FDM 13-40-1 Underdrains

June 19, 2013

1.1 Introduction

Underdrains are installed to control three specific types of groundwater:

1. Seepage in cuts or sidehill areas,
2. High-water tables, and
3. Subbase and/or subgrade areas where water enters from either the surface or below the surface. Often a subsurface drain performs multiple functions.

There are many variables and uncertainties about actual subsurface conditions. In general, the more obvious subsurface drainage problems can be anticipated in design; the less obvious are frequently uncovered during construction. Extensive exploration may be required to obtain the design variables with reasonable accuracy. For these reasons many designs are based on local experience and empirical rules that have given satisfactory results. Refer to FDM 10-10-33 for additional information about subsurface drains.

1.2 Descriptions

Underdrains are described below and shall be provided where required (refer to Attachment 1.1).

1.2.1 Sidehill Seepage

The interception of side hill seepage is accomplished by a perforated underdrain laid in a trench on the shoulder, in the ditch, or on the back slope. The flow line should be below the water bearing material but not more than six feet deep. The top six inches of backfill should be impervious.

1.2.2 High-Water Table

High water-tables can be lowered by providing entrenched perforated underdrain on each side of the pavement. The trench should be at least four feet deep to be effective but should not exceed six feet. The top six inches of backfill should be impervious.

1.2.3 Subgrade Drainage

To drain the subgrade or base (usually of water deposited by surface leakage through the pavement or shoulder), longitudinal perforated underdrains (edgedrains) are placed adjacent to the edge of the pavement to a depth equal to or slightly greater than the depth of the subbase. A minimum invert depth would be 20 inches below the top edge of pavement, placed in base aggregate open graded. The trench should be topped with about six inches of asphaltic material in rural sections. In curb and gutter sections, the edgedrain should be placed beneath the curb. Where a permeable base and subbase is extended out to the subgrade shoulder point, edgedrains are not usually required.

1.2.4 Outlets

Edgedrain outlets (drain outs) are placed at low points at a maximum spacing of 250 feet on long grades to provide outlet drainage. The outlets are connected to the edgedrain by elbows. The outlet underdrain and elbow should be unperforated. The outlet should be free from brush or dirt, above surrounding surface water, screened to keep out animals, and marked for location. The marker is to be 8" x 8", white, cold-painted and non-reflective, painted on the centerline of the apron endwall located 6" from the edge of pavement, See SDD "Edgedrain Outlet and Outfall Markers" for more detail. The outlet shall be elevated a minimum of one foot above the bottom of the ditch it is discharging into. Outlets should not be located near other drainage features such as culverts.

1.3 Design Criteria

1.3.1 Size and Length Requirements

The minimum inside pipe diameter for a standard pipe underdrain shall be six inches for lengths of 500 feet or less. As a general rule, this size is adequate as a collector or lateral in most soils. For lengths exceeding 500 feet, the minimum diameter shall be eight inches.

1.3.2 Separation of Drainage

Surface drainage shall not be permitted to discharge into an underdrain. The discharge from an underdrain into a

roadway drainage system or a culvert is permissible if the outfall for the underdrain is not under pressure.

1.3.3 Cleanouts

A terminal cleanout is required at the upper end of the underdrain. This is made by bringing the pipe to ground level on a 45° angle. Intermediate inspection wells are required at maximum 500-foot intervals. They must consist of a vertical riser with a light cast-iron cover brought to ground level. The diameter of the riser shall be at least the diameter of the conduit.

1.3.4 Grade Requirements

In general, the grade should not be flatter than 0.5 percent. If this slope is unobtainable, grades of 0.20 percent for laterals and 0.25 percent for mains will be acceptable.

1.3.5 Depth and Spacing of Underdrains

The depth of the underdrain depends on the permeability of the soil, the elevation of the water table, and the amount of drawdown needed to ensure stability. When practical, an underdrain pipe should be set in between an impervious and pervious zone. The pipe should be set in the pervious zone just above the impervious layer. Attachment 1.2 gives suggested depths and spacing of underdrains according to soil types. It is only a guide and should not be considered a substitute for field observations or local experience.

1.4 Underdrain Conduit Installations

The types of underdrain installations relative to conduit characteristics and anticipated service are as follows:

1.4.1 Perforated Underdrains

Perforated underdrains should typically be used when the drainage layer (the pervious material the underdrain is installed in) is open graded aggregate, Installations in native soils may require a wrapped underdrain.

1.4.2 Unperforated Underdrains

Unperforated underdrains are typically used to connect longitudinal perforated pipe underdrains (edgedrains) to outlets.

1.4.3 Wrapped Underdrains

Wrapped underdrains can be plowed into place and are typically more cost effective than Pipe Underdrains placed in open graded material. Refer to FDM 14-5-5 for a discussion of base aggregate open graded. The geosynthetic material or “sock” can reduce their capacity so they should not be used under the roadway or where there is a significant drainage concerns. They should be used in native permeable soil outside the roadway where replacing backfill is not necessary or costs effective. In locations where native soil contains higher percentages of silt or clay their use should be determined on a case by case basis as the silt or clay can clog the "sock".

1.5 Material Considerations

Pipes for underdrains may be made of metal, corrugated polyethylene or other materials specified in WisDOT Standard Specifications.

Non-Metallic Pipes: Perforated pipes of corrugated polyethylene may be used in soils of low resistivity and in the presence of highly aggressive soil or water. Corrugated polyethylene is satisfactory in longitudinal drains where settlement is not anticipated.

Corrugated polyethylene should not be used in deep stabilization trenches where settlement is anticipated or in shallow installations subject to damage by construction traffic.

Metal Pipes: Perforated pipes of corrugated metal (either steel or aluminum) are satisfactory for use in the structural situations mentioned in subparagraph (a) above. However, their use is contingent upon providing the necessary protection against corrosion and abrasion where this is dictated by requirements of the location and limitations of the pipe material.

Steel pipes are appropriate for installations with a 50-year design service life and aluminum pipes for installations with a 25-year design service life.

If a material listed in the Standard Specification is not to be allowed than a note shall be made in the miscellaneous quantities.

1.6 Geotextile Fabric

Geotextile Fabric is used to separate the drainage layer from the surrounding soil. The need for the fabric is dependent on the thickness of the layer and location of the drain. See SDD "Edgedrains" for more guidelines on

location of the fabric. If fabric is necessary, Geotextile Fabric Type DF Schedule A must be used unless otherwise justified and must be added as a separate bid item.

1.7 Selection of Type

In cases where more than one material meets the foregoing structural, corrosive, abrasive, and design service life expectancy requirements, alternatives should be specified on the basis of optional selection by the contractor. The selection of a single type of underdrain may be appropriate due to other related factors.

1.8 Construction

The filter material for backfill shall have the same or greater permeability than the surrounding soil but must be fine enough to prevent soil from washing into or through it. Research has shown that a graded material roughly equivalent to fine concrete aggregate is most suitable. Size requirements for this aggregate are found in the Standard Specifications.

The top layer shall always be impervious to avoid infiltration of silty surface water.

The pipe shall conform to the standard specification for underdrains and be laid with perforation down.

LIST OF ATTACHMENTS

Attachment 1.1	Subdrains
Attachment 1.2	Suggested Depth and Spacing of Underdrains for Various Soil Types