SECTION 02470

DRILLED SHAFTS/PIERS

PART 1. GENERAL

1.1 General Requirements

A. The general provisions and documents of the Contract, including General and Special Conditions, apply to the work specified in this Section.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.

C. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 Description of Work

A. General

1. The Work covered by this Section, without limiting the generality thereof, consists of furnishing all plant, labor, equipment, appliances and material and performing all operations in connection with the installation of foundations to support column loads with fully cased rock socketed drilled shafts/piers to the lines and grades shown on the Drawings.
2. The Contractor shall include all Work necessary to maintain a stable excavation during drilling and concreting.

B. The work under this section within shall include installing a permanent steel casing as shown on the drawings in order to provide an outer sleeve for drilling and shaft/pier construction.

C. The Contractor shall manage drill spoils generated from shaft/pier installation. Drill spoil solids will be removed from the site, and disposed by the Contractor.

D. Installation of reinforcing as shown on the drawings and placement of tremie concrete from the bottom of each shaft to cut-off elevation.

E. The Contractor shall protect adjacent buildings, property, streets, public utilities and structures, and completed work, from damage associated with excavation operations.

F. Remnants of old utilities, foundations, walls, slabs, and other buried structures may exist within the site area and may be encountered during drilled shaft/pier excavation.

G. Prior to shaft/pier construction, determine location of utilities. Protect, maintain and/or relocate according to Drawings, utilities interfering with shaft/pier construction.

H. Support and protect utilities if and as necessary. The Contractor shall be responsible for all damage to utilities caused by shaft/pier construction operations. Fully and promptly

repair and/or restore all utilities which are damaged at no expense to the Owner, the City of Portland, or utility owner.

1.3 Related Work Specified Elseware

Section 00300: Subsurface Data
Section 02400: Construction Dewatering
Section 02200: Lateral Support of Excavation
Section 02200: Excavation and Backfilling
Section 03300: Cast-in-Place Concrete

1.4 Definitions and Reference Standards

A. Owner: The Owner is Waterview Development, LLC.

B. Architect: The Architect is the firm of CWS Architects.

C. The Owner's Geotechnical Representative is Haley & Aldrich, Inc. The Owner's Geotechnical Representative, or their authorized representative, is the authorized representative of the Owner for Work covered by this Section.

D. Engineer: The Structural Engineer is the firm of Becker Structural Engineers.

E. Construction Manager: The Construction Manager is the firm of Allied/Cook Construction.

F. Contractor: The Contractor is the person or organization identified in the Agreement as being responsible for the Work under this Section. The term Contractor shall also refer to an authorized representative of the Contractor.

G. ASTM: Specifications of the American Society for Testing and Materials.

H. AWS: Standard Code for Welding in Building construction, of the American Welding Society.

I. AISC: Specification of the American Institute of Steel Construction.

J. ACI: American Concrete Institute.

K. Code: Current Edition of the International Building Code.

1.5 Job Conditions

A. Refer to Section 00300 for subsurface data.

B. The Contractor shall protect adjacent property, public utilities and structures, and completed work, from damage associated with the foundation installation operations. Damage due to foundation installation shall be repaired by the Contractor at no additional cost to the Owner.

C. The Contractor shall be aware that cobbles and boulders could be encountered within the glacial till soil strata and shall develop appropriate means and methods to remove them from excavations if/when they are encountered.

1.6 Quality Assurance

A. Comply with all rules, regulations, laws and ordinances of the State of Maine, City of Portland and all other authorities having jurisdiction. All labor, materials, equipment and services necessary to make work comply with such requirements shall be provided without additional cost to Owner.

B. Field Monitoring and Testing

1. Full-time monitoring of the Work of this Section will be provided by the Owner. No Work shall be completed except in the presence of an authorized representative of the Owner's Representative.
2. The Owner will provide on-site monitoring of concrete placement. Concrete test cylinders will be taken by the Owner's Testing Agency during placement. The Contractor shall fully cooperate with the Owner's Testing Agency to facilitate obtaining and storing samples.

C. Approvals given by the Owner's Representative or by testing agencies shall not relieve the Contractor of the responsibility for performing the Work in accordance with the Contract Documents.

1.7 Lines and Grades

A. The Contractor shall stake the locations of the foundations and establish all elevations required. A baseline and benchmark located on or close to the site will be provided by the Owner. The Contractor shall be responsible for the maintenance and protection of the baseline and benchmark, and all location stakes.

B. The Contractor shall employ a licensed Registered Land Surveyor or a Registered Civil Engineer, who shall establish lines and levels. The Contractor shall be responsible for the correct location of foundations and establishing actual locations. Locations of the centers of completed units shall be shown on a drawing in relation to the design location and submitted to the Engineer and Owner's Representative within two days after completing the unit. Drawings certified by said Surveyor or Engineer shall include the following:

1. Column lines and north arrow.
2. Each foundation element identified by a separate number.
3. Elevation of the foundation bearing surface to nearest 0.1 foot.
4. Deviation in inches, to the nearest one-half inch, from plan location at cutoff elevation.

1.8 Submittals

A. All submittals shall be submitted to the Owner's Representative for review at least 3 weeks prior to the start of the Work. Submittals shall be prepared and stamped by a Licensed Professional Engineer registered in the State of Maine, retained by the Contractor.

B. The time period(s) for submittals are the minimum required by contract for the Owner's Representative to review, evaluate and respond to the Contractor. If, after review, the Owner's Representative requires resubmission for any reason, the specified time period(s) shall commence upon the date of receipt of the re-submittals. The Contractor is responsible for scheduling specified submittals and re-submittals so as to prevent delays in the work.

C. The Contractor shall submit for review a list of at least five projects indicating relevant previous project experience. Experience shall emphasize rock drilling/coring for foundation units to similar sizes and depths as required in these Contract Documents. The submittal shall include project names, locations and a list of references for each project who can attest to the Contractor's performance on the project.

D. Shop Drawings shall include plan layout (scale 1 in.= 10 feet.) of drilled shafts/piers, showing the proposed location, length, diameter, bottom elevation, and identification number for each individual unit.

E. Submit procedures, layout, set up of drill spoil segregation and material handling facility, and procedures for disposal of drill spoils. Submittal shall include proposed drill spoil segregation operation and procedures for separating drill spoil solids from liquids.

F. Mix Design, Equipment and Materials:

1. Concrete mix designs and supplies, as required in the Contract Documents.
2. Certificates for reinforcing steel and other steel members incorporated in the design.
3. Description of all equipment to be used for construction of the drilled shafts/piers, including staging areas, space requirements for operations, fabrication of reinforcing cages, and storage of materials.

G. Proposed Means and Methods:

1. Proposed method of continuous monitoring for plumbness and deviation of drilled shafts/piers during excavation and details of corrective measures to be implemented as required.
2. Contractor's proposed method of maintaining stability of excavated drilled shafts/piers when left open overnight.
3. Contractor's proposed method of cleaning the bottom of the drilled shafts/piers prior to tremie concreting, and verifying the depth of the shaft/pier.

4. Contractor's proposed method to remove obstructions that may be encountered at the drilled shaft/pier location.

H. As-Built Records:

1. During drilled shaft/pier construction, the Contractor shall maintain and submit to the Owner's Representative as-built records of the Work. These as-builts shall contain, as a minimum, the following:

a. Shaft/pier identification.

b. Plan dimensions of the shaft/pier, and top and bottom elevations.
c. Dates and times of shaft/pier excavation, bottom cleaning, reinforcing steel placement, tremie concreting, and volume of concrete placed.
d. Description of soils encountered, description of obstructions and excavation problems, if any, and the time spent.
e. Description of steel reinforcing, threaded inserts, variations from shop drawings, if any.
f. Plumbness and deviation from plan location.

2. During drilled shaft/pier construction, any unusual conditions encountered shall be noted and reported to the Owner's Representative immediately.

PART 2. PRODUCTS

2.1 Materials

A. Concrete for use in drilled shaft/pier shall conform to Section 03300, unless otherwise indicated hereinafter in this Section.

B. Reinforcing steel for use in drilled shafts/piers shall be ASTM A615 Grade 60.

2.2 Concrete

A. The design and testing of concrete mixes for use in drilled shafts/piers shall conform to the requirements of specification section 03300.

1. Minimum compressive strength of 4,000 psi at 28 days.
2. See specification section 03300 Cast-in-place Concrete for additional requirements.

2.3 Reinforcing Steel

A. Reinforcing steel shall be standard deformed steel reinforcing bars conforming to the requirements of ASTM A615, Grade 60.

PART 3. EXECUTION

3.1 General

A. Foundation elements shall be installed by a contractor specializing in the type of work described hereinafter, having experience on similar installations under similar soil, rock and groundwater conditions.

B. The Contractor shall provide a fully equipped excavation rig in full-time operation at the site during the Work, and shall mobilize additional equipment, if necessary, to complete the Work on schedule.

C. The Contractor shall coordinate foundation installation operations with other work on the project.

D. The Contractor shall protect adjacent property, utilities and structure, and completed Work from damage, including settlement due to loss of ground, associated with the foundation installation operations. Damage due to foundation installation shall be repaired by the Contractor at no additional cost to the Owner.

E. The foundation subcontractor is responsible for controlling the amount of dust and dirt created by the foundation installation process using whatever methods are most appropriate.

F. All foundations shall be installed at the proper locations as shown on the Drawings. Foundation locations shall be checked during installation and appropriate measures taken, as necessary, to maintain the correct location.

G. Monitoring and evaluation of the foundation installation at any stage will be made by the Owner's Geotechnical Representative. The Contractor shall measure the depth to the bearing stratum at the request of the Owner's Geotechnical Representative to determine compliance with the specification requirements. If it is the Owner's Geotechnical Representative's conclusion, based on visual observations or other methods, that the rock at the foundation bearing level is not capable of supporting the design load, the Owner's Geotechnical Representative will direct the Contractor to drill deeper. The Contractor will be paid for the extra drilling (depth of hole) at the Contract Unit Price. Foundations shall not be concreted until the hole has been evaluated by the Owner's Geotechnical Representative.

H. When the rock is first reached, regardless of depth, the Contractor shall notify the Owner's Geotechnical Representative, who will determine the actual depth.

I. If, while drilling the foundations, the Contractor encounters an obstruction, the Owner's Representative shall be notified immediately. Obstructions will be defined as concrete, timber, logs and other man-placed material which prevent the advance of the foundation excavation. The Owner's Representative will require the Contractor to probe to locate the extent of the obstruction. After such probing, the Owner's Representative will direct the Contractor to remove the obstruction. The Contractor shall be reimbursed for authorized additional work to remove obstructions and backfilling. Boulders or cobbles encountered in the naturally deposited soils shall not be considered obstructions.

3.2 Drilled-in Shaft/Pier

A. Rock-socketed drilled shafts/piers shall be installed at the lines and grades indicated on the Drawings. These shafts/piers shall be permanently cased throughout their entire length, and seated into bedrock. At selected locations as shown on the Drawings, the shaft/pier will be advanced a designated depth into the bedrock.

B. Drilled shafts/piers shall have a diameter equal to or greater than the minimum diameter shown on the Drawings or as specified hereinafter.

C. Shafts/piers shall be machine-drilled. The method of shaft/pier installation shall be determined by the Contractor, subject to the approval of the Owner's Representative. Shaft/pier installation shall be made by non-displacement methods such as augering, rotary drilling or other methods. The rock socket shall be formed by such methods as coring, rotary drilling or chiseling.

D. Drilling shall be made in such a manner to prevent loss of ground beyond the specified diameter. The drilling operation shall employ the use of a permanent casing. The permanent casing shall extend a minimum depth of 1 ft.-6 in. below the top of the rock.

3.3 Rock Socket Construction

A. Shafts/piers shall be drilled into the rock to depths as given on the shaft/pier schedule shown on the Drawings or as directed by the Owner's Representative.

B. Suitable rock is defined as hard to moderately hard, slightly weathered Phyllite. Based on review of test boring logs, the top few feet (1 to 2 ft.) of rock may be highly weathered and unsuitable for foundation support.

3.4 Placing Reinforcing Steel and Concrete

A. Do not place steel or concrete until the drill hole has been evaluated by the Owner's Representative.

B. Maintain minimum three inch clearance between and sides of excavation and reinforcement.

C. Prior to placing concrete and reinforcing steel, the bottom of the shaft/pier shall be cleaned of all loose material using equipment designed for that purpose or similar equipment acceptable to the Owner's Representative.

D. Reinforcing steel assemblies shall be accurately located and securely held in place prior to and during the concreting. As the steel cage is lowered into the shaft, suitable guides and spacers, such as concrete skids, shall be used. If the sides of the rock socket are disturbed during installation of the reinforcing steel such that loose rock fragments are found to have accumulated on the bottom of the shaft/pier, the Contractor shall reclean the bottom of the excavation.

E. Concrete shall be placed by tremie pipes, either by gravity flow or by pumping, in such a manner that the concrete fills the shaft/pier progressing from the bottom, rising uniformly to the cutoff elevation and such that intermixing of the concrete and any accumulated water will not occur. The tremie pipe shall be kept as close to the center of the shaft as possible. The tremie pipe shall be suitably made to prevent mixing of the concrete and any accumulated water and shall be of adequate size to permit the free flow of concrete. Initially, there shall be a suitable plug at the bottom of the tremie, which will not discharge concrete until the concrete head has at least reached the level of any accumulated water/fluid in the shaft/pier. Thereafter, a positive concrete head will be maintained throughout.

F. The bottom of the tremie pipe shall be embedded at least 5 ft into the concrete during placement, and this depth shall be maintained throughout the pour.

G. The concrete level during placement shall be kept essentially horizontal.

H. Concrete shall be placed in the drill shaft hole within two hours after placement of reinforcing steel cage and shall proceed continuously until completion of the concreting.

If foundations cannot be concreted the same day in which they are drilled, the reinforcing steel shall not be placed in the drill hole. Foundations that are not concreted within four hours after completion of drilling operation shall be recleaned prior to concreting.

I. Provide steel dowels as detailed or scheduled. Secure reinforcement, including dowels, in place, free of contact with sides of excavations.

J. All concrete for the shafts/piers shall be carefully placed so as to form a consolidated monolith to at least one foot above cut-off.

3.5 Improper Installation

A. The cost of any and all changes due to improper installation shall be paid by the Contractor. This shall include additional services by the Owner's design team made necessary by such failure, as well as costs for labor and materials.

3.6 Tolerances and Criteria for Acceptance

A. Shafts/piers shall be accurately located. Any of these foundation elements which have the center of shaft at any level more than D/10 from the design location shown on the Drawings, where D is the least diameter of the shaft/pier, shall have its conditions corrected by means of reinforcing in the concrete, to the satisfaction of the Engineer, at no additional cost to the Owner. At cut-off level, the shaft/pier center shall not deviate more than 2 inches from design center.

B. The foundation bearing surface shall be prepared in accordance with the criteria established herein.

3.7 Field and Quality Control

A. Full-time monitoring of foundation installation operations will be provided by the Owner's Geotechnical Consultant employed by and paid for by the Owner. No foundations shall be installed except in the presence of an authorized representative of the Owner's Representative.

B. Approvals given by the Architect, Owner's Representative, Owner's Geotechnical Representative, Owner's Structural Engineer, or by testing agencies will not relieve the Contractor of the responsibility for performing the Work in accordance with the Contract Documents.

PART 4. MEASUREMENT AND PAYMENT

A. All Work of this Section shall be measured and paid for as part the project's Guaranteed Maximum Price (GMP). The portion of the GMP for the drilled shafts/piers shall include all labor, materials, and equipment required to construct the required drilled shafts.

B. No separate measurement and payment will be made for obstruction removal, quality control testing, final surface preparation or any other operations related to drilled shaft construction.

C. No separate measurement for payment will be made for acquisition of permits, backfill, equipment, material disposal, police details, water, electricity, construction dewatering, stockpiling, material rehandling, vibration monitoring, surveying, or other associated items or work considered incidental to the conduct of foundation construction.

D. Whenever mislocation, misalignment, or rejection of a drilled shaft necessitates a structural redesign, the costs of such redesign will be deducted from sums otherwise due to the Contractor under the Contract.

E. Whenever misalignment or rejection of a drilled shaft necessitates structural redesign and/or creation of a cap beam and the redesign structure requires greater quantities of concrete and reinforcing steel, the quantities required will be compared with the quantities required for the original design and the additional labor, equipment, and material will be provided at no additional cost to the Owner.

F. For drilled shafts/piers required and directed by the Architect or Owner's Representative to be drilled deeper into rock than specified on the Contract Documents, the Contractor shall be paid at a unit price per foot of shaft in rock as provided by the Contractor at the time of the bid.

END OF SECTION