INDIANA DEPARTMENT OF TRANSPORTATION

INTER-DEPARTMENT COMMUNICATION
Standards Section -- Room N642

August 30, 1999

DESIGN MEMORANDUM No. 99-13
TECHNICAL ADVISORY

TO: **All Design, Operations, and District Personnel, and Consultants**

FROM: ***/s/ Richard L. VanCleave***
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Contracts & Construction Division

RE: **Underdrains, Design Manual Section 52-10**

EFFECTIVE: All Lettings After January 1, 2000

The purpose of this memo is to give additional information related to the underdrain design policy discussed in the Policy Change portion of Design Memo #99-13 and its underdrain design procedure document attachment. Section references included in this memo are in accordance with those in the underdrain design policy document.

52-10.0 UNDERDRAINS

52-10.01 Definitions:

Underdrain Pipe/Outlet Pipe: When the term underdrain pipe is used, it refers to the perforated pipe installed in longitudinal trenches. The term outlet pipe refers to the non-perforated pipe that conveys the water collected by the underdrain pipe to the drainage system.

Single Access/Dual Access Underdrain: A single access underdrain is the type of underdrain system that INDOT has traditionally installed. It consists of an outlet pipe connected to the low end of an underdrain pipe. A cap is

placed on the high end of a single access underdrain to prevent aggregate backfill from entering the underdrain pipe.

A dual access underdrain features a second outlet pipe installed at the high end of the underdrain pipe instead of an end cap. This second outlet pipe is not intended to convey water, but is provided for inspection and maintenance purposes.

Intercept Station & Elevation/Outlet Station & Elevation: The intercept station is defined as the location where the connection between an underdrain pipe and an outlet pipe is made. Similarly, the intercept elevation is the elevation at which the above connection occurs. The outlet station is defined to be the location where the outlet pipe outfalls at an outlet protector or is connected to a drainage structure. The outlet elevation is the elevation at which the above outfall or connection occurs. If the connection includes two 45^{o} elbows as shown on the detail from the 718-UNDR series of INDOT *Standard Drawings*, the intercept station and outlet station will be identical.

52-10.02 Existing Underdrain Perpetuation

Roadways with existing underdrains must have all outlet pipes located and perpetuated as part of any project. Generally, this work involves removal of miscellaneous existing items, such as outlet protectors, delineator posts, and damaged existing outlet pipe, as well as installation of new outlet pipe and construction of new outlet protectors.

52-10.03 Underdrain Warrants

Not every project warrants the installation of underdrains. In general, only those that include new pavement construction or rehabilitation of existing pavement are considered candidates for underdrain installation. Even projects that are in the above categories require a design year traffic volume of at least 3000 vehicles per day and a net paving length of at least 600 m before underdrain installation is warranted. Projects that do not meet the above criteria should include underdrains only if the existing pavement sections adjacent to the project area in both directions include underdrains.

Designers who are responsible for performing pavement designs must evaluate whether the projects meet the underdrain

warrants and account for the presence or absence of underdrains when determining the project pavement section.

52-10.04 Design Criteria

52-10.04(01) Slope

The slope of an underdrain pipe is normally related to the proposed pavement profile. Figure 1 illustrates a typical project vertical alignment and underdrain pipe design segments.

Referring to Figure 1, if g_1 is equal to or steeper than 0.2 percent, all underdrain pipe within segment 1 will be installed at a fixed dimension below the pavement, as shown in Section 52-6.0. If g_1 is flatter than 0.2 percent, all underdrain pipe within segment 1 will require a special design. The special design must utilize a longitudinal slope of 0.2 percent or steeper, resulting in an underdrain pipe installed at a varying depth below the pavement along its length.

52-10.04(03) Outlet Spacing

Outlets are required at all vertical alignment low points encountered along a project. Low points can result from sag vertical curves, paving exceptions, or obstacles that interrupt underdrain pipe installations.

Underdrain pipe cannot be of unlimited length because inspection and maintenance operations must be performed. Therefore, most underdrain systems require outlets in addition to those needed at low points along a project's vertical alignment. At the same time, it is also desirable to minimize the number of outlets in an underdrain system.

One way to minimize the number of outlets is to utilize dual access underdrains wherever possible. Because outlet pipes provide access to the underdrain pipe at both ends, underdrain pipe lengths of up to 200 m are appropriate for a dual access underdrain. In situations where the proposed outlet spacing results in an underdrain pipe length of less than or equal to 120 m, it is acceptable to use a single access underdrain.

Figure 1 can be used to demonstrate how outlet spacing requirements affect underdrain pipe design. The project vertical alignment illustrated in the figure dictates that underdrain segment 1 requires an outlet at the sag vertical

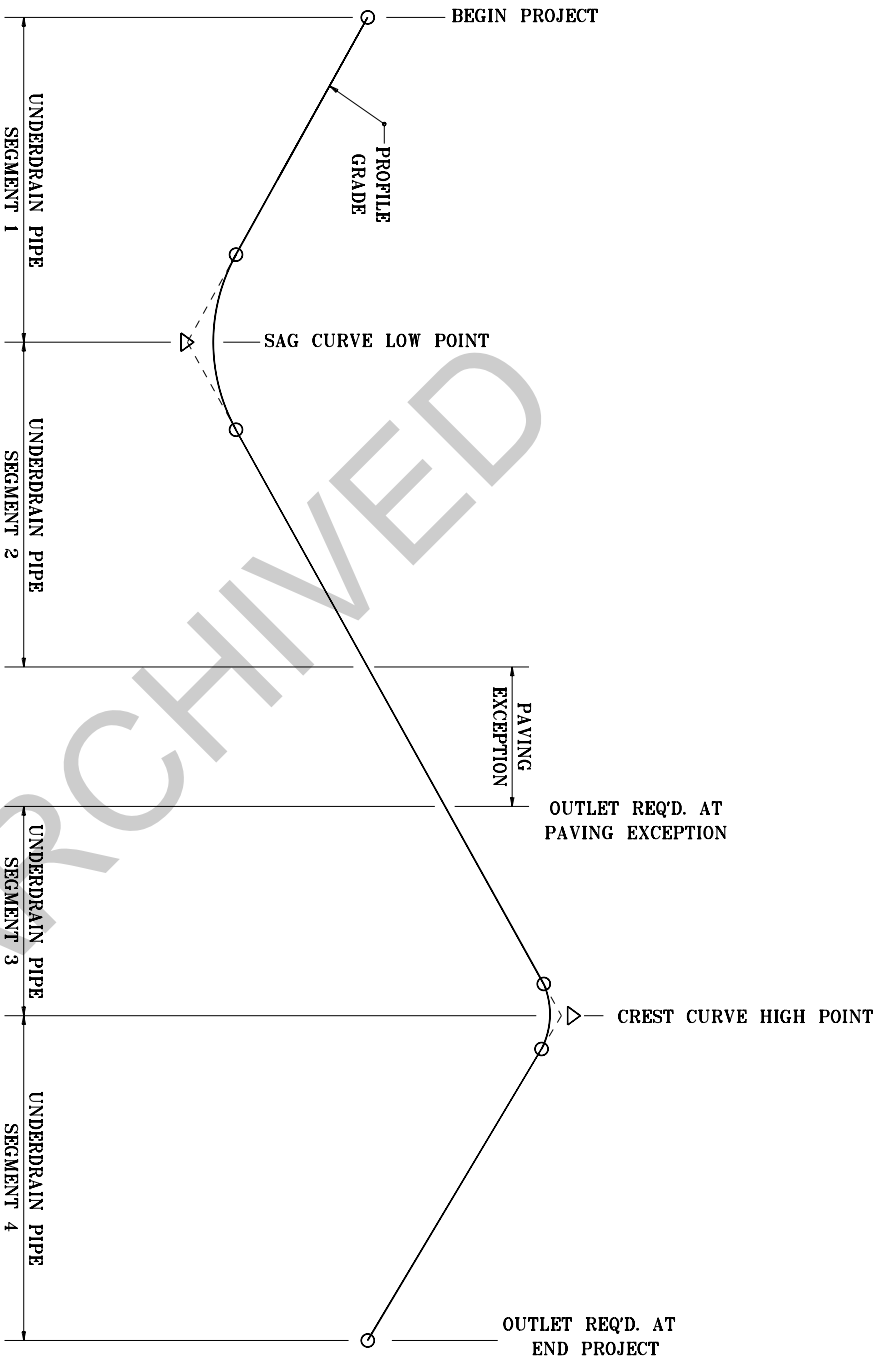

FIGURE 1– SAMPLE UNDERDRAIN LAYOUT

curve low point. The number of additional outlets required within segment 1 depends on the distance between the begin project location and the sag vertical curve low point. Below are three scenarios with different distances between the begin project location and the sag outlet and a description of the preferred underdrain pipe segment 1 layout associated with each situation:

1. **Case 1, Sag Vertical Curve Low Point is 100 m from Begin Project Location**—Because only 100 m of underdrain pipe is required, the preferred segment 1 installation is one run of single access underdrain.
2. **Case 2, Sag Vertical Curve Low Point is 200 m from Begin Project Location**—The preferred segment 1 installation is one run of dual access underdrain.
3. **Case 3, Sag Vertical Curve Low Point is 500 m from Begin Project Location**—The preferred segment 1 installation is two 200 m dual access underdrain pipes and one 100 m single access underdrain pipe.

The above preferred underdrain pipe designs are based on maximum outlet spacing criteria only. Project specific conditions may require that other underdrain pipe layouts be used.

52-10.04(4) Location

The location of underdrain pipe within each proposed cross section should be in accordance with the typical cross sections shown in Section 52-6.0. Underdrain pipe installation should be as continuous as possible throughout the project area. Potential conflicts, such as drainage structures and underground utility facilities, should be designed in a manner that minimizes the interruption of underdrain pipe installations.

Generally, outlet pipe is used to convey water collected by the underdrain pipe to the drainage system. However, if an inlet, catch basin, manhole, or similar structure is located along the proposed underdrain pipe alignment, the underdrain pipe may be connected directly to the structure. This situation occurs most often with curb inlets and inlets adjacent to concrete median barrier.

Underdrain pipe should not be connected directly to pipe culverts or precast concrete culverts. If a pipe or precast concrete culvert prevents the continuous installation of an

underdrain pipe, the culvert should be treated as an obstacle. Outlet pipes or end caps should be provided as appropriate on the underdrain pipe ends immediately adjacent to the culvert.

Crest vertical curve high points should also be treated as an obstacle in terms of underdrain pipe installation. Referring to Figure 1, a crest vertical curve high point serves as the boundary between underdrain pipe segments 3 and 4. At this location, caps or outlet pipes should be installed at the underdrain pipe ends. The 718-UNDR series of INDOT *Standard Drawings* includes a detail that illustrates a typical crest vertical curve high point installation with caps placed on the underdrain pipe ends.

Typically, the connection detail shown on the 718-UNDR series of INDOT *Standard Drawings* should be utilized at all connections between underdrain pipe and outlet pipe. The detail allows the designer the flexibility to omit one of the 45^{o} elbows if necessary to provide a positive outlet. If it becomes necessary to develop project specific connection details for any reason, the detail should not include 90^{o} elbows or tees. Abrupt bends in the underdrain system make it difficult to perform video inspection and maintenance operations.

Another outlet pipe installation requirement intended to improve maintenance and inspection capability is that separate outlet pipes must be provided for each underdrain pipe. Referring again to Figure 1, the outlet at the sag vertical curve low point requires that two outlet pipes be installed—one for the underdrain pipe from segment 1 and one for its adjacent counterpart from segment 2. The two outlet pipes are installed in a common trench as shown on the 718-UNDR series of the INDOT *Standard Drawings*. Outlet pipes installed in common trenches should outfall at the same elevation.

The practice of using a transverse pipe to connect parallel underdrain pipes is not appropriate, as it violates the policy of providing separate outlet pipes for each underdrain pipe.

Another factor affecting the location of outlet pipe is outfall freeboard. A minimum of 300 mm should be provided between the outlet elevation and a median ditch flow line and 600 mm is the recommended minimum freeboard for outfalls at a side ditch. Connections between outlet pipe and drainage structures should be made at least 150 mm above the drainage structure invert.

If the above freeboard requirements cannot be met at an adjacent ditch or drainage structure, it is acceptable to install the outlet pipe under the pavement to a suitable outlet located on the other side of the roadway. Figure 2 illustrates a typical installation of outlet pipe under pavement to an acceptable outlet on the opposite side of the roadway.

52-10.04(06) Outlet Protectors

Outlet protectors are required at all locations where an outlet pipe intersects a median or side slope.

Outlet protectors can accommodate one or two pipes.

Figure 52-10A of the design policy document includes the steepest and flattest slopes appropriate for the installation of each outlet protector type. For many slope magnitudes, more than one outlet protector type is acceptable. As a general rule, the largest appropriate protector should be utilized.

For example, assume a designer must select the appropriate protector type for an outlet located on a 3:1 outside slope. Figure 52-10A indicates that all outlet protector types can be constructed on a 3:1 slope located on the outside. In accordance with the above rule, a Type 1 protector is the preferred protector type. However, if a field condition will not permit the construction of a Type 1 protector, a Type 2 protector should be considered next. Only after verifying that both of the larger protector types cannot be constructed at an outlet location, should the Type 3 protector be considered.

52-10.04(07) Geotextile for Underdrains

Historically, this item has been one of the misunderstood underdrain system elements. Geotextile lining of underdrain pipe trenches is only appropriate when it can be determined that project area soils are silts or loams. The purpose of the geotextile lining is to prevent the migration of silt or loam particles into the underdrain pipe trench. If no silt or loam soils exist in the project area, there is no need to line underdrain trenches with geotextile.

Underdrain pipe trench lining should only be used when either of the following situations exists:

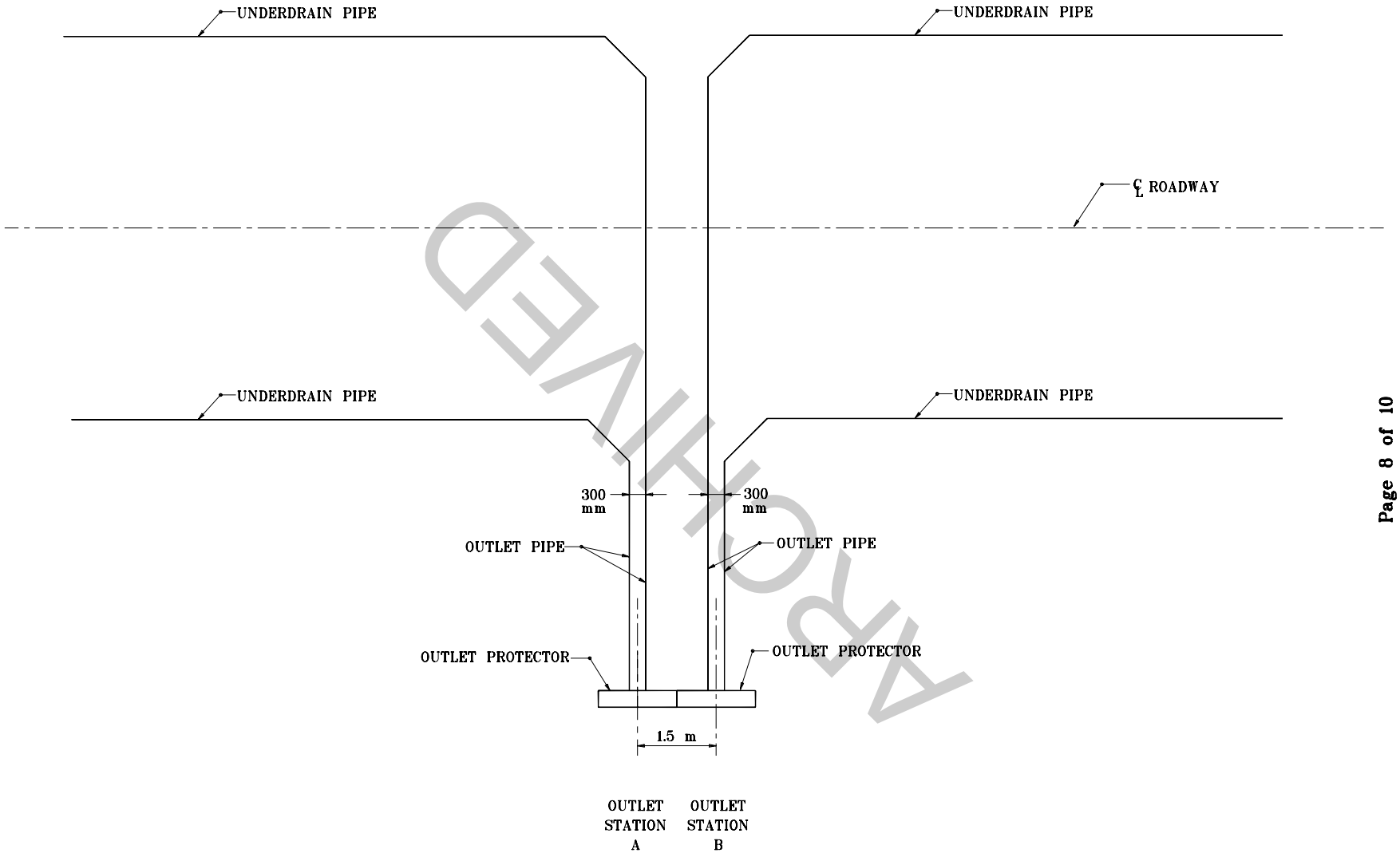

FIGURE 2 – TYPICAL OUTLET PIPE INSTALLATION ACROSS ROADWAY

1. **Geotechnical Engineering Report Recommendation**—A Geotechnical Engineering Report has been prepared for the project and it recommends that geotextile lining of underdrain pipe trenches be utilized.
2. **Silt or Loam Soil Documentation**—No Geotechnical Engineering Report has been prepared for the project currently under development, but a report prepared for an earlier project constructed at the site, county soil survey, or other source verifies the presence of silt or loam soils in the project area.

A second application for geotextile for underdrains provides a barrier between embankment material placed behind a curb and an adjacent underdrain pipe trench. This geotextile should be installed in accordance with Section 52-6.0 and is always required when a curb is constructed above an underdrain pipe trench.

52-10.05 Contract Preparation

52-10.05(01) Plans

In general, information related to underdrains should be shown on plan sheets as early as possible. One criticism of past underdrain designs commonly made by contractor and construction personnel is that the design often appeared to be an afterthought. Hopefully, incorporating underdrain design data onto plan sheets as soon as it becomes available during the design development process can eliminate this problem.

Figure 3 includes a schedule for incorporation of underdrain related elements onto plan sheets during the design development process. For example, the figure indicates that when the profile grade can be shown on the plans, the special underdrain limits should also be shown on the profile portion of the Plan & Profile Sheet.

Design Landmark	Underdrain Information Required On Plan Submittal
Profile Grade Determined	Special Underdrain Limits Shown On Profile Portion of Plan & Profile Sheet
Receipt of Approved Pavement Design	Underdrain Pipe Trench Details Shown On Typical Cross Section Sheet. Underdrain Table Data Including: • Underdrain Pipe Limits • Outlet Pipe Locations • Underdrain Pipe And Outlet Pipe Flow Line Elevations • Outlet Protector Design Data
Final Check Prints	Underdrain Table Including All Required Pay Item Quantities

UNDERDRAIN PLAN SUBMITTAL REQUIREMENTS
Figure 3

52-10.05(04) Proposal

The following codes apply to underdrain related pay items.

Pay Item Description	Pay Item Code
Pipe, Type 4, Circular, 100 mm	715-05230
Pipe, Type 4, Circular, 150 mm	715-05048
Pipe, Underdrain Outlet, 150 mm	715-05053
Aggregate for Underdrains	718-52610
B Borrow for Structure Backfill	211-02060
HMA for Underdrains	718-06526
Geotextile for Underdrains	718-99153
Outlet Protector, 1	718-06528
Outlet Protector, 2	718-06529
Outlet Protector, 3	718-06531
Video Inspection	718-06532

UNDERDRAIN PAY ITEM CODES
Figure 4

If there are questions regarding this matter, please contact me at (317) 232-5347.

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