

SECTION 02150
BORED AND JACKED CASINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies jacked casings, installation of carrier pipe in the casing, and installation of end seals. Work includes jacking of casings up to 48 inches in diameter for the water transmission pipeline and 18 inches in diameter for the water distribution line.

1.2 QUALITY ASSURANCE

- A. Qualifications:
1. Jacked Casing Contractor:
 - a. On all shifts, use the firm(s) determined acceptable as part of Section 00305 in the bid evaluation.
 - b. Utilize competent site safety representative and personnel responsible for confined space entry that have appropriate training and experience to meet Washington State Department of Labor & Industries' definition of a competent person.
 2. Pipe Jacking Welder and Welding Procedure to be Qualified:
 - a. Certified under the provisions of AWS D1.1. When qualified, use an independent local approved testing agency not more than six months prior to commencing work on the casing or pipeline unless continuously employed in similar welding jobs since last certification.
 - b. In qualification tests, use machines and electrodes similar to those to be used in the work. Furnish all material and bear the expense of qualifying welders.
 - c. Welding procedures: Longitudinal and girth or special welds for pipe cylinders, casing joint welds, reinforcing plates, and grout coupling connections.
 3. Surveyor:
 - a. The surveyor responsible for line-and-grade control shall be a licensed surveyor registered in the state of Washington who has experience with similar projects and a minimum of three years of experience with underground construction.

1.3 SUBMITTALS

- A. Procedures: Section 01300.
- B. Qualifications:
1. Pipe Jacking Welder.
 2. Surveyor.
- C. Jacked Casing Plan for each jacked casing crossing.
- D. Certification that the jacking reaction frame and support and excavation support system design are constructed as designed by responsible Professional Engineer prior to loading of the excavation support system.
- E. Reports and Records.
- F. Casing Pipe:
1. Product information, including diameter, thickness, and class for each jacked casing crossing.
 2. Mill certificates of the physical and chemical properties of steel casing.
- G. Casing Spacers:
1. Details of all materials, banding, and insulating material.
 2. Letter from the casing spacer manufacturer that the proposed casing spacer material is suitable for the weight of the pipe and the length of push.

- H. Installation details for casing, casing spacers, and carrier pipe.
 - 1. Methods and procedures for installing carrier pipe inside casing.
 - 2. Pipe manufacturer’s recommended spacing for casing spacers.
 - 3. Methods and procedures to stabilize carrier pipe against annular space grouting forces and maintain pipe grade while annular space grouting is installed.
- I. Certification:
 - 1. Welder certification.
 - 2. Provide a certified affidavit of compliance for all pipe and other products or materials furnished under this Section requirements, including physical and chemical properties of all steel.
- J. Health and Safety Plan – specific to jacked casing operations.
- K. Manufacturer’s data for the following:
 - 1. External grout.
 - 2. Annular space grouting, including plans for venting (number and location of vents relative to pipe diameter and stiffness).
 - 3. Casing end seals.
- L. As-Built Records (Drawings).

1.4 DEFINITIONS

- A. Caving: The removal of soil or material located beyond or outside of the casing exterior surface (casing outside diameter) by the boring equipment, thereby, resulting in a volume of soil greater than the volume of the planned bore hole thereby leaving a “cave” or void outside of the casing that has the potential to collapse and cause a sinkhole or settlement.
- B. Cobble: Rock having a maximum orthogonal dimension between 3 and 16 inches and an unconfined compressive strength of up to 60,000 pounds per square inch. Cobbles are not Obstructions.
- C. Boulder: Rock having a maximum orthogonal dimension greater than 16 inches and an unconfined compressive strength of up to 60,000 pounds per square inch.
- D. Wood: Timber piles, logs, tree trunks, roots, dimensional lumber, and any other fibrous organic material shall be considered wood.
- E. Obstruction: Boulder, Wood, or other natural or man-made material having a maximum orthogonal dimension greater than 16 inches that is located at the edge of the casing and prohibits advancing of the casing. Cobbles are not Obstructions, and all encountered shall be removed by the Contractor’s excavation and spoil removal methods. Boulder, Wood, or other natural or man-made material having a maximum orthogonal dimension greater than 16 inches located completely within the cross-sectional area of the casing (and not at the edge) are not Obstructions, and all encountered shall be removed by the Contractor’s excavation and spoil removal methods.
- F. Annular Space: Void between the outside of the carrier pipe and the inside of the casing.

1.5 JACKED CASING PLAN

- A. Submit a separate Jacked Casing Plan for each jacked casing.
- B. Jacked Casing Plan shall include the following, at a minimum:
 - 1. Jacked casing manufacturer's literature describing in detail the equipment:
 - a. Machine type and manufacturing date.
 - b. Grade and alignment control system.
 - c. Spoils removal system.
 - d. Method of face stabilization.
 - e. Method of groundwater control.
 - f. Jacking mechanism and jacking pressure monitoring design.
 - g. Provisions for injecting casing pipe lubricants.
 - 2. Detailed layout and drawings of jacking and receiving pits including:

- a. Jacked casing operation setup.
- b. Location of the power and control units.
- c. Spoils handling system.
- d. Hydraulic jack configuration.
- e. Thrust reaction backstop configuration.
- f. Pipe rail layout.
- g. Pipe entrance and exit seals.
- h. Detailed locations and sizes of jacking and receiving pits.
3. Pit ventilation layout details and calculations. Ventilation system shall meet Part Q of Chapter 296-155 WAC.
4. Calculations:
 - a. Calculations and design of jacking reaction frame and support for thrust restraint.
 - 1) Prepared, stamped, dated, and signed by a Professional Engineer registered in the State of Washington and coordinated with excavation support system design per Section 02160.
 - 2) Design the reaction frame and support for the maximum jacking capacity to be experienced plus a minimum safety factor of 2.0.
 - 3) Demonstrate the ability of the soils to resist the forces transmitted to it without excessive deflection, damage to existing improvements, or exceedance of allowable passive resistance/lateral capacity.
 - b. Calculations of maximum jacking force anticipated for each drive and a description of the controls to ensure that the maximum allowable hydraulic pressure will not be exceeded during jacking operations.
 - 1) Identify the maximum jacking resistance for the complete casing. At a minimum, the calculations for the maximum frictional resistance and the maximum face pressure are required to determine maximum jacking load for design of the jacking reaction frame and supports, jacking mechanisms, casing pipe, and casing pipe joints. The pipe, pipe joint, and the reaction frame shall be designed for the maximum jacking capacity to be experienced plus a safety factor.
 - 2) Prepared, stamped, dated, and signed by a Professional Engineer registered in the State of Washington that clearly state the relationship between hydraulic pressure in each jacking circuit and the force applied to the pipe during jacking.
 - 3) Maximum force that the jacking equipment is capable to produce.
 - c. Calculations showing the casing pipe and joints can withstand the maximum stresses to be imposed during installation.
 - 1) Stresses to be imposed on the casing include earth loads, jacking forces, external loads such as live loads, face pressures, and frictional resistance along the casing string, and any other loads that may be reasonably anticipated during installation.
 - 2) Prepared, stamped, dated, and signed by a Professional Engineer registered in the State of Washington.
5. Casing pipe diameter, thickness, and joint type proposed.
6. Jacked casing pipe lubricant description.
7. Grouting procedure for filling voids outside of jacked casing pipe.
8. Description about how small diameter carrier pipes (where applicable) will be secured within the casing with the large diameter carrier pipe.
9. Line and grade calculations and layout with tolerances for casing installation. Demonstrate that carrier pipe and casing spacers will be installed to the line and grade indicated in the Drawings. Specify maximum allowable casing variance from line and grade that will allow for installation of carrier pipe and casing spacers to the line and grade indicated in the Drawings.
10. Detailed schedule for jacked casing operation including identification of activities that will require the Contractor to obtain written approval from local authorities having jurisdiction.
11. Tunnel spoils disposal plan including slurry handling and dewatering and disposal of decanted liquid. Testing shall be included.
12. Contingency plan: Step-by-step description of the planned operation to deal with specified situations listed below. Include an itemized list of materials and equipment required to be available on site to complete the work.

BORED AND JACKED CASINGS

- a. The presence of cobbles, boulders, wood, or other materials that obstruct forward progress of the casing.
 - b. Caving conditions at the face of the excavation or elsewhere along alignment.
 - c. Groundwater seepage at the face of the excavation.
 - d. Movement or failure of jacking reaction frame.
 - e. Excessive frictional forces that jeopardize the successful completion of the casing installation.
 - f. Misalignment of casing and inability to install carrier pipe to the line and grade indicated in the Drawings.
 - g. Grade control in areas of soft ground and peat.
13. Statement that the Contractor takes sole responsibility for the structural integrity and safety of the proposed operation.
- C. Permits associated with the pipe jacking operations.

1.6 REPORTS AND RECORDS

- A. Certified survey notes and shift reports, including as-built location of steel casing.
- B. Volume of external grouting applied.
- C. Maintenance records of the pipe jacking system.
- D. Volume of soil removed per linear feet of casing installed.
- E. Daily Log:
 - 1. During jacking operations submit a daily log including:
 - a. Jacking forces exerted on the casing in tons.
 - b. Pipe position in relation to line and grade.
 - c. Lubrication volume.
 - d. Pumping pressure.
 - e. Volume of muck.
 - f. Daily readings on excavation support system of pits to detect any vertical or horizontal movement.
- F. Volume of annular space grouting applied.
- G. Reporting of all information does not relieve the Contractor of its responsibility nor does it place on the District responsibility for control and protection of the work.

1.7 HEALTH AND SAFETY PLAN

- A. Prepare a Health and Safety Plan specific to pipe jacking operations.
- B. Text shall address all Work in this Section including, but not limited to, man entry inside the casing during installation and after the casing is installed for external grouting and carrier pipe installation.
- C. Perform work in a manner to maximize safety and avoid exposure of workers and equipment to hazardous and potentially hazardous conditions in accordance with applicable safety standards and Contractor's safety procedures. Specify items required for the emergency plan that are not covered in the general safety plan being prepared under Section 01352.
- D. Tunnel conditions, safety provisions, and operations shall be in conformance with WAC 296-155-730.

1.8 EQUIPMENT

- A. Capable of alignment and grade required to install carrier pipe to the line and grade indicated in the Drawings, as indicated in the Jacked Casing Plan submittal.
- B. To avoid voids outside the casing, design so that excavation is carried out entirely within the head and not in advance of the head.

- C. Excavated materials: Removed from the casing as the jacking operation progresses with no accumulation of excavated materials within the casing.

1.9 JACKED CASING MEETINGS

- A. Schedule and conduct meetings with the District, Engineer, and local authorities having jurisdiction to review the Jacked Casing Plan prior to each jacked casing operation.
- B. Meetings to occur a minimum of two weeks prior to starting jacked casing field operations.

1.10 PERSONNEL

- A. Field superintendent shall be present full-time at the job site whenever pipe jacking work is in progress.

1.11 BASELINE GROUND CONDITIONS

- A. Purpose of Baseline:
 - 1. Provides a basis for bidding.
 - 2. Provides a basis for evaluation and resolution of differing site conditions related to the items being baselined.
 - 3. Provides a basis for the type of jacked casing equipment to be utilized for the work.
 - 4. Sets baselines for geotechnical conditions assumed to be encountered during construction. Although based on geotechnical information and data gathered through geotechnical explorations and other sources, the baseline ground conditions are not statements of geotechnical fact and shall not be considered a warranty that such conditions will actually be encountered.
 - 5. No representation is made relative to geotechnical conditions not explicitly addressed in the Baseline. See Section 01012 for geotechnical information for the Contract.
- B. Baseline for Bored and Jacked Cased Crossing for Water Transmission Pipeline under State Route 9:
 - 1. No representation is made relative to the location of potential Obstructions along the length of the alignment or relative to the casing wall.
 - 2. Up to two Obstructions will be encountered during excavation of the casing located at any station and in no particular orientation. Potential Obstructions encountered along the alignment that are ingested by the excavation equipment due to their size, location, and orientation shall not be considered an Obstruction. Obstructions in excess of the two Obstructions included in the bid item lump sum price shall be considered for payment under the provisions for changes.
- C. Baseline for Bored and Jacked Cased Crossing for Water Distribution Line under State Route 9:
 - 1. No representation is made relative to the location of potential Obstructions along the length of the alignment or relative to the casing wall.
 - 2. No Obstructions will be encountered during excavation of the casing. Potential Obstructions encountered along the alignment that are ingested by the excavation equipment due to their size, location, and orientation shall not be considered an Obstruction. Obstructions shall be considered for payment under the provisions for changes.

1.12 SITE CONDITIONS

- A. See Section 01012 for the Geotechnical Data Report.

PART 2 - PRODUCTS

2.1 CASING

- A. The steel casing pipe shall be in accordance with ASTM A283, Grade C, unless indicated otherwise.
- B. The minimum diameter and wall thickness shall be as indicated in the Drawings. Increase casing wall thickness as needed based on Contractor's means and methods.
- C. Yield strength of the casing: 36,000 psi, minimum.

- D. Provide 2-inch grout port connections regularly spaced at 5 feet on center alternating at 30 degrees from plumb each side of the vertical centerline. Longitudinal spacing between the grout port connections may be decreased to provide more frequent grouting, but in no case shall the spacings shown or specified be exceeded.
- E. Casing section joints shall be butt welded in the field. Each end of the casing for butt welding shall be prepared by providing 1/4-inch by 45-degree chamfer on the outside edges.
- F. Pipe used for jacking shall be capable of withstanding the jacking forces imposed by the process of installation, as well as the final in-place loading conditions.

2.2 LUBRICANT

- A. Lubricant shall be a refined, processed natural high swelling montmorillonite clay (Bentonite slurry) or other product acceptable to the District as necessary to produce satisfactory lubrication and earth support.

2.3 EXTERNAL GROUT

- A. Grout shall consist of one part Portland cement and three parts sand by volume and the minimum amount of water necessary to obtain the desired consistency.
- B. Grout mixtures shall contain 2 percent of bentonite by weight of the cement. Portland cement, water and sand shall conform to the applicable requirements of Section 03002, except that sand to be used shall be of such fineness that 100 percent will pass a Standard No. 8 sieve and at least 45 percent, by weight, will pass a Standard No. 40 sieve.

2.4 CASING SPACERS

- A. Insulators shall be a manufactured non-centered/restrained positioning type as indicated in the Drawings.
- B. Band:
 - 1. Length: 12 inches.
 - 2. Material: Stainless steel or fusion epoxy coated steel.
- C. Runners:
 - 1. 2 inches wide, of glass-reinforced plastic or high density polymer.
 - 2. Minimum of four runners shall be used to support the bottom of the carrier pipe and at least two runners shall be used at the top of the pipe.
- D. Riser (between band and runner):
 - 1. Manufacturer's standard of sufficient height to provide the clearances indicated in the Drawings.
 - 2. Material: Stainless steel.
- E. Provide a letter from the casing spacer manufacturer that the proposed casing spacer material is suitable for the weight of the pipe and the length of push.
- F. Acceptable Manufacturers:
 - 1. Cascade Waterworks Manufacturing, Co..
 - 2. PSI: Model C or W.
 - 3. Advanced Products and Systems.
 - 4. Approved Equal.

2.5 ANNULAR SPACE GROUT

- A. Portland cement and additives.
- B. Other lightweight material that minimizes the buoyant forces on the carrier pipe.
- C. Compressive Strength:
 - 1. Penetration resistance of 100 psi in 24 hours when tested in accordance with ASTM C403.
 - 2. Compressive strength of 300 psi in 28 days when tested in accordance with ASTM C495 or ASTM C109.

- D. Acceptable Manufacturers (Grout Mix Series):
 - 1. Pacific International Grout Company LDB 662.
 - 2. Masterflow 713.
 - 3. Geofill Cellular Concrete, LD.
 - 4. Approved Equal.
- E. Mix Designs: To completely fill the annular space, develop one or more mixes based on the following requirements:
 - 1. Size of the annular void.
 - 2. Sufficient strength and durability to prevent movement of the carrier pipe.
 - 3. Provision of adequate retardation.
 - 4. Low hydration temperature.
 - 5. Provide less than 1 percent shrinkage by volume.
- F. Density: Design a grout mix with a density to prevent floating of the carrier pipe and to meet the requirements of the grouting procedure.
- G. Viscosity: The grout efflux time shall not exceed 35 seconds in accordance with ASTM C939.

2.6 CASING END SEALS

- A. Seal shall be a synthetic rubber sleeve, attached to end of the casing pipe and around the carrier pipe with stainless steel band clamps. Type may be either a pull-on conical model or a split wrap-around model.
- B. Acceptable Manufacturers:
 - 1. Cascade Waterworks Manufacturing, Co.: Model CCES.
 - 2. Advance Products and Systems.
 - 3. PSI: Model C or W
 - 4. Approved Equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide a minimum of 10 days advance notice of the start of excavation for pipe jacking operations.
- B. Immediately notify the District, in writing, when any problems are encountered with equipment or materials, or if the Contractor believes the conditions encountered are materially and significantly different than those represented by the Contract Documents.
- C. Use only equipment identified in the Jacked Casing Plan receiving a Review Action of NO EXCEPTIONS TAKEN or MAKE CORRECTIONS NOTED and implementing the work covered in the submittal in accordance with the markings noted; see Section 01300.
- D. For the WSDOT jacked casing installations, comply with all requirements of Section 01060.
- E. Attend jacked casing meetings as required per this Section.

3.2 WELDING

- A. Welding procedures used to fabricate steel casings shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or special welds for pipe cylinders, casing joint welds, reinforcing plates, and grout port connections.
- B. Welding shall be done by Pipe Jacking Welder, qualified per this Section.
- C. Inspect and test field welds and complete weld repairs as required prior to jacked casing operations.
- D. Perform the following inspection and testing:
 - 1. Visually inspect field welds per AWS D1.1.

2. Test fillet welds of field single-welded lap joint using the magnetic particle testing procedures and acceptance criteria set forth in AWS D1.1, Section 6.14.5, Table 6.1.
3. Test field butt welds by 100 percent radiographic of the first two welded pipe joints, and 10 percent of the joints thereafter using methods and acceptance criteria in API Standard 1104. If visual inspection notes questionable welding or a test fails, then testing shall be on a continuous basis until acceptable welds are accomplished. Repair welds deficient in size by adding weld metal.

3.3 EXCAVATION AND DEWATERING

- A. Excavation and the excavation support system of the jacking and receiving pits shall be in accordance with Section 02200 and Section 02160, respectively. The excavations for the pipe jacking operations shall be adequately shored to safeguard existing substructures and surface improvements and to ensure against ground movement in the vicinity of the jack supports.
- B. If groundwater is encountered, the water and flow shall be controlled such that the work is protected and flowing soil conditions do not occur. Dewatering, if required, shall be provided in accordance with Section 02140.
- C. Excavated materials removed from the pipe jacking operations shall be removed as the pipe jacking operation progresses and disposed of in accordance with Section 02200. No excavated material shall be left within the casing. Sluicing or jetting to remove materials shall not be allowed.

3.4 CONSTRUCTION OF PITS

- A. Per Section 02160.
- B. Construct the pit support system to the necessary size, shape, and depth to allow construction and to provide adequate space and safe support for the pipe jacking and excavation work.
- C. Install support systems in a manner that will maintain safety and minimize ground movement. If used, interlocking sheeting and liner plate shall be installed with tight joints to minimize ground loss. For braced excavation, wedge or jack all supports to ensure a tight fit and positive load on the supports before continuing the excavation. Fill all voids behind sheeting before tightening supports. Record daily readings on the support system to detect any vertical or horizontal movement. Corrective measures shall be taken immediately where movement or deformation of support systems may in any way impair the integrity of such support system, or that of adjacent facilities. Immediately repair any damage to existing facilities caused in part or wholly as a result of the Contractor's operations.
- D. Provide security fencing around work areas. Open pits shall be steel plated overnight.
- E. Care shall be taken when setting the pipe guide rails in the jacking pit to ensure correctness of the alignment, grade, and stability. If a concrete thrust block or treated soil zone is used, concrete or other materials shall have attained the required strength before jacking begins.
- F. Penetrations of the pit excavation support system shall be made with procedures and installations to prevent the intrusion of soil and water.
- G. The Professional Engineer(s) responsible for the design of the jacking frame and support and excavation support system shall certify that the systems were constructed as designed prior to loading of the excavation support system.

3.5 STEEL CASING

- A. Install casing by jacking in the trenchless locations indicated in the Drawings.
- B. Repair, if approved by the District, or remove and replace casing damaged during the jacking operation.
 1. Repair or replace casing damaged during the jacking operation. All proposed repairs shall be certified by a Professional Engineer registered in the State of Washington that the repair is equal to or exceeds the original strength of the casing.
- C. Alignment and Grade:
 1. Line and grade of the casing shall not exceed the maximum allowable variance required to allow installation of the carrier pipe within the casing to line and grade.

2. Check the alignment and grades of the leading end of the casing often enough to be able to correct any line or grade deviations while the jacked casing is in progress.
 3. Line and grade checks at intervals not exceeding 40 feet.
 4. Correct any deviation from grade or alignment.
 5. Laser control: Use for both vertical and horizontal alignment.
- D. Avoidance of Caving:
1. Take special care during the installation of the jacked casing to ensure that no Caving and settlement is caused to the above surface and that existing facilities and the ground surface near the casing alignment are not affected by sinkholes or settlement.
 2. Repair any caving caused by the placement of the casing pipe.
- E. Excavate the jacked pipe in accordance with the methods described herein:
1. Conduct all jacked casing operations by methods and with equipment, which will positively control dust, fumes, vapors, gases, fibers, fog, mists, or other atmospheric impurities.
 2. Provide compressed air and electricity for operations from a source outside the jacked casing.
 3. Maintain clean working conditions at all times inside the casing.
 4. Remove all muck, slush, grout spills, unusable timber, and any other material not required for jacked casing operations.
- F. Structural steel or concrete cradles of sufficient length shall be provided to assure accurate control of pipe jacking alignment. Provide adequate space within the excavation to permit the insertion of the lengths of casing to be jacked. Concrete or structural steel sections shall be anchored to ensure action of the jacks in line with the axis of the casing.
- G. Casing Pipe Preparation and Handling:
1. Inspect all casing pipe prior to lowering into the jacking pit to ensure that no defective materials are being used.
 2. Pipe delivered with visible damage shall not be used. Damaged or defective pipe shall be marked with a permanent marking as rejected and shall be promptly removed from the job site.
 3. Use proper tools and equipment to handle pipe. Slings shall be made of rope, nonmetallic webbing, or other materials that will not damage the pipe or casing. Chain or cable slings or chokers shall not be used to handle the pipe. Lifting eyes, if used, shall be constructed to provide uniform bearing along the top of the pipe. Lifting eyes shall not be used.
 4. Clean ends of pipe thoroughly. Remove foreign matter and dirt from pipe joints during laying.
- H. Install instrumentation, take readings, and provide copies of measurement data to certify all jacking forces. These readings shall include all forces exerted during the jacking. Readings are intended to show the actual forces exerted on the casing to verify that these forces do not exceed the design requirements for the casing materials used.
- I. Continuously monitor, record, and control the rate and amount of pipe string advance with the rate and volume of excavation to ensure that no over-excavation occurs. Promptly notify the District if the volume of excavated materials exceeds the in-place volume of an individual casing section by more than 10 percent. Alter operations to allow excavation within that allowed by the specification.
- J. Modify the jacking operation if there is an inability of the Contractor to complete a jacking run without exceeding the maximum unit hydraulic pressure as stated in the Contractor's Jacked Casing Plan, or suspend jacking in that run.
- K. Notify the District immediately if obstruction stopping forward motion of operation is encountered during installation.
- L. Casing Pipe Installation:
1. The installation of the casing shall be subject to the approval of the local authority having jurisdiction over the area containing the pipe jacking operations.
 2. Once jacking commences, jack continuously, with maintenance stoppages not to exceed 8 hours per day. This requirement may be modified if the Contractor submits to the District, for prior acceptance,

methods and details that shall prevent “freezing” of the casing pipe and ensure that the heading is stable at all times.

M. Lubricant:

1. A bentonite slurry shall be used for lubricating the exterior of the casing pipe during jacking operations.
2. Bentonite slurry may be pumped through the grout port connections; however, the bentonite slurry shall not be injected ahead of the pipe.
3. Provide a pressure gauge at the grout port that indicates pumped slurry pressure.

N. External Grouting:

1. Immediately after completion of the pipe jacking operations, inject grout through the grout port connections in such a manner as to displace the lubricant and completely fill all voids outside the casing pipe resulting from the jacking operations.
2. Grout pressure shall be sufficient to displace the lubricant and controlled so as to avoid deformation of the steel casing and avoid movement of the surrounding ground.
3. After completion of the grouting operations, close the grout port connections with cast-iron threaded plugs.

O. Caved Areas:

1. Inspect each grout port after opening to confirm the requirement for grouting. Pump external grout into each port under low pressure.
2. Place grout by positive displacement pumps.
3. Place grout at pressures that are requisite for the conditions encountered.
4. Provide gages to indicate grout pressure obtained.
5. Fill all voids and record the amount of grout placed

P. Caving/Heave:

1. Take care during the installation of the casing pipe to ensure that no caving, settlement, or heave of above surfaces is caused.
2. Maintain close observation of the above surfaces and be prepared to contact the District, Engineer, and WSDOT if settlement, caving, or heave is detected.
3. Coordinate and arrange for repairs as required.

Q. Cleaning and Testing:

1. Clean casing, leaving it free of debris.
2. Casing shall be inspected after external grouting and prior to installing the carrier pipe. Acceptance of the casing shall be based on a final inspection conducted by the Contractor and observed by the District.
 - a. No visible leakage will be allowed.

3.6 GROUND MOVEMENT

- A. Be responsible for monitoring ground movements associated with the work and making suitable changes in construction methods to control ground movements and prevent damage to the Work and roadway.
- B. Ground movement at the roadway shall be monitored per Section 02212.
- C. Perform pipe jacking excavation in a manner that will minimize the movement and minimize subsidence of the ground in front of, above, and surrounding the casing. Support the ground in a manner to prevent loss of ground and keep the perimeter and face of the heading stable at all times including shutdown periods.

3.7 EMERGENCY MEASURES

- A. Wherever there is a condition which, in the opinion of the District, may endanger the stability of the excavation or adjacent structures, operate with a full crew for 24 hours a day, including weekends and holidays, without intermission until those conditions no longer jeopardize the stability of the Work.

3.8 INSTALLATION OF CARRIER PIPE, ANNULAR SPACE GROUTING, AND CASING END SEALS

- A. Prior to installation of the carrier pipe, verify that the alignment, grade, and deflection of the casing pipe will allow the carrier pipe to slide into place without binding.
- B. The entire length of casing shall be in place before installation of the carrier pipe. Install the casing spacers on the carrier pipe in accordance with the manufacturer's recommendations, join the pipe, and slide the carrier pipe into the casing.
- C. Implement measures to maintain integrity of coating of the carrier pipe.
- D. The first carrier pipe joint outside of the casing shall be within 12 inches of the casing end.
- E. Annular Space Grouting:
 - 1. Complete testing of the carrier pipe before annular space grouting.
 - 2. Install annular space grouting between the carrier pipe and casing pipe.
 - 3. Accomplish grouting by filling the carrier pipe with water and pressurizing to offset the grout head pressure, so that the net external pressure does not exceed the allowable buckling pressure of the carrier pipe.
 - 4. Prior to grouting, cap, bulkhead the ends of the casing, and provide appropriate venting. Submit plans for venting, including the proposed number and location of vents relative to pipe diameter and stiffness.
 - 5. The annular space shall be completely (100%) grouted.
 - 6. Shield or protect coating of carrier pipe during grouting operations.
- F. Casing End Seals:
 - 1. Install seals at both ends of casing in accordance with the manufacturer's instructions. Completed installation shall provide an earth tight seal.

3.9 CASING SURVEY

- A. After completing the casing installation and prior to demobilization of the installation equipment, use the licensed surveyor to provide the District with survey information related to as-built location of the casing.

3.10 CLOSING OF PITS

- A. After jacking equipment and excavated materials from the pipe jacking operations have been removed from the launching pit, prepare the bottom of the launching pit as a pipe foundation. Remove all loose and disturbed materials below pipe grade to undisturbed earth and recompact the material in accordance with Section 02200.

3.11 RECORD KEEPING

- A. As-built records:
 - 1. Maintain a daily project log of drilling operations and a guidance system log. Copies of both logs shall be given to the District at completion of project. Upon completion of pipe jacking operations, prepare as-built drawings to scale, certified as to accuracy by Contractor.

END OF SECTION

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