101 CAISSON (NO BELL): ITEM 701 062, 701 995

(A) GENERAL - Work under these items consists of furnishing all materials for and installation of permanent caissons meeting the requirements of AASHTO M270.

(B) MATERIALS

1. Portland Cement Concrete – Concrete shall conform to Class B and be otherwise in accordance with the requirements set forth in Section 817 of the Standard Specifications, Portland Cement Concrete Mixtures.

2. Reinforcing Steel – Reinforcing bars shall be in accordance with the sizes, spacing, dimensions, and details shown on the plans and shall conform to the requirements of Section 812 of the Standard Specifications, Reinforcing Steel and Wire Rope.

3. Steel Casing – Casing shall be steel, smooth, clean, watertight, and of ample strength to withstand both handling and driving and installation stresses and the pressure of both concrete and the surrounding water and earth materials. Thickness of the casings shall not be less than 0.25-inch. The inside diameter of casing shall not be less than the specified size of the shaft. No extra compensation will be allowed for concrete required to fill an oversized casing or oversized excavation. Caissons are to remain permanently cased; casings shall not be removed from shaft excavations. Casings shall be constructed of ASTM A252 Grade 2 Steel or ASTM A36 Steel.

4. Crosshole Sonic Logging Tubes – Caissons, as indicated on the AB sheets within the plans, shall be equipped with access tubes for Crosshole Sonic Logging (CSL) tests at the locations shown in the plans and according to Section E(9) of these Specifications. Access tubes for CSL testing shall be 2 inches internal diameter (I.D.) schedule 40 steel pipe conforming to ASTM A 53, Grade A or B, Type E, F, or S. Pipes shall have a round, regular internal diameter, free of defects or obstructions; including any defect at the pipe joints, so to permit the free unobstructed passage of source and receiver probes. CSL probes should be 1.35 inches diameter or smaller and 6 to 10 inches long. Each tube or steel pipe shall be fitted with a watertight shoe onto the bottom and a removable cap at the top. Both, shoe and cap shall be watertight and free from corrosion, and the internal and external faces of the tubes clean to ensure passage of the probes and good bond with the concrete.

5. Slurry

a. Slurry shall be a stable suspension of mineral or polymer in potable water. The Contractor shall anticipate encountering brackish groundwater, ash and cinder fill, leakage from storm and sanitary sewers, and other agents that may be deleterious to slurry. The Contractor is responsible for and shall modify the slurry mix as required so as to maintain a stable suspension at all times.

b. Bathe slurry must be readily displaced by the tremie concrete.

c. Additives shall be used in the slurry if needed to maintain the necessary properties.

d. Fluid loss in an open excavation shall be limited to a drop in the slurry level of no greater than 1-inch per hour per 20-ft of excavation depth, and no more than 24-inches total in a twenty-four-hour period.

e. Bentonite slurry shall be a mineral slurry of powdered Wyoming or Dakota bentonite. Attapulgite mineral slurry may be used for sites with brackish or saline water. Bentonite and Attapulgite slurry shall conform to the following range of values:

Range of Values (at 68° degrees F for Bentonite and Attapulgite Slurry)

Property (UNITS)	**Time of Slurry Introduction**	**Time of Concreting (In Hole)**	**Test Method**
Density (lb/ft^3)	64 to 69	64 to 75	Density Balance
Viscosity (sec per quart)	32 to 49	32 to 49	Marsh Cone
pH	7 to 11	7 to 11	pH paper or meter

Notes:

(1) Increase density values by 6 lb/ft^3 in salt water.
(2) At time of concreting, sand content shall not exceed 4 percent (by volume) at any point in the shaft excavation as determined by ASTM D4381 sand content test.
(3) Mixing time shall be a minimum of ten minutes for mineral slurry.
(4) Storage time to allow hydration shall be a minimum of six hours for mineral slurry.

f. Polymer slurry shall be a suspension of powdered polyacrylamide or vinyl polymer with the following density, viscosity, and pH:

Range of Values (at 68° degrees F for Polymer Slurry)

Property (Units)	**Time of Slurry Introduction**	**Time of Concreting (In Hole)**	**Test Method**
Density kg/m^3	63 to 67	63 to 67	Density Balance
Viscosity (sec per quart)	56 minimum*	56 minimum	Marsh Cone
pH	8 to 11	8 to 11	pH paper or meter

Notes:

(1) Increase density values by 6 lb/f^3 in salt water.

(2) If desanding is required, sand content shall not exceed 1 percent (by volume) at any point in the shaft excavation as determined by ASTM D4381 sand content test.
(3) Maximum viscosity by Marsh Cone method shall be in accordance with manufacturer's recommendations.
(4) Mixing time shall be a minimum of fifteen (15) minutes for polymer slurry.
(5) Storage time to allow hydration shall be a minimum of two hours for polymer slurry.

(C) EQUIPMENT - The Contractor shall furnish all equipment and instrumentation necessary for installation of the caissons.

The excavation and drilling equipment shall have adequate capacity including power, torque, and down thrust to excavate a hole of the maximum diameter shown on the plans and to a depth of fifteen (15) feet or 20 percent beyond the depths shown in the contract documents, whichever is greater.

The excavation and tools shall be of adequate design, size, and strength to perform the work shown in the contract documents or described herein. When the material encountered cannot be drilled using conventional earth augers with soil or rock teeth, drilling buckets, and/or over-reaming tools, the Contractor shall provide special drilling equipment including, but not limited to, rock core barrels, rock tools, air tools, blasting materials, and other equipment as necessary to construct the shaft excavation to the size and depth required.

Provide a descriptive listing of dewatering methods and equipment, as well as available equipment that is fully capable of cleaning shaft bottoms under wet conditions.

(D) SUBMITTALS - Prior to commencement of construction, verifications of the following requirements and documents shall be submitted for approval in accordance with the District Department of Transportation *Standard Specifications for Highway and Structures*, 2009, Section 105.02.

1. Contractor Qualifications

a. The Contractor shall have previous caisson installation experience in soil similar to the project conditions. The Contractor shall submit construction and structural details and point of contact information for at least three (3) previous successful projects utilizing caisson foundations of similar scope to this project.

b. The Contractor shall assign an on-site foreman, who will be in charge full time of all operations, having experience on at least three (3) projects over the past five (5) years installing caisson foundations of a similar scope to this project.

c. The Contractor shall submit the completed project reference list and personnel. The project reference list shall include a brief project description with the owner's

name and current phone number. The personnel list shall identify the supervising project Engineer, personnel who will install the caissons, and on-site foremen to be assigned to the project. The personnel list shall contain a summary of each individual's experience and be complete for the Engineer to determine whether each individual satisfies the required qualifications. Additional time required due to incomplete or unacceptable submittals will not be cause for time extension or impact or delay claims. All costs and delays associated with incomplete or unacceptable submittals shall be borne by the Contractor.

d. The Contractor shall employ the services of an Independent Testing Agency (ITA) for the inspection and testing of the installation of the caissons. The ITA shall submit a resume of the responsible professional in charge of the project, describing at least three (3) caisson projects completed in the last five (5) years with client contact information.

e. Submit project experience and resumes in accordance with Contractor Qualification.

2. Installation Plan

The Contractor shall submit to the Engineer for review and approval, an installation plan for the construction of caissons not less than thirty (30) days before the start of work as detailed in this Special Provision. The submittal shall include at least the following:

a. List of proposed equipment to be used including cranes, drills, augers, bailing buckets, dewatering equipment, final cleaning equipment, tremie or concrete pumps, casing, and other appurtenances.

b. Details of overall construction operation sequence and the sequence of shaft construction in bents or groups, including plan and profile showing the location, size and movements of equipment setup and operations. The completion of any required integrity and loading tests shall be noted in this construction operation sequence.

c. Details of shaft excavation and stabilization methods.

d. Method of monitoring verticality of the shaft excavation during excavation and details of proposed corrective measures to be implemented as necessary.

e. Very specific details of methods to clean the shaft excavation. Details shall include at least three (3) alternative bottom cleaning and inspection methods with descriptions of equipment to be used when installing caissons with wet methods. Include details of method for identifying type of bearing material for consistency with design criteria on the plans prior to placement of concrete.

f. Details of reinforcement placement including support and centralization methods.

g. The concrete mix design, including admixtures to be used, in accordance with Section B(1) of this Special Provision. Details of concrete placement, curing, and protection.

h. A copy of the proposed report format for planned shaft inspections. Record information for each shaft and details of any required load or integrity tests.

i. Other information shown on the plans or requested by the Engineer.

The Contractor will not be permitted to start construction of any caisson, until the complete installation plan submittal as described above has been received, reviewed and written approval to begin construction has been issued by the Engineer.

The Contractor will not be permitted to start the construction of caissons for which working drawings are required until the Engineer has approved such drawings. Such approval will not relieve the Contractor of responsibility for results obtained by the use of these drawings or any of his other responsibilities under the contract.

Submittals during construction shall include record information for each shaft and details of any required loading or integrity tests as required.

3. Quality Assurance/Control Submittals

a. Certified test reports showing compliance with specified characteristic and physical properties.

b. Manufacturer's certificate that products meet or exceed specified requirements.

c. Mill test reports.

d. Accurately record the type, size and actual locations of caissons.

e. Grout mix design.

f. Logs of shaft installation inspections.

4. Final Location Drawings.

a. Within thirty (30) days after completion of required work, the Contractor shall submit an accurate print or prints showing the locations and top and bottom elevations of all installed caissons.

(E) CONSTRUCTION METHODS - The following minimum procedures shall be performed.

1. Subfoundation Investigation

Prior to excavation of the shafts, complete Standard Penetration Testing (SPT) or cone penetration test (CPT) to a depth of at least two shaft diameters beyond the proposed tip elevation in accordance with ASTM D1586 or ASTM D3441 for each caisson. Soil samples from the SPT sampler shall be described using the Bermeister system and classified using the AASHTO soil classification system. The Engineer will evaluate the results of the subfoundation investigation to verify the bearing capacity of the bearing material.

2. Protection of Existing Structures

All reasonable precautions shall be taken to prevent damage to all existing structures, utilities, and the public. These measures shall include, but are not limited to, monitoring, and controlling the vibrations from the driving of casing and drilling of the shaft. The Contractor shall verify that there are no subsurface utilities in close proximity of each shaft before beginning excavation activities.

3. Methods of Construction

Excavations required for shafts shall be performed through whatever materials are encountered, to the dimensions and elevations shown on the plans or otherwise required by the Standard Specifications and Special Provisions. The permanent casing method will be used to produce sound, durable concrete foundation shafts that are free of any defects.

The permanent casing shall be placed in the hole and sealed in the nearly impervious formation. Casing may be installed by drilling, driving, or vibratory procedures in advance of excavation. Slurry may be used as necessary. After the reinforcing steel cage has been placed, fill the excavation with concrete.

The estimated lengths shown on the plans and in the geotechnical reports should be considered approximate. Additional shaft lengths might be required depending on actual subsurface conditions. Shorter shaft lengths than indicated on the plans may only be constructed with the written approval of the Engineer.

4. Excavations

The bottom elevation of caissons shown on the plans may be adjusted prior to construction if the Engineer determines that the results of the subfoundation investigation, as described in Section E(1) of this Special Provision, necessitate such changes. The Engineer will inspect the samples and determine the final depth of required shaft excavation.

The Contractor shall maintain a construction method log during shaft excavation. The log shall contain information such as the description and approximate top and bottom elevation of each soil material, seepage of water, and remarks.

Excavated materials which are removed from the shaft excavation and any drilling fluids used shall be carefully collected so that no material is allowed to fall or enter into the river. All excavated materials shall be collected and disposed of off-site by the Contractor.

The Contractor shall adhere to the DDOE Water Quality Certification (included in Appendix T) and Sampling Report (included in Appendix U) requirements regarding the removal, sampling and disposal of excavated material.

5. Obstructions

The Contractor shall remove surface and subsurface obstructions at caisson locations. Such obstructions may include man-made materials, such as debris deposited within the river, and natural materials, such as boulders. Boulders are defined as stones with a least dimension greater than 1-foot. Special tools and/or procedures shall be employed by the Contractor after the hole cannot be advanced more than 1-foot in thirty minutes using approved equipment operating at maximum power, torque, and down thrust, using conventional augers fitted with soil or rock teeth, drilling buckets, and/or under-reaming tools. Such special procedures/tools may include but are not limited to: chisels, boulder breakers, core barrels, air tools, hand excavation, temporary casing, and increasing hole diameter. Blasting shall not be permitted unless specifically approved in writing by the Engineer.

6. Lost Tools

Drilling tools that are lost in the excavation shall not be considered obstructions and shall be promptly removed by the Contractor without compensation. All costs due to lost tool removal shall be borne by the Contractor including, but not limited to, costs associated with hole degradation due to removal operations or the time the hole remains open.

7. Excavation Inspection

The Contractor shall provide details of shaft construction to the Engineer for review. The Contractor shall provide equipment for checking the dimensions and alignment of each shaft excavation. The Contractor shall determine the shaft dimensions and alignment under the observation and/or direction of the ITA. The ITA shall determine the final bottom elevation of the caissons after final cleaning. All holes shall be inspected and approved. If slurry is used, video inspection shall be performed and recorded electronically.

Prior to placement of reinforcing steel and concrete, the Contractor shall ensure that loose material from the bottom and sides of excavation have been removed and that shaft is within the specified tolerances. Specified tolerances are listed in Section E (12) of this Special Provision. The shaft excavation shall be cleaned to remove all accumulated sediment. The bottom of the caisson shall be an undisturbed, level plane.

The Contractor shall be responsible for correcting caissons that are not constructed within the specified tolerances. Remedial measures, including engineering analysis and redesign, to correct for out-of-tolerance caisson foundations shall be performed at no additional cost to the District.

8. Reinforcing Steel Cage Construction and Placement

The reinforcing steel cage consisting of the steel shown on the plans plus cage stiffener bars, spacers, centralizers, and other necessary appurtenances shall be completely assembled and placed as a unit immediately after the shaft excavation is inspected and accepted and prior to shaft concrete placement. Prior to installation of the steel cage in the shaft excavation, inspect and clean the reinforcing steel of materials that prevent effective bonding. Clear spacing between bars of the rebar cage shall be at least five (5) times the size of the maximum coarse aggregate. Interior hooks must be designed to permit adequate clearance for a concrete tremie pipe (i.e., 12-inch minimum). Where clearance is a problem, hooks may be placed on dowels that may be rotated after concrete placement and repositioned after the tremie is removed. The concrete must remain fluid during dowel repositioning. Shafts that require a large amount of reinforcing steel shall use bundled longitudinal bars to maintain the minimum clear spacing requirement. The assembled rebar cage outside diameter shall be at least 6-inches smaller than the drilled hole diameter, which corresponds to at least 3-inches of concrete cover over the rebar on all sides.

The reinforcing steel in the shaft shall be tied and supported so that the reinforcing steel will remain within allowable tolerances until the concrete will support the reinforcing steel. Temporary hold-down devices shall be used to prevent uplifting of the steel cage during concrete placement by tremie methods. Concrete spacers or other approved noncorrosive spacing devices shall be used at sufficient intervals not exceeding 5-feet along the shaft excavation. At least three (3) spacers shall be evenly distributed around the circumference of the reinforcing steel at each elevation where used.

9. Installation Requirements for CSL Integrity Tests

Crosshole Sonic Logging (CSL), a nondestructive testing (NDT) method, measures the time for an ultrasonic pulse to travel from a signal source in one access tube to a receiver in another access tube. Caissons must be fitted with CSL test tubes to evaluate their integrity as indicated in the plans, Contract Documents, or as designated by the Engineer. Install the access tubes or pipes as nearly parallel and far as possible from the longitudinal bars. A minimum of four (4) CSL tubes shall be installed in each caisson at 90 degree spacing.

The tubes shall be securely attached to the interior of the reinforcement cage with a minimum concrete cover of 3-inches, and they shall be wire-tied to the reinforcing cage every five-feet to secure the tubes in position during placement of the reinforcing steel cage. In all cases the tubes shall be as near to vertical and parallel as possible. The Contractor shall install the tubes in the caissons in a regular and symmetric pattern such that each tube is spaced a maximum distance possible from its adjacent tube and distributed around the caisson perimeter.

The tubes shall extend from the bottom of the caisson to at least 3-feet above the top of the caisson or 2-feet above the ground surface for shafts with cut-offs below the ground surface. The tubes must be capped to prevent concrete or debris from entering during manipulation of the cage and concreting. Care must be taken during lifting and lowering the steel reinforcement so as not to damage the tubes. The CSL tubes shall be filled with clean water no later than 4 hours after concrete placement. Do not break the bond between the tube and the concrete by applying excessive torque, hammering, or other sort of stress while removing the caps or plugs from the pipes. Upon completion of the CSL tests, remove all the water from the access tubes or drilled holes and fill them up with an approved grout. CSL testing procedures are found in Section (G) of these Specifications.

10. Concrete Placement, Curing, and Protection

All concrete placement, consolidation and curing activities shall conform to the recommendations of Section 703, Concrete for Structures, of the Standard Specifications, except as otherwise specified herein.

Concrete shall be placed within 8 hours of the acceptable inspection of the bottom of excavation and as soon as possible after reinforcing steel cage placement. Concrete placement shall be continuous in the shaft to the top elevation of the shaft. Placement shall continue after the shaft is full until good quality concrete is evident at the top of the shaft.

Concrete shall be placed through a tremie or concrete pump. The tremie shall be supported so as to permit free movement or permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be sealed closed at the start of work so as to prevent water or slurry from entering the tube before the tube is filled with concrete. After placement has started, the tremie tube shall be kept full of concrete to the bottom of the hopper. If water enters the tube after placement is started, the tremie shall be withdrawn, the discharge end resealed, and the placement restarted. The flow of concrete shall be continuous until the work is completed. The discharge end of the tremie shall always be located a minimum of 5-feet below the level of the already placed concrete.

Tremie pipes shall be a minimum of 10-inch diameter. Tremie pipes shall not have aluminum parts that will react with concrete. Pump hoses shall be a minimum of 4-inch diameter. All tremie pipe or pump hoses and connections shall be watertight.

The concrete placing rate shall be not less than 30 cubic yards of concrete per each one-hour period.

After placement, any exposed surfaces of the shaft concrete shall be protected to allow proper curing.

For at least 48-hours after shaft concrete has been placed, no construction operations that will cause soil movement adjacent to the shaft, other than mild vibration, shall be conducted.

All laitenance at the top of the shaft as a result of tremie shall be removed to sound concrete at the final elevation.

11. Casings and Forms

Temporary casings shall not be used for this project. All casing is to be watertight and remain in place following the installation of the caissons.

12. Construction Tolerances

The following construction tolerances shall be maintained in constructing caissons.

The center of the caisson shall be within 3-inches of the plan position in the horizontal plane at the plan elevation for the top of the shaft.

The vertical alignment of the shaft excavation shall not vary from the plan alignment by more than 0.25-inch per foot.

After all the shaft concrete is placed, the top of the reinforcing steel cage shall be no more than 3-inches above and no more than 3-inches below plan position.

The inside diameter of the casing shall not be less than the shaft diameter shown on the plans.

The top elevation of the shaft shall be within 1-inch of the plan top of shaft elevation.

The bottom of the shaft excavation shall be normal to the axis of the shaft within 1-inch per foot of shaft diameter.

The reinforcing steel shall be placed so that the outer edges of the reinforcing cage are located uniformly a minimum of 3-inches inside the perimeter of the design shaft size.

Caisson excavations constructed in such a manner that the concrete shaft cannot be completed within the required tolerances are unacceptable. Correction methods shall be submitted by the Contractor for the Engineer's approval. Approval will be obtained

before continuing with the caisson construction. Materials, engineering and work necessary to effect correction for out-of-tolerance caisson excavations shall be furnished at no cost to the District.

13. Record Information

The Contractor shall provide the following minimum record information. For each caisson foundation installed, record on caisson installation logs:

(a) The installed location of the caisson.

(b) The time drilling started and stopped and any significant stoppages or delays.

(c) The alignment of the caisson.

(d) The dimensions of the caisson.

(e) The top and bottom elevations of the shaft.

(f) The depth of the bearing stratum penetration.

(g) A description of the materials encountered at all elevations.

(h) The condition of the bottom of the excavation.

(i) All applicable concrete data, including time started and stopped.

(j) The verticality and deviation of shaft or reinforcing steel from the plan location.

(k) The theoretical volume of excavation.

(l) The volume of concrete placed versus depth.

(m) The total volume of concrete placed.

(n) All other data called for on the report form or pertinent to the caisson.

(o) Report observed irregularities to the Engineer within eight (8) hours of discovery.

Minimum Record Information shall be in accordance with FHWA Publication No. IF-99-025 "Drilled Shafts" or Association of Drilled Shaft Contractors' "Drilled Shaft Inspector's Manual" (1989). A copy of the inspection report form planned for use shall be submitted to the Engineer for approval. Submit draft record information for each completed shaft to the Engineer within twenty-four (24) hours of completion. Submit final record drawings of each caisson installed no more than three (3) weeks after

completion of the work. Submit records on a weekly basis, or more frequently if variation occurs.

14. Site Operations

The Contractor shall conduct his operations in a neat and orderly manner. Equipment and materials shall not be placed or stored beyond limits approved by the Engineer and shall promptly be removed when no longer needed. All materials, water, slurry, and auger cuttings shall be confined to the specified work area so as not to migrate from the specified work area.

15. Construction Adjacent to Freshly Drilled Shafts

No construction activity, including drilling, within a radius of three shaft diameters of a freshly drilled shaft shall take place until the concrete shaft has cured for at least 48-hours and the Engineer has provided written approval.

(F) INDEPENDENT TESTING AGENCY - The services of a qualified independent testing agency (ITA) shall be employed for inspection and testing for installation of caissons. The ITA shall be a Professional Engineer licensed in the District of Columbia, have a demonstrated record of experience with similar drilled installations, and be approved prior to beginning auguring for the caissons. The ITA shall submit a resume in accordance with Section D(1). of this Special Provision. The ITA shall not be contracted to perform construction work on this project.

The ITA shall submit a plan containing the proposed methods to be used to inspect the caissons as specified herein.

Caissons shall be founded in material having the specified minimum design bearing capacity shown on the plans. The ITA shall verify the bearing capacity of the material through the use of the subfoundation investigation. The ITA shall verify that the caissons were properly drilled to a satisfactory depth and bearing and that both the reinforcing steel and concrete were placed as specified here-in.

(G) CROSSHOLE SONIC LOGGING TEST

1. General

Crosshole Sonic Logging, CSL, is a nondestructive testing, NDT, method that measures the time for an ultrasonic pulse to travel from a signal source inside an access tube to a receiver inside another access tube and evaluates the integrity of caissons. In uniform, good quality concrete, the travel time between these equidistant tubes will be relatively constant from the bottom to the top of the caissons and corresponds to a reasonable concrete pulse velocity. In uniform, good quality concrete, the CSL test will also produce records with good signal amplitude and energy. Longer travel times and lower amplitude/energy signals indicate the

presence of irregularities such as poor quality concrete, voids, honeycombs, or soil intrusions. The signal will be completely lost by the receiver and system recorder for more severe defects such as voids and soil intrusions.

The Contractor must install access tubes intended for Crosshole Sonic Logging CSL testing and perform the tests as indicated in the plans and in Section (E)(9) of this Special Provision. When the Contractor is required to perform CSL tests in the Contract Documents, he must only employ experienced personnel and engage the services of approved independent testing firm with previous experience in this sort of testing. The Contractor shall submit to the Engineer for his approval the list of personnel and testing firms he intends to use during the CSL testing program along with their competence and field experience to perform, evaluate, and report the results of CSL tests. The Contractor shall perform the CSL tests in the number and locations specified in the Contract Documents or as requested by the Engineer, and he shall execute the test after at least forty-eight (48) hours of concrete curing to allow for hardening of the concrete. The Engineer may specify a longer curing time when retarders are used in the mix design or other factors that may result in a slower rate of concrete setting. All CSL testing must be completed within forty-five (45) calendar days of concrete placement.

Prior to beginning the CSL test, the Contractor shall assure that the test probes can pass through and down the tubes to the bottom of every installed tube. If a tube is obstructed, the Contractor, at his expense, must core a hole within the caisson and near the obstructed tube to the depth indicated in the plans for that CLS tube, and the core shall be large enough to accommodate the probe through its full length. Core equipment, procedure, and location of the hole shall be approved by the Engineer prior to beginning coring. Logged results of the core drilling shall be submitted to the Engineer along with the cores. The CSL test can commence after the core hole is inspected and the probes can pass through.

The Contractor is responsible for submission of the CSL test report to the Engineer within three (3) work days of its performance for a specific caisson. The Engineer will evaluate and analyze the CSL test results within three (3) working days of their receipt and provide the Contractor with a response regarding the acceptability of the caisson tested.

2. Equipment for the Crosshole Sonic Logging, CSL, Test

The CSL test equipment consists of the following components:

a. A microprocessor-based CSL system or analyzer for display of individual CSL records, analog-digital conversion and recording of CSL data, analysis of receiver responses, and printing of CSL logs.

b. Ultrasonic emitter and receiver probes for 2 inches I.D. pipe.

c. An ultrasonic voltage pulse to excite the source with a synchronized triggering system to start the recording system.

d. Winch and tripod and connecting cables.

e. A depth measurement device to determine recorded depths.

f. Appropriate filter/amplification and cable systems for CSL testing.

3. Logging Procedures for Crosshole Sonic Logging, CSL, Test

The test should proceed from the bottom to the top of the test tubes and in depth increments of about 3 inches to include the full depth of both tubes. Any slack shall be removed from the cables prior to pulling the probes providing accurate depth measurement records. Test a pair of perimeter and/or diagonal tubes, and include evaluation of the condition of the caisson bottom. The source and receiver should be lifted simultaneously at a speed less than 1 ft per second, and a set of readings carefully taken at their corresponding depths. The CSL tests shall be carried out with the source and receiver probes in the same horizontal plane unless test results indicate potential anomalies/defects, in which case the questionable zone may be further evaluated with fan shape or angled tests (source and receiver are vertically offset inside the tubes). Equipment, procedure, and evaluation shall be adjusted to detect, locate, and assess the extent of any irregularity or void that appears in the path of the sonic pulse. Any anomalies/defects indicated by longer pulse arrival times and significantly lower amplitude/energy signals should be reported to the Engineer on site and any further tests should be carried out as necessary to evaluate the extent of such anomalies/defects.

Additional testing may be conducted in the event anomalies should be detected or suspected during the test. Information of the caisson bottom and top elevations, length, along with construction dates shall be provided to the testing organization before or at the time of the CSL tests. Levels will be taken on top of each tube, and actual tube plumbness and length be recorded. CLS tests shall be conducted between pairs of tubes, and the determination of which pairs to be tested made by the independent testing agency.

4. Reporting Results of the Crosshole Sonic Logging, CSL, Test

Results of CSL test shall be presented in a report including:

a. A brief explanation of how the test was performed, the CSL logs, the analyses, and the test results of each caisson.

b. Record the arrangement of the tubes and their dimensions per caisson tested.

c. Present a Plan View of the CSL test locations in relation to the bridge foundation.

d. Arrival time of acoustic pulse versus depth in each pair of tubes for every caisson tested.

e. Pulse energy/amplitude versus depth in each pair of tubes for every caisson tested.

f. A CSL log shall be presented for each pair of tube tested, and when applies with any anomaly/defect zones properly discussed. Any zone with long arrival times and low power relative to other zones should be considered anomalous.

(H) ACCEPTANCE OF DRILLED SHAFTS - Rejection of a caisson based on the caisson crosshole sonic logging testing shall be conclusive evidence that a defect exists in the caisson that will result in inadequate or unsafe performance of the caisson under service loads. The acceptance of each caisson shall be the decision of the Engineer based on the results of the caisson integrity testing report(s) and other information on the caisson placement. If the CSL records are inconclusive, the Engineer may require coring or excavation of the caisson to verify caisson conditions. If a defect is confirmed, the Contractor shall be responsible for all coring or excavation costs. If no defect is encountered, the District will pay for all coring or excavation costs, including grouting of all core holes. Cores that cannot be advanced to the location of interest will not be paid for.

In the event testing discloses voids or discontinuities in the concrete which indicate that the caisson is not structurally adequate, the caisson shall be rejected, and construction of additional caissons shall be suspended until the Contractor repairs, replaces or supplements the defective work, and the Engineer approves the remedial work. The Contractor shall suspend caisson construction until the Engineer approves proposed changes to the methods of caisson construction submitted in writing by the Contractor.

In the case that any caisson is determined to be unacceptable, the Contractor shall submit a plan for remedial action to the Engineer for approval. Any modifications to the foundation caissons and load-transfer mechanisms caused by the remedial action will require calculations and working drawings prepared by and stamped by a Professional Engineer, hired by the Contractor and registered in Maryland / Washington D.C., for all foundation elements affected. The Contractor shall provide all labor and materials required to design and repair or remediate caissons at no additional cost to the District and with no extension of the contract time.

The Contractor may continue to construct caissons at his own risk before the receipt of notice of acceptance by the Engineer of the previously tested caissons or caissons constructed by a modified means and method of construction, however, if the Engineer finds the tested caisson or caissons to be unacceptable, the Contractor shall repair to the satisfaction of the Engineer, at the Contractor's sole expense, the unacceptable caissons and (a) prove to the satisfaction of the Engineer, at no expense to the District, the acceptability of all caissons constructed since the unacceptable caisson was built and the acceptability of the procedure to be used in construction of future caissons, or (b) cease all caisson construction until a new construction procedure has been proposed by the Contractor and accepted by the Engineer. In the latter case, caissons built after the unacceptable caisson shall be repaired at the Contractor's expense and to the satisfaction of the Engineer.

(I) MEASURE AND PAYMENT - All subfoundation investigation, furnishing and setup of auguring equipment, auguring, drilling, excavating, dewatering, inspection, testing,

services of the shaft installer and ITA, sleeves, permanent casing, reinforcement, concrete, and disposal of excess and unsuitable material in accordance with the Special Provision for Management and Disposal of Excavated Soil for Caisson construction shall be considered incidental to the substructure unit being constructed. No separate measurement will be made.

CSL testing, including all work related to the mobilization, installation, instrumentation, performance and documentation of the CSL tests will be incidental to the substructure unit being constructed. No separate measurement will be made.