PART 1 GENERAL

1.01 SCOPE OF WORK

The Contractor shall furnish all labor, materials, tools, equipment and incidentals necessary to install all Reinforced Concrete Pressure Pipe (RCPP), including fittings, specials, rubber gaskets, accessories and joint protection as shown on the drawings and as specified herein. The work shall include the testing of materials, pipe and pipelines.

1.02 RELATED WORK

A. Trenching, Backfilling and Compaction are addressed in Section ___.
B. Valves & Appurtenances are addressed in Section ___.
C. (Insert Other Section References as Necessary)

1.03 REFERENCE STANDARDS

The work as specified herein shall be governed by the latest revision/edition of the following standards and codes in effect at the time of bid opening:

A. American Water Works Association (AWWA)

1. AWWA C302 – Reinforced Concrete Pressure Pipe, Noncylinder Type
2. AWWA Manual M9 – Concrete Pressure Pipe, Manual of Water Supply Practices

B. American Society for Testing & Materials (ASTM International)

1. ASTM A27 – Standard Specification for Steel Castings, Carbon, for General Application
2. ASTM A36 – Standard Specification for Carbon Structural Steel
3. ASTM A82 – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
4. ASTM A185 – Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
5. ASTM A283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
6. ASTM A285 – Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
7. ASTM A370 – Test Methods and Definitions for Mechanical Testing of Steel Products
8. ASTM A496 – Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
9. ASTM A497 – Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
10. ASTM A568 – Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled, and Cold-Rolled, General Requirements for
11. ASTM A575 – Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
12. ASTM A576 – Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
13. ASTM A615 – Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement

14. ASTM A635 – Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for
15. ASTM A659 – Standard Specification for Commercial Steel (CS), Sheet and Strip, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled
16. ASTM A663 – Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties
17. ASTM A675 – Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
18. ASTM A706 – Standard Specification for Low-Alloy Steel, Deformed, and Plain Bars, for Concrete Reinforcement
19. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High Strength Low-Alloy, and High Strength Low-Alloy with Improved Formability (structural steel or commercial steel)
20. ASTM A1018 – Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial Drawing, Structural, High Strength Low-Alloy, and High Strength Low-Alloy with Improved Formability, and Ultra- High Strength
21. ASTM C29 – Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate
22. ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
23. ASTM C33 – Standard Specification for Concrete Aggregates
24. ASTM C39 – Compressive Strength of Cylindrical Concrete Specimens
25. ASTM C94 – Standard Specification for Ready-Mixed Concrete
26. ASTM C127 – Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption for Coarse Aggregate
27. ASTM C128 – Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
28. ASTM C150 – Standard Specification for Portland Cement
29. ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete
30. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
31. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
32. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete
33. ASTM C497 – Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
34. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

C. American Concrete Pipe Association (ACPA)

1. Concrete Pipe Design Manual
2. Concrete Pipe Handbook

D. American Association of State Highway & Transportation Officials (AASHTO)

1. A Policy on Geometric Design of Highways and Streets

E. American Concrete Institute (ACI)

1. ACI 305R – Guide to Hot Weather Concreting

F. Canadian Standards Association (CSA)

1. Canadian Highway Bridge Design Code (CHBDC)

G. American Railway Engineering and Maintenance-of-Way Association (AREMA)

1. Manual for Railway Engineering

1.04 SUBMITTALS

A. Layout Documents

Submit tabulated laying schedule or drawings based on information as shown on project drawings. Laying schedule or drawings shall show code/piece numbers for all pipe, fittings and specials. These code/piece numbers shall correspond to markings on the pipe, fittings and specials. The location of all pipe, fittings and specials shall conform to the locations indicated on the drawings. Pipe supplied from inventory shall be approved by the Engineer.

B. Delivery Schedule

Submit anticipated delivery schedule.

C. Joint Details

Submit details of the pipe, joint rings and reinforcing steel size and spacing.

D. Test Reports (If Required)

1. Reinforcing Steel
2. Cement
3. Gasket Rubber

1.05 QUALITY ASSURANCE

A. Qualifications

All reinforced concrete pressure pipe, fittings and specials shall be furnished by a manufacturer with a minimum of five (5) years experience in the manufacture of reinforced concrete pressure pipe. The pipe manufacturer shall be a member of the American Concrete Pressure Pipe Association and the manufacturing facility shall have a current Lloyd's Register Audit Certification for the manufacture of reinforced concrete pressure pipe, noncylinder type (AWWA C302). The pipe, fittings and specials shall be designed, manufactured and installed in accordance with industry standards and methods and shall comply with specification requirements as stated herein.

B. Pipe Handling and Inspection

Care shall be taken during storage, loading and transporting to prevent damage to the pipe, fittings, specials or coatings.

PART 2 PRODUCTS

2.01 MATERIALS

Unless otherwise specified herein, materials and workmanship shall be governed by AWWA C302. Wall thickness shall be as specified in AWWA C302.

A. Concrete

1. Portland Cement

Portland cement shall conform to ASTM C150, Type II. Cement shall be stored in a dry, well-ventilated location protected from the weather. If the temperature of the cement exceeds 150°F, it shall not be used until cooled to less than 150°F, or the measures recommended in ACI 305R are applied to control the effect of high temperature.

Note: Other types of portland cement may be required based on specific job conditions.

2. Cement Replacement Material

Fly ash, natural pozzolan or silica fume may be used as a partial cement replacement. The replacement material shall conform to ASTM C618 or ASTM C1240. Storage requirements for cement replacement material shall be the same as portland cement.

3. Aggregates

Aggregates shall conform to ASTM C33.

4. Water

Water used in mixing and curing concrete and mortar may be fresh or recycled and shall be clean and free from deleterious amounts of oil, acids, alkalies and organic materials.

5. Admixtures

Admixtures conforming to ASTM C494 may be used unless otherwise specified. The use of admixtures containing chlorides is prohibited.

6. Concrete Mix

The proportions of portland cement, cement replacement material (if specified), fine aggregate, coarse aggregate and water used in concrete for pipe shall be determined and controlled to provide a uniform, dense, durable concrete. Concrete shall have a portland cement content of not less than 560 pounds per cubic yard, except that up to 20 percent by weight of the cement may be replaced by an approved fly ash or natural pozzolan or up to ten (10) percent by weight of the cement may be replaced by an approved silica fume. The water-soluble chloride ion (Cl^-) content of the concrete mix, expressed as a percentage of the weight of cement, shall not exceed 0.15 percent.

The minimum 28-day concrete compressive strength shall be 4500 psi or that required by the pipe design, whichever is greater.

To satisfy the 28-day strength requirements, a set of at least two (2) standard test cylinders shall be made each day from every 50 cubic yards of mixed concrete or per pipe, whichever is less, to a maximum of six (6) cylinders per day. The concrete shall be removed from the mix in accordance with ASTM C172. Test cylinders shall be made in conformance with ASTM C31. The initial curing of the test cylinders shall be at the same temperature, for the same total length of time, and by the same means (accelerated cure, water, or combination) as applied to the pipe. After initial curing, the test cylinders shall be cured in accordance with ASTM C31. All test cylinders shall be tested in accordance with ASTM C39.

The moving average strength of any ten (10) consecutive strength tests of cylinders representing the 28-day strength for each mix design shall be equal to or greater than the required strength. Not more than two (2) of ten (10) strength tests shall have less than the required result. No individual strength test shall be more than ten (10) percent below the specified strength.

Note: Under certain design conditions, other types of cementitious materials may need to be considered.

B. Reinforcing Steel

1. Bars

   Steel bar reinforcement shall conform to ASTM A36 (modified to minimum yield strength of 40,000 psi), ASTM A615 or ASTM A706.

2. Stirrups

   Stirrup reinforcement shall confirm to ASTM A82 or ASTM A615.

3. Wire

   Steel wire reinforcement shall conform to ASTM A82 or ASTM A496.

4. Welded Wire Reinforcement

   Welded wire reinforcement for pipe or mortar coating of fittings shall conform to ASTM A185 or ASTM A497.

5. Joint Rings

   Steel for joint rings shall have minimum yield strength of 30,000 psi and minimum elongation of 20 percent (2-inch gauge length).

   Steel strip for bell rings shall conform to ASTM A659, ASTM A1011 (except that the maximum carbon content shall be 0.25 percent) or ASTM A1018.

Steel plate for bell rings or special shapes for spigot rings shall conform to ASTM A36, ASTM A283 (Grade B or C), ASTM A576 (Grade 1012 or 1015) or ASTM A635 (Grade 1012 or 1015). Merchant quality bars conforming to ASTM A575 (Grade M1012 or M1015) or ASTM A663 (Grade 50) may be used, provided the surface finish is satisfactory.

C. Gaskets

Gaskets for the joints shall be continuous solid rings made of a composition of natural or synthetic polyisoprene rubber. The cross section of gaskets shall be circular with a diametral tolerance of plus or minus 0.015 inch. Surfaces of gaskets shall be smooth and free from pits, cracks, blisters and other imperfections. The rubber compound shall be dense, homogeneous and free from porosity and air pockets, and shall contain no rubber substitute, reclaimed rubber or deleterious substance

Two (2) splices in each gasket will be permitted, provided the length of gasket between splices is at least 24 inches. Gaskets shall be stored in a cool, dry area and protected from the direct sunlight.

2.02 BASIS OF DESIGN

A. Pipe

Pipe shall be designed in accordance with the AWWA Manual M9, using the design parameters as stated herein. These parameters shall also be used in the design of any fittings and specials that include an interior and exterior coating of portland cement mortar on a steel cylinder.

1. Internal Pressure

a. Design Working Pressure (P_w) shall be ___ psi.

Note: AWWA Manual M9 requires the actual system working pressure for design purposes. The working pressure should not be increased as AWWA Manual M9 utilizes appropriate safety factors.

b. Transient (surge) Pressure (P_t) shall be ___ psi.

Note: Transient pressure is the pressure that can occur over and above the working pressure during a transient (surge) event. In the absence of a design transient pressure (P_t) specified by the purchaser, the industry recommends using a transient pressure of 40 percent of the working pressure or 40 psi, whichever is greater. In gravity flow conditions, the transient pressure will be zero (0).

c. Field Test Pressure (P_{ft}) shall be ___ psi.

Note: AWWA Manual M9 recommends a field test pressure of 120 percent of the working pressure.

2. External Loading

a. Earth Loads

Earth loads shall be computed using Marston equations for trench conditions based on the following:

1) Depth of cover as shown on project plans
2) Trench width as shown on project plans

***Note**: Typically, the most economical pipeline projects are achieved by minimizing trench widths. ACPPA recommends the following trench widths for proper placement of the pipe and bedding material:*

Pipe Diameter (inches)	*Trench Width*
16 – 48	*Outside Pipe Diameter + 2.0 feet*
54 – 72	*Outside Pipe Diameter + 2.5 feet*
84 – 96	*Outside Pipe Diameter + 3.5 feel*
102 – 120	*Outside Pipe Diameter + 4.0 feet*
126 – 144	*Outside Pipe Diameter + 5.0 feet*

b. Olander Coefficients

Olander coefficients shall be based on the following:

1) TYPE R___ Bedding

***Note**: The five (5) bedding details for RCCP are contained in AWWA Manual M9. For most installations, R3 or R4 bedding is sufficient.*

2) Bedding Angle = ___ Degrees

***Note**: The recommended bedding angle for R3 is 60 degrees. The recommended bedding angle for R4 is 90 degrees.*

***Note**: Unlike flexible pipe materials such as steel, ductile iron, fiberglass and plastic, RCCP is designed as a rigid structure that does not rely on soil side support to resist external loads. The bedding and backfill details on the project plans should reflect this benefit in order to obtain the most economical design for the client.*

3) Unit Soil Weight = 120 pounds per cubic foot

c. Live Loads

Live loads shall be computed in accordance with the ACPA *Concrete Pipe Design Manual or Concrete Pipe Handbook*, based on the following:

1) AASHTO HS-20 or CHBDC CL-625, Section 3.8.3.2 for two trucks passing
2) AREMA Cooper E-80 for pipe within a railroad right-of-way and not in a tunnel liner or casing

3. Thrust

In areas where the pipe alignment will be subject to unbalanced hydrostatic thrust forces (i.e., at bends, tees, bulkheads, wyes or valves), the unbalanced forces shall be addressed in accordance with AWWA Manual M9.

Note: Consult ACPPA or your local pipe manufacturer for recommended methods of pipe restraint.

4. Wall Thickness

The minimum wall thickness of the pipe shall be $^{1}/_{12}$ of the nominal pipe diameter.

5. Lengths

The manufacturer shall designate the standard length to be furnished, and all standard pipes shall be uniformly of that length. To meet special requirements as approved by the Engineer, pipe sections may be furnished shorter than the standard length.

B. Joints

Each length of standard pipe shall have a steel bell ring and a steel spigot ring. The spigot ring shall have a groove in its exterior for the purpose of retaining a solid O-ring rubber gasket, which shall seal the joint under normal conditions of service.

C. Fittings

Fittings shall be of the steel cylinder type. Steel sheet or plate thickness of all fittings shall be designed in accordance with Chapter 8 of AWWA Manual M9. Fittings shall be designed for the same conditions as the adjacent pipe.

2.03 MANUFACTURING

A. Equipment

The manufacturer shall furnish necessary plant, storage facilities, forms and equipment for manufacturing and curing the pipe and testing the components.

B. Steel Reinforced Cages

1. Circumferential Reinforcement

The circumferential reinforcement shall consist of a minimum of two (2) cages of bars or wire wrapped in a hoop or helical form, or welded wire reinforcement, rolled to the proper diameter. Splices may be lap or butt-welded, but the weld must develop the full strength of the wire or bar.

2. Longitudinal Reinforcement

The size and spacing of longitudinal reinforcement in the pipe shall be determined by the manufacturer such that it shall be sufficient to make the cage rigid and to support the transverse reinforcement firmly in place in the forms during placing and consolidation of the concrete. The pipe shall be manufactured with sufficient longitudinal reinforcement to allow the finished pipe to be properly handled during installation in the construction of the pipeline. Longitudinal reinforcement in the outside cage may extend to the ends of the pipe.

3. Placement

Reinforcing cages shall be placed in the wall of the pipe such that the minimum concrete cover is one (1) inch +/- ¼ inch. Spacers or chairs may be used to position the cages and they may extend to the concrete surface.

C. Joint Rings

1. Forming

The bell stock and special spigot shape shall be rolled and butt-welded to form round steel rings. Resistance or electric arc welding shall be used. Welds on gasket contact surfaces shall be ground smooth and flush with the adjacent surfaces. Joint rings shall be sized by expansion beyond their elastic limits. Joint rings shall be welded to the inside cage reinforcement.

2. Coating

Prior to pipe shipment, the exposed portions of the steel joint rings on the completed pipe shall be cleaned and protected with a shop-applied rust-inhibiting primer or metalized zinc coating.

D. Pipe Concrete Wall

1. Concrete

Fine aggregate, coarse aggregate, cement and cement replacement material, if specified, shall be batched by weighing. Water used in the mix shall be metered or weighed, and allowance shall be made for any free moisture present in the aggregates. All materials shall be mixed to a homogeneous mixture. No water may be added to the mix once the concrete has been discharged from the mixer. The temperature of the mix shall not be less than 40oF at the time of placement.

2. Casting

The pipe wall shall be produced by vertical wet casting method.

3. Curing

After casting, the pipe shall be initially cured by accelerated or water curing methods, as described in the following paragraphs, or by a combination of these methods.

Concrete test cylinders made and tested in accordance with Section ___ shall verify the required compressive strength.

a. Accelerated Curing

As soon as practical after completion of casting, the pipe shall be enclosed within a suitable curing chamber that protects it from outside drafts. Enclosures shall allow full circulation around the inside and outside of the pipe. Until four (4) hours after final placement of the concrete, the ambient temperature within the enclosure shall not be less than 40oF and shall not be raised above 100oF by introducing heat. After the 4-hour delay period, the temperature shall be increased at a rate not to exceed 40oF per hour, and thereafter maintained at a temperature between 90oF and 125oF for a minimum of eight (8) hours, except for the time required to remove the casting forms. The total curing period, consisting of the 4-hour delay period, the accelerated cure and the ambient cure, shall be sufficient to produce the concrete strength required by design. The ambient temperature in the curing chamber shall be thermostatically controlled and continuously recorded. Exposed concrete surfaces shall be kept continuously moist, either by maintaining an atmosphere in the curing chamber with a relative humidity of not less than 85 percent or by the presence of free water in contact with the exposed surfaces. The forms shall not be removed until at least 6 hours after the start of curing. As soon as practicable after removal of the forms, the pipe shall again be enclosed and curing continued.

For that part of the cure after removal of the forms, the curing facility shall provide a moist atmosphere about the entire pipe core with a relative humidity of not less than 85 percent.

b. Water Curing

Water curing may be substituted on a time-ratio basis of 4 hours of water to 1 hour of accelerated curing for any part of the cure after removal of the forms. The pipe may be water cured by a system of perforated pipe, sprinklers, porous hose or other approved means that keeps the outside and inside of the pipe continuously moist.

E. Repairing

Repairs may be made to damaged pipe, so long as they are compatible with the method of pipe making. All repairs are subject to approval of the Engineer.

F. Marking

Each length of standard pipe and special pipe shall have the manufacturer's identification marks and date of casting plainly marked inside one end of the pipe. Each pipe shall be sufficiently identified to show its proper location in the pipeline by reference to layout

drawings or schedules. Beveled pipe shall be marked at the spigot end to show the degree of bevel and the point of maximum pipe length.

PART 3 EXECUTION

3.01 GENERAL

A. Pipe Care

Pipe shall be handled carefully, shipped and stored in a manner designed to prevent damage to any part of the pipe, fittings, specials or coatings.

B. Inspection and Acceptance

Minor imperfections shall be repaired in the field in accordance with the manufacturer's procedures.

Damaged pipe, fittings or specials shall be repaired in the field if permitted by the Engineer or returned to the pipe plant for repairs or replacement. All repairs shall be in accordance with the manufacturer's procedures. All materials used for repair shall be approved by the Engineer and pipe manufacturer. Repairs shall be carefully inspected before installation of the pipe.

Damaged pipe discovered after installation shall be repaired in place if permitted by the Engineer and pipe manufacturer. All repairs shall be in accordance with the manufacturer's procedures. If in-place repairs are not permitted, the damaged pipe shall be removed and replaced.

C. Live Loads

The Contractor shall regulate and control equipment and construction operations such that live loads on the pipe do not exceed the design loads for the pipe. If longitudinal cracks caused by construction equipment or other loads exceed those allowed by AWWA C302, the pipe shall be repaired in accordance with the manufacturer's procedures as approved by the Engineer.

D. Pipe Manufacturer's Field Service Representative

The pipe manufacturer shall provide a qualified Field Service Representative, who shall be available to be on the project site upon proper notice.

1. Experience

The Field Service Representative, who shall be an employee of the pipe manufacturer, shall have experience as a representative of the manufacturer in the area of providing such field services.

2. Onsite Services

Installation of the pipeline shall be performed in accordance with specified standards and manufacturer's recommendations. The Contractor shall ensure the manufacturer's Field Service Representative will be onsite to provide the following services:

a. Perform initial pipe pre-installation training
b. Evaluate problems and provide advice during pipe installation

3.02 INSTALLING PIPE AND FITTINGS

A. General

Reinforced concrete pressure pipe, fittings and specials shall be installed in accordance with AWWA Manual M9, except as otherwise required herein. A firm, even support shall be provided along the entire pipe length by tamping the bedding material in the haunch areas and at the sides of the pipe to achieve the required bedding support angle. Blocking shall not be permitted.

B. Pipe Interior

All pipe, fittings and specials shall be thoroughly cleaned before installation and shall be kept clean until used in the work. The pipe interior shall be maintained dry and broom clean throughout the construction period.

C. Pipe Installation

Installation of pipe, fittings and specials shall confirm to the lines and grades shown on the drawings. When laying is not in progress, the open ends of the pipe shall be closed by watertight plug or other means approved by the Engineer to prevent unauthorized entrance of people, animals, dirt, debris or water into the pipeline already installed.

D. Joint Deflections

Angular changes in pipe alignment shall be formed by deflecting joints, straight pipe with beveled ends, fittings or a combination of these techniques. Joints may be deflected to form curves, to span angle points or to correct alignment. The deflections at joints shall not exceed the amount recommended by the pipe manufacturer.

E. Jointing

Gasket, gasket groove and bell sealing surfaces shall be cleaned and lubricated with a lubricant furnished by the pipe manufacturer. The lubricant shall be approved by the Engineer for use in potable water and shall be harmless to the rubber gasket. Pipe is normally installed with bell ends facing the direction of laying. The method of pipe jointing shall be in accordance with AWWA Manual M9 and the pipe manufacturer's recommendations. Once the joint is made, the position of the gasket in the spigot ring groove shall be checked with a feeler gauge provided by the pipe manufacturer. If the gasket is found to be displaced, the joint shall be removed, the gasket replaced, the joint re-laid and the gasket position rechecked.

F. Joint Protection

Exposed surfaces of steel joint rings shall be protected by methods compatible with the pipe manufacturer's production processes and in accordance with AWWA Manual M9.

Note: Consult ACPPA or your local pipe manufacturer for recommended methods of joint protection.

3.03 CLEANING

At the conclusion of installation and prior to post-construction hydrostatic testing, the pipeline shall be flushed with water or other method approved by the Engineer to remove all dirt, stones and debris which may have entered the pipeline during construction.

3.04 TESTING

The completed pipeline (or completed sections of the pipeline) shall be bulkheaded, filled with water and pressure tested to 120 percent of the internal working pressure as measured at the low point of the pipeline. After the line is filled with water, and prior to pressure testing, the pipe shall be allowed to soak under low pressure for a minimum of 48 hours so the pipe walls can absorb water and the temperature can stabilize. When filling the line, the contractor shall properly bleed off any trapped air to avoid adversely affecting the leakage test results.

During hydrostatic testing, the contractor shall use a calibrated meter or other device approved by the Engineer to accurately measure the quantity of water necessary to maintain the test pressure on the gauge. The pipeline will be accepted when the measured quantity is less than 50 gallons per inch of diameter per mile of pipeline per 24-hour test period.

Visible leaks shall be repaired using a procedure approved by the Engineer regardless of measured leakage.

END OF SECTION