosive materials.

PLANS AND SPECIFICATIONS

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