Iowa Department of Transportation

SPECIAL PROVISIONS
FOR
FUSIBLE POLYVINYLCHLORIDE PIPE FOR INSTALLATION BY HORIZONTAL DIRECTIONAL DRILLING

Woodbury County
IM-NHS-029-6(257)147--03-97

Effective Date
March 18, 2014

THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

120145.01 DESCRIPTION.

A. Summary.
This section specifies fusible polyvinylchloride siphon piping, including acceptable fusion technique and practice, safe handling and storage, and installation of the pipe by horizontal directional drilling (HDD).

B. Reference Standards.

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

- ANSI/AWWA C110/A21.10 American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids.
- ANSI/AWWA C111/A21.11 American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- AWWA C605 Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
- AWWA C900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. (100mm through 300mm), for Water Distribution.
- AWWA C905 Standard for Polyvinyl Chloride (PVC Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. (350mm-1200rnm), for Water Distribution.
- AWWA M23 AWWA Manual of Supply Practices PVC Pipe-Design and Installation.
- ASTM C495 Standard Test Method for Compressive Strength of Lightweight Insulating Concrete.
- ASTM D638 Tensile Properties of Plastics.

- ASTM D1238 Flow Rates of Thermoplastics by Extrusion Plastomer.
- ASTM D1505 Standard Test Method for the Density of Plastics by the Density-Gradient Technique.
- ASTM F1057 Standard Practice for Estimating the Quality of Extruded Poly (Vinyl Chloride) (PVC) Pipe by the Heat Reversion Technique.
- ASTM F1417 Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.
- UNI-PUB-6 Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.
- PPI TR-2 PVC Range Composition Listing of Qualified Ingredients.
- NASTT Horizontal Directional Drilling Good Practices Guidelines.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of construction. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

3. Where document dates are given in the previous listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

C. Manufacturer Requirements.
Fusible polyvinylchloride pipe shall be tested at the extrusion facility for properties required to meet all applicable parameters as outlined in AWWA C900, AWWA C905, and applicable sections of ASTM D2241. Testing priority shall be in conformance with AWWA C900 and AWWA C905.

D. Fusion Technician Requirements.
Pipe fusion shall be conducted by the pipe manufacturer, Underground Solutions, Inc (USGI). Fusion Technicians shall be employees of USGI and shall be fully qualified by the pipe manufacturer to install fusible polyvinylchloride pipe of the type(s) and size(s) being used. Qualification shall be current as of the actual date of fusion performance on the project.

E. Heat Fusion Training Services.
Only certified USGI employees will be allowed to complete this fusion work.

F. Specified Pipe Suppliers.
Fusible polyvinylchloride pipe as manufactured under the trade names Fusible C-900®, Fusible C-905®, and FPVC™, for Underground Solutions, Inc., Poway, CA, (858) 679-9551 or an approved equal.

G. Directional Boring Contractor Requirements.

1. The Directional Boring Contractor shall have successfully completed at least five installations in which 30 inch or larger pipe of a length and depth similar to the work under this contract was installed using HDD techniques.

2. Contractor personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety. Each person must have been fully trained for on all facets of directional drilling, including, but not limited to machine operations, mud mixing, locating, and material fusion. A responsible representative, who is thoroughly familiar with the equipment and type of work to be performed, must be in direct charge and control of the operation at all times. In all cases the supervisor must be continually present at the job site during the actual directional bore operation. The Contractor shall have a sufficient number of competent

workers on the job at all times to make the directional bore in a timely and satisfactory manner.

H. Submittals.

1. Work Plan.

Within 30 calendar days after Contract Award and prior to beginning work, the Contractor shall submit to the Engineer a comprehensive detailed realistic work plan based on actual working conditions for this project. The Engineer will distribute the work plan to the Iowa DOT, the City of Sioux City, the Union Pacific Railroad and other appropriate stakeholders. The work plan shall include, but not be limited to, the following.

a. Previous Experience.

List five similar projects completed by the Contractor conforming to the requirements of Article 120145.01, G. Include the name and contact information of the Contracting Authority, the location, the project environment (e.g., urban work, river crossing, railroad crossing), product diameter, length and depth.

b. Project Organizational Chart.

A project organizational chart that identifies key personnel and subcontractors assigned to the work. Chart format shall graphically illustrate project organization hierarchy, work tasking and lines of communication.

c. Contractor Personnel.

Identify the full-time Superintendent, shift Foremen, and other key personnel assigned to the work under this contract as identified on the project organization chart. Submit a resume for each that Includes title, experience record and personal references.

d. Subcontractors.

For the subcontractors identified on the project organization chart, submit a brief company biography, a list of personnel assigned to the work, company experience record for work similar to the work to be performed on their designated work task(s), and references. Possible work tasks include, but are not limited to:

- Utility location
- Hydro-excavation
- Trucking
- Leak and/or deflection testing
- HDD tracking and/or surveying
- Mud-mix disposal
- Excavation/shoring of entry/exit pits
- Site restoration

e. Construction Operations.

1) Provide a detailed schedule formatted using the Critical path Method (CPM) indicating the sequence of the work, the time of starting and completing each part, and milestone dates. The schedule shall be continuously updated to reflect changes in the progress of the work and shall be resubmitted each week until completion.

2) Contractor business license and any required permits including, but not be limited to:

- Traffic control and road closure
- Street cut
- Water hydrant
- For storage and piling of material
- Material disposal including drilling fluids, solids and spoils

3) Describe how each worksite will be accessed. Include a parking plan for Contractor, subcontractor and employee vehicles. Describe traffic control measures that are in addition to that shown on the construction plans.

4) A drawing of each worksite indicating the location and footprint of each piece of equipment, the location of entry and exit pits, the location of slurry containment pits and the location of water source(s).

5) Drill Rig and Ancillary Equipment.

a) Type, capacity and performance characteristics of the drilling rig to be used.
- List make and model
- List engine make, model and horsepower
- List powertrain
- List maximum tensile capacity in pounds at a rate in feet per minute
- List maximum thrust capacity in pounds at a rate in feet per minute
- List torsional capacity in foot-pounds at a rate in revolutions per minute
- List maximum carriage speed in feet per minute
- List maximum rotating speed in revolutions per minute

b) Drill pipe specification and quantity.

c) Down hole drilling tools.
- List drill bit(s) type, make, model and application
- List reamer(s) type, make, model and application
- List survey tracking equipment type, make and model
- List breakaway pulling head(s) and swivel(s) type, make and model

d) Type, make, model, capacity and performance characteristics of the drilling mud system to be used that may include, but is not limited to, water/mud intake system, tanks, mixing system, pumps, solids/recycling system (controls, shaker boxes, desander and desilter cyclones).

e) List type, make, model, operating range and degree of accuracy of tracking equipment to be used

f) List other auxiliary equipment (e.g., pipe rollers, skates, protective devices, baskets, side booms, etc.).

6) Describe every step of the drilling, pre-reaming, and backreaming/product pullback operation from pilot hole drilling through completed installation of annulus grouting. Include planned buoyancy modification and water ballasting measures.
- List pilot hole diameter
- List number and size of pre-reams
- List number of sections in which the product piping is to be installed

7) Describe every step of the mud mixing and recycling operation from mud mixing through recovery/reintroduction. Include:
- Mixing method
- Recycling method
- Slurry/spoil handling and containment
- List equipment type, make and model

8) Drilling fluid mix design.
- List type, supplier and quantity of bentonite in pounds per 100 gallons
- List type, supplier and quantity of polymer in pounds per 100 gallons
- List supplier and quantity of soda ash in pounds per 100 gallons
- List mix design viscosity, density and pH
- List anticipated volume of slurry required

9) Drilling Fluid and Spoil Collection and Disposal Operation.
Describe every step of the operation from collection through disposal. Include:
- Method of transporting drilling fluids/residuals and spoils off the site
- List disposal site for drilling mud and spoils

10) Annulus Grouting Operation.
Describe every step of the annulus grouting operation from CLSM mixing through placement. Include:
- Mixing method
- Delivery method (e.g., pump(s), tremie)
- List equipment type, make and model

11) CLSM mix design.
- List type, supplier and quantity of cementitious materials
- List supplier and quantity of additives

- List supplier and quantity of sand
- List supplier and quantity of water
- List supplier and quantity of air
- List mix design density, compressive strength and slump
- List anticipated volume of slurry required

12) Describe demobilization and site restoration operations to return worksites to preconstruction condition.

f. Safety.
Submit a copy of the company safety manual. Include MSDS of any potentially hazardous substances to be used.

g. Frac-Out Contingency Plan.
Describe operational procedures and responsibilities for the prevention, containment and clean-up of frac-outs that may result in the release of drilling fluids into the surface environment. Specific objectives of the frac-out contingency plan are:

- Minimize the potential for a frac-out associated with HDD activities.
- Provided for timely detection of frac-outs and establish stop work protocols to determine corrective measures.
- Protect the integrity of the surrounding environment.
- Ensure an organized, timely, and “minimum-impact” response in the event of a frac-out and release of drilling fluid.
- Ensure that all appropriate notifications are made immediately.

h. Spill Prevention Plan.
Describe operational procedures and responsibilities for the prevention, containment and clean-up spills that may result in a release into the surface environment.

i. Communication Plan.
Submit a communication plan that describes the form and frequency of communication with the Engineer, the Iowa DOT, the City of Sioux City, the Union Pacific Railroad and other appropriate stakeholders. Identify key personnel responsible for communications. At a minimum issues to be communicated are safety, progress and unexpected techinal difficulties.

2. Product Data.

a. Name of the pipe manufacturer and a list of the piping and quantities to be provided by each manufacturer.

b. Product data and pipe supplier data indicating conformance with this specification and applicable standards, including written documentation regarding any intended variance from this specification and applicable standards.

c. Material and pipe property testing in conformance with applicable standards. In addition for FPVC pipe indicate pipe extruder conformance with AWWA C900 and AWWA C905:

- Dimensional Checks
- Pipe Burst
- Flattening
- Extrusion Quality (Acetone Immersion)

Test results from the pipe extruder shall be made available to the Engineer upon request for each extrusion run.

d. Fusion joint data and fusion technician data indicating conformance with this specification and applicable standards, including written documentation regarding any intended variance from this specification and applicable standards. This will include fusion joint warranty information and recommended project specific fusion parameters, including criteria logged and recorded by data logger.

e. Drilling fluid mix design.

f. CLSM mix design.

3. As-Built Data.

a. Submit as-built records in duplicate within five days after completing the pull back.

b. Submit Fusion Technician's joint reports for each fusion joint performed on the project, including joints that were rejected. Each report shall include:
- Pipe Size and Dimensions
- Machine Size
- Fusion Technician Identification
- Job Identification Number
- Fusion Number
- Fusion, Heating, and Drag Pressure Settings
- Heat Plate Temperature
- Time Stamp
- Heating and Cool Down Time of Fusion
- Ambient Temperature

c. Drilling Fluid Monitoring Data. The as-built data shall include recorded fluid pressure at drill head, and fluid property test results for viscosity, density, pH and volume (data every 30 feet of main at a minimum).

d. CLSM Placement Monitoring Data. The as-built data shall include recorded fluid pressure at tremie pipe end, and property test results for slump, density, air content and volume (data every 30 feet of main at a minimum).

e. Leak test data.

f. Deflection test data.

g. Record Drawing. The as-built record drawings shall include a plan, profile (data every 10 feet of main at a minimum), and all information recorded during the progress of the work, including all subsurface anomalies identified by Ground Penetrating Radar or vacuum excavation. The HDD contractor shall certify the accuracy of all as-built record drawings.

1) The as-recorded plan will reflect horizontal offset from the baseline and depth of cover.

2) All fittings, valves, or other appurtenances will also be referenced and shown.

3) This document, along with tracking log sheets shall be provided to the Engineer. Tracking log sheet data shall include any and all that apply, including position, roll angle, tilt angle, depth, and hydraulic pull back force measured.

4) Recorded maximum pull-back hydraulic pressure during pull-back operations.

5) As-recorded plans shall show any deviations from the original plans.

120145.02 MATERIALS.

A. Fusible Polyvinylchloride Non-Pressure Pipe for Wastewater.

1. Fusible polyvinylchloride plastic material for pipe shall conform to AWWA C900 or C905, ASTM D1784, and cell classification 12454. Pipe shall be CI/DIPS standard dimensions as indicated in these specifications.

2. Pipe shall be manufactured with 100% virgin resin.

3. Fusible polyvinyl chloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.

4. Fusible polyvinylchloride pipe shall be manufactured in standard 20 foot, 30 foot, or 40 foot nominal lengths.

5. Fusible polyvinylchloride pipe shall be green in color.

6. Pipe shall be marked per AWWA C900 or AWWA C905, and shall include as a minimum:

a. Nominal size

b. PVC
c. Dimension Ratio, Standard Dimension Ratio or Schedule
d. AWWA pressure class or rating
e. AWWA Standard designation number
f. Extrusion production-record code
g. Trademark or trade name
h. Cell Classification 12454 and/or PVC material code 1120 may also be included.

7. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.

B. Fusion Joints.

Fusible polyvinylchloride pipe lengths shall be assembled in the field with butt-fused joints. Follow the pipe supplier's written instructions for this procedure. Joint strength shall be equal to the pipe as demonstrated by testing requirements. All fusion joints shall be completed as described in this specification.

C. Connections & Fittings.

1. Connections shall be defined in conjunction with the linking of project piping, as well as the tie-ins to other piping systems.

2. Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard ductile iron fittings conforming to AWWA/ANSI C110/A21.10 and AWWA/ANSI C111/A21.11.

3. Restrained connections to fusible polyvinylchloride pipe may be made using a restrained retainer gland product for DIPS or IPS sizing, as well as for MJ or flanged fittings. Example manufacturers include:
a. EBAA Iron -Megalug Series 2000PV, 2000SV, 2100, or Series 2200;
b. Smith-Blair -Cam-Lok, 1111120 series;
c. or approved equal.

4. Bends, tees and other ductile iron fittings shall be restrained with the use of thrust blocking.

5. Ductile iron fittings and retainer glands must be installed per the manufacturer's recommendations.

6. Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard PVC gasketed pressure push-on fittings conforming to AWWA C900 and AWWA C905.
a. Acceptable fittings for use joining fusible polyvinylchloride pipe other sections of fusible polyvinylchloride pipe or other sections of PVC pipe shall include gasketed PVC, push-on type couplings and fittings, including bends, tees, and couplings.
b. Bends, tees and other PVC fittings shall be restrained with the use of thrust blocking as indicated on the drawings.
c. PVC gasketed, push-on fittings and mechanical restraints, if used, must be installed per the manufacturer's recommendations.

7. Sleeve-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained as indicated on the drawings and in these specifications. Acceptable sleeve-type mechanical pipe couplings shall include for unrestrained coupling:
a. Smith~Blair Omni-Coupling;
b. Dresser Style 253 or Long Style 253;
c. or approved equal.

8. Acceptable sleeve-type mechanical pipe couplings shall include for restrained coupling EBAA Iron Series 3800 or approved equal.

9. Expansion-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained.

10. Acceptable expansion-type mechanical pipe couplings shall include:
- **a.** EBAA Iron EXTEND 200,
- **b.** Smith~Blair Type~611 or Type~612,
- **c.** or approved equal.

11. Acceptable flexible couplings shall include EBAA Iron FLEX-TEND or approved equal.

12. Bolts and nuts for buried service shall be made of non-corrosive, high-strength, low-alloy steel having the characteristics specified in AWWA/ANSI C111/A21.11 regardless of any other protective coating.

D. Drilling System Equipment.

1. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore(s) and pullback of the pipe(s), a drilling fluid mixing and delivery system of sufficient capacity to successfully complete the crossing, a guidance system to accurately guide boring operations, and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project. All required equipment shall be identified in the work plan as submitted per these specifications.

2. The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull drill pipe while delivering a pressurized fluid mixture to a steer-able drill head. The machine shall be anchored to withstand the pulling, pushing and rotating forces required to complete the project.

3. The drilling rig hydraulic system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks.

4. The drilling rig shall have a system to monitor and record position data (x-y-z) including roll angle, tilt angle, depth, drill head fluid pressure and hydraulic pull back force measured. Data shall be recorded at each

5. The horizontal directional drilling equipment shall produce a stable fluid lined tunnel with the use of a steerable drill head. The system must be able to control the depth and direction of the pipe. Drill head shall contain all necessary cutters and fluid jets for the operation, and shall be of the appropriate design for the medium being drilled.

E. Drilling Fluid System.

1. Drilling fluid shall be composed of clean water and the appropriate additive(s) for the fluid to be used. Water shall be from a clean source and shall meet the mixing requirements of the manufacturer.

2. The water and additives shall be mixed thoroughly to assure the absence of any clumps or clods. No hazardous additives may be used.

3. Drilling fluid shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of bore wall(s).

4. Drilling fluid shall be disposed of offsite in accordance with local, state and federal

requirements and/or permit conditions.

5. No additional chemicals or polymer surfactants shall be allowed to be added during construction to the drilling fluid mix-design as submitted for this project without written consent of the Engineer.

6. A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid for the project.

7. The mixing system shall be able to ensure thorough mixing of the drilling fluid. The drilling fluid reservoir tank shall be sized for adequate storage of the fluid.

8. The mixing system shall continually agitate the drilling fluid during drilling operations.

9. The drilling fluid pumping system shall have a minimum capacity to supply drilling fluid in accordance with the drilling equipment pull-back rating at a constant required pressure.

10. The delivery system shall have filters or other appropriate in-line equipment to prevent solids from being pumped into the drill pipe.

11. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and properly disposed of The use of spill containment measures shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system (if used) to prevent spills into the surrounding environment. Pumps, vacuum truck(s), and/or storage of sufficient size shall be in place to contain excess drilling fluid.

12. A closed-loop drilling fluid system and a drilling fluid cleaning system shall be used to whatever extent practical. Under no circumstances shall drilling fluid that has escaped containment be reused in the drilling system.

F. Pipe-Pull Heads.

1. Pipe-pull heads shall be utilized that employ a positive through-bolt design assuring a smooth wall against the pipe cross-section at all times.

2. Pipe-pull heads shall be specifically designed for use with fusible polyvinylchloride pipe, and shall be as recommended by the pipe supplier.

G. Drilling Control System.

1. Calibration of the electronic detection and control system shall be verified prior to the start of the bore.

2. The drilling head shall be remotely steer-able by means of an electronic or magnetic detection system. The drilling head location shall be monitored in three dimensions:
- **a.** Offset from the baseline;
- **b.** Distance along the baseline; and
- **c.** Depth of cover.

3. Point of rotation of the head shall also be monitored.

4. For gravity application and on-grade drilling, use approved equipment applicable for grade increments of 0.1%.

H. Delivery & Off-Loading.

1. All pipes shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Engineer.

2. Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify Engineer immediately if more than immaterial damage is found.

3. Each pipe shipment should be checked for quantity and proper pipe size, color and type.

4. Pipe should be loaded, off-loaded, and otherwise handled in accordance with AWWA M23.

5. A forklift with chisel forks shall be used to off-load the pipe. The fork chisel should be checked to be sure it is not thicker than the gap between the units of pipe strapped together for shipping and handling purposes. Extend forks to remove each top unit from the truck. When unloading 20 foot lengths, remove back units first. Do not run forks too far under the units, as fork ends striking adjacent units may cause damage. Insure that the forks are fully engaged. The 30 foot and 40 foot lengths are shipped in single length units. Because these are longer, the packages will flex or bend more than the 20 foot length units. If left bundled in units, unloading can be done with a single forklift so long as it is of sufficient capacity to handle the load. If sag exceeds manufacturer's recommendation, then each piece of pipe should be unloaded individually. The forks should be placed as far apart as possible to provide support to the unit. When unloading individual pieces of pipe, the pipe should be supported at approximately the 1/3 point measured from each end of the pipe.

6. Sag is the measurement of the pipe ends relative to the pipe center. With a pipe raised on the forklift, a string line can be pulled from the bottom of one end of the pipe to the bottom of the other end of the pipe. The distance in the center from the string to the bottom of the pipe is the sag.

7. If a forklift is not available, a spreader bar with fabric straps capable of handling the load should be used. Recommended lift points when using fabric slings are at the point approximately 1/3 of the length measured from each end of the unit.

8. Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.

9. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.

10. If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to insure that pipe is not dropped or damaged.

11. Pipe should be carefully lowered, not dropped, from trucks.

12. In preparation for pipe installation, placement of pipe should be as close to the fusion area as practical.

I. Handling & Storage.

1. Any length of pipe showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the Engineer.

2. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and can be rejected unless determined acceptable by the Engineer.

3. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.

4. Pipe shall be handled and supported with the use of woven fiber pipe slings or approved equal. Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way. Use of hooks, chains, wire rope or any other handling device which creates the opportunity to damage the surface of the pipe is strictly prohibited.

5. After delivery to the project site, fusible polyvinylchloride pipe shall be stored at ambient temperature and protected from ultraviolet light degradation. If pipe is to be stored for a period of 6 months or longer, the pipe must be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.

6. Racks or dunnage to prevent damage to the bottom of the pipe during storage should support the pipe lengths. Supports should be spaced to prevent pipe bending and deformation. The pipe shall be stored in stacks no higher than that given in the following table:

Pipe Diameter (inches) Max.	No. of Rows Stacked
8 or less	5
12 to 21	4
24 to 30	3
33 to 48	2

120145.03 CONSTRUCTION.

A. Fusion Process.

1. Fusible polyvinylchloride pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's recommendations.

2. Fusible polyvinylchloride pipe will be fused by qualified fusion technicians, as documented by the pipe supplier. Training records for qualified fusion technicians shall be available to the Engineer upon request.

3. Each joint fusion shall be recorded and logged by an electronic monitoring device (data logger) affixed to the fusion machine. Joint data shall be submitted as part of the As-Built information, in accordance with this specification.

4. The fusible polyvinylchloride pipe will be installed in a manner so as not to exceed the recommended bending radius.

5. Where fusible polyvinylchloride pipe is installed by pulling in tension, the recommended Safe Pulling Force, according to the pipe supplier, will not be exceeded.

6. Only appropriately sized, and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following properties, including the following elements:

a. Heat Plate.
Heat plates shall be in good condition with no deep gouges or scratches within the pipe circle being fused. Plates shall be clean and free of any contamination. Heater control shall properly function, and cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's recommendations.

b. Carriage.
Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.

c. General Machine.
Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.

d. Datalogger.
The current version of the pipe supplier's recommended and compatible software shall be used. Protective case shall be utilized for the hand held wireless portion of the unit. Datalogger operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.

7. Other equipment specifically required for the fusion process shall include the following: Pipe rollers shall be used for support of pipe to either side of the machine.
a. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement and/or windy weather.
b. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.
c. Facing blades specifically designed for cutting fusible polyvinylchloride pipe.

8. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of thermoplastic pipe. The software shall register and/or record the parameters required by the manufacturer and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

B. Drilling Operations.

1. Grades, radii, and alignment of the proposed HDD installation are presented in the drawings for reference and intended bore path. The path of the bore may be modified based on field and equipment conditions. Entry and exit locations and control-point elevations shall be maintained as shown on the drawings and specified, unless otherwise approved by the Engineer.

2. Bend radii shown on the drawings arc minimum allowable radii and shall not be reduced. Control-point elevations shown on the drawings are minimum allowable cover and/or separation and shall not be reduced.

3. Correct location of all underground utilities that may impact the HDD installation is the responsibility of the Contractor, regardless of any locations shown on the drawings or previous survey completed.

4. Utility location and notification services shall be contacted prior to the start of construction.

5. All existing lines and underground utilities shall be positively identified, including exposing those facilities that are located within an envelope of possible impact of HDD installation as determined for the project specific site conditions. It is the Contractor and HDD system

operator's responsibility to determine this envelope of safe offset from existing utilities. This will include, but is not limited to, soil conditions and layering, utility proximity and material, HDD system and equipment, and foreign subsurface material.

6. Work site as indicated on drawings shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made

7. Confine all activities to designated work areas.

8. The drill path shall be accurately surveyed with entry and exit areas placed in the appropriate locations within the areas indicated on drawings. If using a magnetic guidance system, drill path will be surveyed for any surface geomagnetic variations or anomalies.

9. Instrumentation shall be provided and maintained at all times that accurately locates the pilot hole, measures drill-string axial and torsional loads and measures drilling fluid discharge rate and pressure.

10. Entry and exit areas shall be drilled so as not to exceed the bending limitations of the pipe as recommended by the manufacturer.

11. Pilot hole shall be drilled along bore path. In the event that the pilot bore does deviate from the bore path, notify the Engineer, who may require contractor to pull-back and re-drill from the location along bore path before the deviation.

12. Limit curvature in any direction to reduce force on the pipe during pullback. Ideally, the directional bore should lie in a vertical plane. The minimum radius of curvature shall be no less than that specified by the pipe manufacturer and as indicated on the drawings.

13. In the event that a drilling fluid fracture, inadvertent returns or returns loss occurs during pilot hole drilling operations, Contractor shall cease drilling and contact the Engineer.

14. Engineer will approve the pilot hole bore alignment prior to back reaming phase and pipe installation.

15. After successfully completing the pilot hole, the bore hole shall be reamed to a diameter which meets all local jurisdictional standards and the following table as a minimum:

Nominal Pipe Diameter	Bore Hole Diameter
< 8 inches	Pipe Dia. + 4 inches
8 inches to 24 inches	Pipe Dia. X 1.5
> 24 inches	Pipe Dia. + 12 inches

16. Multiple reaming passes shall be used at the discretion of the Contractor and shall conform to these specifications.

17. A swivel shall be used between the reaming head and the fusible polyvinylchloride pipe to minimize torsion stress on the assembly.

18. In the event of a drilling fluid fracture, returns loss or other loss of drilling fluid, immediately inform the Engineer, restore any damaged property to original condition and clean up the area in the vicinity of the damage or loss.

C. Pipe Pull-Back and Insertion.

1. Pipe shall be fused prior to insertion, if the site and conditions allow, into one continuous

length.

2. Handle the pipe in a manner that will not over-stress the pipe prior to insertion. Vertical and horizontal curves shall be limited so that the pipe does not over-deflect, buckle, or otherwise become damaged. Damaged portions of the pipe shall be removed and replaced.

3. The pipe entry area shall be graded as needed to provide support for the pipe and to allow free movement into the bore hole.
   a. The pipe shall be guided into the bore hole to avoid deformation of, or damage to, the pipe.
   b. The fusible polyvinylchloride pipe may be continuously or partially supported on rollers or other Engineer approved friction decreasing implement during joining and insertion, as long as the pipe is not over-stressed or critically abraded prior to, or during installation.

4. Buoyancy modification shall be at the sole discretion of the Contractor, and shall not exceed the pipe supplier's recommendations. Water ballasting of the pipeline is required. Damage caused by buoyancy modifications shall be the responsibility of the Contractor.

5. Once pullback operations have commenced, the operation shall continue without interruption until the pipe is completely pulled through the bore hole. Except for drill rod removal, pull-back operation shall not cease until the pipe has been completely installed to final position. During the pull-back operations, excessive pullback force shall be reported to Engineer.

6. The pipe shall be installed in a manner that does not cause upheaval, settlement, cracking, or movement and distortion of surface features. Any damages caused by the Contractor's operations shall be corrected at no cost to the Contracting Authority.

D. Installation Acceptance and Cleanup.

1. The Contractor shall at all times provide and maintain instrumentation that will accurately locate and record pilot hole position, measure drill-string axial and torsional loads, and measure drilling fluid discharge rate and pressure.
   - Pilot hole position, measure drill-string axial and torsional loads shall be recorded at intervals of 10 feet minimum.
   - Drilling fluid discharge rate and pressure shall be recorded at 30 feet intervals minimum.

2. The Contractor shall at all times provide and maintain instrumentation that will accurately locate and record pull-back axial loads. Pull-back axial loads shall be recorded at intervals of 10 feet minimum.

3. **Tolerances.**
   a. Actual entry and exit points shall be located within three feet laterally from the points shown on the drawings
   b. Actual entry point shall be located no more than 10 feet longintudinally past (in the direction of drilling) the point location shown on the drawings. The actual entry point cannot be located longitudinally behind the point shown on the drawings.
   c. The actual end of casing points must be located within one foot (in any clock face direction) from the points shown on the drawings.
   d. The casing pipe springline must be within one full borehole diameter (any clock face direction) from the springline location shown on the drawings.

4. If the final grade of the finished installation is not satisfactory to the Engineer, the pipe shall be abandoned, full pressure grouted in place in accordance with the jurisdictional authority, and an alternate installation shall be made. The abandoned pipe shall be properly shown on as recorded drawings to be submitted following conclusion of the construction work.
5. The Engineer shall inspect the installed pipe ends for roundness and/or damage. Evidence of

significant surface scratching shall be brought to the attention of the Engineer. Gouges or excessive surface damage of more than 10% of the wall thickness may be grounds to abandon the bore and re-drill another line at no additional cost to the Contracting Authority.

6. Following the installation, the project site shall be returned to a condition equal to or better than the pre-construction condition of the site. All excavations will be backfilled and compacted to 95% maximum density. All pavement and hardscape shall be repaired per applicable jurisdictional standards, excess materials shall be removed from the site, and disturbed areas shall be re-landscaped. All drilling fluid shall be properly disposed of per these specifications and all applicable jurisdictional laws.

E. Leakage Testing For Non-Pressure Piping.

1. Gravity sanitary sewers shall be tested for excessive leakage. This may include appropriate water or low pressure air testing. The leakage outward or inward (exfiltration or infiltration) shall not exceed 25 gallons per inch of pipe diameter per mile per day for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet. The air test, if used, shall be conducted in accordance with one of the following Standards:
a. ASTM F1417
b. UNI-B-6

2. The testing method selected shall properly consider the existing groundwater elevations during the test. If the test section fails the test for excessive leakage, the Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the Contracting Authority.

F. Deflection Testing For Non-Pressure Piping.

1. After completion of the backfill, the Engineer may require that a deflection test be performed. If the test section fails the test for excessive deflection, repair or replace all defective materials and/or workmanship at no additional cost to the Contracting Authority.

2. Deflection tests should be conducted using a go/no-go mandrel. The mandrel's outside dimension shall be sized to permit no more than 7.5% deflection. The percent deflection shall be established from the base inside diameter of the pipe. If the internal beading of the joints for the pipe are not required to be removed, the mandrel shall account for this clearance as well. The mandrel shall be approved by the Engineer prior to use. Lines that permit safe entry may allow other deflection test options, such as direct measurements with extension rulers.

G. Partial Testing.
Segments of the pipe may be tested separately in accordance with standard testing procedure, as approved by the Engineer.

H. Pipe-System Connections.
Pipe connections shall be installed per applicable standards and regulations, as well as per the connection manufacturer's recommendations and as indicated on the drawings. Pipe connections to structures shall be installed per applicable standards and regulations, as well as per the connection manufacturer's recommendations.

120145.04 METHOD OF MEASUREMENT.
Lump Sum Item.

120145.05 BASIS OF PAYMENT.
Payment will be lump sum per bid item Cased Dual-Siphon System (24 inch and 30 inch Carrier Pipe).