



Natural Resources Conservation Service
CONSERVATION PRACTICE STANDARD
UNDERGROUND OUTLET

Code 620

(ft)

DEFINITION

A conduit or system of conduits installed beneath the surface of the ground to convey surface water to a suitable outlet.

PURPOSE

To carry water to a suitable outlet from terraces, water and sediment control basins, diversions, waterways, surface drains, roof runoff structures, other similar practices or flow concentrations without causing damage by erosion or flooding.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Disposal of surface water is necessary.
- An outlet is needed for a terrace, diversion, water and sediment control basin or similar practice but a surface outlet is impractical because of stability problems, topography, climatic conditions, land use or equipment traffic.
- The site is suitable for an underground outlet.

CRITERIA

General Criteria Applicable to All Purposes

Underground outlets shall be planned, designed, and constructed to comply with all federal, state, tribal, and local laws and regulations.

Capacity. The design capacity of the underground outlet is based on requirements of the structure or practice it serves. The underground outlet can be designed to function as the only outlet for a structure or it can be designed to function with other types of outlets. The capacity of the underground outlet for natural or constructed basins shall be adequate for the intended purpose without causing inundation damage to crops, vegetation, or works of improvement.

Underground outlets may be designed for either pressure or gravity flow. If a pressure system is designed, all pipe and joints must be adequate to withstand the design pressure, including surges and vacuum. To fully utilize conduit capacity, design the inlet to provide maximum flow in the conduit. To prevent pressure flow or overloading of the conduit, a flow restricting device such as an orifice or weir can be used to limit flow into the conduit.

NRCS reviews and periodically updates conservation practice standards. To obtain the current version of this standard, contact your Natural Resources Conservation Service office or web site (www.oh.nrcs.usda.gov).

If there are multiple structures flowing into an underground outlet, design the system so that upstream structures do not discharge into downstream structures unless the downstream structure is designed to accommodate the extra flow.

Pressure-relief wells may be used to allow excess flow to escape the conduit and flow over the surface. Only use pressure relief wells where there is a stable outlet for the flow from the relief well. Cover pressure relief wells with a grate or other appropriate covering to prevent the entry of small animals and debris.

Inlet. An inlet can be a collection box, a perforated riser, or other appropriate device. For perforated risers, use durable, structurally sound material that is resistant to damage by rodents or other animals. Use fire resistant materials for the inlet if fire is an expected hazard.

Inlets must have an appropriate trash guard to ensure that trash or other debris entering the inlet passes through the conduit without plugging.

Design collection boxes large enough to allow maintenance and cleaning operations.

Use blind inlets where the installation of an open or above ground structure is impractical. Design the blind inlet with a graded granular filter around the conduit. Design the filter based on the particle size of the surrounding soil and the desired flow rate. Refer to National Engineering Handbook (NEH) Part 650, Engineering Field Handbook, Chapter 14, and NEH Part 633, Chapter 26- Gradation Design of Sand and Gravel Filters for the design of blind inlets.

Do not use blind inlets with Ohio Conservation Practice Standard (638) - Water and Sediment Control Basins (Code 638) or (600) - Terrace unless the embankment is protected from overtopping should the inlet capacity be reduced by sedimentation.

Conduit. Underground outlets shall be conduits of tubing, tile or pipe. The minimum allowable conduit diameter is 4 inches. Design hydraulically smooth joints using materials and methods recommended by the manufacturer of the conduit.

The maximum design velocity must not exceed the safe velocity for the conduit materials and installation according to the conduit manufacturer's recommendation. Refer to Conservation Practice (606) - Subsurface Drainage for design criteria for safe velocity.

If junction boxes and other structures are needed, design them to allow cleaning and other maintenance activities. Maintain a downward grade towards the outlet in all sections of the underground outlet.

Minimum Velocity and Grade. In areas where sedimentation is not a hazard, minimum grades shall be based on site conditions and a velocity of not less than 0.5 feet per second. If a sedimentation hazard exists, a velocity of not less than 1.4 feet per second shall be used to establish the minimum grades. 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.

Maximum Velocity. The maximum velocity must not exceed the safe velocity for the conduit material and method of installation (see Table 1).

Maximum Velocity for non-perforated dual-wall polyethylene (PE) pipe and joints is 20 ft/s. All joints and fittings shall be watertight, capable of withstanding 10.8 psi internal pressure (designed for external or internal pressures less than 25 ft. of head).

| Soil Texture | Perforated | Non-Perforated |
|-----------------------|------------|----------------|
| Sand and Sandy Loam | 3.5 | 8.0 |
| Silt and Silt Loam | 5.0 | 10.0 |
| Silty Clay Loam | 6.0 | 12.0 |
| Clay and Clay Loam | 7.0 | 12.0 |
| Coarse Sand or Gravel | 9.0 | 12.0 |

Non-perforated polyvinyl chloride (PVC), smooth steel, or corrugated metal pipe have no velocity restrictions if joints are watertight and the pipe is aligned to prevent cavitation and water hammer.

Materials. Plastic, concrete, aluminum, steel, and ductile iron pipe shall meet or exceed the requirements specified in the applicable ASTM, AWWA, or AASHTO standard. All materials specified in Ohio Conservation Practice Standard (606) - Subsurface Drains can be used for underground outlets for non-pressure flow conditions. Materials must meet or exceed applicable site specific design requirements for leakage, external loading, internal pressure or vacuum.

Underground outlet conduits can be perforated or non-perforated depending on the design requirements. Use a filter fabric wrap (sock) or appropriately designed granular filter if migration of soil particles into the conduit is anticipated. Design the filter based on the particle size of the surrounding soil to prevent rapid clogging of the filter. Refer to Ohio Conservation Practice Standard (606) - Subsurface Drainage for criteria for the design of filter media. Protect all exposed plastic materials from degradation due to exposure to sunlight.

Outlet. The outlet must be stable for anticipated design flow conditions from the underground outlet. Design the underground outlet for water surface conditions at the outlet expected during the design flow conditions.

The outlet must consist of a continuous 10 foot section or longer of closed conduit or a headwall at the outlet (see Table 2). If a closed conduit is used, the material must be durable and strong enough to withstand anticipated loads, including those caused by ice. If the outlet is directed to a ditch or channel, at least two-thirds of the closed conduit shall be buried in the ditch or channel bank and the cantilever section must extend to the toe of the ditch or channel. Do not design outlets to be placed in areas of active erosion. Use fire resistant materials if fire is an expected hazard. All outlets must have animal guards to prevent the entry of rodents or other animals. Design animal guards to allow passage of debris while blocking the entry of animals that cannot easily escape from the conduit.

Table 2. Minimum Length of Outlet Pipe Sections.

| Pipe Diameter, in. | Min. Section Length, ft. |
|--------------------|--------------------------|
| 8 and smaller | 10 |
| 10 to 12 | 12 |
| 15 to 18 | 16 |
| Larger than 18 | 20 |

Underground outlets installed for the purpose of discharging roof runoff water may outlet into an existing tile provided the non-pressure flow capacity of the existing tile is not exceeded. Orifices and/or surface overflow bypass structures can be used to reduce the peak flow into the existing tile. The design folder

will include an analysis of the capacity of the existing tile and measures taken to reduce the peak discharge.

Stabilization. Reshape and regrade all disturbed areas so that they blend with the surrounding land features and conditions. Revegetate or otherwise protect from erosion all disturbed areas that will not be farmed as soon as possible after construction.

CONSIDERATIONS

Pressure relief wells, if not properly covered, can present a safety hazard for people or animals stepping into the well. In addition, pressure relief wells can be easily damaged by field equipment. To prevent accidents, mark the location of pressure relief wells with a high visibility marker.

The rapid removal of water through an underground outlet will affect the water budget where it is installed. It can reduce infiltration. It can increase or decrease peak flows to receiving waters and reduce long term flows into the same waters. Consider these long term environmental, social, and economic effects when making design decisions for the underground outlet and the structure or practice it serves.

If perforated pipe is used for the subsurface conduit, locate the practice so that it has a minimal effect to the hydrology of wetlands.

Where perforated risers are used, often the risers are perforated below the surface of the ground to facilitate drainage. In this situation, if soil entry into the riser perforations is a problem, use an appropriately designed gravel or geotextile filter around the buried portion of the riser.

Seasonal water sources can be very important for migratory waterfowl and other wildlife. The use of a water control structure, on the inlet of an underground outlet during non-cropping times of the year, can allow water to pond in the structure to provide water for wildlife. Refer to Ohio Conservation Practice Standard (646) - Shallow Water Development and Management for information on managing seasonal water sources for wildlife.

Underground outlets can provide a direct conduit to receiving waters for contaminated runoff from crop land. Underground outlets and the accompanying structure or practice should be installed as part of a conservation system that addresses issues such as nutrient and pest management, residue management, and filter areas.

The construction of an underground outlet in a riparian corridor can have an adverse effect on the visual resources of the corridor. Consider the visual quality of the riparian area when designing the underground outlet.

The construction of an underground outlet can disturb large areas and potentially affect cultural resources. Be sure to follow state cultural resource protection policies before construction begins.

If an installation in a crop field is too shallow, tillage equipment can damage an underground outlet. Consider the type and depth of tillage that will likely occur when designing the depth of an underground outlet. A minimum of 2 feet of cover is recommended over all conduits.

Geotextile fabric should be placed between the soil or sand cover and coarser base material in a blind inlet to facilitate easy replacement of the cover material.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for underground outlets that describe the requirements for applying this practice according to this standard. The plans and specifications for an underground outlet may be incorporated into the plans and specifications for the structure or practice it serves. As a minimum the plans and specifications shall include:

- A plan view of the layout of the underground outlet.
- Surface drainage area delineation when blind inlet is installed to replace a surface inlet
- Typical cross sections showing trench details, backfill requirements, and backfill material gradation when applicable
- Profile of the underground outlet.
- Details of the inlet and outlet.
- Seeding requirements if needed.
- Conduit material and connection specifications applicable to the design usage
- Construction specifications that describe in writing the site specific installation requirements of the underground outlet.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. The minimum requirements to be addressed in a written operation and maintenance plan are:

- Periodic inspections, especially immediately following significant runoff events, to keep inlets, trash guards, and collection boxes and structures clean and free of materials that can reduce flow.
- Prompt repair or replacement of damaged components.
- Repair or replacement of inlets damaged by farm equipment.
- Repair of leaks and broken or crushed lines to insure proper functioning of the conduit.
- Periodic checking of the outlet and animal guards to ensure proper functioning.
- Repair of eroded areas at the pipe outlet.
- Maintenance of adequate backfill over the conduit.
- To maintain the permeability of surface materials on blind inlets, periodic scouring or removal and replacement of the surface soil layer may be necessary.

REFERENCES

USDA-NRCS, National Engineering Handbook, Part 633, Chapter 26- Gradation Design of Sand and Gravel Filters

USDA-NRCS, National Engineering Handbook, Part 636, Chapter 52- Structural Design of Flexible Conduits

USDA, NRCS. National Engineering Handbook, Part 650 Engineering Field Handbook, Chapter 3- Hydraulics; Chapter 6- Structures; Chapter 8- Terraces; and Chapter 14- Water Management (Drainage)

Blind Inlets to Reduce Sediment Loading from Farmed Depressional Areas. Authors: Douglas R. Smith and S.J. Livingston, USDA-ARS, National Soil Erosion Research Laboratory

Ohio Drainage Manual, Ohio Department of Natural Resources, 2009