

## 1. GENERAL

a) This work consists of supply and installation of horizontal drain in slopes aimed to lower and drain out the groundwater. The Contractor shall provide all necessary resources including skilled labour, drilling machine/equipment, and materials to complete all the scope of works of the horizontal drains in accordance to the details shown on the Drawings and with the requirements of this Specification.

### b) Method statement

The Contractor shall prepare and submit method statement of installation of horizontal drains to the SO/Engineer for prior written approval by at least 7 working days before commencement of work. The method statement shall include, but not limited to the following details:

- **Introduction:** About the project name, scope of works to be carried out (number/size/length of horizontal drains to be installed, etc.), brief site conditions, brief sub-soil conditions, special construction requirements. Site plan, layout plan of horizontal drains and details of horizontal drains should be included as Appendix A.
- **List of specific machine/equipment/tools to be mobilized**  
List of specific machine/equipment/tools (types/make/model/capacity with catalogues/photos for drilling machine with drill accessories/tools) and type of staging for working platform to be mobilized to execute the works as specified and complete the works within the specified work program shall be clearly stated.  
Catalogues and details of the drilling machine & drill tools should be included as Appendix B.
- **List of specific materials/products to be used**  
List of specific details of materials/assembled or site prepared products (type and class of PVC pipe with coupler/centralizers/spacers, casing, etc.,) to be used including their respective trade names, manufacturers, factory QC test certificates together with samples/photos should be submitted for review and approval of SO/Engineer.  
Catalogues/test certificates and details of materials/products should be included as Appendix C.
- **List of manpower/key operator and technician to be engaged**

List of manpower/key personnel (site manager, QC manager, operators & skilled workers) with names and their respective job designation/duty and brief CV shall be included for SO/Engineer or CRE/RE's review and approval. Work permit for foreign workers, if relevant, should be included.

Detailed CV, personnel details & work permits if relevant can be included as Appendix D.

- **Sequence of works**

Important sub-activities such as site inspection, staging & working platform preparation, drilling, inserting of perforated PVC pipe, pull-out checks, drain outlet preparation, QC testing, etc., shall be included with descriptions and machine/equipment layout in diagrammatic presentation, etc.

Works program and details of necessary temporary works with necessary justifications/calculations by qualified P.Eng should be included as Appendix E.

Statements such as “suitable drilling machine will be deployed or experienced operators will be engaged or high-quality materials will be used” are not specific or too general and are unacceptable.

- **Output of works**

The estimated **daily output** works (time/hours taken to complete drilling & placement of assembled horizontal drains or how many horizontal drains completed per day) shall be indicated to ensure the works can be completed within the scheduled work program.

- **QC tests/checks**

Specified quality control tests/checks with respect to type and frequency plus their respective **acceptance criteria** shall also be included in the method statement, and

- **Remedial measures** shall also indicate in the method statement in cases where the acceptance criteria cannot be complied.

In brief, the method statement shall clearly prescribe how the horizontal drain installation work shall be carried out with particular reference to sequence of works, realistic work output, quality control and resources requirements, etc., to ensure the work can be completed within the stipulated or agreed time frame and according to the specification and approved program.

The method statement shall be prepared by experienced project manager/engineer who has extensive and intensive working experience and also is knowledgeable about the

characteristics, capacity and efficiency of the resources available to his disposal. In addition, the project manager/engineer shall have inspected the site/surrounding conditions and studied the specification thoroughly before preparation of the method statement.

**c) Safety facilities for access to slope**

Facilities/means of access to slope consisting of scaffolding/staging constructed of stable/rigid metal pipes or other strong materials agreed by the SO/Engineer shall be properly installed to enable the workers to work and SO/Engineer or his representative to examine closely the horizontal drain installation works. The scaffolding/staging shall reasonably stable and safe.

Protection fences and barriers shall be provided for the work areas.

**2. MATERIALS**

Materials for horizontal drains shall meet the following requirements:

**(a) Plastic drain pipe.**

Unless otherwise specified on drawings, plastic drain pipe shall consist of perforated Polyvinyl Chloride (PVC) pipe of Class 7 in accordance with MS 628 or BS 3505 or other written approved equivalent. Unless otherwise specified in the Drawing, the nominal PVC pipe size shall be 50mm (ID) with minimum thickness of 5mm for nominal horizontal drain drill-hole of 76mm. All necessary jointing shall be socket joints with pipe end capped.

The Contractor shall submit drain samples plus joints with test certificate from the ISO accredited manufacturer and indicate the source of the proposed materials prior to delivery to the site and shall allow sufficient time for the SO/Engineer to evaluate the material. At least 7 days prior to the installation of horizontal drains, the contractor shall submit to the SO/Engineer for his review and written approval, details of the sequence and method of installation. Approval by the SO/Engineer will not relieve the Contractor of his responsibility to install drains in accordance with this Specification.

- (b) Non-woven geotextile** used to wrap the horizontal drain shall be manufactured by ISO accredited factory from needle punched polypropylene/polyester/ polyethylene fiber with minimum mass of **190 gm/m<sup>2</sup>** (ISO 9864) and minimum width tensile strength of 13 kN/m

at 40% elongation (ISO 10319). The non-woven geotextile shall have no chemical influence between pH 2 to 13. Test certificate of the non-woven geotextile shall be submitted to SO/Engineer for approval.

(c) **Perforations**

The perforations shall consist of 2 rows of 3mm to 5mm wide slots at 150mm centre to centre spacing on  $2 \times 105^0$  cut around the circumference (staggered) of the Class 7 PVC pipe to allow inflow of underground water into the perforated PVC pipe and the unslotted/uncut section of the pipe shall be laid at the bottom ( $110^0$ ) and stiffened at the top ( $40^0$ ) to drain the water out from the hole.

The full length of perforated PVC pipe shall be wrapped with the non-woven geotextile (minimum  $190 \text{ gm/m}^2$ ) in 2 layers and tightened around with galvanized wire (SWG 16) at 100mm pitch.

**3. CONSTRUCTION**

**3.1 Requirements**

The location and length of the horizontal drains shall not deviate/vary by more than 100mm from the locations indicated on the drawings unless otherwise instructed/approved by the SO/Engineer.

Drains that are out of their proper location by more than 100 mm or drains that are damaged during construction/pull-out checks (Clause 3.3), or drains that are improperly completed shall be rejected by the SO/Engineer, and no compensation will be allowed for any materials furnished or for any work performed on such drains. Temporary casing shall be used when the PVC pipe is damaged or difficulty in inserting the pipe is encountered.

The contractor shall provide the SO/Engineer with suitable means of making a linear determination of the quantity of drain material used.

**3.2 Drilling.**

Unless otherwise approved by SO/Engineer, drilling shall be dry method using pneumatic rotary percussion method. Odex drilling or cased method shall be used if encountered collapsible soils. The equipment used for drilling holes shall be capable of drilling holes

in soils/rocks of not less than nominal 76 mm in diameter and up to 40 meters in length to the designated lines and grade through soil and rock formations. Unless otherwise specified in drawings or directed by Engineer/SO, horizontal drain shall be tilted upwards as shown on Drawing but not exceeding 5 degrees.

Drilled holes shall be adequately large or temporarily cased in such a manner to facilitate the horizontal plastic drain (PVC pipe of about 65+ mm OD) to be push-in with ease. The horizontal drain pipe shall be properly jointed together where necessary to form a continuous pipe and it shall not be impaired when in completed. Records of drilling including soil/hard materials/dusty/wet soils, water table, collapsible holes, etc., shall be submitted to SO/Engineer for evaluation and record.

The Contractor shall deploy suitable drilling equipment plus skilled operator and supervisor that have adequate capacity and experience to produce the drill hole according to the required size, length and accuracy as shown in the Drawings and as specified in this Specification.

The position of each horizontal drain shall be marked and pegged clearly on the ground/slope before the commencement of drilling works. If necessary, survey equipment shall be used to locate the position of horizontal drains.

The temporary drilling working platform shall be erected firmly on the ground/slope, such that no excessive movements or sway occurs during drilling.

The drain holes shall be drilled at an inclined angle into the ground/slope. The angle of inclination shall be as shown on Drawing, but not exceeding 5° upwards.

Dry rotary drill, auger or down-the-hole hammer shall be used. Suitable drill bit slightly larger than the PVC pipe wrapped with non-woven geotextile and jointing shall also be used. In ground likely to collapse, the drilled shaft shall be protected by suitable temporary casing or Duplex drilling technique shall be used. Drill holes shall be flushed clean on completion of drilling and the opening protected or sealed to prevent the entry of

any foreign matter. A drilling record for each horizontal drain shall be carried out as specified in Clause 3.5.

Drilling for the whole design length of horizontal drain shall be carried out uninterrupted and completed with necessary hole cleansing within about two hour. To ensure reliable and effective cleansing of the drill holes, an additional drilled length of about 0.3 m to the design length shall be provided so that cleansing of cuttings and debris towards the bottom of the drill holes by the compressed air through the drill rods can be effectively and eventually carried out. Alignment of drill holes shall not deviate more than 25 mm in 3 m in any direction.

### **3.3 Drain pipe installation.**

Join individual section of perforated PVC plastic pipe with suitable couplings or joints (socket joint) machined to provide a smooth internal wall when installed, and securely bonded with a bonding material recommended by the ISO accredited pipe manufacturer. Securely plug the entrance end of the pipe with end cap. Install the perforated plastic pipe in the drilled hole with the perforations on top, unless otherwise directed by the SO/Engineer. Unless otherwise approved by SO/Engineer, the assembled perforated PVC pipe shall be inserted into the drilled hole immediately (within 1.0 hr.) after cleansing and completion of drill-hole.

After inserting about 80% of the total design length into the drill-hole, the perforated PVC pipe wrapped with non-woven geotextile shall be withdrawn to check the conditions of the non-woven geotextile and the perforations by SO/Engineer, Such **pull-out checks** shall be carried out on at **least the first 3 locations per day** selected by SO/Engineer. If damage or serious contamination (due to hole collapse) is observed or difficulty in inserting the PVC pipe is encountered, the Contractor shall use temporary casing or other method approved by SO/Engineer. Photos showing the perforated PVC pipe before and after wrapped with non-woven geotextile, conditions of pull-out checks (at least 3 locations daily as directed by SO/Engineer) shall be captured for record purpose.

Unless otherwise shown in the Drawing or instructed by the SO/Engineer, non-perforated Class 7 PVC of 1m long shall be installed at the mouth or outlet of all horizontal drains.

All the collapsed, loose and soft material (at least 75mm deep) around the exposed outlet of the non-perforated PVC pipe shall be removed and replaced by 1:3 cement-sand mortar.

### **3.4 Control of water**

Control water for drilling and water encountered during the drilling operation to ensure that siltation or damage will not occur to adjacent roads and streams.

### **3.5 Submittals**

The Contractor shall keep records for each horizontal drain installation and shall submit one signed copy to the SO/Engineer not later than noon of the next working day after the horizontal drains have been installed. The record for each horizontal drain shall include horizontal drain reference number, date/time of commencement and completion of drilling and inserting of pipe, names of supervisor and operators, plus the necessary drilling details, photos showing the perforated PVC/uPVC pipe before & after wrapped with non-woven geotextile, conditions of pull-out checks (at least 3 locations daily as directed by SO/Engineer as specified in Clause 3.3), etc.

**Drilling records** shall include:

- Location of horizontal drain (No., Ch., Berm/slope reference, etc)
- Description of drilling debris returns
- Observed exceptions & peculiarities
- Size, length, coupler and Class of PVC pipe (minimum class E/specified)
- Type/make of filter cloth/non-woven geotextile (minimum 190 gm/m<sup>2</sup>)
- Drill-hole diameter/drill bit type & size. Total drilled length
- Time of start & completion of drilling
- Time of start & completion of inserting the horizontal drain.
- Photos showing drilling in progress & conditions of cuttings/debris (at least at 3 locations per day selected by SO/Engineer.

### **3.6 Horizontal drains near soil nails/anchors**

In case the horizontal drains are to be installed together with soil nails/ground anchors/rock bolts on the same slope, the installation of soil nails/ground anchors/rock bolts shall be completed first before the commencement of horizontal drains.

### 3.7 Concrete lined chute

Where necessary and shown in drawing, Grade 25 concrete lined chute with minimum thickness of 75mm and 100mm wide shall be constructed to drain the water from the outlet of the horizontal drain to the nearby drain.

## 4. MAINTENANCE

The contractor shall maintain the completed horizontal drains:

- a) To ensure outlet and the inside of all horizontal drains is free of debris.
- b) To clear vegetation cover to access drain outlets and collector system cleanouts and ensure drain are freed draining.
- c) To flush the drain casings of sediment and cleans the slots and perforation of obstruction and caking.

## 5. MEASUREMENT

The method of measurement and payment shall be as shown in the BQ.

BQ description should be “*Supply and installation of 76 mm diameter horizontal drain of 12m long and as shown in drawings including drilling in soil/rock, inserting of 50 mm (ID) perforated PVC pipe (Class 7, minimum 5mm thick) fully wrapped with non-woven geotextile (minimum 190 gm/m<sup>2</sup>) tightened around by wire (SWG 18) at 100mm pitch, pull-out checks and drain head preparation, etc.*”. Paid in nos.

NCA/Spec-H D/Oct 06/ revised Jun 20