

DRILLING, PERMEABILITY TESTING AND LABORATORY ANALYSIS SPECIFICATIONS

I. SCOPE OF WORK:

The Department of Environmental Protection (DEP), Bureau of Waterways Engineering and Wetlands, requires a contractor to drill test borings, perform permeability tests in boreholes and perform laboratory analyses for a flood protection project in Monroe Borough, Bradford County. **Drilling and field testing will begin on April 2, 2018 and Demobilization must occur on or before May 9, 2018.**

Drilling and field testing will start at test boring DH-4 and proceed to boring DH-19 before returning to borings DH-2 and DH-3. Test boring locations are shown on test boring plans **TB-1 through TB-11** (attached). **Table 1** (attached) provides a summary of expected drilling and field testing. **Attachment A - Bid Award**, shows estimated drilling, field testing and laboratory test quantities.

The test described in **Section II.O. Field Permeability Testing**, will be performed in borings advanced specifically for those tests using **driven casing**, only (**Section II.L. Overburden Drilling to Permeability Test Interval**). Hollow stem augers and rotary/drilled casing are otherwise acceptable for advancing borings, as indicated in the Specifications.

Three (3) test borings, previously drilled at the site, were advanced using augers, but with considerable difficulty in some horizons (**see attached logs for DH-1, DH-2 and DH-4**). Surface materials at other locations (**see especially DH-3 and DH-12**) indicate that even coarser overburden materials may be drilled. Therefore, contractors must have rotary casing available, with inside diameter capable of passing NQ-2 coring equipment. Contractors must also have a track-mounted drilling rig to access borings across uneven wooded terrain. Special attention should be given to the access routes for DH-3/DH-3A and DH-12, when preparing bids.

All contractors must submit an equipment list with their bid. The DEP may reject bids when, at its sole discretion, the contractor does not possess equipment suitable for the work described herein. Any work not fully outlined in these Specifications shall be performed according to best prevailing practice, as determined by the DEP.

Questions: Any questions regarding the technical aspects of the Specifications shall be directed to Scott Cox at 717-783-7995, or via e-mail at sccox@pa.gov. Questions regarding the contracting or bidding procedures shall be directed to Sherry Morrow at 717-772-1216, or via e-mail at smorrow@pa.gov.

II. TECHNICAL CONTRACT REQUIREMENTS:

A. Utility Line Marking:

Contact "Pennsylvania One Call System" at 1-800-242-1776 or 8-1-1 at least three (3) business days prior to drilling to have utility lines marked. No separate payment will be made for utility clearance.

B. Boring Locations/Depths and Laboratory Analysis Services:

Boring locations/depths and laboratory analysis services indicated in **Table 1** are tentative. The final number and depth of borings and laboratory analysis services may be increased or decreased at the discretion of the DEP.

C. Inspection:

The contractor shall provide the DEP the opportunity to inspect all work. If any unsatisfactory work is performed, the defects shall be remedied by the contractor, at his expense, to the full satisfaction of the DEP. No drilling or testing shall be done except in the presence of the DEP, unless specific permission has been granted to the contractor.

D. Access and Liability:

The DEP is responsible for obtaining property access. Every effort shall be made to minimize damage resulting from access and drilling. Maximum use shall be made of existing roads and lanes for access. Where access routes deviate from roads and lanes, deviation shall be by one (1) track, causing the least damage. Tree cuttings will be allowed only with permission of the DEP.

All property disturbed by the contractor shall be restored, at the contractor's expense, to the satisfaction of the DEP, irrespective of whether the damage was caused by the contractor's negligence or was an unavoidable consequence of the drilling operations. The contractor shall leave the land in the same or better condition, in the opinion of the DEP, than it was in prior to entry upon the land. All borings shall be backfilled as described in **Section II.G. Backfilling Boreholes.**

E. Drilling Record:

The contractor shall keep accurate logs and records of all borings on a form, approved by the DEP, similar to **Figure 1, Test Boring Log** (attached), which shall include the following information:

1. Project name and contract number, boring number, location of boring, ground elevation, total depth of hole, time-date of starting, time-date of completion.
2. Size and depth of casing, size and type of drilling tools and sampling devices used to advance the hole.
3. Depths of top and bottom of soil samples, blows per six (6) inches on the sampler and the blows per foot for advancing casing.
4. Depths of top and bottom of each core run.
5. Earth shall be described and recorded in accordance with the following classifications:
 - Kind - Topsoil, loam, clay, sand, gravel, etc.
 - Color - Light, medium, dark, etc., plus color
 - Moisture - Dry, moist, wet, very wet, etc.
 - Compaction - Loose, medium, compact, stiff, etc.
6. Rock shall be described and recorded in accordance with the following classifications:
 - Rock Type - Sandstone, shale, slate, limestone, etc.
 - Hardness - Soft, medium, hard, very hard, etc.
 - Orientation of beds or layers as measured from the horizontal.

Total length of core recovered, plus the maximum and average length of individual core pieces, for each run.

7. Color changes in drill-water returned.
8. Depths at which sudden losses or gains of drill-water return occur, and estimated quantities involved.
9. Nature and extent of fracturing of the rock cored, as determined by a field description of the recovered core, and the "feel" of the drill during the coring.
10. Depth of top of firm or fresh rock and all other contacts between dissimilar materials.
11. Location of soft zone or "break-through", as indicated by rod chatter or change in the rate of penetration.
12. Water level observations.
13. Notes, remarks and information on pertinent incidents occurring during drilling operations.
14. Depth of drilling at the end of each shift.

Within ten (10) business days of the completion of all drilling and field testing, the contractor shall submit all boring logs and other records, as required by these Specifications, to the DEP.

Any costs relating to **Section II.E. Drilling Record** shall be considered incidental and no reimbursement shall be made.

F. Abandoned Boreholes:

Except with the permission of the DEP, the contractor shall not abandon any boring or remove any casing or drilling equipment without first affording the DEP the opportunity to obtain the depth of the boring and to secure samples of materials already penetrated, and any other information which the DEP may require. No payment shall be made for any boring which has been abandoned by the contractor before reaching the depth, elevation or condition specified, unless the DEP approves and accepts the boring as complete. The DEP may accept a boring which fails to reach the required depth due to strata which, in its opinion, could not be drilled or sampled using the methods described in these Specifications.

G. Backfilling Boreholes:

The contractor shall leave borings open at least twenty-four (24) hours, unless directed by the DEP to backfill immediately. All drill holes must be backfilled before demobilizing from the site. A 4-3-1 bentonite-cement-sand grout ratio shall be used to backfill boreholes, unless otherwise directed by the DEP.

Grout pipe shall be inserted to the bottom of each finished hole, prior to the removal of casing or augers, so that holes can be backfilled from the bottom upward. Holes shall be backfilled as casing or augers are removed from the hole, or at some later time, as directed by the DEP.

At holes requiring immediate backfilling, casing or augers shall be removed slowly, as the grout level rises in the hole, in order to prevent caving of soil or rock into the hole, prior to grout introduction. At holes not requiring immediate backfilling, casing and augers shall be removed slowly, in order to prevent excessive caving of soil or rock into the hole, and to prevent grout pipe from being pulled upward. The contractor shall cover open holes completely, as directed by the DEP. When grouting holes where casing or augers were previously removed, grout pipe shall be slowly removed, keeping the bottom of the pipe below, or as close as possible to, the grout level.

All completed holes shall be marked by stakes, upon completion of the backfilling. Holes drilled through concrete or asphalt pavement shall be plugged with the equivalent material, through a minimum depth equal to the pavement, and finished even with the existing surface.

All costs for backfilling boreholes are incidental to the cost of drilling, and no separate reimbursement shall be made.

H. Samples:

Overburden sample boxes and core boxes shall be stored at a safe place at or near the job site, by the contractor, as the holes are completed. All samples shall be protected from moisture and freezing.

Upon job completion, the contractor will remove samples from the job site and store samples temporarily, until all testing has been completed. Cores and overburden samples shall then be delivered, at the contractor's expense, to Harrisburg, Pennsylvania. Contractor shall contact the DEP for delivery instructions.

Samples selected for laboratory testing shall be delivered to the designated laboratory at the contractor's expense.

I. Mobilization and Demobilization:

1. Mobilization is the delivery and assembly of all equipment and supplies required to complete the work and comply with all local, state and federal laws and regulations, and the satisfactory storage of all materials and supplies. The work also includes obtaining the required permits, insurance, bonds and any other initial items required for the start of work.

Prior to beginning work, the contractor's equipment and supplies shall be inspected for contract compliance, and complete set-up in proper working order, and shall be subject to the approval of the DEP.

No separate payment shall be made for moving equipment and supplies between borings and setups at individual boring locations.

2. Demobilization is the removal of all equipment and supplies from the project site, and cleanup and restoration of all areas disturbed by the contractor, after work completion. The contractor shall restore any disturbed areas to a condition equal to or better than that which existed prior to the work, as determined by the DEP.

3. Mobilization and Demobilization will be paid as a lump sum price, constituting all compensation for labor, equipment and supplies required to satisfactorily complete the work.

J. Overburden Drilling and Sampling:

1. *Summary:* Overburden borings will be drilled by alternately sampling and then advancing the cased boring to the bottom of the previous two-foot sample interval. Standard Penetration Test methods shall be used to drive a split-spoon sampler. Borings will be advanced using one of the methods described below.
2. *Equipment:* Power-driven drilling and drive machinery shall be used for Overburden Drilling and *Sampling*. The drill rig and accessories must be suitable for advancing holes and driving the sampler using the procedure described in **Section II.J.3. Procedure**, and for coring rock using the procedure described in **Section II.N. Rock Coring (NQ-2 or larger)**. Supplies shall include all accessories required for drilling and sampling, and all boxes, labels and containers required for sample preservation.

Sampling shall be performed with a twenty-four-inch (24") long, two-inch (2") outside diameter split barrel spoon as defined by ASTM D1586. The spoon shall be equipped with a reliable ball and check valve at the top. A flap valve or basket type retainer must be available for use in soils which otherwise are difficult to recover. The drive shoe must be in good condition, in order to obtain optimum recovery and penetration.

The inside diameter of casing or augers must be sufficient to allow driving of the spoon sampler, without significant friction caused by contact with the casing or residual cleanout material. Typically, this shall require casing or augers with a minimum three and one-quarter-inch (3¼") inside diameter. Drive casing shall be extra heavy flush-joint pipe, preferably with four-inch (4") minimum nominal diameter. The drive casing shoe must be in good condition.

3. *Procedure:* Borings may be advanced with hollow stem augers, drive casing, or rotary/drilled casing. Rotary/drilled casing may be used only when the hole cannot be advanced with augers or drive casing.

Regardless of the method used, holes must be advanced and cleaned to the bottom of the previous sample interval, without unnecessarily disturbing deeper soil. Holes must be advanced and cleaned following each sample, unless, in the DEP's opinion, driving the spoon sampler into the previous spoon sample hole will provide adequate results. Wash water shall be used, only to the extent needed, to clean the hole, in order to avoid disturbing deeper soil.

When flowing/heaving soils are encountered, the contractor shall fill the hole with water, to a level sufficient to prevent soil movement into casing/augers. Water must be maintained at a sufficient level for the duration of drilling and sampling. Samplers and cleanout tools must be removed slowly, in order to prevent rapid loss of pressure and resulting movement of soil into the hole.

Drive casing shall be advanced using a 300-pound hammer, dropped through an eighteen-inch (18") free fall, unless an alternate method is approved by the DEP. The number of blows for each foot of casing penetration shall be recorded. Casing shall be

driven and cleaned to the bottom of the previous sample interval. Typically, a rotary bit shall be used to grind material within the casing so that it can be ejected from the hole with wash water. Pulling the casing out of the hole, for the purpose of cleaning it and then introducing it back into the hole, shall not be permitted. Simultaneous washing and driving of the casing shall not be permitted, except by order of the DEP and, where permitted, the elevations between which water was used shall be recorded.

Hollow stem augers must be used with the center bit assembly in place, unless the DEP gives permission to omit the assembly. Advance augers to the bottom of the previous sample interval and clean hole using augers. If deemed necessary by DEP, use an appropriate clean-out tool to remove any remaining material to the bottom of the augers.

Rotary/drilled casing must be used with a casing advancer, unless the DEP gives permission to omit the advancer and clean the hole after advancing casing. Advance casing to the bottom of the previous sample interval, using the minimum amount of water necessary. If deemed necessary by the DEP, use an appropriate clean-out tool to remove any remaining material to the bottom of the casing.

Soil samples shall be recovered with a sampling spoon attached to the end of the hollow drill rod. The sample spoon shall be lowered slowly to the bottom of the previously cleaned hole and driven into the undisturbed soil below the bottom of the casing. Two-foot-(2') long samples shall be obtained continuously, starting at the ground surface and ending at the depth specified by the DEP.

Samples shall be obtained by driving the spoon with a 140-pound weight having a thirty-inch (30") free fall. Special precautions shall be taken to ensure that the energy of the falling weight is not reduced by friction between the drive hammer and the guides or the hoisting line and any pulleys. A wire cable is not acceptable for hoisting and releasing the drive weight.

A record shall be kept of the number of blows for each six inches (6") of penetration. Samples shall be carefully removed from the hole in order to prevent sample loss. If a sample is not obtained the first time, or if it consists of wash material, the spoon shall be driven again, to a depth of twenty-four inches (24") below the bottom of the casing. Should the material be so loose that the second driving of the spoon fails to secure a sample, a spoon with a flap valve or basket retainer shall be driven. If such spoons are used, the flap valve or basket retainer may remain in place only at such times as approved by the DEP. In no event shall samples be obtained by driving and removing the casing.

If the spoon bounces or requires fifty (50) blows to advance 0.1 foot, the sampler is said to have reached "refusal." Whenever refusal is reached prior to the bottom of a two-foot (2') sample interval, the sampler will be removed and the hole advanced to the top of the next two-foot (2') sample interval. Sampling will then be attempted again. Overburden Drilling and Sampling will be terminated when DEP's representative determines that further attempts are unlikely to recover useful samples or penetration data, or that Rock Coring (see **Section II.N**) will likely produce more useful information.

All soil samples shall be placed in wide-mouth, rubber-sealed, screw-top, quart-size clear glass jars and clearly labeled, immediately upon removal from the hole. Labeling shall include hole number, sample number, sample depth and hammer blow counts. Jars and

lids shall be labeled with a waterproof permanent marker. All jars and lids shall be new and in original cartons, complete with cardboard separators. USED JARS and LIDS, regardless of condition, are **NOT** acceptable. Cartons shall be free from markings other than those of the manufacturer. Samples from each hole shall be stored together and shall be protected from moisture and freezing.

The contractor shall record information indicated in **Section II.E. Drilling Record**, on a form similar to **Figure 1, Test Boring Log** (attached).

4. *Payment:* The contractor will be paid for the total linear feet of holes drilled and accepted by the DEP. Payment unit is linear-foot. The price bid for Overburden Drilling and Sampling will constitute full compensation for both overburden drilling and sampling and any incidental costs. No separate payment will be made for advancing overburden holes through coarse-grained strata, such as coarse gravel, cobbles or boulders, or through other obstructions.

K. Overburden Drilling to Rock or Undisturbed Sample:

1. *Summary:* Borings will be drilled through overburden, to the top of firm rock, or to the depth required for undisturbed sampling. Samples of the overburden will not be required. The contractor shall record information as indicated in **Section II.E. Drilling Record**, as applicable, on a form similar to **Figure 1, Test Boring Log** (attached).
2. *Equipment:* Power-driven drilling and drive machinery shall be used for Overburden Drilling to Rock or Undisturbed Sample. The drill rig and accessories must be suitable for advancing holes using the procedure described in **Section II.K.3. Procedure**, for coring rock using the procedure described in **Section II.N. Rock Coring (NQ-2 or larger)**, and for obtaining undisturbed samples using the procedure described in **Section II.M. Undisturbed Sampling**. Supplies shall include all accessories required for drilling to the specified depths.
3. *Procedure:* Holes may be drilled with augers, drive casing, or rotary/drilled casing, and shall be advanced to rock or to the depth required for rock cores or undisturbed samples. Rotary/drilled casing may be used for undisturbed sample holes, only when the hole cannot be advanced with augers or drive casing. Borings must be carefully cleaned down to the sample depth, as described under **Section II.J. Overburden Drilling and Sampling**.
4. *Payment:* The contractor will be paid for the total linear feet of holes drilled and accepted by the DEP. Payment unit is linear-foot. The price bid for Overburden Drilling to Rock or Undisturbed Sample will constitute full compensation for overburden drilling and any incidental costs. No separate payment will be made for advancing overburden holes through coarse-grained strata, such as coarse gravel, cobbles or boulders, or through other obstructions.

L. Overburden Drilling to Permeability Test Interval:

1. *Summary:* Borings will be drilled through overburden, to field permeability test intervals, using drive casing. Hollow stem augers and rotary/drilled casing are not acceptable for advancing borings to permeability test intervals. Samples of the overburden will not be required. The contractor shall record information as described in

Section II.E. Drilling Record, as applicable, on a form similar to **Figure 1, Test Boring Log**.

2. *Equipment:* Power-driven drilling and drive machinery shall be used for Overburden Drilling to Permeability Test Interval. The drill rig and accessories must be suitable for advancing holes and driving the sampler, using the procedures described in **Section II.L.3. Procedure**, and **Section II.O. Field Permeability Testing Procedure**. Supplies shall include all accessories required for driving casing to the specified depths.
3. *Procedure:* Holes shall be drilled with drive casing methods, as described in **Section II.J. Overburden Drilling and Sampling**, to the depth required for field permeability testing. Borings must be driven with an un-deformed drive shoe, in order to preserve tight contact between casing and overburden. Borings must be cleaned carefully, down to the test depth, as described in **Section II.J. Overburden Drilling and Sampling**. Whenever refusal of the casing is encountered prior to the target depth, the contractor shall, at the direction of the DEP, advance the boring below this point by reaming with a rotary drill. This procedure does not encompass formation of the test interval by driving the sample spoon, as described in **Section II.O. Field Permeability Testing**.
4. *Payment:* The contractor will be paid for the total linear feet of holes drilled and accepted by the DEP. Payment unit is linear-foot. The price bid for Overburden Drilling to Permeability Test Interval will constitute full compensation for overburden drilling and any incidental costs. No separate payment will be made for advancing overburden holes through coarse-grained strata, such as coarse gravel, cobbles or boulders, or through other obstructions.

M. Undisturbed Sampling:

1. *Summary:* Thin-wall tube samplers or Denison core barrels will be used to obtain undisturbed soil samples.
2. *Equipment:* The thin-wall sampler shall be approximately thirty inches (30") long and shall consist of thirteen (13) or sixteen (16) gauge, three-inch (3") O.D. brass or steel tubing with a beveled cutting edge and positive inside clearance, as defined by ASTM D1587 / D1587M. The inside of the tube shall be smooth, clean and free from rust. The use of any other type of sampler for obtaining undisturbed samples shall be subject to the approval of the DEP. A stationary piston, as approved by the DEP, may be used in conjunction with the thin-wall tube. Low-shrink, microcrystalline wax shall be used to seal sample tubes.
3. *Procedure:* When a sample is to be taken, disturbed material shall be removed from the casing. The clean-out shall be performed so that the soil immediately below the bottom of the casing shall remain as undisturbed as possible. After the piston rod is fastened at the surface to prevent movement, the thin-wall sampler shall be forced, but not driven, into the soil with a downward pushing or jacking action. Hydraulic devices may be used. The Denison core barrel shall be advanced by methods as specified by the manufacturer and by such methods commonly used to obtain an undisturbed sample. After the sampler has been pushed or rotated, if a Denison core barrel is used, a period of rest or adjustment of at least five (5) minutes shall be allowed, prior to any further operations with the sampling device. After suitable rest or adjustment period, the drill rod shall be rotated at least two (2) full turns to shear the sample from the soil, at the cutting edge of

the sampler. If less than one point five feet (1.5') of sample is recovered, or if the sample is disturbed by the contractor, another undisturbed sample shall be obtained from that depth, in an adjacent hole, as directed by the DEP. If the original sample is unacceptable due to the contractor's negligence, drilling of the adjacent hole and acquiring another undisturbed sample shall be done at the contractor's expense.

Immediately after the thin-wall sampler or *Denison* core barrel is removed from the hole, the following procedure shall be used to seal the sample:

- a.) Top of the *Sample* Tube - A reamer shall be used for removal of cuttings and disturbed material. The inside of the tube shall be cleaned thoroughly and wiped with a dry rag to insure the bonding of wax to the tube wall. The wax shall be heated to a liquid state and then allowed to cool until a thin film of cooled wax shows on the surface before being used. The wax shall be poured into the tube in two (2), one-half inch (1/2") layers allowing sufficient time for the first layer to cool before the second layer is poured. The end of the tube shall then be capped, friction or plastic tape shall be wound around the joints of the tube and caps and the end of the tube dipped in wax. All other holes in the tube shall then be sealed with the tape.
 - b.) Bottom of the Sample Tube (Cutting Edge) - Soil shall be removed from the bottom of the tube to a depth of three-quarters (3/4) of one (1") inch or until undisturbed material is in evidence and placed in a sample jar. The jar shall be properly labeled for identification. The bottom of the tube shall then be prepared in the same manner as the top of the tube.
 - c.) Thin-Wall Tube Samples - Each undisturbed sample tube shall be labeled to clearly show the top of the sample, number of the boring, the number of the sample, the depth below the surface from which the sample was obtained and the amount of sample recovered. The sample tubes must be handled, stored and transported in an upright position and protected against impact or vibration in accordance with ASTM D4220. The sample tubes shall be delivered to the soils laboratory which has been approved by the DEP.
4. *Payment:* The contractor will be paid for each sample obtained and accepted by the DEP. Payment is per sample, for a) Three-Inch (3") Thin Wall Piston Sampler, and b) Three-Inch (3") Denison Sampler. No separate payment shall be made for pushing the sampler, sealing the sample tubes or for handling and transporting the sample tubes. If a suitable sample cannot be obtained, payment shall be made, provided DEP has verified that all specified procedures for undisturbed sampling were followed. No additional payment shall be made for obtaining a replacement sample (in an adjacent hole) when, in the opinion of the DEP, the original sample was unacceptable, due to contractor negligence.

N. Rock Coring (NQ-2 or larger):

1. *Summary:* Rock cores will be obtained using wireline equipment that recovers **two-inch (2") minimum diameter core.**
2. *Equipment:* Power-driven drilling and drive machinery shall be used for Rock Coring. The drill rig and accessories must be suitable for coring rock, using the procedure

described in **Section II.N.4. Procedure**. Supplies shall include all accessories required for drilling and sampling, and all boxes, labels and containers required for sample preservation. The contractor shall use a standard ball bearing, swivel-type, double-tube core barrel, equipped with diamond set core bits and standard core lifters, unless otherwise directed by the DEP. Bits shall be compatible with the type of rock being cored.

3. *Containers:* Longitudinally partitioned wooden or polypropylene core boxes shall be used for all rock cores. Core boxes, including partitions, shall be substantially constructed of dressed lumber, or polypropylene, in accordance with the arrangement and dimensions shown in **Figure 2**. If polypropylene is used, it must be white or colorless, and at least three millimeters (3 mm) thick. Core boxes shall be of new construction and unmarked; **USED CORE BOXES**, regardless of condition, are **NOT** acceptable. Core boxes shall be equipped with all necessary partitions, covers, hinges, spacer blocks, screws or hooks for holding down the cover, complete identification, and other accessories, as required.
4. *Procedure:* At the elevation where the test boring encounters rock, the hollow stem auger or casing shall be seated tightly on the rock, and thoroughly cleaned-out prior to coring. In coring rock (including shale and indurated clays), the contractor shall operate his drill at such speeds, feeds and water or air pressure, as will ensure maximum core recovery.

During the initial run, and where soft or broken zones in rock are present, the contractor shall limit the length of "runs" to two feet (2') or less, in order to reduce core loss and keep core disturbance to a minimum. The individual drill runs in the coring operation shall not be in excess of five (5') feet, unless otherwise approved by the DEP.

The contractor shall frequently check the condition of the core lifter, reaming shell and rotation of the inner barrel, so as to avoid any grinding of the core. Whenever blockage of the core barrel occurs, the "run" shall be terminated immediately. The core barrel shall then be removed from the hole and the recovered core placed in the core box. The core barrel shall be dismantled horizontally and the core pushed out into a trough when, in the opinion of the DEP, such steps are necessary for the protection of the core during removal from the barrel.

A core recovery of less than ninety percent (90%) is generally considered unsatisfactory. When a "run" is made which results in complete core loss, the tools shall be checked for damage or malfunction, and a second attempt shall be made to recover the material by coring an additional few inches or by deliberately blocking the bit. If there is still no recovery, or very poor recovery because the material has the characteristics of overburden, the hole shall be advanced by the driving of a split spoon sampler. If necessary, the cored portion of the hole shall be reamed and casing advanced to prevent persistent caving into the hole.

Failure to comply with the foregoing procedures, when ample warning of unusual subsurface conditions has been received, shall constitute justification for the DEP to require re-drilling at the contractor's expense, of any boring from which the core recovery is unsatisfactory.

The contractor shall exercise particular care in recording water losses, rod jerks, and other unusual coring experiences which, supplementing the core record, will throw light on the nature and extent of rock fracturing. Other information to be recorded by the contractor is described in **Section II.E. Drilling Record.**

All cored rock shall be arranged neatly in the partitioned boxes, in the sequence in which it occurred, before removal from the hole. Facing the open box, core shall be arranged in descending sequence beginning with the left end of the partition nearest the hinges and continuing in other partitions, from left to right. Wood or polypropylene spacers shall be inserted at the beginning and end of each run to show depths. The first box of core from any one (1) hole shall contain core from the highest elevation. The other boxes shall contain the core from consecutively lower elevations. Cores from more than one (1) boring shall not be placed in the same box without previous approval. The labeling of rock core samples shall be done in the manner described and shown in **Figure 2.** If it is necessary to break rock core to fit into the core boxes, the breaks shall be indicated on spacer blocks or on the core boxes. All rock cores shall be protected from rain and extreme temperatures.

5. *Payment:* The contractor will be paid for the total linear feet of holes drilled and accepted by the DEP. Payment unit is linear-foot. The price bid for Overburden Drilling and Sampling will constitute full compensation for Rock Coring and any incidental costs. No separate payment will be made for obtaining drilling water or for the use of a split spoon sampler, if required, for advancing the hole through "soft" zones in the rock.

O. Field Permeability Testing:

1. *Summary:* Sediment-free water will be discharged into a cased boring. The flow-rate that maintains a constant water level in the boring will be measured. Methods for advancing borings to test intervals are described in **Section III.L. Overburden Drilling to Permeability Test Interval.** The two (2) test types, "Open-Hole Permeability Test" and "Open-End Permeability Test" are defined below.
2. *Equipment:* Permeability testing equipment shall consist of a minimum of one (1) testing assembly, meeting DEP approval and in good working order. The entire discharge assembly shall be free *from* leakage, especially between the meter and discharge point into the borings. No fittings, pipes, hoses, or valves in the assembly shall be of smaller diameter than the meter used.

Each *testing* assembly shall include:

- a.) Pump(s) and other equipment capable of supplying sufficient water for each test.
- b.) Water meter(s) capable of passing sufficient water for highly permeable test intervals, but not so large that poor precision is obtained at low flows. If very high flow is required, the use of two (2) meters may be required. Meter(s) must be calibrated no more than ninety (90) days prior to commencement of work, and the accuracy shall be within two percent (2%) of the actual delivery. The contractor shall furnish certified calibration chart(s) to the DEP before beginning any testing.

- c.) Hose and/or pipe, of length and capacity, sufficient to transmit the necessary water from the supply to the test hole.
 - d.) Supply and bypass valves capable of satisfactorily regulating water flow.
 - e.) Fittings in good condition.
 - f.) All other miscellaneous equipment and materials required for the satisfactory performance of the tests.
3. *Water Supply:* Water used for the tests shall be free of suspended sediment. If necessary, a settling tank or filter shall be used.

4. *Procedure:*

a.) Open-Hole Permeability Test:

After driving and cleaning casing to the test interval (**Section II.L. Overburden Drilling to Permeability Test Interval**), a two-foot (2') spoon sample shall be taken from the section to be tested. After removal of the sample spoon, the contractor shall determine if the hole remained open. If the hole is open, a permeability test will be conducted immediately. If the hole has collapsed, no test shall be performed, unless directed otherwise by the DEP.

Stable, saturated conditions must be established in test horizons, above or near the water table. This will be accomplished by introducing water into the test hole, until the water level in the hole remains at the same elevation, under a constant flow rate, for a period of five minute (5) minutes. Initially, water will be introduced into the test hole at a slow rate, in order to avoid damaging the test interval.

After this initial equilibration period, the quantity of water required to maintain a constant water level, typically at the top of casing, shall be recorded for each of three (3), five (5)-minute intervals. The depths and heads at which permeability tests are performed shall be recorded in the logs.

At the completion of the test, the contractor shall determine whether the hole remained open during the permeability test.

b.) Open-End Permeability Test:

This type of test will be used in loose, permeable soils that will not maintain an open, uncased test section, throughout the test interval. The open-end of the casing will be the test section.

After driving and cleaning casing to the test interval (**Section II.L. Overburden Drilling to Permeability Test Interval**), the testing procedure indicated above, for Open Hole Permeability Test, will be performed, except that no spoon will be driven.

Complete records shall be kept and presented on a form similar to **Figure 3, Report of Field Permeability Tests** (attached). If the contractor uses his own data sheet for recording test information, it shall include the following information:

- i.) Project name and number, hole location and number.
 - ii.) Groundwater level and elevation, including date of observation.
 - iii.) Elevation top of casing, or of hole, plus "stick-up" of casing.
 - iv.) Quantity of water used in each of the three (3), five (5)-minute test intervals.
 - v.) Depth to point of test (bottom of casing).
 - vi.) Dimensions of test section.
5. *Payment:* The contractor will be paid for each complete test accepted by the DEP. The unit price bid per test will cover all labor and supplies required to complete a test, including assembly of complete testing apparatus, establishing stable, saturated conditions whenever requested to do so by the DEP, maintaining a stable water flow into the test hole for each of the three (3), five (5)-minute intervals, and recording the test data described above. No additional payment will be made for obtaining suitable water and transporting it to the site, for determining whether the hole was open before and after a test, or for driving the sample spoon for the Open-Hole Permeability Test. No payment shall be made if the spoon-hole collapsed and no test was conducted.

P. Stand-By Time:

Stand-By Time is the time that the DEP requests a drilling crew to be idle, when the crew is otherwise prepared to work. Payment for delays will only be made when the delay is the sole responsibility of the DEP. No payment will be made when the drilling crew is not fully prepared to work, or when supplies and equipment are not fully operational or adequate.

The contractor will be paid for Stand-By-Time at the contract unit price bid per hour.

Q. Laboratory Testing:

1. *Scope:* Soil obtained from drilling and sampling will be tested in order to determine the physical, mechanical and hydraulic properties of selected samples. The contractor will assign a qualified testing laboratory to perform tests on samples selected by the DEP.
2. *Soil Testing Laboratory:* The soil testing laboratory shall have demonstrated that it can properly perform the required tests and obtain accurate results; that it has been utilized by other government agencies and private engineering firms to perform the tests required herein; and that it is manned by experienced *personnel* who are normally engaged in such work. The equipment must be certified and the laboratory must be approved by the DEP, prior to shipping any samples.
3. *Sample Selection:* The DEP will submit a testing order to the contractor, summarizing the tests it desires. Subsequent testing orders may be issued *after* the DEP reviews test results.
4. *Handling and Storing Samples:* Test samples shall be stored in the *laboratory*, in a manner that preserves the original characteristics of the soils.

5. *Testing Procedures:* Tests will be performed according to the most recent version of the referenced ASTM International standard. The DEP must be notified immediately if testing problems occur. No similar tests may be started until problems are resolved.
6. *Tests:*
 - a.) ASTM D2216 - Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
 - b.) ASTM D422 - Particle-Size Analysis of Soils. Samples will be prepared according to ASTM D421 - Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
 - c.) ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils.
 - d.) ASTM D7263 - Laboratory Determination of Density (Unit Weight) of Soil Specimens.
 - e.) ASTM D4253 - Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - f.) ASTM D4254 - Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - g.) ASTM D854 - Specific Gravity of Soil Solids by Water Pycnometer.
 - h.) ASTM D2850 - Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils.
 - i.) ASTM D4767 - Consolidated Undrained Triaxial Compression Test for Cohesive Soils.
 - j.) ASTM D3080 / D3080M - Direct Shear Test of Soils Under Consolidated Drained Conditions.
 - k.) ASTM D2435 / D2435M – One (1)-Dimensional Consolidation Properties of Soils Using Incremental Loading.
 - l.) ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)
7. *Test Results:* Results of soil tests, including all computations and data sheets, shall be prepared in a form acceptable to the DEP. Results shall be sent either electronically to the address supplied by the DEP, or via hard copy to the Department of Environmental Protection, Bureau of Waterways Engineering and Wetlands, P.O. Box 8460, Harrisburg, Pennsylvania, 17105-8460.
8. *Delays:* Test results must be sent to the DEP within fifteen (15) business days after receipt of the testing order. The contractor will assign another approved laboratory if the selected laboratory delays test completion.

9. *Payment:* Laboratory Testing will be paid at the contract unit price bid per test. Payment at the contract unit price will constitute full compensation for all labor, facilities, equipment and supplies required to perform the tests, and for submission of test results.

III. ADHERENCE TO TIMEFRAMES:

- A. Contractor shall return calls from DEP within two (2) business days.
- B. Drilling and field testing will begin on April 2, 2018 and Demobilization must occur on or before May 9, 2018.
- C. All laboratory tests shall be completed and forwarded to DEP within fifteen (15) days after receipt of sample.
- D. All boring logs shall be forwarded to DEP within ten (10) business days after the completion of all drilling and field testing.

IV. CONTRACT REQUIREMENTS:

The contractor agrees to complete **Attachment A – Bid Award**, and submit electronically with your bid documents. Failure to submit **Attachment – A Bid Award** may cause your bid to be rejected as non-responsive. Additionally, contractor agrees to comply with **Attachment B, Nondiscrimination/Sexual Harassment Clause and Attachment C, Steel Products Procurement Act**, as attached.

V. INSURANCE REQUIREMENTS:

The contractor shall purchase and maintain, at its expense, the following types of insurance issued by companies acceptable to the Commonwealth.

- A. **Workmen's Compensation Insurance** sufficient to cover all of the employees of contractor working to fulfill this contract.
- B. **Comprehensive General Liability Insurance, including** bodily injury and property damage insurance, to protect the Commonwealth and the contractor from claims arising out of the performance of the contract. The amount of public bodily injury insurance shall not be less than \$1,000,000 per occurrence. The amount of property damage insurance shall not be less than \$500,000 per occurrence. If the policy is issued for bodily injury and property damage combined, the amount shall not be less than \$1,500,000 per occurrence. Coverage shall include underground, explosion and collapse hazards.
- C. **Automotive Liability Insurance**, including bodily injury and property damage insurance, to protect the Commonwealth and the contractor from claims arising out of performance of the contract. The amount of automobile bodily injury insurance shall not be less than \$500,000 per person and \$1,000,000 per occurrence.

The amount of automobile property damage insurance shall not be less than \$500,000 per occurrence. If the policy is issued for bodily injury and property damage combined, the amount shall not be less than \$1,500,000 per occurrence.

The required insurances shall be of the contractual liability type and the named insured parties shall include the Commonwealth of Pennsylvania. The insurance shall not contain any endorsements or any other form designed to limit and restrict any action by the Commonwealth, as an additional insured, against the insurance coverage regarding the work performed for the Commonwealth. Prior to the commencement of work under this contract, the contractor must provide the Commonwealth with current Certificates of Insurance. These Certificates shall contain a provision that coverage afforded under the policy shall not be cancelled or changed until at least thirty (30)-days' written notice has been given to the Commonwealth.

Within seven (7) days of notification, the apparent low bidder shall present to the DEP, Insurance Certificates as identified above. No work orders shall be issued by the DEP until a current Certificate of Insurance has been received by the Commonwealth.

VI. CONTRACTOR QUALIFICATIONS:

After bid opening and prior to award, the DEP reserves the right to request three (3) references from the contractor providing proof of experience.

VII. CONTRACT TERM:

The contract shall commence April 1, 2018 and terminate June 30, 2018.

VIII. PAYMENT TERMS:

Payment shall be on a reimbursement basis for actual services performed. The invoice shall be clearly identified in accordance with **Attachment A - Bid Award**. **The invoice shall be submitted for review to the DEP upon completion of the project. Once approved by the DEP the invoice shall be mailed/scanned to the Bill To address identified on the Purchase Order.**

IX. BID AWARD:

The bid shall be awarded to the lowest responsible and responsive bidder as per **Attachment A - Bid Award**. **Attachment A – Bid Award** must be uploaded and attached to your bid submission. All bids must be submitted electronically through the Department of General Services' (DGS) eMarketplace website. The eMarketplace website is located at <http://www.emarketplace.state.pa.us>. DEP is not responsible for the maintenance of the eMarketplace website.

DGS's Supplier Service Center (Supplier Service Center) is available to assist vendors with registration, bidding and account management. For questions regarding registration help, send an e-mail to RA-PSC_Supplier_Requests@pa.gov or call (877) 435-7363, choose option 1. For questions regarding bidding help, send an e-mail to srmhelp@pa.gov or call (877) 435-7363, choose option 2.

X. ESTIMATED QUANTITIES:

The contract quantities herein are estimated only and may increase or decrease depending on the needs of the DEP. Contractor shall be paid at the unit price bid for actual work performed.

