

# Underground Outlet

**Definition:** A conduit installed beneath the surface of the ground to collect surface water and convey it to a suitable outlet.

**Purpose:** To dispose of excess water from diversions, subsurface drains, surface drains, or other concentrations without causing damage by erosion or flooding.

**Conditions Where Practice Applies:**  
This practice applies where:

1. Excess surface water needs to be disposed of.
2. A buried outlet is needed for diversions, or similar practices.
3. An underground outlet can be installed that will safely dispose of excess water.
4. Surface outlets are impractical because of stability problems, climatic conditions, land use, or equipment traffic.

## Effects on Water Quantity and Quality

This practice will have a negligible effect on the quantity of surface and ground water.

There may be a decrease in the sediment delivered to the receiving waters because there is no bank and channel erosion with the flow in the underground outlet. There is reduced infiltration of water within the reach the underground outlet occupies. This may reduce slightly the amount of soluble substances which percolate toward

the ground water. Any substances which enter the underground outlet will be delivered to the receiving waters.

## Design Criteria

**Capacity:** The underground outlet shall be designed, alone or in combination with other practices, with adequate capacity to insure that the diversion, or other practices function according to the standard for the specific practice. For example, an underground outlet can be used in combination with a grassed waterway or a surface drain to carry part of the design flow. The capacity of the underground outlet for natural basins shall be adequate for the intended purpose without causing excessive damage to vegetation or improvements.

Procedures contained in the standard for culverts may be used to determine the capacity of short sections of underground outlets. Longer sections of conduit or those containing bends or other restrictions should be designed in accordance with accepted hydraulic engineering methods.

**Inlets:** Inlets can be drop inlets, perforated risers, hood inlets with baffle or canopy inlets. The capacity shall be adequate to provide the maximum design flow in the conduit. Flow-control devices shall be installed as necessary. Inlets must be durable material, structurally sound, and resistant to damage by rodents or other animals. Blind inlets can be used where they are effective. Collection boxes must be large enough to facilitate maintenance and cleaning operations. The inlet

must have an appropriate trash guard to insure that trash or other debris entering the inlet passes through the conduit without plugging. It must also have an animal guard to prevent the entry of rodents or other animals.

Inlets will be designed with sufficient anchorage to prevent flotation, with a factor of safety of 1.5. Concrete inlets, 5 ft. or less in height, shall have a minimum wall thickness of 6 inches and be reinforced with one layer of welded wire fabric (6"x6"-8-gauge x 8-gauge minimum). All other concrete inlets will be designed according to accepted structural engineering methods.

When more than one inlet is used, the upper inlets will be designed to control the flow so discharge will not occur through the lower inlets.

**Conduits:** Underground outlets shall be continuous conduits, tubing or tile with a minimum diameter of 3 inches. They can be perforated or nonperforated, depending on the design requirements.

Pipe will meet the design requirements for internal pressure or vacuum and external loading. Thrust protection will be provided at elbows, bends and other fittings as necessary.

Conduits will be designed with a minimum velocity of 0.5 ft. per second when there is no hazard of siltation and with a minimum velocity of 1.4 ft. per second if siltation is a problem. If site conditions are such that minimum velocity cannot be met, provi-

sions will be made for preventing sedimentation by use of filters or by collecting and periodically removing sediment from installed traps. Planned cleaning of lines with high-pressure jetting systems may also be considered.

Pipe will meet the requirements for external load, internal pressure, and installation. Pipe which is not pressure rated for water, such as corrugated polyethylene drainage tubing, will only be used when inlet controls, such as orifice plates, are used to restrict flow to that capacity at which the pipe just begins to flow full; determined by the equation:

$$Q = \frac{A_p 1.49 r^{2/3} S^{1/2}}{n}$$

where:

n= Manning's Roughness Coefficient

A<sub>p</sub>= Area of the Pipe (sq. ft.)

r= Hydraulic radius =  $\frac{\text{pipe diameter (ft.)}}{4}$

s= Conduit slope (ft./ft.)

When inlet control is not provided and pressure flow occurs, pipe with pressure ratings equal to or higher than design pressures will be used. Joints will be capable of withstanding the same pressures.

All systems will be designed to protect the pipe from excessive vacuum and surge pressures at elbows and other fittings when:

1. The pipe grade increases in the direction of flow by 10% or more, or
2. The pipe grade decreases in the direction of flow by 5% or more, or
3. The velocity in the pipe exceeds 15 ft. per second.

This protection may be provided by:

1. Designing pipe and joints to withstand the pressures, or
2. Installing vents or vacuum release valves where pipe grade increases, or
3. Installing pressure relief wells, pressure relief valves, or surge tanks where pipe grade decreases.

**Outlets:** Outlets will be designed to be stable and provide for release of flow at non-erosive velocities, as follows. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load, and pipe supports shall be provided when needed. Pipe supports will be installed on all pipes where:

1. The exit velocity is 10 ft. per second or greater.
2. The length of the cantilever portion, measured along the pipe invert, is more than 35% of the total length of the last joint of pipe for pipe diameters 15 inches or less.
3. The length of the cantilever portion is more than 20% of the total length of the

last joint for pipe diameters greater than 15 inches.

Energy dissipating outlet structures will be installed for all pipe outlets, unless the outlet is on rock, discharges into a permanent pool of water, or is located where erosion will not be a problem.

Small animal guards or gates will be installed as needed.

The invert elevation of all conduit outlets shall be a minimum of 1.0 ft. above the outlet channel.

**Vegetation and Fencing:** Vegetation of all disturbed areas shall be accomplished in accordance with standards for seeding and planting.

Fencing necessary to exclude livestock or humans for safety or protection of the practice, shall be constructed around inlets, outlets and along the pipe.

## Operation and Maintenance

An operation and maintenance plan shall be developed for the installed underground outlet. The plan shall outline the minimum maintenance necessary to ensure the outlet functions for its design life.

As a minimum, the plan shall address the following:

1. Annual inspections and inspections after each major storm occurrence to assess the need for repair.

2. Removal of debris accumulations and sediment deposits at inlets and outlets.
3. Liming, fertilizing, and mowing of vegetation to maintain a healthy growth.
4. Repair of damaged inlets, outlets, trash racks, animal guards, fences, safety measures, and other items to maintain the system in good operating order.
5. Repair of eroding areas by revegetating or mechanical treatment such as riprap.

## Specifications

Excavation for installation of underground outlets will be to the line and grade shown on the drawings. Trench width will be maintained to that shown on the drawings.

Soft compressible material found in the trench bottom will be removed by over excavation and the area backfilled with gravel or hand compacted earthfill.

Caution will be exercised when working in or around trenches with unstable side slopes. Workers will not enter any trench over 4 ft. deep without proper shoring or sloping of the trench walls to a minimum of 2h:1v above the 4 ft. depth.

Pipe, fittings and connectors will meet the requirements of the applicable ASTM specifications shown on the drawings, and will be installed according to the manufacturer's recommendations.

Inlet structures, outlet structures, thrust blocks (if used) and vents or relief wells (if used) will be installed as shown on the drawings.

Concrete used in construction of inlets, thrust blocks, and outlets shall be ready-mixed concrete (3000 psi - 6 bags/c.y. mix.), pre-bagged commercially available concrete mix, or be hand mixed on-site. Cement will be Type I or IA meeting requirements of ASTM C150 and aggregates will meet the requirements of ASTM C33. Coarse aggregate will be Size No. 57 or No. 67 for ready-mix and hand mixed concrete. Hand mixed concrete shall be mixed at a ratio of 1 part cement, 2 parts sand, and 3 parts coarse aggregate. Pre-bagged concrete mix will be mixed according to the manufacturer's recommendation. Mixing water will be clean and free of substances that would effect the strength or durability of the concrete. Concrete will be mixed to a consistency that will allow consolidation in the forms, but not so wet that aggregates separate from the mortar (approximately 3"-6" slump).

Concrete will be mixed and placed in the forms in a timely manner so that it does not begin to set prior to placement, or cold joints are not formed between successive layers. Forms shall be mortar tight and unyielding as concrete is placed.

Reinforcing steel shall be placed as shown on the drawings and held securely in place while concrete is placed.

Riprap for slope or pipe outlet protection, if required, will be commercially available limestone riprap or on-site field stone that has demonstrated its durability against weathering. Riprap size, gradation and details of installation will be as shown on the drawings.

Gravel for pipe bedding or as a filter under riprap, if required, will meet the grading and quality requirements shown on the drawings and will be installed as detailed on the drawings.

Selected backfill material shall be placed, in layers not exceeding 4" in thickness, around structures and pipe conduits at approximately the same rate on all sides to prevent damage from unequal loading, and hand compacted. Construction equipment shall not be permitted within 2 ft. of structures or conduits. Rocks and other sharp objects that may damage structures or pipe will be removed from the fill adjacent to the pipe or structure. When the surface level of the fill reaches 2 ft. above the pipe and at other locations more than 2 ft. from structures or pipe, the fill may be placed in 8-inch layers and compacted by a minimum of two passes with construction equipment.

The moisture content of fill material shall be adequate to permit the degree of compaction specified. The moisture content shall be sufficient to permit molding a firm ball when firmly squeezed in one's fist. The soil shall not be so wet that water runs out when squeezed nor so dry that the ball easily crumbles when slightly deformed. Water may need to be added if too dry.

Appropriate safety measures, such as warning signs, fencing, etc., will be installed as shown on the drawings.

Upon completion of construction, all disturbed areas shall be graded smooth and blend with the surrounding ground.

A protective cover of vegetation shall be established on all disturbed areas where soil and climatic conditions permit. Lime and fertilizer will be spread at the rate shown on the drawings and will be disked into the soil to a depth of 4 inches to prepare a seedbed. Seed and mulch will be spread at the rate shown on the drawings. Where soil or climatic conditions preclude the use of vegetation and protection is needed, nonvegetative means such as mulches or gravel may be used. In some cases, temporary vegetation may be used until conditions are right for establishment of permanent vegetation.

Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution will be minimized and held within legal limits.