APPROVED:
Division Administrator

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By: _____

FEDERAL HIGHWAY ADMINISTRATION

Supplemental Technical Specification for

Drilled Pile Foundations

SCDOT Designation: SC-M-716-1 (07/26)

716.1 Description

1 Install Drilled Pile Foundations in cylindrically excavated holes that extend into rock (i.e., rock socket) to support the structure and applied loads. The piles that are inserted in the excavated holes are typically steel H-piles and are concreted or grouted into place within the rock. The H-piles may be either placed in the excavation without being driven or the H-piles may be driven using pile driving equipment. Casing may or may not be required in a Drilled Pile Foundation construction to maintain the stability of the soils above rock. The casing may be either construction casing that remains in-place or temporary casing that is removed during the backfilling process above the concreted rock socket. See the Plans for casing requirements.

716.1.1 Site Information

1 Data on subsurface conditions are not intended as representations or warranties of continuity of such conditions. It is expressly understood that the Department will not be responsible for interpretations or conclusions drawn by the Contractor. Data is made available for the convenience of the Contractor and is not guaranteed to represent conditions that may be encountered.

2 Available soil borings are plotted on the Plans, and a copy of the Geotechnical Subsurface Data Report (GSDR) is included in the proposal for the project.

3 Additional test borings and other exploratory operations may be made at the Contractor's option at no additional cost to the Department, unless required by the Plans and Special Provisions.

716.2 Materials

1 Provide Class 4000DS Concrete as specified in **Section 701** for all drilled piles unless specified differently in the Plans. Adjustments to the mix design may be requested, when characteristics of materials, job condition, weather, test results, or other circumstances warrant. All adjustments are subject to acceptance by the OMR. Make accepted adjustments at no additional cost to the Department.

2 Provide steel H-piling used in Drilled Pile Foundations that conforms to **Section 711**.

716.3 Construction

716.3.1 Equipment

1 Use drilling equipment with adequate capacity including power, torque, and down thrust to excavate a hole of both the maximum diameter and to a depth 10 ft beyond the tip elevation shown on the Plans.

2 Ensure that the excavation and over-reaming tools are of adequate design, size, and strength to perform the work shown in the Plans or described herein. Use equipment that is well maintained and in good working condition. The BCE will be the sole judge of whether the drilling equipment is appropriate and in good working condition. Provide sufficient equipment to enable execution of the work according to the project schedule and completion of the work in the specified time.

3 Provide pile driving equipment that conforms to the requirements of **Section 711**, when the Plans indicate that the piles are to be driven after placement in the cylindrical excavation.

716.3.2 Qualifications of the Contractor

1 Ensure that cylindrical excavations are performed by personnel who specialize in the drilling of cylindrical excavations (i.e., similar to drilled shafts). Further ensure that the pile driving is performed by personnel who specialize in pile driving and meet the requirements of **Section 711**. Ensure that the supervisory personnel in charge of daily operations of the subcontractor's personnel have a minimum of 3 years of work experience in the installation of drilled foundations. Provide a drilled pile supervisor with at least this minimum experience on site during the entire construction process of all drilled foundations (i.e. drilling, coring, pile driving, concreting, etc.) to troubleshoot any problems that may arise during the construction process. Complete and sign the drilled pile documentation as specified in **Subsection 716.3.3**.

2 Failure to comply with the above requirements will result in the suspension of all work related to the drilled foundations. Do not begin work on the drilled foundations until the required personnel qualifications and experience is accepted by the BCE. The Department is not liable for any damages or costs related to the suspension of this work, nor will the project completion date be postponed for delays in furnishing the qualifications.

716.3.3 Drilled Pile Installation Plan

1 Submit a *Drilled Pile Installation Plan* and transmittal letter to the RCE and BCE for review and acceptance. Submit the *Drilled Pile Installation Plan* a minimum of 30 days before the proposed date to begin drilled pile work.

2 Ensure that the plan addresses and includes, but is not limited to, the following information:

- List and size of proposed equipment to be used on the project such as cranes, drills, augers, bailing buckets, final cleaning equipment, concrete pumps, casings, templates, etc.
- Details of sequence of construction operations and sequence of pile construction in bents or pile groups. Submit the wet method of construction as standard, indicate

in the *Drilled Pile Installation Plan* whether mineral or polymer slurry will be used. However, if dry method of construction can be performed, submit to the RCE, for acceptance, the necessary construction operations and details prior to commencing construction. See **Subsection 716.3.4.2** for dry method of construction criteria.

- Details of excavation methods.
- Details of proposed methods to clean the excavation after initial drilling.
- Details of concrete placement, such as proposed procedures for free fall of concrete, initial placement, lifts during placement, and overfilling of the concrete. Indicate the total length of time (time from when first load of concrete is batched until all concrete is placed within the drilled pile rock socket(s)) necessary to pour the drilled pile rock socket based on the availability of materials, equipment, and construction techniques being used, concrete trucks available, haul distance, etc.
- Required submittals such as shop drawings and concrete design mixes with slump loss tests (if concrete batching, mixing and placement exceed 2 hours).
- Means of disposing of excavated materials.
- The proposed method to check the dimensions and depth of the pile. Indicate the method for determining horizontal and vertical alignment, vertical position of the top of pile.
- Construction and/or temporary casing details with a sketch, the dimensions, and elevations. Include splice details, painting, and/or casing removal details, if applicable.
- Details of the fixed template, adequate to maintain drilled pile position and alignment during all excavation and concreting operations.
- Details of the proposed method of protecting the integrity of adjacent structure(s) during installation of the piles.
- Other information required by the Plans or requested by the Department.

3 If the piles are to be driven after being placed in the rock sockets, provide the following additional information:

- List and size of proposed equipment including cranes, driving equipment, jetting equipment, compressors, and predrilling equipment, including manufacturer's data sheets on hammers.
- Pile and Driving Equipment Data form.
- Methods to determine hammer energy or stroke in the field for determination of pile capacity. Include in the submittal the necessary charts and recent calibrations for any pressure measuring equipment and the method for monitoring pile advancement.

- Detailed drawings of any proposed followers.
- Sequence of driving footing piles for each different configuration of pile layout.
- Proposed schedule for the index pile program and production pile driving.
- Details of proposed items and procedures used to protect the integrity of existing structures.
- Methods and equipment proposed to prevent displacement of piles during placement and compaction of fill, including MSE wall backfill placement, within 15 ft of the piles. Include detailed procedures with sketches for maintaining the piling within the plan alignment.
- Other information required by the Plans or Special Provisions or otherwise requested by the Department.

4 The BCE will evaluate the *Drilled Pile Installation Plan* for conformance to the Contract requirements. The BCE will notify the Contractor within 21 days of receipt of the plan of either acceptance or whether any additional information is required and/or if changes are necessary for acceptance of the plan. If any part of the plan is unacceptable, the entire plan will be rejected. If so, submit a revised *Drilled Pile Installation Plan* for re-evaluation. The BCE will notify the Contractor within 7 days after receipt of the revised plan of its acceptance or rejection. Acceptance given by the BCE is subject to satisfactory performance in the field.

5 Do not commence installation of drilled pile foundations until the *Drilled Pile Installation Plan* is accepted by the BCE.

6 Acceptance of the *Drilled Pile Installation Plan* does not relieve the Contractor of the responsibility to provide sound and adequate foundations that conform to the Contract. Do not make changes in the methods or equipment after acceptance of the *Drilled Pile Installation Plan* without the written consent of the BCE.

7 With the assistance of the inspector, provide the RCE with the following documentation, as appropriate, complete and signed, for each drilled pile foundation:

- Drilled Pile Log
- Drilled Pile Excavation Log
- Drilled Pile Inspection Log
- Drilled Pile Concrete Placement Log
- Pile Driving Record (only required if piles are driven)

8 Submit completed and signed documentation by the drilled pile supervisor before beginning construction the next working day. Provide the RCE with the above documentation for each drilled pile foundation no later than 72 hours after the completion of each drilled pile foundation. Submit only those forms applicable to a specific drilled pile.

9 If soil conditions warrant, the BCE may direct that the piles be extended below the estimated bottom elevations shown on the Plans. Any additional compensation will be at the Contract unit price for respective items as described in **Subsection 716.5**.

716.3.4 General Construction Methods

1 Perform the excavations required for the drilled pile foundations through the materials encountered to the dimensions and elevations shown on the Plans or otherwise required by the Special Provisions. Use methods and equipment for the intended purpose and the materials encountered.

716.3.4.1 Wet Construction Method

1 Use the wet construction method for placement of the drilled pile foundation except as permitted by the RCE and BCE. Use water, slurry (mineral or polymer), or a casing (only with the written permission of the BCE or as indicated in the Plans or Special Provisions) to maintain stability of the excavation perimeter while advancing the excavation to its final depth, and concreting the pile foundation. Conform the slurry to the requirements in **Section 712.3.7**.

716.3.4.2 Dry Construction Methods

1 Use the dry construction method for constructing drilled pile sockets only as accepted by the RCE and BCE. The RCE and BCE will only allow dry method of construction when the excavation demonstrates the following:

A. Less than 6 in. of water accumulates in the bottom of the excavation over a one-hour period with no pumping permitted. For dry excavations, do not allow the depth of water to exceed 3 in. immediately before concrete placement in the excavated hole. Record in the Drilled Pilet Log the actual depth of water in the excavated hole just before concrete placement.

B. The sides and bottom of the excavation remain stable without detrimental caving, sloughing, or swelling. If immediately following the completion of the excavation, the stability of the hole is questionable, the RCE may order up to a 4-hour observation period before setting the pile and placing concrete.

C. Loose material and water can be satisfactorily removed before inspection and before concrete placement.

D. where the sides and bottom of the excavation may be visually inspected by the RCE before placing the concrete

2 If the RCE and BCE deems that the excavation meets all the criteria for the dry construction method, drill the excavation by removing accumulated water and loose material from the excavation, set the pile and concrete the pile in a relatively dry excavation. Casing may be used to facilitate dry construction if shown on the Plans or authorized in writing by the BCE.

3 Begin the setting of the steel H-pile and concreting immediately after completion of the drilling process (i.e., excavation, cleaning, inspection, and acceptance of the hole).

716.3.4.3 Casing Method of Construction

1 Casing may be used to stabilize the excavation with either wet or dry construction methods when shown on the Plans or authorized in writing by the BCE. Install the construction casing to produce an effective seal at the bottom of the casing. Ensure that casings left in place conform to the requirements for construction casing in **Subsection 716.3.6**.

716.3.5 Excavation

716.3.5.1 General

1 Unless otherwise specified or accepted by the BCE, install casing before beginning excavation. The Plans will indicate the expected length of drilled pile, the elevation of the top of the drilled pile foundation, and the estimated elevation of the bottom of drilled pile foundation. The BCE reserves the right to alter the elevations of the drilled pile foundations based on the top of rock and/or the results of a Load Test, if performed. Where drilled pile foundation lengths are altered, adjustment in price will be made by applying the original Contract unit prices to the change in quantity with no additional expense per unit.

2 Perform the drilling process for each individual excavation as a continuous operation. With written acceptance by the BCE, the drilling for an individual excavation may be discontinued if the walls can remain stable until drilling is resumed within 12 hours. See **Subsection 716.3.4.2** for additional requirements.

3 Haul off waste material removed from excavations, concrete spillage, and other debris and dispose of offsite at location(s) obtained by the Contractor. Assume responsibility for all fees or permits required for disposal of waste material. Submit copies of all agreements and/or licenses for the disposal site(s) to the RCE. Ensure that the disposal complies with local, state, and federal environmental pollution laws and ordinances.

4 Do not permit workers to enter the excavation for any reason unless both a suitable casing has been installed and the water level has been lowered and stabilized below the level to be occupied. Ensure that the proper OSHA safety equipment and procedures are used by the workers entering the confined space excavation.

716.3.5.2 Obstructions

1 Remove surface and subsurface obstructions within the top 10 ft below the elevation of the original ground at drilled pile foundation locations at no additional cost to the Department. Notify the RCE of any unforeseen obstruction deeper than 10 ft below the elevation of the original ground. Such obstructions may include man-made materials such as old concrete and timber foundations. Use special procedures and/or tools if excavation cannot be advanced using conventional augers fitted with soil or rock teeth, drilling buckets, and/or under-reaming tools. The special procedures/tools may include, but are not be limited to, chisels, boulder breakers, core barrels, air tools, hand excavation, temporary casing, and increasing the excavation diameter. Do not perform blasting unless specifically accepted in writing by the RCE and BCE. All reasonable costs for removing unforeseen obstructions are paid by the Department as extra work.

2 Drilling tools that are lost in the excavation are not considered obstructions. Promptly remove them without compensation. Assume all costs due to lost tool removal including, but not limited to, costs associated with excavation degradation due to removal operations for the time the excavation remains open.

716.3.5.3 Soil Excavation for Drilled Pile Foundations

1 Consider all excavation for drilled pile foundations as Soil Excavation unless a pay item is included for Rock Excavation. If rock is encountered, and there is a Rock Excavation pay item, Soil Excavation is measured from the actual top of ground to the top of rock elevation for each individual pile. Top of rock elevation is determined as indicated in **Subsection 716.3.5.4**.

716.3.5.4 Elevation of Rock

1 If rock is encountered more than 2 ft higher or lower than the elevation shown on the Plans, immediately notify the RCE and BCE.

2 Rock is defined as any material that cannot be drilled with rock augers and under-reaming tools and requires the use of core barrels, rotary percussion drills, and/or blasting. Notify the RCE when rock is encountered during drilling for verification of the rock elevation. Provide the RCE with samples of the excavated material to verify that rock has been encountered. For pay purposes, all earth seams, rock fragments, and voids included in the rock excavation area are considered rock for the full volume of the excavation from the initial contact with rock.

3 Use drilling equipment appropriate for the purpose and depths to determine the top of rock. Due to variations in rock strength, provide rock drilling equipment capable of drilling rock up to 25% stronger than the maximum compressive strength shown in the Contract at no additional time or cost to the Department. If additional cost is requested due to rock strengths exceeding 125% of the maximum strengths provided by the Department, provide rock strength testing performed by an OMR approved AASHTO accredited testing firm. Obtain rock core specimens using NQ or NX coring equipment unless otherwise approved by the BCE. Determine compressive strengths using ASTM D7012, Methods C or D.

716.3.6 Steel Casings

716.3.6.1 General

1 Use steel casings that are smooth, clean, watertight, and have ample strength to withstand both handling and driving stresses and the pressure of both concrete and the surrounding earth materials. Ensure that the outside diameter of casing is not less than the specified size of the drilled pile foundation. Unless otherwise authorized in writing by the BCE, insert casings near existing foundations or structures to the full required depth before any drilling.

2 Pre-drilling with slurry and/or over-reaming to beyond the outside of the casing may require the installation of oversized casing, but do not use unless accepted in writing by the BCE. Even when the use of an oversized casing or excavation is allowed, it will be at no extra cost, and the extra concrete used to fill the oversized casing or excavation will not be considered for payment. When removing a casing to substitute a longer or larger diameter

casing through caving soils, stabilize the excavation with slurry or backfill before removing the old casing. Other methods may be used to control the stability of the excavation and protect the integrity of the foundation soils. All methods must be accepted by the BCE before use. Such removal and stabilization operations are at the Contractor's expense.

716.3.6.2 Temporary Casing

1 Unless a pay item for Construction Casing is included in the pay quantities, all subsurface casings are considered Temporary Casing. Withdraw casings from excavations after the completion of the concrete placement to the top of the rock socket, provided the soils above the rock socket are determined to be stable by the RCE and groundwater was not encountered in the soil.

2 Remove the temporary casing according to the following requirements:

- The concrete has attained a compressive strength of 3000 psi as determined from test cylinder breaks.
- The concrete is not exposed to moving water or tidal water for at least 7 days after removal of the casing.

3 Use temporary casing consisting of spiral welded steel pipe or straight seam welded steel pipe. Do not use "Zipper Cans" as temporary casing.

4 If the Contractor intends to use telescoping casing, it must be requested in the *Drilled Pile Installation Plan*. Provide details indicating adequate support for the drilled pile. The use of telescoping casing will be at the discretion of the BCE. Space the pile concentrically inside the excavation with adequate support.

5 Do not extend oversized casings larger than the specified construction casing below the scour elevation. Where potential scour is not specified, do not extend oversized casings larger than the specified construction casing lower than 10 ft below the top of ground elevation.

6 Do not withdraw the casing until the level of fresh concrete in the casing is at the top of the rock socket. As the casing is withdrawn, install clean granular material (e.g., A-1 or A-3 sand or No. 789 stone).

716.3.6.3 Construction Casing

1 Use construction casing that is specified in the Plans to facilitate construction through water or other material that is not normally conducive to the use of temporary casing. Do not use construction casing unless it is specified in the Plans or approved in writing by the BCE.

2 Use construction casing of the size specified in the Plans or by the BCE. Assume responsibility for determining the wall thickness of the casing. Unless otherwise directed by the BCE, use new steel casing conforming to ASTM A36 or ASTM A252, Grade 2 or 3 spiral welded steel pipe, or straight seam welded steel pipe. Do not use "Zipper Cans" as construction casing. Additional stiffening may be required to withstand handling and driving stresses and the pressure of the surrounding earth and/or fluid pressures. Increase the

casing wall thickness as necessary to allow for installation within the subsurface conditions anticipated on the project. Ensure that the casing is smooth and watertight.

3 For drilled pile construction casing installed to the top of rock elevation, establish an effective seal before excavating to prevent overburden material from caving into the proposed excavation. Unless a seal into rock is required, do not extend the bottom of the construction casing below the elevation shown on the Plans without approval of the BCE. Review the elevations indicated on the Plans and determine the appropriate top of casing elevations based on this information and the field conditions encountered at the time of construction. Support the top of the casing to maintain construction tolerances and stability during construction.

4 If the Contractor intends to use telescoping casing, it must be requested in the *Drilled Pile Installation Plan*. The use of telescoping casing will be allowed at the discretion of the BCE.

5 Install casing in a continuous unit. Each unit may be fabricated from one or more sections. Use section as long as feasible and spliced as described below. Grind exposed edges of construction casing smooth, remove attached steel.

6 Thoroughly clean wall surfaces of construction casings of any organics and other materials detrimental to the soundness of the drilled pile concrete and steel H-pile.

716.3.6.4 Welded Splices

1 Do not use splices in construction casing unless authorized in writing by the BCE. If splices in casings are necessary and are authorized, make welds as follows:

- Bevel the surface of only one section of casing on the outside edge of the wall at an angle of approximately 45° with the horizontal. A surface of ⅛ in. may be left unbeveled. Guide bars may be temporarily attached to the casing wall to align the sections before welding.
- Butt the beveled section to the unbeveled section and temporarily clamp thereto. Separate the beveled edge approximately ⅛ in. from the edge of the unbeveled section, and make the axes of the two sections coincide by adjusting the clamps.
- Butt weld the entire periphery of the joint with a shielded metal arc low hydrogen electrode of proper size and with sufficient generating amperage to fuse the root of the weld. Make the weld with sufficient passes to completely fill the joint, removing the slag of each pass before beginning the next pass. The weld specified is the butt weld designated as B-U4b in ANSI/AASHTO/AWS D1.5*, Bridge Welding Code*.

2 Remove all coatings from the metal at the welds before welding is initiated and remove the slag after all welding is complete.

3 Splices in temporary casing are considered incidental work, and no additional compensation is allowed for this work.

4 Ensure that the welding of steel casing, including bracing, caps, splices, etc., conforms to ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.

716.3.7 Inspection of Excavations

716.3.7.1 Dimensions and Alignment

1 Provide equipment for checking the dimensions and alignment of each excavation. Determine the dimensions and alignment of the drilled pile foundation excavation under the observation and direction of the RCE. Check the alignment and dimensions during and after excavation by the following methods as necessary:

A. Insertion into the drilled pile excavation of a rigid rod or pipe assembly with several 90° offsets equal to the drilled pile diameter for alignment and dimension checks.

B. Other proposed methods provided to and accepted by the BCE.

2 Ensure that any rod or pipe assembly or other device used to check dimensions and alignment can be inserted into the excavation to the full-depth of the foundation.

716.3.7.2 Depth

1 Reference the depth of the excavation during drilling to the appropriate marks on the Kelly bar or other suitable methods. Measure final excavation depths after final cleaning with a suitable weighted tape or other accepted methods.

716.3.7.3 Excavation Inspection

1 The RCE will verify each excavation for acceptance before placement of the H-pile and concrete. Provide the necessary equipment and qualified personnel for inspecting the excavation. Ensure that the inspection equipment is compatible with the construction methods. The Contractor is responsible for providing all necessary safety precautions, equipment, and procedures required for confined space entry and fall protection by current OSHA standards for these inspections. Perform any corrective work found necessary because of the inspections. Allow the necessary time for performance of these inspections.

716.3.7.4 Excavation Cleanliness

1 Provide a cleaning operation so that a minimum of 50% of the base of each excavation has less than ½ in. of sediment at the time of placement of the concrete. Ensure that the maximum depth of sedimentary deposits or any other debris at any location on the base of the excavation does not exceed 1½ in. Inspect the excavation for cleanliness. Cleanliness will be verified by the RCE. In addition, for dry excavations, ensure that the maximum depth of water does not exceed 3 in. immediately prior to concrete placement. The Drilled Pile Foreman shall record in the Drilled Pile Log the actual depth (in inches) of water present in the shaft at the start of concreting.

2 Check the bottom of the excavation before setting the steel H-pile and immediately before concreting the excavation. If the cleanliness of the excavation does not meet the requirements indicated above before concreting, remove the steel H-pile and clean the excavation until the requirements are satisfied.

716.3.7.5 Construction Tolerances

1 Ensure that the following construction tolerances for drilled piles meet the requirements of **Subsection 711.3.5.3** unless otherwise stated on the Plans or in the Special Provisions and the following: Construction tolerances are the same as the tolerances mandated for the applicable piling as shown in **Section 711**.

A. All casing diameters shown on the Plans refer to OD (outside diameter) dimensions. The dimensions of casings are subject to American Pipe Institute tolerances applicable to regular steel pipe. When allowed by the BCE, a casing larger in diameter than shown on the Plans may be used.

B. Excavation equipment and methods are designed so that the completed drilled pile excavation has a planar bottom. Ensure that the cutting edges of excavation equipment are normal to the vertical axis of the equipment within a tolerance of ± ⅜ in. per ft of diameter.

2 Drilled pile excavations and completed drilled piles not constructed within the required tolerances are unacceptable. The Contractor is responsible for correcting all unacceptable drilled pile excavations and completed drilled piles to the satisfaction of the BCE. Ensure that the materials and work necessary, including engineering analysis and re-design to complete corrections for out of tolerance drilled pile excavations, are furnished without additional cost to the Department or an extension of Contract time.

716.3.8 Concrete Placement

1 Place the piles in the excavation or if shown on the plans, drive to the required driving resistance at the design tip elevation. Practical refusal of the pile is defined as 5 blows per 1/2 in. Pile driving bearing criteria will be waived if the bottom of the hole is sound rock as determined by the RCE.

2 Place concrete as soon as possible after placing the steel H-pile. The concrete may be placed before placement of steel H-pile, with the written acceptance of the BCE, if a suitable set retarding agent is used to ensure the ability to place steel H-pile to the specified tip elevation and to verify bearing, if required, before hardening of the concrete.

3 Maintain continuous concrete placement from the specified tip elevation of the excavation to the final elevation specified on the Plans. Place concrete by concrete pump. Free fall from the top may be allowed in a dry construction excavation with conditions outlined in **Subsection 716.3.4.2**.

4 Multiple drilled piles may be drilled before placing concrete if the drilled holes remain in a stable condition. A longer concrete placement time than the specified 2 hour limit may be requested if the concrete mix supplied maintains a slump of 4 in. or greater over the longer placement time as demonstrated by trial mix and slump loss tests. Provide the slump loss test data in a form acceptable to the RCE. Conduct the trial mix and slump loss tests using concrete and ambient temperatures appropriate for site conditions.

5 Once concrete starts to set, wait a minimum of 12 hours as determined by the RCE or BCE before installing or driving adjacent piling, if required, or drilling adjacent drilled pile within a 20-ft radius of the concrete item cast.

6 Remove any accumulation of water from the excavation by pumping before concreting and backfilling. If water cannot be removed, concreting using the wet construction method may be required. After installation of the pile and concreting is complete, backfill the space between the pile and the excavation with clean granular material (e.g., A-1 or A-3 sand or No. 789 stone) and tamp in an approved manner. Do not backfill above the top of concrete until at least 24 hours after concrete placement.

716.3.8.1 Pumping Concrete

1 Concrete pumps and lines may be used for concrete placement in either wet or dry excavations. Ensure that the pump lines are a minimum of 5 in. in diameter and are constructed with watertight joints. Do not begin concrete placement until the pump line discharge orifice is at the bottom of the excavation.

2 If a wet excavation is required, equip the pump line with a flat metal plate or a foam plug of sufficient size to ensure separation between the fluid in the pump line and the concrete being placed. Remove the device from the excavation, or ensure that the device is of a material accepted by the BCE and will not cause a defect in the shaft if not removed.

3 Ensure that the discharge orifice remains at least 10 ft below the surface of the fluid concrete for wet excavation concrete placement. When lifting the pump line during concreting, temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation. If at any time during the concrete placement, the pump line orifice is removed from the fluid concrete and discharges concrete above the rising concrete level, the drilled pile is considered defective. In such case, remove the H-pile and concrete, complete any necessary sidewall repairs directed by the BCE, and repeat the concrete placement of the drilled pile. The Contractor is responsible for all costs of replacement of defective drilled piles.

716.3.8.2 Free-Fall of Concrete

1 With the written acceptance of the BCE, the free-fall of concrete may be allowed under the following conditions:

- The excavation is a dry construction method excavation as defined under **Subsection 716.3.4.2**.
- The inspector can see the top of the rising concrete during the pour and can determine if the concrete is striking the H-pile.
- The concrete is placed in a chute with a rigid pipe to direct the concrete straight down.
- The concrete fall is less than 75 ft.
- The maximum size of aggregate is ¾ in.; the slump is in the 7-in. to 9-in. range; and there are no strength problems.

- A tremie or pump is on site and is prepared for use if it becomes necessary.
- Permission to use the free-fall method is conditional, and the Department reserves the right to require a tremie or pump on any drilled pile if, for any reason, the RCE and/or BCE determines that the free-fall method is not producing satisfactory results.

716.4 Measurement

716.4.1 Soil Excavation for Drilled Pile Foundation

1 The quantity for the pay item Soil Excavation for Drilled Pile Foundations is determined by the length of the soil excavation required to encounter rock or other suitable hard soil as determined by the RCE in conjunction with the plans and is measured by the linear foot (LF), complete and accepted. The length for Soil Excavation for Drilled Pile Foundations is the difference between the elevation of the top of ground determined by field measurement and the elevation of the final bottom of the drilled pile foundation in hard soil authorized by the RCE and/or BCE. No measurement is made for overdrilling beyond the elevation authorized by the RCE and/or BCE.

2 If a pay item for Rock Excavation for Drilled Pile Foundation is included in the Contract, the length for Soil Excavation for Drilled Pile Foundation is the difference between the elevation of the top ground determined by field measurement and the authorized elevation of the top of rock determined according to **Subsection 716.3.5.4**.

716.4.2 Rock Excavation for Drilled Pile Foundation

1 The quantity for the pay item Rock Excavation for Drilled Pile Foundation is determined by the length of the rock excavation required to place the H-pile portion of the drilled pile foundation and is measured by the linear foot (LF), complete and accepted.

2 The length of the rock excavation is the difference between the top of rock excavation determined according to **Subsection 716.3.5.4** and the final bottom of the drilled pile elevation authorized by the RCE and BCE or the actual bottom of drilled pile elevation, whichever produces the lesser length. No measurement is made for overdrilling beyond the elevation authorized by the RCE and BCE.

716.4.3 Drilled Pile Foundation Concrete

1 The quantity for the pay item Concrete for Structures - Class 4000DS shall be determined according to Section 701.4.

716.4.4 Construction Casing

1 The quantity for the pay item Construction Casing is the length of the construction casing determined below and is measured by the linear foot (LF), complete and accepted.

2 Unless otherwise directed by the BCE, the length of construction casing is the difference between the authorized top of casing elevation and the final authorized bottom of casing elevation. Portions of the unpaid length of construction casing removed become the property of the Contractor for disposal away from the site.

3 Installation and removal of temporary casing is not measured for payment and is included in the cost of the drilled pile foundation item.

716.4.5 Steel H-Piling

1 Steel H-piling for drilled pile foundations is measured according to **Subsection 711.4.7**.

716.4.6 Drilled Pile Set-up

1 The quantity for the pay item Drilled Pile Set-Up is measured for payment by each (EA) drilled pile set-up, including pile driving as required in the Plans, complete and accepted.

716.5 Payment

716.5.1 Soil Excavation for Drilled Pile Foundation

1 Payment for the accepted quantity of Soil Excavation for Drilled Pile Foundations is full compensation for excavating soil for placement of drilled pile foundations as specified or directed, including all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item according to the Contract.

716.5.2 Rock Excavation for Drilled Pile Foundation

1 Payment for the accepted quantity of Rock Excavation for Drilled Pile Foundations is full compensation for excavating rock for placement of drilled pile foundations as specified or directed, including all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item according to the Contract.

716.5.3 Drilled Pile Foundation Concrete

1 Payment for the accepted quantity of Concrete for Structures - Class 4000DS shall be determined according to Section 701.5.

716.5.4 Construction Casing

1 Payment of the accepted quantity of Construction Casing is full compensation for furnishing and installing the construction casing as specified or directed, including all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item according to the Contract. It also includes any temporary bracing necessary to hold the casing in alignment and the removal of any obstructions to satisfactorily complete the work as specified.

716.5.5 Steel H-Piling

1 Steel H-piling for drilled pile foundations is paid for according to **Subsection 711.5.7.**

716.5.6 Drilled Pile Set-Up

1 Payment for the accepted quantity of Drilled Pile Set-Up is full compensation for the fixed costs in the preparation for installation of drilled piles as specified or directed, including pile driving as required in the plans. Include all materials, labor, equipment, tools, supplies,

transportation, and incidentals necessary to fulfill the requirements of the pay item according to the Contract.

716.5.7 Pay Items

1 Pay items under this section include the following:

Item No.	Pay Item	Unit
7160008	Drilled Pile Set-Up	EA
716002X	Soil Excavation for Drilled Pile Foundations - (*diameter*)″ Diameter	LF
716006X	Rock Excavation for Drilled Pile Foundations - (*diameter*)″ Diameter	LF
7160XX5	Construction Casing - (*diameter*)″ Diameter	LF