

**SPECIAL PROVISION**  
**REGARDING**  
**HORIZONTAL DRAIN INSTALLATION**  
**SPECIFICATIONS**

**610.01 Description.** The work consists of furnishing and installing horizontal drains as shown on the Plans and as directed by the Engineer. The work also includes construction of all required temporary work such as access roads, drilling pad, sedimentation control (for management of drilling fluids) and the routing of drilling sediment to sedimentation basin(s) and or tank(s) and sediment and erosion control.

**610.02 General.** Prior to commencement of drilling, the Contractor shall submit to the Engineer for his review, written information that describes the project specific experience and qualifications of its key drilling personnel that will be deployed on the project (on site) for the drilling and installation of the horizontal drains. As a minimum, the written information shall include.

- Resume for the drilling foreman (i.e. the crew chief or drilling superintendent);
- Resume for the lead driller(s) for each rig deployed;
- Evidence of the drilling foreman and lead driller's successful and safe completion of horizontal drain installation work on at least 5 projects of similar scale and complexity over the prior 3 year period;
- Copies of the drilling foreman and lead driller's safety training records and current certifications and licenses.

**610.03 Method Statement.** Prior to commencement of drilling, the Contractor shall provide to the Engineer for his review, a Method Statement that describes the means, methods and specific equipment that are proposed for the drilling, flushing, slope/water head measurement, drain installation, drain cleaning, drain orientation and inclination measurements, sealing the annulus at the outlet, and installation or outlet piping, valves and hoses.

**610.04 Subsurface Conditions.** Refer to the Geotechnical Investigation for detailed information regarding the subsurface conditions. Some subsurface information may be shown in the plans. A geotechnical report may be available upon request.

**610.05 Materials.**

**PVC Pipe**

Horizontal drains shall consist of nominally 1.5 inch Schedule 80 polyvinyl chloride (PVC) pipe conforming to the requirements of ASTM Designation D1785. At the Contractor’s option, the type grade, and design stress designation of the pipe shall be 1120, 1220, 2112, 2116 or 2120 as specified in the ASTM D1785.

Slotted pipe shall have three rows of machined slots. Slots shall be factory machined. On-site fabrication of slots shall not be permitted. The rows shall be in the longitudinal direction of the pipe, the slots cut in the circumferential direction of the pipe. The rows shall be centered on the third points (120 degrees apart) of the pipe circumference, with the slots spaced uniformly along the pipe. The minimum opening will be measured on the inner surface of the pipe. Each row of slots shall conform to the following configuration.

Number of Slots per Linear Foot, ±1	Slot Width (inches)	Minimum Opening per Linear Foot (square inches)
46	0.010	0.46

Fittings for the PVC pipe shall be Schedule 80, Type II, PVC, solvent weld type fittings to the requirements of ASTM Designation D 2467. Factory machined male and female ends may be used in lieu of couplings.

Un-slotted (i.e. solid wall) PVC pipe, approximately 5 feet in length shall be used at the outlet end of each drain.

**Steel Casing (Collar)**

A steel casing (acting as a collar) to be nominally 5 feet (min.) in length with a minimal outside diameter of 5 inches shall be installed per the plans at the outlet end of each drain.

Corrugated metal pipe (CMP) shall not be permitted for this application.

**Horizontal Drain Seal (Packer)**

A drain seal in the form of a compressive packer shall be used to seal the annulus between the steel casing (collar) and the horizontal PVC drain pipe as shown on the plans.

**Cement Bentonite**

The Contractor shall use a blended Portland cement bentonite grout with a minimum of 30% (by weight) of bentonite powder. The water cement ratio (by weight) shall be 2.5 and the grout shall achieve a minimum unconfined compressive strength at 28 days of 50 psi.

**Concrete Pack**

The Contractor shall use Portland cement concrete (TDOT Class A) with a minimum compressive strength of 3000 psi to fill the annulus between the drill hole and the drain pipe at the surface of the slope per the plans, to prevent leakage and erosion.

**Water**

The Contractor shall furnish water for drilling operations and shall use temporary pipes and other materials necessary to route sediment laden drill water (or other drilling fluids, flush returns) to in-place temporary sedimentation detention devices. The Contractor shall add flocculent if necessary to enable the sediment to fall out of suspension. Polyethylene tanks (such as Baker Corp tanks or equivalent) may be used to supplement or replace sedimentation detention basins. The clear water from installed horizontal drains can be pumped for re-circulation and used for drilling, but must be controlled so as not to cause erosion. The Contractor shall remove sediment from sedimentation detention basins and/or tanks as needed, and shall control water flow from the detention basins or tanks to prevent erosion and site contamination. The Contractor shall dispose of the sediment at an approved location. The Contractor shall pump sediment laden fluids into storage tanks for removal from the site to an approved off-site location.

**610.06 Construction Requirements**

Prior to the beginning of drilling, the drilling foreman (i.e. crew chief or drilling superintendent) and lead drillers(s) for each rig deployed shall meet with the Engineer to review the drilling program.

**Access Roads**

The Contractor shall construct access roads after the limits of routes have been delineated and approved and only after the erosion and sediment control plan has been received and approved by the Owner.

The Contractor shall prevent sediment-laden fluids that may result from constructing the access roads from leaving the site.

**Sedimentation Detention Basin (and/or tanks)**

The Contractor shall construct in-place sedimentation detention basins and/or deploy tanks, such as Baker Corp. Polyethylene tanks (or equivalent), after the limits of the areas have been

delineated and the erosion and sediment control plan has been received and approved by the Engineer.

**Drilling Pads for Horizontal Drains**

The Contractor shall construct the drilling pad after the limits of the area have been delineated and approved and the erosion and sediment control plan has been received and approved.

The design, construction and maintenance of the drilling pad (or “working platform”) shall be by the Contractor to suit his particular means and methods of construction, and be so designed, constructed and maintained throughout the duration of the work such that it is stable, trafficable and sustain safely the bearing pressures imposed upon it by the equipment for the duration of the work.

The Contractor shall prevent sediment-laden fluids from the construction of the drilling pad from leaving the site and shall dispose of them in an approved location.

**Installing Horizontal Drains**

The locations of the horizontal drains shown on the Plans are approximate only and the exact location and sequence of placing horizontal drains (including azimuth, inclination and length) shall be agreed on site under the direction of the Engineer.

If used, drilling water shall be re-circulated to minimize the volume discharged in and on the slope (landslide debris) and to reduce environmental impacts. The Contractor shall deploy pumps as necessary for recirculation of drilling water.

Water for disposal shall be routed in temporary pipes to a designated sedimentation detention basin (or tanks). The Contractor shall collect clear water from horizontal drains by connecting them to temporary pipes and routing the flows to an approved discharge location to prevent erosion.

In the event of difficult drilling conditions, the Contractor shall be prepared to deploy drilling methods as required to achieve the specified length of drain hole, which may include use of down the hole hammer methods in conjunction with casing advancement (for example “Odex”, “Tubex”, and Symmetrix systems). The Contractor shall have the means to mobilize the necessary tooling for these methods within 24 hours.

During the drilling operation (i.e. as the hole is being advanced) the Contractor shall determine the elevation of the drilled hole at 50 feet intervals in each and every drain hole. The Contractor shall use intermediate intervals if the drill hole is suspected of having deviated from the design slopes and or is close to impacting or interfering with a subsurface obstruction such as utilities, bridge foundations, etc.

The elevations of the drill hole during advancement of the hole shall be determined by measuring the water head in a closed tube inserted in a water filled tube placed within the drill hole to the distance specified.

Drill bits are to have a one-way check valve to prevent drill water or ground water from re-entering the drill rod while water head measurements are being taken. The Contractor shall mark the clear tube in 0.1 feet increments with the 0.0 datum equal to the discharge end (collar) elevation of the drilled hole or otherwise reference to actual ground survey elevations, if available. Prior to taking water head measurements, the tube shall be filled with water until the level no longer rises, indicating equilibrium between the level in the clear tube and the inserted end in the drill hole. The water head shall be measured utilizing either a pressure gauge or vertical clear water tube plus survey level. The pressure gauge shall be calibrated on site by attaching it to a water filled hole and varying the elevation of the other end of the hose. The accuracy of the elevation measurement approach shall be demonstrated by the Contractor to the satisfaction of the Engineer. The Contractor is responsible for furnishing all labor, materials, tools, equipment and incidentals as necessary for determining the drill hole elevations. The head measurements for each drain shall be tabulated on the Contractor's daily field notes.

### **Installing PVC Pipe**

The Contractor shall install the PVC drain pipe with slots on top by inserting the pipe inside the drill rod and then retracting the drill rod so that the drilled hole is cased to full depth. The leading end of the PVC pipe shall be fitted with solid rounded plug or a sealed pointed extension piece no more than one foot in length, that shall assist in the insertion and will prevent ingress of sediment through the end of the pipe.

### **Cleaning of Horizontal Drains**

Upon completion of each drain, the Contractor shall jet each drain for its entire length to positively verify that the entire pipe is free of sediment. The jet nozzle on the end of the hose or tube shall be inserted the full length of the drain pipe to accomplish the cleaning operation. The water jet shall be controlled during insertion and removal to flush materials from the pipe slots and any blockages within the bore of the pipe. The jet nozzle shall have a minimum of six equally spaced holes made on 15 degree angles with the axis of the base (for side flushing) and single hole at the head of the nozzle. The after pressure shall be controlled to no more than 500 psi with a constant flow rate of between 5 to 10 gallons per minute.

**Horizontal Drain Tolerances – Orientation (azimuth) & inclination.** Upon completion of each horizontal drain, and immediately following the jet cleaning of each drain, its orientation (azimuth) and inclination shall be measured using a Pajari Instruments Ltd. Tropari "single shot" direction survey instrument (or approved equal) at 50 feet intervals along the PVC drain, and at other intervals as may be directed by the Engineer. A final measurement 25 feet from the end of

the drain shall also be made. The data shall be recorded in table form and submitted to the Engineer for review and approval. No measurements shall be made closer than 25 feet to the end of the drain to avoid magnetic interference from the sacrificial (“knock off”) drill bit (if used).

Each horizontal drain shall be constructed with the orientation measured along the centerline of the PVC drain pipe within a tolerance of 1 in 30. For example, at the end of a 240 feet long drain, the end of the PVC pipe shall be no more than eight feet from the planned orientation of any direction. Similarly, the inclination of the centerline of the PVC drain pipe, measured with respect to the horizontal, shall be within two degrees up or down of the planned inclination.

The Contractor shall be responsible for furnishing the Pajari Instruments Ltd Tropari instrument and incidentals for determining the elevations, slopes and compass bearings.

### **Drill Hole Flushing**

The Contractor shall conclude drilling/flushing operations for each hole after the planned length has been measured and recorded and after the return water is observed to be relatively clear, indicating that the fines have been washed from the hole.

Drill rod/casings shall be removed from the hole in such a controlled manner as to prevent any damage, dislodgement or pulling out of the PVC drain pipe from the hole.

### **Installing Steel Casing (Collars)**

The Contractor shall protect the outlet end of each drain using a nominally 5 inch diameter steel casing (or collar) that is 5 feet (minimum) length.

### **Installing Horizontal Drain Seals**

The Contractor shall install the horizontal drain seal (compression packer) in the annulus between the horizontal drain pipe and the steel casing or collar as shown on the plans and in accordance with the manufacturer’s directions. The intended purpose of this seal is to function as a cut-off to all water flow through the annulus. Installation of the seal includes furnishing all labor, materials and equipment to achieve a tight continuous seal.

### **Grouting the Annulus**

The Contractor shall grout the annulus between the solid wall PVC pipe at the outlet and the steel casing or collar as shown on the plans to within 6 inches of the face of slope. The cement-bentonite grout shall be thoroughly mixed in a high-speed, high shear colloidal grout mixer and it shall be pumped into the annulus.

**Constructing the Concrete Pack**

Once the cement-bentonite plug in the annulus has cured, the Contractor shall use Portland cement concrete (TDOT Class A) with a minimum compressive strength of 3000 psi to plug the remainder of the annulus between the steel casing or collar and the solid wall PVC pipe, such that the plug of concrete is made flush with the exposed surface of the slope at the outlet location.

**Permanent Markers**

On completion of each horizontal drain, a permanent stainless steel marker tag shall be fixed securely to the PVC outlet, with the identification number stamped (i.e. embossed, indented) into the plate. Stainless steel rivets and/or stainless steel pipe clamps maybe used to fix the permanent marker to the pipe.

**Installing Temporary Discharge Pipes**

The Contractor shall route clear water from each horizontal drain immediately by connection to temporary piping to the satisfaction of the Engineer. The Contractor shall implement means and methods to prevent erosion of the slopes prior to the drain being installed.

**Sediment and Erosion Control**

The Contractor shall implement and maintain sediment and erosion control measures throughout the project period in compliance of the approved sediment and erosion control plan. Sediment and erosion control pay items in the current contract may be overrun for this purpose.

**610.07 Measurement of Quantities & payments.****Horizontal Drain Equipment Mobilization**

Measurement and payment for horizontal drain equipment mobilization includes the full compensation for accessing and leaving the drill site, traffic control and incidentals, as require by the TDOT Standard Specifications as amended and the project specific TDOT Special Provisions.

The items shall include:

- Access road
- Drilling pads
- Crushed rock and earthen fill for drilling pads
- Sedimentation detention basins (and or sedimentation tanks)
- Removal and disposal of silt from sedimentation detention basins, tanks and silt fences
- Water supply (e.g. water truck, water wagon, pumps, and hoses)

Horizontal drain equipment mobilization will be measured on a lump sum basis for complete mobilization of drill rigs and all equipment required to accomplish the work. The unit price for mobilization will be measured as complete once the Contractor has demonstrated the ability to drill the designated horizontal drain holes in conformance with the Special Provisions, and to the satisfaction of the Engineer.

**Horizontal Drains**

Payment for horizontal drains will be made per linear foot of drilled drain and shall include furnishing all materials, labor, equipment, and incidentals necessary to perform all work required to install the horizontal drains, complete and sealed in place, as shown on the plans and specified in the TDOT Standard Specifications as amended, and the project specific TDOT Special Provisions, and as directed by the Engineer. Payment shall include for drilling and flushing the drill holes, making slope/water head measurements, furnishing and installing PVC drain pipe, jet cleaning and Tropari measurements of azimuth and inclination

The Engineer may direct early termination of drill holes if they are misaligned or if other issues arise. The Engineer may also direct the drilling of additional holes if required.

**Horizontal Drain Outlet Completion Details**

Payment shall be made per each horizontal drain outlet, complete in place. This payment item shall include furnishing all materials, labor, equipment and incidentals necessary to perform all work required for the installation of the permanent steel casings (collar), seals (compression packers), cement-bentonite grouted annulus, concrete pack, permanent markers, outlet piping, hoses and valves required to connect into the collector drain.