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SECTION 500 - WATER

SECTION 500 – CONSTRUCTION REQUIREMENTS

500.01 – DESCRIPTION

This section covers general construction requirements of water lines and appurtenances as described herein.

500.02 – PREQUALIFICATION

For this Water Project, the bidder shall be pre-qualified as Class “A” or “B” to perform all Water Construction Work as required by the ORDINANCE NO.20, 815, passed by the Council of the City of Oklahoma City on May 27, 1997. The Contractor must obtain all permits required by the City of Oklahoma City, State and federal regulations and laws.

500.03 – CONSTRUCTION OUTSIDE CITY LIMITS

The Contractor performing work outside the corporate limits of Oklahoma City shall comply with all ordinances, regulations, and policies of the county and city wherein the work is located. He shall obtain any permits, provide barricades and lights, and make repairs as required by the responsible authorities.

500.04 – TEST HOLES

Test hole information, when shown on the plans or included in the specifications, shall only represent subsurface characteristics to the extent indicated, and only for the point location of the test hole.

Each bidder shall make his own interpretation of the character and condition of the materials that will be encountered between test hole locations. Each prospective Bidder may, at his own expense, make additional surveys and investigations as he may deem necessary to determine conditions which will affect performance of the work.

500.05 – ORDER OF CONSTRUCTION

The Contractor shall start at enough different locations to complete the entire contract within the time limit specified. Water Line appurtenances shall be constructed as soon as the Water Line that they serve is constructed to their locations. Postponing the construction of appurtenances until the Water Line has been completed, or the building of appurtenances in advance of the construction of the Water Line, will not be permitted.

A) The construction of Water Lines for more than six hundred feet (600') in advance of appurtenances which are incomplete or the construction of which has not been started, will not be permitted.

B) Unless otherwise directed by the Engineer, the Contractor shall leave no more than six hundred feet (600') between backfilling operations and the complete restoration of paving, paving cut and permanent repairs, driveway permanent repairs, fencing, sodding, etc.

C) When Temporary Surfacing is provided for in the contract documents, the Contractor shall complete temporary paving repair immediately before backfill is completed.

D) Temporary Surfacing shall be done in accordance to Section 824.02. Materials shall be asphalt in accordance to Section 824.02 Part A.

E) All water lines that are to be abandoned in place shall be cut to the nearest connections and either capped or plugged as required to provide a tight connection. The Contractor shall be responsible for providing the appropriate plug or cap for the job. When an existing valve is abandoned in a grassy area the box is to be pulled and the top nut removed from the valve. The cost of this work is considered incidental.

500.06 – DELIVERY OF MATERIALS

Construction materials shall not be delivered to the site of the work more than three (3) days in advance of their anticipated use nor shall the quantity of pipe or other materials on hand at the site of the work at any time be in excess of the amount required to complete six hundred (600') feet of Water Line unless with special permission of the Engineer.

500.07 – SURFACE DRAINAGE STRUCTURES

When not called for on the plans or specified as a separate bid item, all surface drainage structures and appurtenances shall be removed and replaced in a condition equal to or better than the original installation when required. No additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

500.08 – CONCRETE AND STEEL REINFORCEMENT

Unless otherwise specified, all concrete used in construction of waterlines and their appurtenances shall be High Early Strength Concrete and have a minimum three (3) day compressive strength of three thousand five hundred (3,500 psi) pounds per square inch and shall conform with the applicable requirements of Section 932. All steel reinforcement used shall be grade sixty (60) with a minimum yield strength of sixty thousand (60,000 psi) pounds per square inch and meet the applicable material requirements of Section 900. All steel reinforcement shall be coated with epoxy coatings and conform to ASTM A 775 standards.

500.09 – DEPTH OF COVER

Where not otherwise indicated on plans, the pipe shall be laid at an elevation that will provide after completion, a minimum depth of cover over the top of pipe shall be 4 feet (4') below the surface.

500.10 – STANDARD DESIGN CONDITIONS

A) **Standard Design Pressures** - Unless otherwise specified, all pipes and fittings shall be designed for the following minimum pressure conditions:

Pipe Nominal Size (inches)	Minimum Internal Pressure (psi)		
	Working	Surge	Design
< 48	150	100	250
? 48	200	200	400

B) **Live Loading** - Unless otherwise specified or called for on the plans, minimum pipe design corresponding to the specified design pressure shall be for highway live loading condition and where waterline is crossing or running parallel to the railroad, corresponding minimum pipe design for railroad live loading condition shall govern (with or without casing).

C) **Section Line Pipes** – Unless otherwise specified all section line mains and pipes shall be greater than twelve (> 12") inches in diameter and ductile iron pipe. The ductile iron pipe shall be installed as per Section 524.

D) **All Pipes** – Pipe materials with allowable sizes shall be in accordance with the following table.

Pipe Material	Size
Pre-stressed Concrete Embedded Cylinder Pipe (PCECP)	? 48”
Polyvinyl Chloride (PVC) Pipe	? 12”
Steel Pipe	? 48”
Ductile Iron Pipe (DIP)	? 64”

500.11 – CLEAN-UP

A) Water main installation procedures require clean-up operations to follow excavation and construction a distance not to exceed three hundred feet.

B) Sodding, seeding, sprigging, and fertilizing operations will be accomplished following completion of water main installation. Sod will be preserved and replace in areas where heavy sod existed prior to construction.

C) Compaction of trench backfill to 90% standard proctor density will be required. Test will be performed to assure density. The cost of this work shall be included in the cost per linear foot. High traffic areas shall be compacted to 95% standard proctor density.

SECTION 505 – PIPE AND FITTINGS INSTALLATION

505.01 – DESCRIPTION

This section covers installation of pipes in open-cuts, in conformity with the lines, grades, and dimensions and as provided in applicable sections of these specifications.

505.02 – MATERIALS

505.02.01 – PIPE AND FITTINGS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Pre-stressed Concrete Embedded Cylinder Pipe (PCECP)	526
Flexible	Polyvinyl Chloride (PVC) Pipe	525
	Steel Pipe	527
	Ductile Iron Pipe (DIP)	524

505.02.02 – EMBEDMENT

A) **General** - Embedment material shall meet the requirements of Section 215. Prior to delivery, the Contractor shall submit laboratory tests for materials to be used for embedment, and backfill. Materials shall be approved by the Engineer prior to placement.

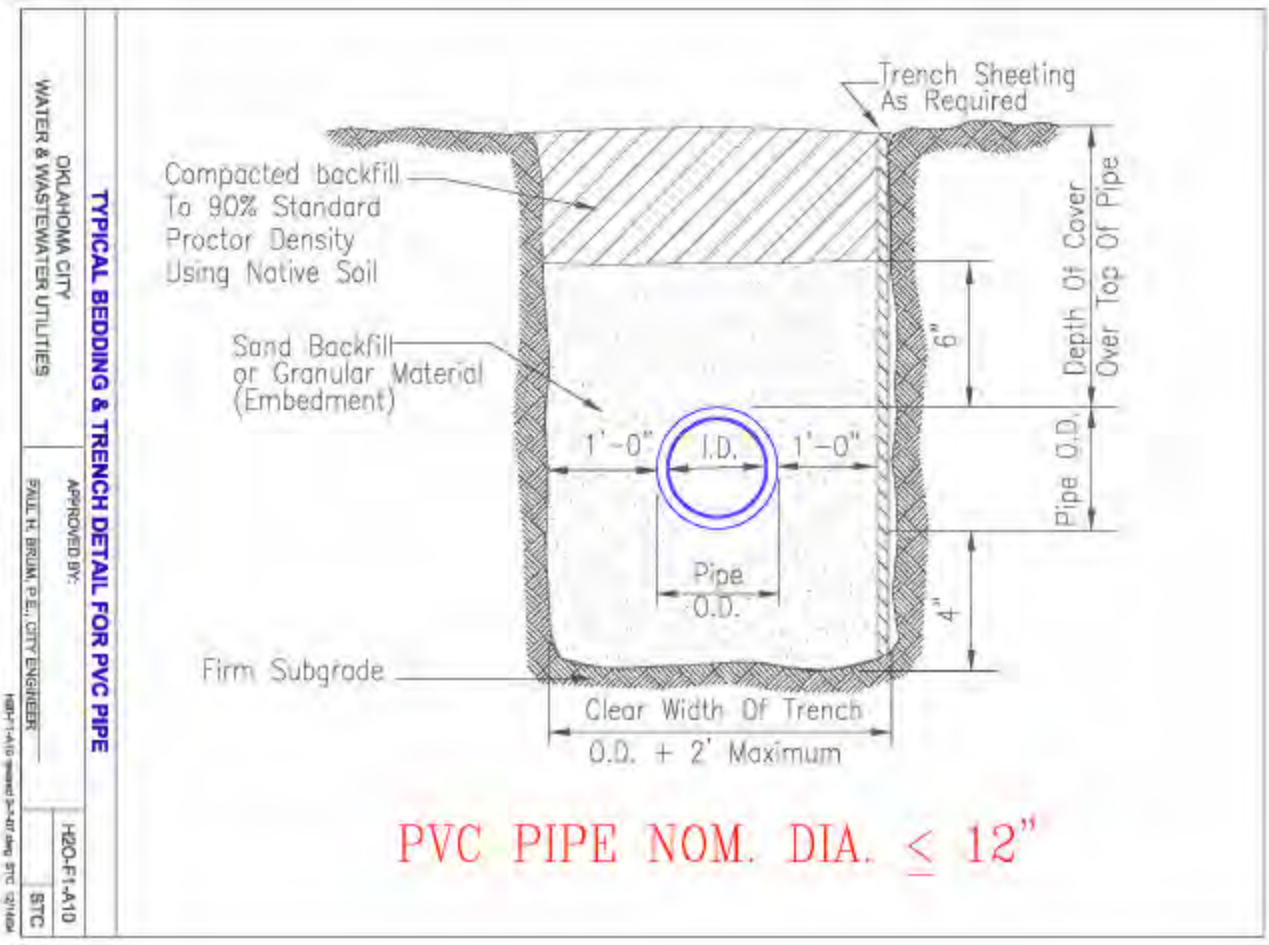
B) **Invoices** - The Contractor shall submit invoices for the purpose of complying with the minimum quantities necessary to complete installation pursuant to the appropriate standard details and the minimum dimensions specified.

505.04 – CONSTRUCTION METHODS

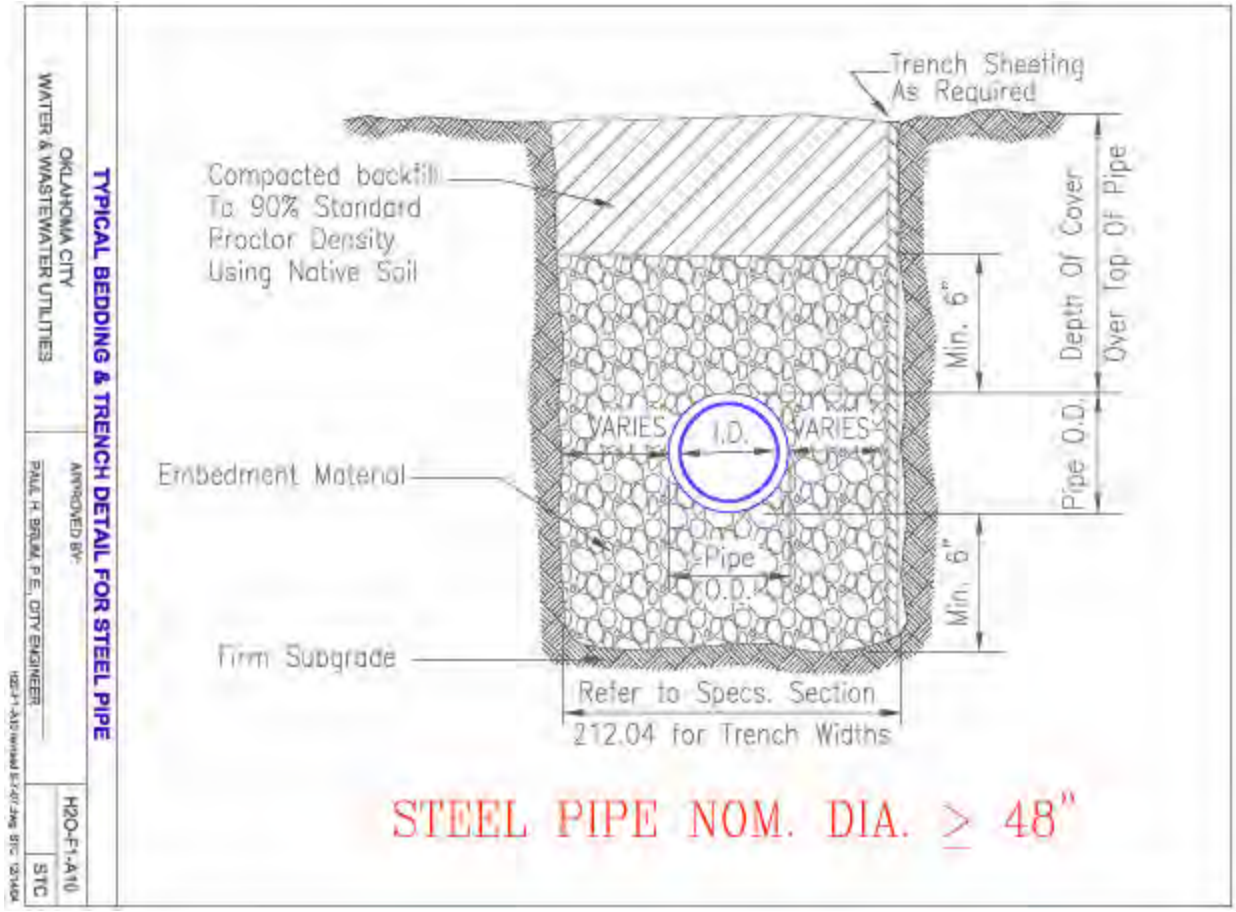
505.04.01 – BEDDING AND HAUNCHING

A) **Rigid Pipe** - All rigid pipes greater than or equal to forty-eight inches (?48") shall be embedded in accordance with AWWA Manual M9, "Concrete Pressure Pipe", Type "4" Bedding and in accordance with the dimensions and lines shown on the Drawings and meeting the requirements of Section 526.

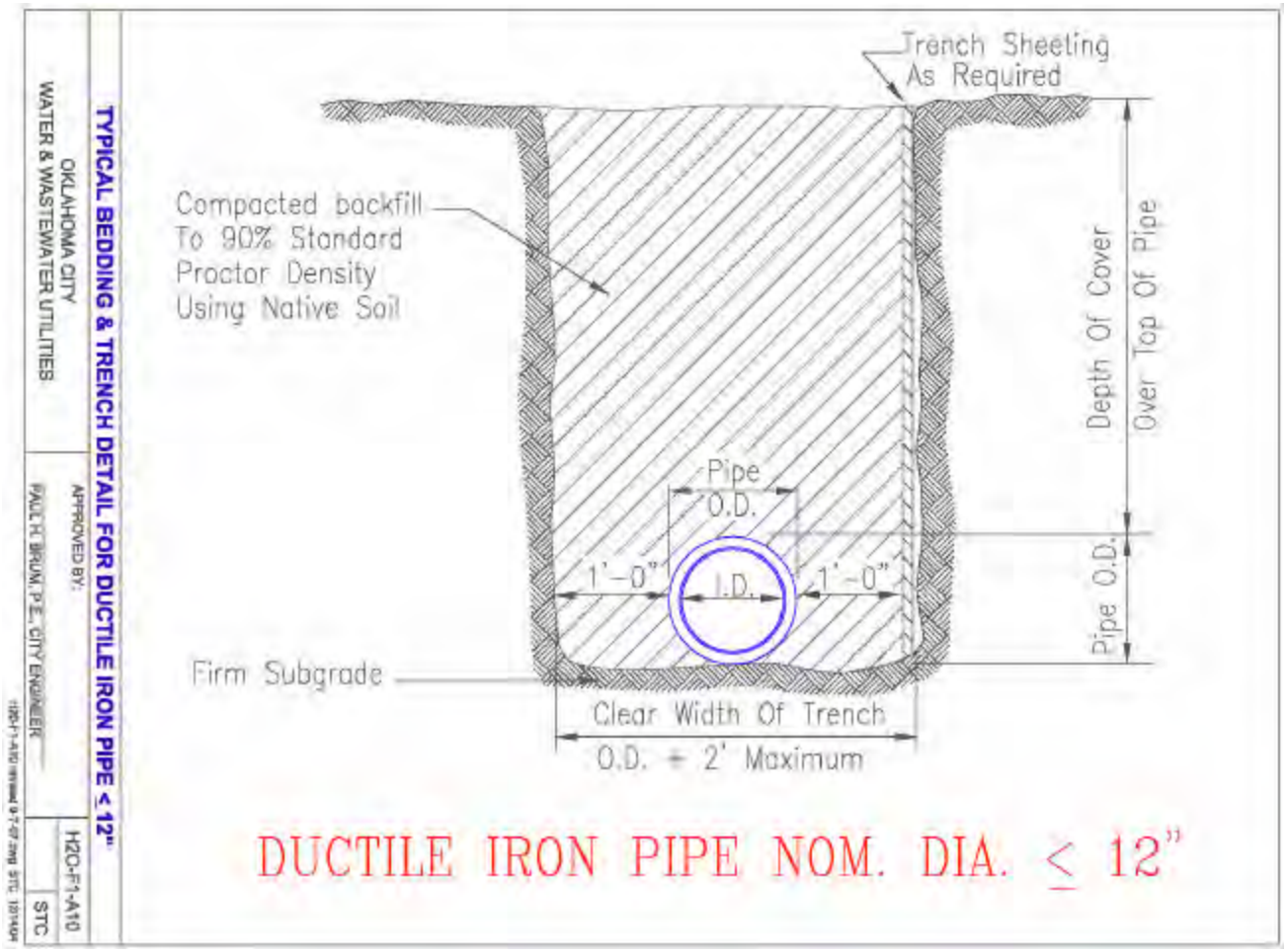
B) **Polyvinyl Chloride (PVC) Pipe**– All PVC pipe less than or equal to 12 inches (? 12")shall be embedded in accordance with ASTM D-2774, "Standard Recommended Practice for Underground installation of Thermoplastic Pressure Piping", and ASTM D-2321, "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe", and as shown on the Standard Detail "Typical Bedding and Trench Detail for PVC Pipe" and meeting the requirements of Section 525 .



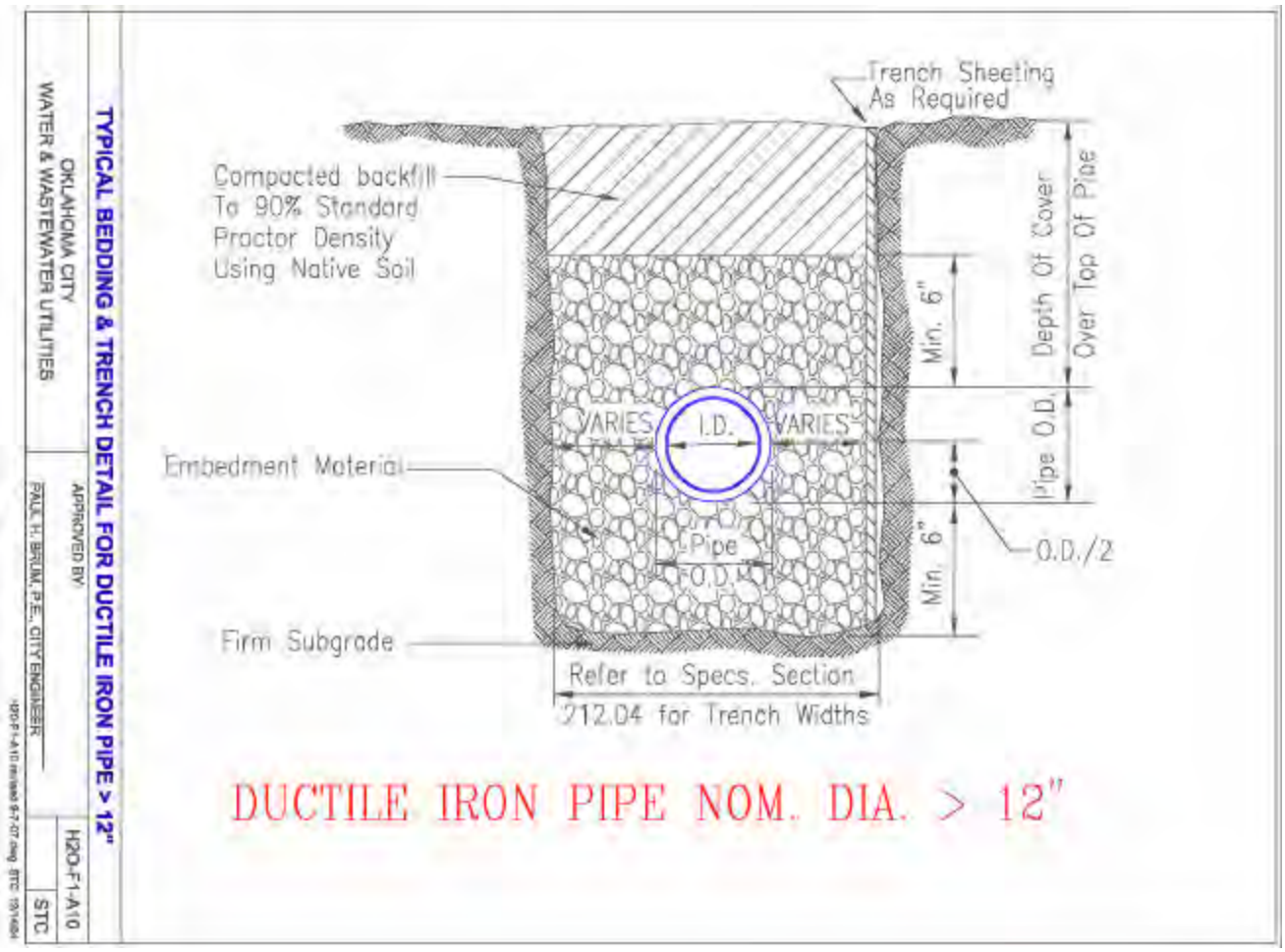
C) **Steel Pipe** – All steel pipes shall be embedded as shown on the Standard Detail ”Typical Bedding and Trench Detail for Steel Pipe” and meeting the requirements of Section 527.



D) **Ductile Iron Pipe (DIP)** – All ductile iron pipe less than or equal to twelve inches (12”) in diameter shall be embedded in accordance with the requirements of Section 524 and as shown on the Standard Detail “Typical Bedding and Trench Detail for Ductile Iron Pipe ? 12””.



All ductile iron pipes greater than twelve (12”) inches in diameter shall be embedded in accordance with AWWA C-150, Type 4 or Type 5 Laying Condition as modified in the Standard Detail “Typical Bedding and Trench Detail for Ductile Iron Pipe > 12”” and meeting the requirements of Section 524.



505.04.02 – INSTALLATION REQUIREMENTS

A) **Shipping, Handling and Storage -** Pipe shall be transported from the plant, where it is manufactured, to the job site employing special methods of packaging to prevent damage to the pipe. After the pipe is received at the job site, it shall be carefully inspected for any damage that may have occurred in transit. The pipe shall be handled at all times with care using padded slings or hooks. The pipe shall not be dropped, skidded or rolled against pipe already on the ground. If any damage occurs to pipe, the pipe shall be rejected. All pipe and accessories shall be stored on flat, level ground with no rocks or other objects under the pipe. Gaskets for push-on joints and pipe shall be stored in cool location out of direct sunlight in accordance with the manufacturer's recommendations.

B) **Pipe Foundation -** No waterline shall be laid unless the foundation is in a condition satisfactory to the Engineer. Where trenches are excavated in soft, unsuitable, or rock, trench bottom shall be stabilized in accordance with Section 215 when directed by the Engineer.

C) **Laying Requirements -** All pipes, specials, fittings and other appurtenances shall be examined carefully for damage and other defects before installation. The City retains the right to reject damaged and defective materials.

The pipe ends shall be free of all lumps, blisters and they shall be wiped clean of foreign materials such as dirt and sand before installation.

Pipe shall be laid with the bell ends facing in the direction of laying unless directed otherwise by the Engineer. Where pipe is laid on a slope of ten (10%) percent or greater laying shall start at the bottom and proceed up the slope.

When laying pipe is not in progress during the noon hour or overnight, the open ends of the pipe shall be closed by watertight plugs. If water is in the trench the plugs shall be left in place until the trench is pumped dry.

Bell holes for bell-and-spigot pipe shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of pipe. Bell holes shall not be excavated more than ten (10) joints ahead of pipe laying. Filling and ramming earth or other material beneath the pipe to raise it to grade shall not be permitted.

The Contractor shall use every precaution at all times during construction of the pipeline. All pipe, specials, fittings, and other appurtenances shall be lowered carefully into the trench with suitable equipment, to prevent damage to the waterline materials. In rock trenches, plywood shields or other approved means shall be used to prevent the cradled pipe from swinging against the sides of the trench.

All joint preparation and joining operations shall comply with the instructions and recommendations of the pipe manufacturer and meet the joint requirements in the appropriate material section. For PCECP, the position of the rubber gasket shall be checked with a feeler after each joint is completed. Additionally, when laying PCECP, the maximum joint opening shall not exceed three-eighths inch (? "). Rubber gaskets shall be positioned on the joint in accordance with the manufacturer's recommendations. Immediately before joints are pushed together, all joint surfaces shall be coated with the lubricant furnished with the pipe.

Any damage to the pipe, from any cause during installation of the pipeline shall be cause for replacement, as directed by the Engineer, and at the expense of the Contractor.

After a section of pipe is properly installed and approved for backfill, the trench shall be backfilled and compacted as per Section 212.

505.06 – METHOD OF MEASUREMENT

Payment for "Waterline Pipe" shall be made at the unit price bid per lineal foot of pipe installed for each size. The price established shall be full compensation for all materials including pipe, short pieces and specials, embedment material, labor, tools, equipment and incidentals necessary to complete this item of work. "Waterline Pipe" shall be measured along the pipe, through fittings and valves.

For pipes less than or equal to sixteen inches (16”) in diameter, payment for fitting shall be paid for by pounds. For pipes greater than sixteen inches (16”) payment for fittings shall be made at price bid for each fitting type. The price established shall be full compensation for all materials including fittings, embedment material, concrete thrust blocks, labor, tools, equipment and incidentals necessary to complete this item of work.

505.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) (TYPE) WATERLINE PIPE (JOINT TYPE)(NOM WALL THICK)	L.F.
FITTINGS (SIZE AND TYPE)	LBS.
FITTINGS (SIZE AND TYPE)	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 510 – WATER SERVICE LINE CONNECTIONS

510.01 – DESCRIPTION

510.01.01 – GENERAL

This section covers water service line connections in sizes five-eighths inch (5/8") through two inches (2") for use in buried service lines from the main to the meter valve or meter setting appurtenance in accordance with ANSI/AWWA C-800 Standard for Underground Service Line Valves and Fittings or as modified herein. All water service lines shall be connected as per city ordinances.

510.01.02 – DEFINITIONS

The following definitions shall apply:

A) **Adapter** - A fitting used to connect pipe, tubing, or other fittings with differing characteristics such as sizes, diameters, or material type.

B) **Chamfer** - A bevel made on the end of a thread to facilitate thread engagement.

C) **Corporation valve (stop)** - A valve attached to the water main to start a service connection, which is used to interrupt flow during installation or maintenance of the service line.

D) **Coupling** - A fitting for connecting two pipes or tubing sections together.

E) **Curb valve** - A valve installed in the water service line and accessible for operation from the surface of the ground for routinely interrupting flow through the service line.

F) **Driving thread** - A thread installed on the outlet end of corporation valves and used to hold the valve during installation.

G) **Dry seal** - A type of pipe thread covered by ANSI/ASME B1.20.3. Dryseal pipe threads are based on the USA (American) pipe thread. They differ from the USA (American) pipe thread in that they are designed to seal pressure-tight joints without the need for sealing compounds.

H) **Fitting** - A part used to connect piping or tubing.

I) **Inlet** - The opening in a valve or fitting through which flow from the water main enters the valve or fitting.

J) **N.P.T.** - National Pipe Thread as specified in ANSI/ASME B1.20.1.

K) **Outlet** - The opening in a valve or fitting through which flow from the water main leaves the valve or fitting.

L) **Service line check valve (backflow preventers)** - A check valve used to minimize backflow and reduce the potential for contamination of water in the main line if pressure in the main is reduced or service pressure is increased.

M) **Tapping saddle** - A fitting that attaches circumferentially to a pipe to provide for attachment of a corporation valve.

510.02 – MATERIALS

Castings - Materials in contact with potable water shall be made from copper alloy No. C83600, in accordance with the chemical and mechanical requirements of ASTM B-62 or ASTM B-584. The alloy shall contain nominally eighty-five (85%) percent copper and five (5%) percent each tin, lead, and zinc, or approved equal.

Component Parts - Component parts such as fasteners, seals, and packing may be of other materials selected for adequate endurance, corrosion resistance, and strength.

510.02.01 – DESIGN OF VALVES AND FITTINGS

General - Valves, fittings, and parts thereof shall be machined to the sizes and tolerances defined in AWWA C-800. End connections may be threaded, brazed, compression, or flared as appropriate.

Pressure Rating - Service line valves and fittings shall be suitable for use with water at one hundred (100?) degree F and one hundred fifty (150 psi) pounds per square inch pressure.

510.02.02 – DETAILED DESIGN OF VALVES AND FITTINGS

Dimensions of Corporation Valves:

A) **General** - Corporation valves shall be installed with drilling or tapping machines. Unless otherwise specified, the minimum inside diameter of the waterway through a corporation valve shall be large enough to accommodate the maximum drill sizes herein. Maximum drill sizes for installation of corporation valves and service clamps or saddles with a driving machine shall be as shown below.

Corporation Valve Size (inches)	Maximum Drill Size (inches)	
	Corporation Valve with AWWA Thread Inlet	Corporation Valve with N.P.T. Thread inlet
?	9/16	.....
¾	11/16	11/16
1	15/16	?
1¼	1 3/16	1?
1½	1 7/16	1 7/16
2	1?	1¾

B) **Overall Body Dimensions** - For corporation valves to be installed by a tapping machine, overall body dimensions shall conform with the dimensions listed below.

Corporation Valve Size (inches)	Maximum Radius (inches)	Maximum Length (less nut) (inches)
?	1.50	4?
¾	1.50	4?
1	1.50	4?
1¼	2.50	9 1/16
1½	2.50	9 1/16
2	2.50	9 1/16

C) **Tapping Saddles -** Tapping Saddles shall conform to the requirements of Section 533.

D) **Service Line Fittings**

a. **General** - The fittings used in service lines shall be designed for connection to the service line by threads, brazing compression, and/or flaring. Small waterways and abrupt corners causing water turbulence and pressure drop shall be minimized.

b. **Solder for service line fittings** - When solder is used with fittings, it shall be "lead free" with a maximum lead content of no more than two-tenths (0.2%) percent as defined in

the 1986 amendments to the SDWA.

E) **Service Line Check Valve** - Check valves may be of an angle design or straight-through design, with good fluid-flow characteristics. The spring shall be strong enough to resist opening with a one (1 psi) pounds per square inch pressure in the direction of flow. The check valve shall be field repairable without removing the valve body from the service line.

510.02.03 – END CONNECTIONS

End connections shall be in conformance with AWWA C-800.

510.04 – CONSTRUCTION METHODS

510.04.01 – GENERAL

The following are general connection requirements only. Additional plumbing code and other requirements may be applicable, which are not included herein.

A) Single taps shall be made at forty-five (45?) degree angles from crown of distribution main. When two (2) or more taps are to be made, they shall be a minimum of thirty-six (36") inches apart and alternate from forty-five (45?) degrees to thirty (30?) degrees from crown of distribution main.

B) Back/reverse tap may be allowed only under adverse conditions and as directed by the Engineer.

C) No tap shall be allowed on fire hydrant leads except under adverse conditions and when approved by the Engineer.

D) Corporation valves (stops) shall be a minimum of one inch (1") for new installations. Existing connections may be replaced with the original size.

E) When tapping dedicated firelines, the tap shall be on the main side of the pit and shall have a gate valve on the outlet side of the double detector check.

F) Direct taps shall be allowed into mains up to twenty (20") inches in diameter. Taps into mains greater than twenty (20") inches shall require a main extension of a size not less than six (6") inches in diameter.

G) Tapping saddles equal to JCM Product No. 406 "Coated Service Saddle with Double Stainless Steel Straps" may be used for three quarter (¾") to two (2") inch service line connections on mains two (2") to twenty (20") inch diameter. Tapping saddle shall also conform with the requirement of Section 533. All other taps shall be accomplished using tapping sleeves in accordance with Section 532.

H) When tapping saddles are installed and approved test shall be performed. Saddles shall hold a minimum of eighty (80 psi) pounds of pressure for thirty (30) minutes.

I) When reconnecting to existing three (3") inch services, reducing of tapping saddles shall only be allowed for a three (3") inch service. A four (4") inch tap shall be allowed with a four (4") inch by three (3") inch reducer from the tapping saddle. No other reductions of the tapping saddles shall be allowed.

J) Service connections two (2") inches and smaller shall be by corporation valve (stop) of the same size as the service line and meter to be installed. Corporation valves shall be as specified in Section 510.02. Service connections to the main for service lines larger than two (2") inches shall be a branch connection, and shall comply with these specifications.

K) Service connections to all ferrous mains shall be electrically insulated by means of an approved insulating fitting. Care shall be taken to properly install corporation valves and provide enough

slack in service lines to protect against pullout.

L) Under no circumstances is a machined-over-all (MOA) asbestos-cement pipe to receive a corporation valve. Machined-over-all (MOA) polyvinyl chloride pipe may receive a corporation valve.

M) When tapping mains where it is necessary to remove part of the polyethylene wrapping, the polyethylene wrap shall be repaired or replaced in such a manner as to protect both the pipe and corporation valve. Any bedding material removed during excavation shall be replaced in kind and compacted.

N) No tees shall be connected to existing water service lines three inches (3") and smaller in diameter providing water to a single meter of the same size.

510.04.02 – AFFIDAVIT OF COMPLIANCE

When requested, the Contractor shall provide an affidavit of compliance that valves and fittings furnished comply with all provisions of these specifications.

510.05 – TESTING

Any valves or fittings found defective shall be replaced with new valves or fittings at the Contractor's expense.

510.07 – BASIS OF PAYMENT

The items as provided above will be paid for at the contract unit price bid:

WATER SERVICE LINE CONNECTION (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 511 – WATER SERVICE LINES

511.01 – DESCRIPTION

511.01.01 – GENERAL

This section covers water service lines intended to be used from the connection to the meter valve for meter setting appurtenance in accordance with AWWA G-800 Standard for Underground Service Line Valve and Fitting or as modified herein. All water service lines shall be connected as per city ordinances.

511.01.02 – TYPES

A short service line is a line not in excess of ten (10') feet. All services in excess of ten (10') feet shall be considered long service lines. Extra long services are used for special circumstances and shall be noted on the plans. Service lines shall be single service unless otherwise directed by the Engineer.

511.02 – MATERIALS

All service lines shall be seamless copper tubing of the designation, "Type K". All fittings shall be brass or copper. Substitutions such as plastic or PVC pipe shall not be accepted. For three-quarter (¾") inch to one inch (1") service lines meter tailpieces shall be "Type K" copper in composition and twenty-four (24") inches in length. A brass male or female union shall be required for the last fitting on the City side of the water service. Said union shall not include plastic or galvanized fittings.

511.04 – CONSTRUCTION METHODS

The following are general construction requirements only. Additional plumbing code and other

requirements may be applicable, which are not included herein.

A) General - Service lines shall be a minimum of one inch (1") for new installations. Existing service lines may be replaced with the original size. Service lines three-quarter (¾") inch to one inch (1") and dead ends shall not be split.

Joints in water lines less than one and one-half (1½") inch in diameter shall not be soldered. No unnecessary unions shall be permitted. A one and one-half (1½") inch diameter service line may be split with two (2) three-quarter (¾") inch or one inch (1") service line only. A two (2") inch diameter service line may be split with six (6) three-quarter inch (¾) inch or two (2) one inch (1") service lines only. No service lines less than one and one-half (1½") inches in diameter shall be split.

B) Boring –

a. Copper lines under street pavement shall not be spliced
b. Street bores shall be a minimum of thirty (30") inches below the bottom of the street.
c. Bores for service lines three-quarter (¾") and one inch (1") in diameter shall not be larger than the service.
d. Bores for service lines one and one-half (1½") inches and two (2") inches in diameter shall not be larger than the service, except when encased with steel pipe.
e. Encasement pipe shall be welded with continuous weld and extend twelve (12") inches past curb lines.
f. Service line bores shall be level and at the same depth as the main.

511.06 – METHOD OF MEASUREMENT

The price established shall be full compensation for all materials including copper service lines, boring, fittings and when required service line check valve, connections to meter, labor, tools, equipment, and incidentals necessary to complete this item of work.

511.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DOUBLE SERVICE (SIZE) EA.
SINGLE SHORT SERVICE (SIZE)EA.
SINGLE LONG SERVICE (SIZE) EA.
SINGLE EXTRA LONG SERVICE (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 512 – METER RELOCATION

512.01 – DESCRIPTION

This section covers meter relocation as called for on the plans and specifications or as directed by the Engineer.

512.02 – MATERIALS

A) General

a. Meters that are three inches (3") and larger in diameter shall be compound meters or turbine meters.

b. Elbows, tees and wyes shall not be allowed on the City side of meters larger than two (2") inches. Wyes and tees shall be allowed only for service splits of one and one-half (1½") inch and two (2") inch services.

c. Isolation valves shall be a minimum of five (5) pipe diameters on the City side of meter, and two (2) pipe diameters on the customer side of meter.

d. Throttling valves, check valves, backflow preventers and pressure-regulating devices shall be no closer than twenty (20) pipe diameters outside of the meter on the customer side. Under no circumstance will these valves be allowed in the same pit with the meter.

e. One and one-half (1½") inch and larger meters shall be set on blocks a minimum of twelve (12") inches above the floor of the pit and shall be centered in pit and shall have a minimum of eighteen (18") inch clearance between the outside of the meter and the inside of the pit wall.

f. Pits for meters three inches (3") and larger shall have a minimum unobstructed pipe length equal to five (5) and two (2) times the diameter of pipe on the City and customer side of meter, respectively.

B) Strainers

a. Two (2") inch compound meters shall be set with strainers. All three (3") inch and larger meters, whether compound or turbine, shall be set with strainers.

b. Strainers on all meters from two (2") inches to six (6") inches shall be bronze. Strainers on all meters eight (8") inches or larger shall be cast iron.

c. Backflow Preventers

i. Backflow preventers shall be required for all service connections in conjunction with fire or lawn sprinkler systems or swimming pools.

ii. Services supplying water that could be chemically treated in-line or within the system shall require backflow preventers. Water connection and services with frost-free spigots, shall require backflow preventers.

iii. Meters shall not be installed until backflow preventer has been installed.

iv. Backflow prevention devices shall be installed on the customer's side of the meter.

v. Backflow prevention devices shall meet the standards set forth in the BOCA National Plumbing Code, and comply with the requirements of AWWA M-14.

C) Fireline with Domestic Meters – Double detector check and backflow preventers shall be installed between the customer's fireline and the customer's domestic facilities. No single service shall be permitted for fireline and domestic facilities without separate meter and cutoff.

512.04 – CONSTRUCTION METHODS

The following are general installation requirements only. Additional plumbing code and other requirements may be applicable, which are not included herein.

A) Meters

a. Meters shall not be installed unless the foundation of the structure is complete. Meters shall not be installed unless the private house line is in place in accordance with the most recent Plumbing Code set forth or incorporated in the Oklahoma City Municipal Code.

b. After the service and the private line are installed and meter is set, and before service is backfilled, the corporation connection shall be turned on to check for leaks in the service line, corporation valve and meter.

c. An approved backflow prevention device shall be installed before sprinkler meters are

set. Sprinkler meters shall have a service separate from the private line or acceptable service split and separate meter pit or tile. Any meter that services a fire sprinkler, irrigation for landscaping, or directly services a swimming pool, is considered a "sprinkler meter" and requires the same installation procedures as a domestic meter with the exception that a backflow prevention device shall be present between the meter and the sprinkler system before the meter can be set.

d. For three-quarter (¾") inch to one inch (1") service lines, the top of curb valve (stop) shall be eighteen (18") inches to twenty-four (24") inches below inside top of meter box.

e. All meters and meter pits shall be installed on City property, easement or right-of-way.

f. When water service cannot be interrupted for the purpose of meter relocation, a bypass around the meter shall be installed.

B) Meter Boxes

a. Meter boxes shall be Carson 2200 or approved equal. Meter boxes shall be set on firm unpaved surfaces and away from sidewalks and drives. Meter boxes shall be accessible to meter readers. Meter boxes shall be used only for one and one half (1 ½") inch and two (2") inch meters

b. The top of meter box shall be set at grade level. If the ground is not to final grade at the time of the installation of the meter box and tile, then the installing contractor shall raise or lower the meter box when the final grade is established.

c. In pedestrian and vehicular traffic areas or areas surrounded by pavement or concrete, a poured-in-place meter pit or MSBCF-XL box/cover or equal shall be installed. Under no circumstances are corrugated steel meter boxes to be used.

d. A "W" must be chiseled/cut in the curb on the City side of meter location.

C) Pits

a. Pits for meters of three inches (3") and larger in diameter shall comply with the Standard Detail for Meter Pits.

b. The pit wall through which the inlet/outlet pipe passes shall be properly sealed with bituminous material.

512.06 – METHOD OF MEASUREMENT

Payment for "Meter Relocation" shall be made at the unit price bid per each, for each size. The price established shall be full compensation for all materials including valves, fittings, meter lock, meter pit, labor, tools, equipment, and incidentals necessary to complete this item of work.

512.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

METER RELOCATION (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 513 - WET CONNECTIONS

513.01 – DESCRIPTION

This section covers wet connections for tie-in to existing mains. The connections shall be either a cross or tee as called for on the plans where tapping is not allowed.

513.04 – CONSTRUCTION METHODS

The wet connection shall begin with isolating the point of tie-in by closing of valves. The existing main shall then be cut where wet connection is to be made and the line drained.

513.06 – METHOD OF MEASUREMENT

Payment for "Wet Connection" shall be made at the unit price bid per each for each size. The price established shall be full compensation for cutting of the line, dewatering or draining of the main, labor, tools, equipment and incidentals necessary to complete this item of work. The cost of furnishing and installation of required fittings shall be paid for separately pursuant to Section 505.

513.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

WET CONNECTION (SIZE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 514 – TAPPING CONNECTIONS

514.01 – DESCRIPTION

This section covers water main tapping for main connections for sizes four (4") inch to forty-eight (48") inch in diameter.

514.02 – MATERIALS

The following materials shall be used and meet the requirements of the appropriate Sections listed below.

Tapping Mechanism	Section
Tapping Sleeves	532
Tapping Valves	520.02.02

514.04 – CONSTRUCTION METHODS

A) Description - A tap is the cutting of a coupon, utilizing a tapping sleeve or saddle with tapping valve for a connection.

B) Methods

a. Direct taps - Direct taps shall be made when the main to be tapped is on the same horizontal plane as the branch. The cutting operation is to be done with a sharp shell-cutter tool, which shall be lubricated with the manufacturer's recommended cutting tool lubricant.

b. Swing Ties - Swing ties shall be made when the main to be tapped is either above or below the branch when called for on the plans or specified. A swing tie may consist of

i. Waterline pipe
ii. Tapping sleeve as necessary;
iii. Tapping valve and Box;
iv. Tap;
v. Solid sleeve;
vi. Ninety degree (90?) bends.

514.06 – METHOD OF MEASUREMENT

Payment for "Tap" shall be made at the unit price bid per each for each size of the following: Tapping

Sleeve, Tapping Valve and Box, and Tap. The price established shall be full compensation for all material, labor, tools, equipment, and incidentals necessary to complete this item of work. Fittings and valves shall be paid for under other items of work.

514.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) TAP EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 515 – FIRELINES

515.01 – DESCRIPTION

This section covers construction of firelines and installation of associated appurtenances as described herein.

A fireline shall be considered any waterline, which exclusively serves fire hydrants, located on private or public property or which serves fire sprinkler or fire standpipe systems located on private property, in addition to a possible domestic service.

Construction of firelines and associated appurtenances shall comply with the applicable requirements of Oklahoma City Code for Fire Prevention and Protection and International Plumbing Code, as amended.

A double detector check valve of a type and manufacture as described herein shall be used to detect the possible leakage or misuse of water and provide a positive separation between the City's domestic water system and automatic fire sprinkler systems. The double detector check valve with bypass meter, with a check valve in the bypass, shall be used as the service inlet to all firelines.

515.02 – MATERIALS

Double detector check valves shall be iron body, bronze seat or disk ring, designed for a bypass meter, flanged or mechanical joint ends, and shall be approved by Underwriter's Laboratories, Inc., or Factory Mutual Laboratories. Double detector check valves shall be approved by the American Society of Sanitation Engineering (ASSE). Upon request of the Engineer, the manufacture shall furnish a certificate of compliance and acceptance by ASSE.

515.02.01 – FIRE HYDRANTS

Fire hydrants shall conform to the requirements of Section 516 and the appropriate Standard Details.

515.02.02 – BYPASS METER

Double detector check valves serving fire lines, regardless of the type of system they serve, shall be equipped with a bypass meter located in the building as the fireline enters the building, or located in an approved pit. The double detector check valve and bypass meter shall be installed in the system prior to any other appurtenances, in an accessible location for periodic inspections by the Fire Department. Bypass meters shall conform to the latest ASSE Standard #1048 and ASSE Standard #1047.

515.02.03 – ISOLATION VALVE

Isolation valves shall be gate valves conforming to the requirements of Section 520. Isolation valves shall be installed on all fire system lines serving fire sprinkler or fire standpipe systems and shall be located on public right-of-way.

515.02.04 – FIRE STANDPIPE

Fire standpipes shall be installed pursuant to the requirements of the applicable sections of the Oklahoma City Code for Fire Prevention and Protection.

515.02.05 – METER PIT

Meter pits shall be constructed to the dimensions shown on the appropriate Standard Details for Meter Pit Construction.

515.04 – CONSTRUCTION METHODS

Construction of firelines and their appurtenances shall conform to the appropriate Standard Detail for Fireline Construction.

515.07 – BASIS OF PAYMENT

Payment for firelines shall be pursuant to the Bid Items as established in the Contract Documents.

SECTION 516 – FIRE HYDRANTS

516.01 – DESCRIPTION

This section covers fire hydrants intended to be used for fire protection when specified or called for on the plans. The hydrant shall be located and positioned in such a way as to be accessible and protected from traffic.

516.02 – MATERIALS

516.02.01 – GENERAL

All fire hydrants furnished shall conform to AWWA C-502, as amended, or as modified herein. No hydrant manufacturer shall be considered which has not regularly manufactured hydrants continuously for a period of at least ten (10) years. No hydrant model shall be considered which has not regularly been in service for a period of at least two (2) years. Fire hydrants shall be the products of the following companies or approved equal.

Hydrants shall conform to AWWA Standard C502, latest revision. Hydrants shall be

Company Name	Product Identification
American Darling	Model 5¼" B-84-B
Mueller	Centurion 200 Model A-423
M & H	Reliant Model 129
U.S.	Metropolitan
Clow	Medallion

516.02.02 – SUBMITTALS

The Contractor shall provide eight (8) copies of all submittals for fire hydrants. The submittal shall clearly identify the make, model, design, and metal characteristics for approval by the Engineer prior to installation.

Drawings shall show principal dimensions, metal thickness, construction details, materials used in all parts of the fire hydrant with ASTM designation and structural properties. Net assembled weight of hydrants shall be shown.

Specifications shall include comprehensive parts list with sufficient drawings or details to clearly identify

parts.

516.02.03 – AFFIDAVIT OF COMPLIANCE

The Contractor shall provide an Affidavit of Compliance that fire hydrants furnished comply with all provisions of these specifications.

516.02.04 – TYPE OF SHUT-OFF

Type of shut-off shall be of the compression type with the flow.

516.02.05 – DELIVERY CLASSIFICATION

All hydrants shall be equipped with two (2) hose nozzles and one (1) steamer nozzle. Leaded in nozzles shall not be acceptable.

516.02.06 – INLET CONNECTION

Unless otherwise specified, the inlet connection shall be a mechanical joint hub complete with all joint accessories. All mechanical joint gland bolts shall be high strength, low alloy, corrosion resistant material, such as Cor-Ten or equal, as specified in ASTM A-252. The inlet valve opening shall be five and one-quarter (5¼") inches net.

516.02.07 – OUTLET CONNECTIONS

The outlet connections shall be two (2) hose nozzles, two and one-half (2½") inches in nominal I.D. and one (1) pumper nozzle five (5") inches in nominal I.D. Nozzle threads shall be Oklahoma City Standard, six (6) threads to the inch for two and one-half (2½") inch nozzles, and four (4) threads to the inch for five (5") inch nozzles pursuant to Standard Detail for Fire Hydrant Nozzle Threads.

516.02.08 – HARNESSING LUGS

Harnessing lugs shall be furnished when specified or called for on the plans.

516.02.09 – NOZZLE CAP GASKET

Gaskets shall be furnished on all nozzle caps. Gaskets shall be neoprene.

516.02.10 – DRAIN VALVE AND OUTLET

A positive operating drain valve or valves shall be provided.

516.02.11 – PAINT

Fire hydrants shall be painted with two (2) coats of high gloss International Orange enamel paint manufactured by Pittsburgh Paint or approved equal. Each coat of paint shall have a minimum dry thickness of two (2) mils.

516.02.12 – SHAPE AND SIZE OF OPERATING AND CAP NUTS

The operating and cap nuts shall be National Standard Pentagon nuts.

516.02.13 – BREAKABLE TYPE

Breakable type (traffic models) shall be furnished. A breakable type hydrant is one that requires no excavation and shall break at the design point.

516.02.14 – STAND PIPE, FLANGES, AND EXTENSIONS

Breakable parts of standpipe shall be located approximately three inches (3”) but not more than five (5") inches above the ground line. These parts shall be of the breakable flange type, breakable coupling or integral flange with sawed bolts. Breakable flanges screwed to the standpipe shall not be accepted. The flange on each end shall have at least eight (8) bolts, or other acceptable method to permit proper orientation of nozzles in forty-five (45?) degree increments and shall be designed so that a wrench can be used on nuts and bolts. Extension of hydrant shall be made by adding at the ground line flange a new coupling and stem section equal to the length of the extension. Stem extensions made by adding new section of stem to the threaded section of the stem at the top of the hydrant shall not be acceptable.

516.02.15 – STEM

Provisions shall be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point in the event of traffic accidents.

516.02.16 – COUPLINGS

If breakable or sleeve type couplings are used, they shall have sufficient torsional strength such that a torsional failure of the stem shall occur at some point other than coupling. Design of the coupling shall be such that when the coupling is broken, no parts shall come loose and fall into hydrant, and the break shall not occur through the pins or bolts holding the coupling to the stem.

516.02.17 – GROUND LINE GASKETS

Gaskets furnished for ground line flanges shall be full face, or flange shall be recessed.

516.02.18 – MAIN AND VALVE SEATS

Main valve seats on the hydrant shall be of such design that incorrect positioning is impossible and that the threads shall be adequately guided into position. Arrangements shall also be made to hold the main valve gasket in place during assembly. The main valve seat shall be made of bronze and threaded into a bronze retainer ring or it may be threaded into a heavy bronze bushing in the hydrant base. All bronze parts in constant contact with the water shall be of type "A", "D", or "E" bronze in accordance with Table 1, AWWA C-212.

516.02.19 – NOZZLE CAP CHAINS

All fire hydrants shall be equipped with nozzle cap chains.

516.02.20 – FLANGES

All flanges shall have a minimum thickness of seven-eighths (? ") inch. Bolt hole edge distance shall be sufficient to provide full support for the bolt heads and nuts.

516.02.21 – OPERATING STEMS

Operating stems shall be high grade bronze, wrought iron or steel. Stem nuts shall be bronze. Where passing through O-rings, iron or steel stems shall have a bronze, stainless steel, or other non-corrodible metal sleeve. Operating threads shall be sealed against contact with water regardless of open or closed position of the main valve. An internal lubricant chamber shall be provided as a part of the dry top construction. An external access for adding lubricant shall be provided

516.26 – O-RINGS

Fire hydrants shall be equipped with O-rings in lieu of stem packing.

516.27 – CAP NUTS

The hydrant shall have a cap nut to seal the bottom end of the stem threads against contact with water.

516.04 – CONSTRUCTION METHODS

516.04.01 – BURY LENGTH

Unless otherwise specified, hydrants shall be furnished with a four (4') foot six (6") inch depth of bury.

516.04.02 – TAPPING OF DRAIN OPENING

Tapping of drain opening shall not be required.

516.04.03 – DIRECTION OF OPENING

The direction of opening shall be to the left or Counter-Clockwise. An arrow and the word "OPEN" shall be cast in relief to be clearly visible on the top of the hydrant, to designate the direction of opening. A minimum number of turns to open shall be ten (10).

516.04.04 – INSTALLATION

The hydrant shall be inspected and cleaned prior to installation. It shall be placed on a concrete mat not less than four inches (4”) thick and sixteen (16") inches square. The rear side of the hydrant, opposite the pipe, shall be blocked with concrete between the hydrant and a vertical face of undisturbed earth. A minimum of seven (7) cubic feet of crushed rock shall be placed around and below the hydrant to allow the hydrant to properly drain. The hydrant shall be firmly supported prior to backfill.

516.05 – TESTING

Hydrostatic tests outlined in AWWA C-502 shall be complied with.

516.06 – METHOD OF MEASUREMENT

Payment for "Fire Hydrants" shall be made at the unit price bid per each. The price established shall be full compensation for furnishing and installing all materials including fire hydrants, extension pipe, riser pipe, and labor, tools, equipment and incidentals necessary to complete this item of work.

516.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

FIRE HYDRANT	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 517 – REMOVAL OF FIRE HYDRANTS

517.01 – DESCRIPTION

This section covers removal of fire hydrant when called for on the plans or specified.

517.04 – CONSTRUCTION METHODS

Construction shall be in conformance with the Standard Detail for Removal of Fire Hydrants. Salvaged materials, including the fire hydrant, shall be disposed of by the Contractor.

Fire hydrants removed from an abandoned water line shall be capped as required to provide a tight connection.

Fire hydrants removed from a functional water line shall be plugged and restrained as required to

provide a tight connection.

517.06 – METHOD OF MEASUREMENT

Payment for "Removal of Fire Hydrant" shall be made at the unit price bid per each. The price established shall be full compensation for all material including solid sleeves, nipples, removal of existing fire hydrant and its appurtenances, labor, tools, equipment and incidentals necessary to complete this item of work.

Cap and or plugs necessary for this work shall be paid in accordance with Section 505.07.

517.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

REMOVAL OF FIRE HYDRANT EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 518 – THRUST BLOCKS

518.01 – DESCRIPTION

This section covers thrust blocks intended to be used to transmit unbalanced thrust forces into undisturbed soil.

518.02 – MATERIALS

High Early Strength Concrete shall be used for thrust blocks. Compressive strength of concrete shall be minimum 3500 psi at three (3) days.

518.04 – CONSTRUCTION METHODS

All construction shall be in accordance with the Standard Details for Thrust Blocks.

518.06 – METHOD OF MEASUREMENT

Payment for "Thrust Blocks" shall be made at the unit price bid per cubic yard (CY) when identified on plans (neat cut dimensions); otherwise, considered incidental to construction of water line. The price established shall be full compensation for all materials including concrete, steel reinforcement, straps, labor, tools, equipment, and incidentals necessary to complete this item of work.

518.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

THRUST BLOCK CY.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 519 – BLOW-OFF CONNECTIONS

519.01 – DESCRIPTION

This section covers blow-off connections intended to be used to provide outlets for draining waterlines at low points in the profile and upstream of line valves located on a slope.

519.04 – CONSTRUCTION METHODS

Blow-off connections shall be constructed of the size, detail and location shown on the plans. Blow-offs shall be provided with a shut-off valve. Blow-offs shall be manufactured in accordance with AWWA C-208

Standard for Fabricated Steel Water Pipe Fittings. Blow off connections shall be constructed in accordance with standard details in contract.

519.06 – METHOD OF MEASUREMENT

Payment for "Blow-Off Connections" shall be made at the unit price bid per each for each size. The price established shall be full compensation for each installation, all materials, including fittings, labor, tools, equipment and incidentals necessary to complete this item of work.

519.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) BLOW-OFF CONNECTION EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 520 – WATER VALVES

520.01 – DESCRIPTION

This section covers water valves of size and type specified or called for on the plans. Unless otherwise specified, all valves twelve (12") inches or smaller in diameter shall be gate valves. Valves sixteen (16") inches and larger shall be butterfly valves. Valves specified shall be of the types shown in the following table:

Valve Type	Reference Standard	Size Range (inches)
Gate (Metal Seated)	AWWA C-500 & C-515	3" - 12"
Gate (Resilient Seated)	AWWA C-509 & C-515	3" - 12"
Tapping	AWWA C-500 & C-515	3" - 48"
Butterfly	AWWA C-504	16" - 72"
Check	AWWA C-506	½" - 10"
Check	AWWA C-508	2" - 24"
Air	.....	1" and Larger

520.02 – MATERIALS

The Contractor shall submit the following for approval prior to installation:

A) Valve make and model
B) Valve detail drawings
C) Type "A" and "B" Certifications.
D) Affidavit of Compliance with specifications

520.02.01 – GATE VALVES

A) General - Gate valves shall conform to the requirements of AWWA C-500, C-509, or C-515 and shall be, bronze mounted, outside screw and yolk, non-rising stem for buried installations and rising stem for unburied installations, open left, double disk (metal seated), parallel seat, "O-ring" for non-rising stem, and shall have standard operating nut.

B) Pressure Rating - Valves produced conforming to AWWA C-500, C-509, and C-515 shall have a design working pressure of two hundred (200 psi) pounds per square inch.

C) Acceptable Manufacturers - Gate valves shall be the product of the following manufacturers or an approved equal.

American Cast Iron Pipe Company
Mueller
US Pipe
Clow
Pratt
M & H

520.02.02 – TAPPING VALVES

A) General - Valves to be used with tapping sleeves shall have connecting flanges (Standard Class 125) with centering lip on the valve flange to fit recess or counterbore on the outlet tapping sleeve flange. The outlet end of the valve shall have a combination mechanical joint end and tapping machine flange.

B) Tapping Valves 4"-12" - Tapping valves shall conform to AWWA C-509 or C-515, except as modified for passage and clearance of tapping machine cutters. The opening through the valve shall be at least one-quarter (¼") inch larger than nominal valve diameter. The outlet end of the valve shall have the desired joint connection for the intended pipe.

Tapping valves shall allow full size cutters to be used. Seating of the disc gate shall not require any sliding or wedging to achieve a zero leakage. A maximum of three (3) internal moving parts shall be required for operation of the valve. The stem collar shall be protected from outside grit, sand, etc., by dual O-rings above stem collar. There shall be an O-ring below stem collar sealing off lubrication chamber from line fluid. Pressure energized O-rings may be used in place of flat gaskets on flanged joints in valve body/bonnet.

All interior and exterior ferrous surfaces shall be protected against corrosion by fusion-bonded epoxy coating. Coating shall be applied prior to assembly to insure coverage of all exposed areas, including boltholes.

C) Tapping Valves 16" and less than 24” - Tapping valves shall conform to AWWA C-500, covering gate valves except as modified for passage and clearance of tapping machines. The outlet end of the valve shall have the desired joint connection for the intended pipe. Valves shall be of the fully revolving, double disc, parallel seat design and have independent wedging action designed to spread the two discs against the seats in the valve body. Seats in the body shall be replaceable without removing valve from pipeline.

The two discs shall be interchangeable and field replaceable without removing valve from pipeline. Either disc shall be able to seat against line pressure. Wedging surface shall be protected by bronze, stainless steel, or other suitable material for corrosion purposes.

Valves twenty-four (24") inches and larger, to be installed with stem in horizontal position, shall be equipped with tracts and scrapers. Enclosed bevel gearing with two (2") inch square wrench nuts to be provided on sixteen (16") inch and larger horizontal stem valves. By-pass valves for equalization of line pressures on both sides of discs to be required for twenty-four (24") inch and larger valves.

All internal and external ferrous surfaces shall be coated with asphaltic varnish per Federal Specification TT-V-51, Military Specification MIL C-450, or equal.

D) Pressure Rating - Tapping valves manufactured conforming to AWWA C-500 and C-505 shall have the following pressure ratings:

Size (inches)	Working Pressure (psig)
? 12	200
? 16	150

E) Acceptable Manufacturers - Tapping valves shall be the product of the following manufacturers or an approved equal:

American Cast Iron Pipe Company
Mueller
US Pipe
Clow
Pratt
M & H

520.02.03 – BUTTERFLY VALVES

A) General - Butterfly valves shall be manufactured to all applicable sections of AWWA C-504 with modifications to permit a non-shock pressure rating of two hundred-fifty (250 psi) pounds per square inch. Unless otherwise shown on the plans, valves twenty (20") inches or smaller in diameter shall be Class 150-B. All valves twenty-four (24") inches and larger shall be equal to or better than specified below. Technical data shall be submitted to the Engineer for approval prior to installation.

B) Bodies - Bodies shall be cast-iron ASTM A-126, Class B, or ductile iron ASTM A-536, grade 65-45-12, heat-treated. Wall thickness shall be in accordance with AWWA C-504, Table 3, Class 150. Flanges shall be ANSI B16.1, Class 250.

C) Shafts - Shafts shall be stub or through shaft type of stainless steel conforming to ASTM A-564, Type 630, with one thousand one hundred fifty (1150?) degrees F. aging, and shall have diameters in accordance with Table 4, Class 150-B. If shafts are made of ASTM A-276 stainless steel, the diameter shall be increased by fifteen (15%) percent over Table 4, Class 150-B. The torsional shear stress shall not exceed fifty (50%) percent of the yield strength of the shaft material used at the maximum torque for the application.

D) Discs - Discs shall be of the double offset design so that the shaft centerline is offset both vertically and horizontally. The disc material shall be ductile iron ASTM A-536, Grade 65-45-12, heat treated or stainless steel ASTM A-296, Grade CF8M, or cast-iron ASTM A-48 or Ductile Iron ASTM A-546, Grade 65-45-12. Flow through or truss type disc shall not be acceptable.

E) Seats - Seats shall be synthetic rubber attached to the disc and held in place by retaining shoulders on both sides of the rubber seat ring and conform to ASTM A-276, Type 316 stainless steel retainer ring screws passing through the seat and retainer ring. The rubber seat ring shall seal against a ASTM A-276, Type 316 stainless steel body ring rolled and mechanically locked into the valve body. Valves twenty (20") inches and smaller shall have bonded seats. Bonded seats shall be simultaneously molded in, vulcanized and bonded to the body. Seat bond shall withstand seventy-five (75-lbs.) pounds pull when tested in accordance with ASTM D-529, Method B. Valve seats on twenty-four (24") inch diameter valves and larger shall be field adjustable and replaceable without dismantling operator, disc or shaft. Seats shall be retained

in the valve body by mechanical means without use of metal retainers or other devices located in the flow stream. The valve disc edge shall have a Type 316 stainless steel edge for mating with the rubber seat. Butterfly valves with rubber seats located on the disc shall not be allowed.

F) Bearings - The shaft shall be supported on both sides of the disc in sleeve type bearings with an area such as not to exceed one-fifth (1/5) of the compressive strength of the bearing or shaft material or the published design load for the bearing material with three hundred fifty (350 psi) pounds per square inch differential pressure across the disc.

G) Actuators - Actuators shall be of the traveling nut or link and lever type with mechanical stops in the open and closed position that are field adjustable and will withstand four hundred fifty (450) ft-lbs. of input torque against the open and shut stops without damage to the actuator.

H) Production Testing - Production testing shall be in accordance with Section 5.2 of AWWA C-504 for the seat leakage test in both directions using three hundred fifty (350 psi) pounds per square inch hydrostatic and Section 5.2.3 of AWWA C-504 for shell testing using five hundred (500 psi) pounds per square inch hydrostatic. Each valve shall be shop operated with the actuator in place for three (3) open-close cycles under no flow conditions as specified in Section 5.2 of AWWA C-214.

I) Proof-of-Design-Tests - Valve designs shall be tested in accordance with Section 5.2.4 of AWWA C-504 with five hundred (500 psi) pounds per square inch used for disc testing and three hundred fifty (350 psi) pounds per square inch used for cyclic testing.

J) Acceptable Manufacturers - Butterfly valves shall be the product of the following manufacturers or an approved equal:

American Cast Iron Pipe Company
Mueller
US Pipe
Clow
Pratt
M & H

520.02.04 – CHECK VALVES

A) General - Check valves shall conform to the requirement of AWWA C-506 Standard for Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types or AWWA C-508 Standard for Swing-Check Valves for Waterworks Service, two (2") inches through twenty-four (24") inches NPS.

B) Pressure Ratings - Check valves conforming to AWWA C-506 shall have a working pressure rating of one hundred fifty (150 psi) pounds per square inch. Valves conforming to AWWA C-508 shall have the following pressure ratings:

Size (inches)	Working Pressure (psig)
2 - 12	175
16 - 24	150

C) Acceptable Manufacturers - Check valves shall be the product of the following manufacturers or an approved equal:

American Cast Iron Pipe Company
Mueller
US Pipe
Clow
Pratt
M & H

520.02.05 – AIR VALVES

A) General - Two (2) types of air valves of size and type may be used to admit or vent air when specified or called for on the plans. The air valve may be as follows:

a. Air release valve

b. Air valve release and air vacuum combination

B) Materials - Unless otherwise specified or called for on the plans, air valves shall have a cast iron body and cover with bronze trim and stainless steel float. They shall be designed to withstand a minimum pressure of three hundred (300 psi) pounds per square inch without damage, and shall be consistent with the following specification:

Body and Cover	Cast Iron	ASTM A-48, Class 35
Float	Stainless Steel	ASTM A-240
Seat	Buna-N or Equal	.....
Retaining Screws	Stainless Steel	ASTM A-276
Guide Bushings	Stainless Steel	SAE 30303

C) Acceptable Manufacturers - Air valves shall be APCO as manufactured by the Valve and Primer Corporation or Valve and Primer Val-Matic or an approved equal.

520.04 – CONSTRUCTION METHODS

Gate valves shall be set with the stems plumb.

Check valves shall be set horizontally.

Tapping valves shall be installed in accordance with the recommendations of the pipe manufacturer being tapped.

Other types of valves shall be set in position shown on the plans or as directed by the Engineer.

At the site of the work and just prior to placing the valve in the trench, the valve shall be fully opened and closed and a record of the number of turns required for full operation shall be furnished to the Engineer. The inside of the valve shall be thoroughly cleaned before installation.

The valve shall be set on a firm base. Valves in PVC pipelines shall be supported by concrete independently of the pipe. The valve and the valve box shall be firmly supported and centered prior to backfill. Installation of valves shall also comply with the appropriate standard detail.

520.06 – METHOD OF MEASUREMENT

Payment for valves , valve boxes and valve vaultsshall be made at the unit price bid per each for each type and size of valve. The price established shall be full compensation for all material including valve, valve boxes, valve vaults, installation, labor, tools, equipment and incidentals necessary to complete this item of work.

520.07 – BASIS OF PAYMENT

Unless otherwise called out on plans, the item measured as provided above will be paid for at the contract unit price bid:

(SIZE) (TYPE) VALVE AND VALVE BOX	EA.
(SIZE) (TYPE) VALVE AND VAULT	EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 521 – VALVE BOXES AND VAULTS

521.01 – DESCRIPTION

This section covers valve boxes and vaults intended to provide means to operate the valve.

521.02 – MATERIALS

A) Valve Boxes - All valve boxes shall be three (3) piece cast iron of the extension type suitable for a depth of cover over the pipeline as required by the backfill requirements at each valve. Each valve box shall be provided with a suitable cast iron base and cover. All parts of valve boxes, bases, and covers shall be coated by dipping in hot bituminous base material.

B) Valve Vaults - Valve vaults shall be reinforced concrete structures constructed to size and dimensions shown on the appropriate standard details for valve vaults.

521.07 – BASIS OF PAYMENT

Payment for valve boxes and vaults shall be paid for as per Section 520.07.

SECTION 522 – HYDROSTATIC PRESSURE TESTING AND DISINFECTION

522. 01 – DESCRIPTION

This section covers hydrostatic pressure testing of installed water mains in accordance with the requirements specified herein.

Hydrostatic Pressure testing of all pipes shall be accomplished pursuant to Section 4 of AWWA C-600. The test pressure shall be not less than one and one-quarter (1.25) times the working pressure and not less than the testing pressures shown in the following table at the highest point along the test section. The allowable leakage in gallon per hour per one thousand (1000') feet of pipe shall not exceed the values shown in the table. The allowable leakage for welded steel pipes shall be zero (0).

Allowable Leakage Per 1000' of Pipe Line - (gph)
Table

Working* Pressure (psi)	Test Pressure (psi)	Nominal Pipe Size - (inches)									
		3	4	6	8	12	16	20	24	30	36
150	175	0.30	0.40	0.59	0.80	1.19	1.59	1.98	2.38	2.98	3.58
200	250	0.36	0.47	0.71	0.95	1.42	1.90	2.37	2.85	3.56	4.27
250	300	0.39	0.52	0.78	1.04	1.56	2.06	2.60	3.12	3.90	4.68

Allowable Leakage Per 1000' of Pipe Line - (gph)
Table (continued)

Working* Pressure (psi)	Test Pressure (psi)	Nominal Pipe Size - (inches)								
		42	48	54	60	64	66	72	78	84
150	175	4.17	4.77	5.36	5.96	6.36	6.55	7.15	7.75	8.34
200	250	4.99	5.70	6.41	7.12	7.60	7.83	8.55	9.26	9.97
250	300	5.46	6.24	7.02	7.80	8.32	8.58	9.36	10.14	10.93

*As a minimum, all pipe shall be tested at 150 psi working pressure. The test pressure shall be maintained for a minimum of two hours.

If any section of pipeline including specials, fitting and appurtenances are discovered to be damaged after the hydrostatic test, they shall be repaired or replaced with sound material and the test shall be repeated to the satisfaction of the Engineer. If any test of pipe installed indicates leakage greater than the allowable leakage, the contractor shall, at his own expense, locate and repair the source of leak in the pipeline until the leakage is within the specified allowance. All visible leaks are to be repaired regardless of the amount of leakage.

522.06 – METHOD OF MEASUREMENT

Payment for "Hydrostatic Pressure Testing and Disinfection" shall be made at the unit price bid lump sum. The price established shall be full compensation for all material, labor, tools, equipment and incidentals necessary to complete this item of work and disinfection as specified in Section 523.

522.07 – FIELD TESTING

HYDROSTATIC PRESSURE TESTING AND DISINFECTION LSUM

SECTION 523 – DISINFECTION

523.01 – DESCRIPTION

This section covers disinfection of water mains, water storage facilities, water treatment plants and wells.

523.04 – CONSTRUCTION METHODS

523.04.01 – GENERAL

A) Water Mains - All new water mains shall be disinfected before they are placed in service. All water mains taken out of service for inspecting, repairing, or other activity that might lead to contamination of water shall be disinfected before they are returned to service. All work shall

comply with AWWA C-651 Standard for Disinfecting Water Mains.

B) Water Storage Facilities - All new storage facilities shall be disinfected before they are placed in service. All storage facilities taken out of service for inspecting, repairing, painting, cleaning, or other activity that might lead to contamination of water shall be disinfected before they are returned to service. All work shall comply with AWWA C-652, Standard for Disinfection of Water Storage Facilities.

C) Water Treatment Plants - All new treatment facilities to be disinfected shall be chlorinated before they are placed in service. All treatment facilities taken out of service for inspecting, repairing, painting, cleaning, or other activity that might lead to contamination of water shall be disinfected before they are returned to service. All units that are downstream from the first point of application of disinfectant in the treatment process shall be disinfected. All work shall comply with AWWA C-653, Standard for Disinfection of Water Treatment Plants.

D) Water Wells - Disinfection and bacteriological testing of water wells shall be done prior to placing in domestic service, any well or any existing well that has received servicing or maintenance that might have caused foreign material or contamination to be introduced into the well. All work shall comply with AWWA C-654, Standard for Disinfection of Wells.

523.04.02 – FLUSHING

The Contractor shall perform preliminary flushing with potable water at a velocity of not less than two and one-half (2½-fps) feet per second. Flushing chlorinated water shall not be discharged into lakes, streams, storm drains or other bodies of water. All flushing water shall be dechlorinated in accordance with AWWA C-651 Section 4.5 prior to disposal. The site for flushing shall be selected with the approval of the Engineer and shall have adequate provision for drainage.

523.04.03 – DISINFECTION

The disinfection of the pipeline shall be performed by the Contractor and the bacteriologic and chemical tests shall be performed by the City. The Contractor shall furnish the necessary equipment and materials for disinfection and the City shall provide the necessary testing. The Contractor shall furnish labor to make the necessary connections and shall provide any temporary drainage measures for disposal of the wastewater.

523.06 – METHOD OF MEASUREMENT

Payment for "Disinfection" shall be as specified in Section 522.06. The price established shall be full compensation for all material including disinfectants, flushing, dechlorination, disinfection, hydrostatic pressure testing, labor, tools, equipment and incidentals necessary to complete this item of work. All necessary water for flushing shall be provided by the Contractor.

523.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for in accordance with Section 522.07.

SECTION 524 – DUCTILE IRON PIPE (DIP)

524.01 – DESCRIPTION

This section covers ductile iron pipe and fittings, for pressure applications, intended to be used for conveyance of raw or potable water, in sizes three inches (3") through sixty-four inches (64”). All Ductile Iron Pipe shall be polyethylene encased as per Section 524.02.08.

524.02 – MATERIALS

524.02.01 – GENERAL

All ductile iron pipe and fittings shall conform to the requirements of the following standards listed below or as modified herein.

A) ANSI/AWWA C-150/A 21.50, Thickness design of Ductile Iron Pipe
B) ANSI/AWWA C-151/A 21.51, Ductile Iron Pipe, Centrifugally Cast in Meal Molds or Sand-Lined Molds, for Water or Other Liquids.
C) ANSI/AWWA C-111/A 21.11, Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
D) ANSI/AWWA C-104/A 21.4, Cement Mortar Lining for Ductile Iron Pipe for Water.
E) ANSI/AWWA C-105/A 21.5, Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
F) ANSI/AWWA C-600, Installation of Ductile Iron Water Mains and Their Appurtenances.
G) ANSI/AWWA C-115/A 21.15, Flanged Ductile Iron Pipe with Threaded Flanges.
H) ANSI/AWWA C-116/A 21.16, Protective Fusion-Bonded Epoxy Coatings for Interior and Exterior surface of Ductile Iron and Gray Iron Fitting
I) ANSI/AWWA C-153/A 21.53, Ductile Iron Compact Fittings

524.02.02 – SUBMITTALS

When requested, the Contractor shall submit the following. No pipe, special sections and fittings shall be manufactured until shop drawings have been reviewed and approved by the Engineer.

Review and approval of the Contractor submittals, by the Engineer, shall not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing ductile iron pipe and fittings as described herein.

A) General - Detail drawings of pipes, specials, fittings, and joints.

B) Laying Schedule - Detail tabulated pipe-laying schedules corresponding to the numbers or identification painted on the pipes, specials and fittings.

C) Certification - Type "A" and "D" certification for pipe, specials, fittings, gaskets, and lining material pursuant to, but not limited to, applicable standards in Section 524. The affidavits of compliance and test reports shall be certified by a registered professional engineer.

D) Guides - The manufacturer's pipe installation guide, standard pipe material repair guide, and written quality control manual.

E) Copies - The Contractor shall provide eight (8) copies of all submittals requested herein.

524.02.03 – DESIGN BASIS

A) General - All ductile iron pipes are designed in accordance with AWWA C-150/ANSI 21.50. The designs are based on prism load of ordinary clay backfill with a unit weight of one hundred twenty (120 pcf) pound per cubic feet, maximum horizontal ring deflection of three (3%) percent, design factor safety of two (2), and for AASHTO HS-20 truck highway (HWY) or Cooper axle E-80 railroad (RR) live loading conditions.

B) Depth of Cover - The minimum design depth of cover shall be ten (10') feet. The assumed depth of cover for design purposes shall be fifteen (15') feet for burial depths of ten (10') to fifteen (15') feet, twenty (20') feet for burial depths of fifteen (15') to twenty (20') feet, twenty-five (25') for depth of twenty (20') to twenty-five (25') feet, thirty (30') feet for depth of twenty-five (25') to thirty (30') feet, and the actual cover for depths over thirty (30') feet. Pipe to be installed inside a casing shall be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

C) Deflection - The allowable deflection for the specified mortar lining system is three (3%) percent. Deflection calculation is in accordance with AWWA C-150.

D) Bending and Hoop Stresses - The bending and hoop stress requirements are met in accordance with AWWA C-150.

E) Buckling -

a. Buried Installations - The controlling load for buried pipes is determined from the greater of hydrostatic and earth loads plus vacuum or hydrostatic and earth load plus live load with a factor of safety of two (2.0) as determined in accordance with Section 6.3 of AWWA M-11. It is assumed that the groundwater level is equal to natural ground surface and the ground is fully saturated.

b. Unburied Installations - For unburied pipes, the internal collapsing vacuum pressure is used in determining the minimum wall thickness(es) in accordance with equation 4-2 of AWWA M-11 for a factor of safety of 1.5 against buckling. The Possion's ratio is 0.28 and modulus of elasticity is 52×10^6 psi.

c. Vacuum Pressure - For both buried and unburied installations, the internal collapsing vacuum pressure is taken as 14.7 psi.

524.02.04 – MINIMUM PIPE DESIGN FOR DUCTILE IRON PIPE

Unless otherwise specified, ductile iron pipe and fittings for buried and unburied installations, including boring, tunneling, and micro and small diameter tunneling, shall have the following minimum nominal thickness(es), in inches, shown below.

For boring, tunneling, and micro and small diameter tunneling installations, the minimum pipe design shall be equal to or greater than the minimum pipe design on either side of the installation.

Minimum Pipe Design for Ductile Iron Pipe		
Pipe Size (Inches)	**Nominal Push on Joint Wall Thickness Class 51 (Inches)**	**Flange Joints Class 53 (Inches)**
4”	0.26”	0.32”
6”	0.28”	0.34”
8”	0.30”	0.36”
12”	0.34”	0.40”
16”	0.37”	0.43”
18”	0.38”	0.44”
20”	0.39”	0.45”
24”	0.41”	0.47”
30”	0.43”	0.51”
36”	0.48”	0.58”
42”	0.53”	0.65”
48”	0.58”	0.72”
54”	0.65”	0.81”
60”	0.68”	0.83”
64”	0.72”	0.87”

524.02.06 – PIPE JOINTS AND FITTINGS

A) General - All specials and fittings may be used with push-on, mechanical, or flanged joints conforming to the requirements of AWWA/ANSI C-110/A 21.16. Fittings with push-on joints shall be installed with thrust blocks when necessary. Mechanical joints shall be adequately protected against unbalanced forces. Fittings with flanged joints shall be used with above ground installations. All joints shall have the same pressure rating as the pipe of which they are a part and shall meet the requirements of AWWA/ANSI C-111/A 21.11.

B) Push-on Joints - Push-on joints are a rubber gasket compression type joint meeting the requirements of AWWA C-111. Push-on joints shall have a deflection capability of three (3?) degrees.

C) Mechanical Joints - A mechanical joint is a bolted joint of the stuffing-box type. Each joint shall consist of a bell that is cast integrally with the pipe or fitting and provided with an exterior flange having bolt holes or slots, and a socket with annular recesses for the sealing gasket and the plain end of the pipe or fitting, a pipe or fitting plain end, a sealing gasket, a follower gland with bolt holes, and T-head and hexagonal nuts.

D) Flanged Joints - The flanged joints for ductile iron pipe shall be in accordance with AWWA C-111. Bolts, gaskets, and installation shall meet the requirements of AWWA C-115, Appendix A. The flanged joints for specials and fittings shall meet the requirements of AWWA C-110.

The flanges shall be rated for two hundred fifty (250 psi) pounds per square inch working pressure with bolt-hole drillings as for Class 125 flanges for service at temperatures ranging from twenty degrees (20?) to one hundred fifty degrees F (150?F) are pressure temperature rated for one hundred fifty (150) to two hundred pounds per square inch (200 psi) as shown in ANSI B 16.1. All flanged joints shall be made with single piece, red rubber gaskets one-eighth (? ") inch thick. Gaskets shall be full face for exposed installations and ring type or full faced for buried service meeting AWWA C-110, Appendix A requirements. As directed by the Engineer or shown on plans, flange joints meeting the requirements of ASME/ANSI B-16.1 may be used.

E) Restrained Joints - Restrained joints shall be as follows or approved equal. Retainer glands shall not be permitted.

Restrained Joints		
Company	**Size**	**Type**
American Cast Iron Pipe Co.	4” to 36”	Flex-Ring
	42” to 64”	Lok-Ring
Eba-Iron Sales Inc.	4” to 48”	Mega-Lug Series 1100
Ford Meter Box Co.	All	Uni-Flange
US Pipe and Foundry Co.	4” to 64”	TR-Flex

F) Sleeve Couplings - All sleeve couplings, except as noted on the plans or otherwise specified, shall be restrained with tie rods and shall be designed for the pipe design pressure and maximum allowable stress not to exceed sixty-five (65%) percent of minimum yield strength of steel used. Sleeve couplings shall be:

Dresser Style 38
Rockwell Steel Coupling 511
Smith Blair

Sleeve couplings for pipes three (3") to sixteen (16") inches shall be compact fittings meeting the requirements of AWWA C-153.

524.02.07 – COATING AND LINING

A) Exterior Coating - The exterior of ductile-iron pipe, specials and fittings shall be coated with the asphalt coating in accordance with AWWA C-151, Section 516. The coating shall have a minimum thickness of one (1) mil. The finished coating shall be smooth, continuous and strongly adherent to the pipe. Any damage to the outside coating during shipping, storage, handling and installation shall be field repaired with a fresh coating in accordance with the manufacturer's recommendations.

B) Interior Lining - Unless otherwise called for on the plans or specified, the interior of ductile-iron pipe, specials and fittings shall be cement mortar lined in the shop, with centrifugally spun lining in accordance with AWWA C-104. The Portland cement for cement mortar lining shall be in accordance with the requirements of ASTM C-150, Type I cement. Field repair of lining shall be made in accordance with AWWA C-104, Section 4-7.2.

The thickness of cement mortar lining shall be in accordance with the following table:

Pipe Nominal Size (inches)	Minimum Lining Thickness (inches)
6 - 12	1/16
14 - 24	3/32
30 - 64	?

524.02.08 – CORROSION PROTECTION

When specified or called for on the plans, all ductile-iron pipe, specials, fittings and other appurtenances shall be polyethylene encased in accordance with AWWA C-105/ANSI A 21.5. Exposure to sunlight of polyethylene wrapped pipe shall be kept to a minimum to prevent deterioration of polyethylene. Damage to polyethylene wrapping shall be prevented during backfilling operations. The minimum thickness for polyethylene is eight (8) mils.

524.05 – TESTING (PLANT TESTING)

524.05.01 – SOURCE QUALITY CONTROL

A) Hydrostatic Testing - Each length of pipe shall be shop tested hydrostatically to a pressure equal to two (2) times design pressure, but not less than five hundred (500 psi) pounds per square inch. The pipe shall be under the full test pressure for a minimum of ten seconds. The test shall be made before the application of cement mortar lining to the pipe. Any pipe that leaks or does not withstand the test pressure shall be rejected.

B) Pinhole Leak Testing - Pinhole leak testing of the ductile-iron pipe shall be done during the hydrostatic test as follows:

   a. During the day's production of pipe, the first five sections of pipe and subsequently one in every ten sections shall be tested for pinhole leaks.

   b. After testing the section of pipe hydrostatically to the pressure specified above in Part "A", the same section of pipe shall be tested hydrostatically to the working pressure and the pipe physically inspected for any pinhole leaks.

   c. Any pipe found to have pinhole leaks during the working pressure hydrostatic test shall be rejected, and the entire production for the day, shall be tested for leakage.

C) Joint Testing - Joints shall be tested and meet the performance requirements established in AWWA C-111/ANSI A 21.11, Section 11-9 and as modified herein. The working pressure rating of the joint shall be established by subjecting the joints to three (3%) percent of the pipe produced to hydrostatic pressure of twice the rated working pressure, but in no event less than twice the minimum working pressure rating shown below. At least two (2) joints shall be hydrostatically tested at a deflected angle of three (3?) degrees at the above specified pressure rating.

The minimum working pressure ratings for joints shall be as follows:

Joint Size (inches)	Pressure Rating (psi)
? 18	350
20	300
24	250
30 - 64	200

D) Test Reports - Test reports for the hydrostatic testing of ductile-iron pipe including the pinhole leak tests shall be submitted to the Engineer on a weekly basis during production.

E) Quality Control Tests - All quality control tests conducted by the manufacturer for each production run of pipe shall be submitted to the Engineer on a weekly basis during production.

F) Charpy Impact Test - Charpy impact test shall be performed in accordance with AWWA C-151. The absorbed energy (ft.-lb_f) requirements shall be 7 ft. lbs. at 70? F ± 10? F.

G) Mill Test Reports - Mill test reports of ductile iron used in the manufacture of pipe, specials, fittings and appurtenances shall be submitted to the Engineer.

H) Welding - All welding shall be done by qualified welders. The ductile-iron pipe manufacturer shall be responsible for quality control and testing of all welding done in the plant during fabrication of special fittings.

Inspection - The City retains the right to inspect the pipe, specials and fittings, all work performed and materials furnished, at the manufacturer's plant and at the project site and to independently monitor the fabrication of the pipe, specials and fittings. Such inspection shall not relieve the Contractor or the manufacturer of their responsibilities to furnish material and perform work in accordance with these specifications.

524.06 – METHOD OF MEASUREMENT

Payment shall be made pursuant to Section 505 for Ductile Iron Pipe. Polyethylene Encasement shall be measured along the pipe and fittings including all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

524.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) POLYETHYLENE ENCASEMENT L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 525 – POLYVINYL CHLORIDE (PVC) PIPE

525.01 – DESCRIPTION

This section covers polyvinyl chloride (PVC) pipe and fittings, for pressure applications, intended to be used for conveyance of raw or potable water, in sizes six (6") inch through twelve (12") inch diameter.

525.02 – MATERIALS

PVC pipe and fittings shall be produced by extrusion from Class 12454-A or 12454-B PVC compound providing a hydrostatic design basis (HDB) of four thousand (4,000 psi) pounds per square inch.

525.02.01 – GENERAL

All PVC pipe and fittings shall conform to the requirements of the following standards listed below or as modified herein.

AWWA C-900-PVC pressure pipe, 4 inch through 12 inch for water distribution.
AWWA C-905-PVC pressure pipe, 14 inch through 36 inch for water transmission.
AWWA M-23-PVC pipe-Design and Installation.
ASTM D-2774-Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
ASTM D-2827-Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
ASTM D-3139-Specifications for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
ASTM F-477-Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
NSF 14-Plastic Piping System Components and Related Materials.
PPI TR3-Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.

525.02.02 – SUBMITTALS

When requested, the contractor shall submit the following. No pipe, special sections and fittings shall be manufactured until shop drawings have been reviewed and approved by the Engineer.

Review and approval of the Contractor submittals, by the Engineer, shall not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing PVC pipe and fittings as described herein.

A) General - Detail drawings of pipes, specials, fittings, and joints. Submittals shall also include design calculations for fittings and specials.

B) Laying Schedule - Detail tabulated pipe-laying schedules corresponding to the numbers or identification painted on the pipes, specials and fittings.

C) Certification - Type "A" and "D" certification for pipe, specials, fittings, gaskets, and lining material. The affidavits of compliance and test reports shall be certified by a registered professional engineer.

D) Guides - The manufacturer's pipe installation guide, standard pipe material repair guide, and written quality control manual.

E) Mill Test Reports - Mill test reports of materials used in the fabrication of pipe, specials, fittings and appurtenances.

F) Copies - The Contractor shall provide eight (8) copies of all submittals requested.

525.02.03 – DESIGN BASIS

A) General - The PVC pipe is designed in accordance with AWWA M23, or as modified herein, and shall conform to minimum DR in Section 525.

B) Depth of Cover - The minimum design depth of cover shall be ten (10') feet. The assumed depth of cover for design purposes shall be fifteen (15') feet for burial depths of ten (10') to fifteen (15') feet, twenty (20') feet for burial depths of fifteen (15') to twenty (20') feet, twenty-five (25') for depth of twenty (20') to twenty-five (25') feet, thirty (30') feet for depth of twenty-five (25') to thirty (30') feet, and the actual cover for depths over thirty (30') feet. Pipe to be installed inside a casing shall be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

C) Allowable Stresses - For pipes six (6") inches through twelve (12") inches, the allowable design stress is sixteen hundred (1,600 psi) pounds per square inch and pipes sixteen (16") inch through thirty-six (36") inch, the allowable design stress is two thousand (2,000 psi) pounds per square inch, as established per AWWA C-900 and AWWA C-905, respectively.

D) Dimension Ratio (DR) - Minimum pipe DR is determined in accordance with equation A.4 or equation 2 of AWWA C-900 and AWWA C-905, respectively.

E) Deflection - The allowable deflection is five (5%) percent of the nominal diameter. Deflections are determined based on the following:

a. Deflection lag factor = 1.0

b. Bedding Constant = 0.10

c. Modulus of soil reaction, E' = 1000 psi

d. Earth load considered is the prism load of ordinary clay backfill with a unit weight of one hundred and twenty (120 pcf) pounds per cubic foot, compacted to 90% density (ASTM D-698).

e. A highway live loading of AASHTO HS-20 truck, or railroad live loading of Cooper Axle E-80.

525.02.04 – MINIMUM DIMENSION RATIO (DR)

Unless otherwise specified, PVC pipe and fittings for buried installations including boring, tunneling, and micro and small diameter tunneling, shall have the following minimum dimension ratios (DR).

For boring, tunneling, and micro and small diameter tunneling installations, the minimum dimension ratio shall be equal to or greater than the minimum dimension ratio on either side of the installation.

Pipe Nominal Size (inches)	Dimension Ratio (DR)
? 12	14
? 16	18

525.02.05 – DIMENSIONS

All PVC pipe shall have Cast-Iron-Pipe equivalent (C.I.) outside diameter (O.D.) dimensions.

525.02.06 – PIPE JOINTS AND FITTINGS

Unless otherwise specified, fittings for use with PVC pipe shall conform to provisions of AWWA C-110/A21.10 and shall be short-bodied style. Fittings shall be mechanical joint type. Pressure rating shall conform to the requirements of Section 524.02.06 for ductile iron pipes and fittings. The outside coating for fittings shall conform to the requirements of Section 524.02.07.

525.04 – CONSTRUCTION METHODS

The owner retains the right to inspect the pipe, specials and fittings, all work performed and materials furnished at the manufacturer's plant and at the project site and to independently monitor the fabrication of the pipe, specials and fittings. Such inspection shall not relieve the Contractor or the manufacturer of their responsibilities to furnish material and perform the work in accordance with these specifications.

525.05 – TESTING

Hydrostatic Pressure Testing and Disinfection shall be accomplished in accordance with Section 522.

525.07 – BASIS OF PAYMENT

Payment shall be made pursuant to Section 505.

SECTION 526 - PRE-STRESSED CONCRETE EMBEDDED CYLINDER PIPE (PCECP)

526.01 - DESCRIPTION

This section covers pre-stressed concrete cylinder pipe and fittings may be used for conveyance of raw or potable water in sizes forty-eight (48") inches and larger when specifically called out on the plans or in the special provisions.

526.02 – MATERIALS

526.02.01 – GENERAL

Except as herein modified, all PCECP and fittings shall be embedded steel cylinder type and shall conform to the requirements of AWWA C-301, and C-304.

526.02.02 – SUBMITTALS

The Contractor shall submit the following:

A) General - All engineering data for review and approval prior to pipe manufacture. Submittals shall include pipe design data, design curves, design computations, joint details, special pipe and fittings, and shop drawings. All pipe drawings shall show weld symbols and indicate manufacturing dimensions and tolerances. Design of pipe shall comply with the requirements and criteria established in Section 526.02.03.

   Review and approval of the Contractor submittals, by the Engineer, shall not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing PCECP and fittings as described herein.

B) Laying Schedule - Pipe laying schedules corresponding to the numbers or identification markings on the pipe, specials and fittings.

C) Samples - Representative samples of the steel cylinders, pre-stress wires, aggregate and cement to be used in the fabrication:

   a. Steel Cylinders - two (2) samples, approximately two (2') feet square, one to include a sample of the cylinder weld.

   b. Pre-stressing wires - two (2) samples, twenty-four (24") inches long.

   c. Coarse aggregate - one hundred (100) pounds

   d. Fine aggregate - fifty (50) pounds

   e. Cement - fifty (50) pounds in a sealed container.

D) Test Reports - Quality control and assurance test reports for pipes, specials, and fittings for each production run, including production welds, mill test reports, all steel plates, sheets and other materials used.

E) Concrete and Mortar Mix Designs - Proportions of materials for the mixtures shall be established on the basis of laboratory trial batches using the proposed materials and curing procedures. The following properties shall be measured and reported in accordance with the respective method.

Property	Method
Slump	ASTM C-153
Compressive Strength	ASTM C-39

The water-cement ratio shall be on the basis of aggregate in a saturated-surface dry condition. Proportions shall be established to obtain the required average compressive strength by the methods of ACI 214-77 at a slump of three to four (3 - 4") inches.

F) Materials Certification - Prior to Engineer's approval required in Part "A", the manufacturer shall submit certified material test reports for the following materials: aggregates, cement, admixtures, wire mesh, reinforcing rod, pre-stress wire, steel sheet, plate and shapes, joint rings, bolts, lugs and gaskets. Water for mortar and concrete mix shall be certified to be clear, clean and to have met the requirements of ASTM C-94. Certified reports shall show the actual results of all required chemical analyses, physical tests, examinations and heat treatments, including times and temperatures. The expense of performing all tests and for providing certified test reports required shall be borne by the Contractor.

G) Proof of Design and Cylinder Hydrostatic Test Reports - Test reports in accordance with Section 526.05.

H) Welders' Qualification Certificates - Certificate of qualifications issued by ASME. Welders shall meet the general requirements of Section 4.6 of AWWA C-301.

I) Affidavits of Compliance - Affidavits of compliance from the manufacturer for the following:

   a. Pre-stressed concrete cylinder pipes as required by AWWA C-301 and as modified herein.

   b. Specials and fittings as required by AWWA M-11 and as modified herein.

   c. The affidavits of compliance shall be certified by a registered professional engineer.

J) Guides - The manufacturer's pipe installation guide, standard pipe material repair guide and written quality control manual.

K) Copies - The Contractor shall provide eight (8) copies of all submittals requested herein.

526.02.03 – DESIGN BASIS

A) General - All pre-stressed concrete cylinder pipe shall be designed for the combination of internal pressure and external load outlined in the referenced AWWA standard (AWWA C-304) referred to in AWWA C-301, or as modified herein.

B) Depth of Cover - The minimum design depth of cover shall be ten (10') feet. The assumed depth of cover for design purposes shall be fifteen (15') feet for burial depths of ten (10') to fifteen (15') feet, twenty (20') feet for burial depths of fifteen (15') to twenty (20') feet, twenty-five (25') for depth of twenty (20') to twenty-five (25') feet, thirty (30') feet for depth of twenty-five (25') to thirty (30') feet, and the actual cover for depths over thirty (30') feet. Pipe to be installed inside a casing shall be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

C) Soil Unit Weight - Unless otherwise specified, the soil unit weight shall be taken as one hundred twenty (120 pcf) pounds per cubic foot.

D) Earth Load - Earth load shall be calculated based on a trench at the transition width using Marston equations.

E) Live Load - Unless otherwise specified, all pipes and fittings shall be designed for AASHTO HS-20 truck load or E-80 Cooper axle railroad conditions.

F) Bedding - The design bedding angle shall be taken as ninety (90?) degrees, pursuant to the

Standard Detail for installation of Rigid Pipes. Bedding shall be installed as per Section 505.

G) Core Concrete - The twenty-eight (28) day compressive strength shall be assumed to be no greater than five thousand (5,000 psi) pounds per square inch and no greater than six thousand (6,000 psi) pounds per square inch for vertically cast cores, and centrifugal or radial compaction, respectively.

H) Elastic Limit Pressure - The elastic limit pressure shall be not less than 1.4 times the design pressure.

I) Burst Pressure - The burst pressure shall be at least three (3) times the working pressure.

J) Trenchless Installations - For boring, tunneling, and micro and small diameter tunneling installations, the minimum pipe design shall be equal to or greater than the minimum pipe design on either side of the installation.

526.02.04 – MODIFICATIONS TO AWWA C-301

The following sections of AWWA C-301 are modified as follows:

A) Marking - The manufacturer's control number or work order number pertaining to any given section of pipe shall be stamped legibly and indelibly on the interior of the spigot joint ring following curing. All inspection reports shall show the work control number. Piece designation corresponding to laying position in lay schedule shall be marked on the outside of the pipe.

Each piece of straight and special pipe and each fitting shall be indelibly stenciled on the inside concrete surface at the pipe end with the following information: inside diameter, class, unique control number, cast date, wrapping date, wire diameter, wire class, wire spacing.

B) Inspection and Testing by Purchaser - The Engineer shall have the right to inspect and review all materials, processes, procedures and records related to the manufacture and repair of pipe. The manufacturer shall provide the Engineer with copies of all written quality control procedures and tests and reports as may be employed by the manufacturer during the production of the pipe. Such information shall be kept confidential when so requested by the manufacturer.

C) Cement - Cement used for the core, slurry, mortar coating, and authorized repairs shall conform to the requirements of ASTM C-150 "Specifications for Portland Cement" Type II. No cement replacement materials or mineral admixtures shall be used without prior approval from the Engineer.

D) Fine Aggregate and Course Aggregate - Acceptance of coarse and fine aggregate failing to meet the requirements for grading and quality as defined in ASTM C-33 "Standard Specification for Concrete Aggregates" shall be based on comparative laboratory test data demonstrating at least equal performance with respect to compressive strength and shrinkage for both concrete and mortar. The coarse aggregate shall be sampled in accordance with Federal Specification CRD-C-119 for thin or elongated pieces, the maximum dimension of which exceeds five times the minimum, shall not be in excess of ten (10%) percent of the coarse aggregate by weight.

E) Water - Clear, clean water in compliance with ASTM C-94 shall be used in all concrete and mortar. The use of recycled or wash water shall not be permitted.

F) Admixtures - No admixture shall be used without prior approval of the Engineer. Test data and compositional analysis of admixtures shall be submitted for acceptance prior to use.

G) Steel for Cylinders and Fittings, Steel sheets and coils - Steel sheets and coils for cylinders shall be hot rolled grade C conforming to the requirements of AWWA C-301.

H) Steel Reinforcement, Pre-stressed Wire - The pre-stressing wire for circumferential reinforcement shall conform to ASTM A 648 "Specification for Steel Wire Hard-Drawn for Pre-stressing Concrete Pipe" except that the following shall be added under the specification paragraphs as noted below:

Section Numbers referred to are those in ASTM-A648

7. Physical Requirements

7.1.5 Reduction of area shall conform to thirty-five (35%) percent minimum for size one-quarter (0.250) inch and larger wire.

7.2 Torsion Test

7.2.2 One test specimen suitable for a twelve (12") inch span shall be taken for each coil.

10. Inspection - The wire supplier's certification that the wire was manufactured and tested in accordance with the specifications, as herein modified, together with a report of the test result shall be furnished to the engineer prior to acceptance of the finished pipe. Such reports shall clearly reference the lot or heat involved and the reference number, code or other designation shall be identifiable on each coil as delivered.

The pipe design shall be based on the minimum tensile strengths of the wire class used. Wire other than Class I, II, or III shall not be used.

I) General Requirements

Core and Coating Tolerances - The minimum thickness of the core for embedded cylinder pipe shall be as shown in the following table.

Diameter (inches)	Core Thickness (inches)
48	4
54	4
60	4½
66	5
72	5½
78	6
84	6½
90	6½
96	6½
102	6½
120	8
126	8½

For embedded cylinder pipe, the thickness of the inner concrete lining shall not vary from the nominal dimension by more than the values shown in the table below:

Diameter (inches)	Inner Concrete Lining Thickness Variance (inches)
48	?
54 – 72	3/16
> 72	¼

The thickness of the mortar coating shall be such as to provide a minimum clear cover of four (4) times the nominal wire diameter over the exterior portion of the wire, but shall not exceed one and one-quarter (1¼") inches.

J) Design of Pipe

Reinforcement - The pre-stress wire shall not be smaller than one quarter (¼") inch diameter. Adjacent wires shall not touch at any point. End wraps shall not be placed more than one and one-half (1½") inches or less than one inch (1") from the edge of the core to be coated with the full depth of the mortar coating. Splices in the pre-stress wire shall not be closer than three (3') feet as measured along the longitudinal axis of the pipe.

K) Concrete for Pipe Core

Mixing - The temperature of the mix shall not exceed ninety (90?) degrees F at the time of placement. The measured slump of the concrete used in embedded-cylinder pipe shall not vary more than one inch (1") from the approved mix design, as measured at the mixer discharge. Pipe made with a concrete slump exceeding this limit shall be rejected.

L) Curing of Pipe

General - Cores shall be cured by the accelerated curing method only. The total continuous cure including the delay period, but excluding the time required to remove the forms or end rings, shall be a minimum of twenty-four (24) hours. Forms or rings shall not be removed until after a minimum of twelve (12) hours of accelerated curing, including the required four (4) hour delay period.

Accelerated Curing - The delay period before temperature is increased during accelerated curing shall not be less than four (4) hours for any pipe core or coating, during which period temperature shall not be raised above one hundred (100?) degrees F and the humidity shall be maintained as specified in AWWA C-301, Placing of Wire Reinforcement.

M) Placing of Wire Reinforcement

General - The temperature of the cores shall be at least forty (40?) degrees F and the cores shall be in a surface dry condition at the time of pre-stressing. Air pockets, honey combing, holes or voids three-eighths (? ") inch depth and/or diameter or greater and offsets as defined in "Repair of Core and Coating" and deeper shall be filled and patched at the time the form is removed. Patches shall be adequately cured prior to pre-stress and finished in such a manner as to prevent bridging or gaps under the pre-stress wire.

Portland Cement Slurry - A retarding admixture shall be used in the mix. The point of application shall be eight (8") to twelve (12") inches ahead of the leading wire or between the lead wraps and final wraps of the lead wrap machines. The rate of application shall not be less than one (1) gallon per ninety (90) square feet. Cores shall not be pre-stressed prior to the fourth calendar day (96 hours) following the completion of casting.

N) Pipe Coating

General - The coating shall be applied within sixteen (16) hours after pre-stressing. The temperature of the pipe shall be at least forty (40?) degrees F at the time of coating.

Mortar Coating - Cement mortar coating shall not contain any rebound and shall consist of a cement-to-fine aggregate ratio between 1:2 and 1:2.75 by weight on the pipe. Batched fine aggregate weights shall be compensated for moisture in the fine aggregate.

The moisture content of the coating as applied shall not be less than six (6%) percent of the total saturated surface dry weight of the sand and cement. Ambient accelerated curing temperatures of the coating shall not exceed one hundred and ten (110?) degrees F. The cured coating shall be free of holes, hollows, delaminations, and cracks.

O) Curing of Coating

Accelerated Curing - All cement mortar coating shall be cured by the accelerated method only and shall be continuous for a minimum of twelve (12) hours, including the four (4) hours delay period.

P) Repair of Core and Coating - Repairs shall not be made without prior approval of the detailed written repair and testing procedures. The following procedures shall be employed where applicable. Exceptions shall be submitted for approval.

"Cylinders" through "Finished Pipe" are created herein, to define what may be repaired and what is not acceptable to be repaired.

Cylinders - All oil, grease, soap, mud, ice, snow, etc., shall be removed. Bumps and dents shall be taken out of cylinders before they are used. To remove bumps or dents, use only a rubber, rawhide, or fiber mallet. For a core that has been rejected, when the concrete is knocked out of the cores, the cylinder must be hydrostatically retested before being reused.

Cores

a. Embedded Cylinder - Cores with indentations which cause bridging of the wire and/or gate offsets in the outer concrete surface exceeding one-eighth (? ") inch will not be pre-stressed without repair.

   Depth of depression and offset shall be determined by an outside template placed on the core surface. Cores having air pockets in the outer envelope three-eighths (? ") inch deep and/or one quarter (¼") inch wide shall be repaired. Surface skin shall be removed. Elongated pockets of equivalent surface area shall be repaired. Sand streaks, honeycombs, casing leaks, or soft and rotten concrete in the inner and outer envelopes shall be removed and patched. So that patches may cure with the pipe, all core repairs shall be done in the bays after the casings are removed and the core temperature is below ninety (90?) degrees F. The patching mix shall be at the same temperature as the core.

b. Embedded Cylinder Core Cracks Prior to Pre-stress - Pipe shall be patched as soon as possible and prior to pre-stressing. Inside longitudinal cracks due to handling, plastic shrinkage, sags or tears must be patched or the concrete broken out and recast or the core rejected.

   Lining circumferential or helical slump cracks of less than fifteen hundredths (0.015") inches in width need not be patched. Circumferential cracks in excess of fifteen thousandths (0.015") inches width, but less than three-thousandths (0.030") inches may be repaired. Cracks that exceed thirty-thousandths (0.030") inches width and twelve (12") inches in length shall not be repaired and the core shall be rejected.

   Cores with external longitudinal cracks of any width are not acceptable and the core shall not be pre-stressed, except for cracks less than five thousandths (0.005") inches width within one (1') foot of bell end or spigot end.

Brush Coating

a. Application Faults - Defects appearing in mortar coating, such as blisters, hollow spots, falloffs, or slippage cracks during or immediately after application, shall be removed and repaired before the pipe is placed in the bay for curing.

   Defective areas greater than fifty (50) square inches or extending more then ninety (90?) degrees circumferentially or exposing pre-stress wire shall be repaired on the machine, not by hand.

   Defective areas smaller than fifty (50) square inches that are not over the pre-stress wire may be hand patched. Pipe to be hand repaired shall be positioned in a revolving machine so that area to be patched is on top when in curing bins.

b. Other Conditions - Holes caused by the depth gauge, used to measure the coating thickness, must be fully pressed closed immediately after removing gauge. Stone holes in the mortar shall be filled and repaired in the curing bins, preferable prior to curing, otherwise prior to yarding. Drip holes shall be repaired prior to yarding pipe.

Finished Pipe

a. Interior of Pipe - Core cracks shall not be slurried, painted over or otherwise dressed to improve appearance. Holes larger than three-eighths (? ") inch diameter and/or one-fourth (¼") inch deep must be repaired. Pre-stressed pipe with shrinkage cracks, either circumferential or helical, shall not be shipped if cracks exceed fifteen thousandths (0.015") inches in width at any point.

   Inner lining longitudinal cracks exceeding two thousandths (0.002") inch width, after pre-stress or with an offset, are cause for rejection except for cracks less than one hundredth (0.01") inches maximum width in the unpre-stressed area between the spigot face and joint ring weld. Circumferential spigot cracks wider than thirty thousandths (0.030") inches at any point, resulting from pre-stressing, shall be filled by epoxy injection prior to shipment.

b. Exterior of Pipe - Cracks in coating of pipe may be cause for rejection. This does not apply to surface craze cracks whose width cannot be measured or where cracks occur over saddles which may be repaired.

c. Ends of Pipe (Over Joint Rings) - All visible coating cracks must be repaired.

Q) Fittings

Design - All fittings shall meet the minimum thickness requirement shown below. Fittings shall be mortar coated on the interior and exterior surfaces. Fittings employing supplemental external reinforcement cages shall not be used.

Pipe Inside Diameter (inch)	**Steel Cylinder Thickness (inch)**
48	½
54	9/16
60	?
? 72	¾

Steel Fabrication

a. General - Remove all scale and other foreign matter accumulating on the plate during rolling and forming operation by an air blast so that it will not be rolled or pressed into the surface of the plate. Complete all rolling and forming prior to making butt welds. Do not heat or hammer for the necessary forming of angles.

b. Fit up - Prior to welding using fillet welds, fit the plates to be welded closely; and during welding hold them firmly together.

   Tack weld the edges of the butt joints or clamp in place in proper alignment and so hold through out the welding process. Do not use dogs, clips, lugs or equivalent devices welded to the steel plate for the purpose of forcing it into position.

c. Cleaning - Prior to welding, clean the surfaces of all plates and members to be welded of all scale and rust for a distance of not less than one inch (1”) and of all oil or grease for a distance of not less than three inches (3”) from the welding edge on both sides of the plates in the case of butt joints.

Remove grease or oil with gasoline, lye or other approved means. Do not use kerosene or any heavier petroleum solvent. When it is necessary to deposit metal over a previously welded surface, remove scale, slag or welding flux by a roughing tool, chisel, air chipping hammer, or other means.

d. Aligning - Where butt-welded joints are used, align edges to be jointed to ensure complete penetration and fusion at the bottom of the joint. Limit the offset in abutting edges to one-sixteenth (1/16") inch at circumferential seams and to one thirty-second (1/32") inch at longitudinal seams.

e. Quality of Welds - Butt welds shall not be made prior to the completion of the rolling and forming. All butt welds for both hand and automatic welding shall be grounded out or back-gouged to sound metal before welding reverse side.

Longitudinal seams shall be welded before girth seams. All welds shall be full strength, ductile, and shall be made to ensure uniform distribution of load throughout the welded section. All welded joints shall be of a type that will produce complete fusion of the plates and shall be free from unsound metal, pinholes, and cracks.

The finish of welded joints shall be uniform, smooth, and free from grooves, depressions, burrs and other irregularities. There shall be no valley or undercut in the center or edges of any weld.

Flanges shall be flat faced. The gasket surfaces shall have a V-serrated finish of approximately thirty-two (32) serrations per inch, approximately one sixty-fourth (1/64") inch deep. Serrations may be either concentric or spiral.

Welded-type outlets shall have a mounting diameter the same as that of the surface upon which they are to be mounted, except that where the mounting surface is curved to a diameter of thirty-six (36") inches or more, the outlet bottom may be flat. Welded-type outlets shall be forged steel.

Steel plate fittings shall be designed in accordance with AWWA M11. Steel plate shall conform to ASTM A-36 or an approved equal. The fittings, specials and appurtenances shall be hydrostatically tested to a pressure not less than that for the pipe. Non-destructive testing in accordance with AWWA C-200, Section 4.3 can be substituted for the hydrostatic test.

Lining and Coating - All fittings shall be cement mortar coated and lined.

R) Curves, Bends and Closures - Where restrained joints are called for on the plans, they shall be made by fully welding the spigot contact ring to the bell mating surface to produce a watertight joint without the use of a rubber gasket. The spigot ring shall be prepared for welding during manufacture of the pipe by cutting off the spigot groove. The fillet weld size shall be equal to the thickness of the bell joint ring.

S) Outlets and Connections on Pipe - Openings for manholes and connections for air valves, blowoffs, and other branches shall be built into the walls of the concrete pipe and shall be designed in accordance with AWWA M-11.

In all cases, the primary steel reinforcement shall not be in the form of a collar. In the case where a collar is sufficient reinforcement according to AWWA M-11, a three hundred sixty (360?) degree wrapper shall be substituted. If secondary reinforcement is required by the AWWA M-11 procedure, a collar may be used. The steel plate shall conform to ASTM A-36 or an approved equal. The wrapper thickness shall be no greater than four times the thickness of the cylinder in the concrete pipe section.

The wrapper shall be welded to the exterior of the cylinder of the pipe section and the portion of the cylinder between the circumferential welds removed. The welds shall be penetrant dye tested for their entire circumference.

The flanges for specials and fittings shall be in accordance with AWWA C-207 Class E with bolt-hole

drillings as for Class 125 cast iron flanges. All flanged joints shall be made with single-piece, red rubber gaskets one-eighth (? ") inch thick. Gaskets shall be full face for exposed installation and ring type or full faced for buried service meeting AWWA C-207 requirements. All nuts and bolts for buried flange joints shall be of stainless steel meeting the requirements of ASTM A-193, Grade B7.

526.05 – TESTING (MANUFACTURERS' TESTING)

526.05.01 – PLANT QUALITY CONTROL AND INSPECTION

A) General - Procedures, tests and requirements as set forth herein are in addition to, and for the purpose of monitoring the quality of pre-stressed concrete pipe supplied under AWWA C-301 standard. The inspections and tests required shall be performed by the material supplier, pipe manufacturer, or designated laboratory and the results forwarded to the Engineer. The Engineer reserves the right to inspect the materials, fabrication process or product at any or all times.

B) Tests and Inspections - Tests and inspections to assure conformance with the specifications are established herein. Inspection to verify the quality of work shall be performed by persons other than those engaged in the activity being examined. Such persons shall not report directly to the production supervisor responsible for the work.

The Engineer will make an effort to inspect each section of pipe at various stages of production. Accordingly, the manufacturer shall provide the Engineer with a written production schedule to facilitate inspections. Testing shall be performed in accordance with the approved procedures. In the absence of established written procedures, the test methods shall be documented by the manufacturer and proved by actual demonstration to the satisfaction of the Engineer. When approved, the manufacturer shall be notified in writing. At lease one (1) copy of the procedures to be followed shall be available to all appropriate personnel at the testing site for reference and use.

All instruments, gauges and other testing and measuring equipment used in activities affecting quality shall be of proper range, type, and accuracy to verify conformance with specification requirements. Procedures shall be in effect to assure that they are calibrated and certified at no longer than annual intervals. Calibration shall be against measurement standards that have known relationship to national standards where such exist. Gauges must be calibrated and certified for the piece of equipment of which they are a part and must remain on the piece of equipment following certification. Materials and items including products previously checked or manufactured with equipment found to be out of calibration or adjustment shall be considered unacceptable until it can be determined that all applicable requirements have been met.

The manufacturer shall maintain records of all required tests and inspections. These records shall include documents such as records of materials, manufacturing, inspection, repairs, and test data taken before and during fabrication. The Engineer reserves the right to request specific data be included in the report which may not otherwise be included. Whenever tests and inspections are performed on a pipe element or pipe, the appropriate identification number shall be shown on the report. Copies of all reports of tests by the manufacturer, including computer printouts of production records, independent laboratory, or material suppliers shall be given to the Engineer in such form as to be appropriate for permanent records.

The Engineer shall have access to all records of tests and inspections related to pipe manufactured and shall also have the right to witness any tests being performed by the manufacturer or his suppliers relative to products, materials, or the pipe being produced.

C) Fabrication Testing and Inspection - Testing and inspection of the materials, used in fabrication of the pipe, shall be executed in accordance with the procedure and at the frequency listed in the following table. The required testing shall be done by either the material supplier, an independent laboratory, or the manufacturer. The test area wherein the tests are performed shall be properly certified and such certification shall meet with the Engineer's approval. Where the frequency of

testing differs in the following table from that required by the referenced specification or test method, the greater frequency shall govern.

MATERIAL	REQUIREMENTS	REFERENCE OR TEST METHOD	FREQUENCY
Cement	Physical and chemical properties	ASTM C-150	Each Shipment
Aggregates	Gradation	ASTM C-136	Weekly
	Moisture content	ASTM C-566	Daily
	Material finer than #200 sieve	ASTM C-117	Weekly
	Organic impurities	ASTM C-40	Test frequency shall be on a source basis. The Engineer reserves the right to call for tests during the manufacture of the pipe. The tests applied to new sources and the results approved by the Engineer prior to use.
	Flat and elongated particles	CRD-C-119	Same as above
	Friable particles	ASTM C-142	Same as above
Aggregates	Lightweight particles	ASTM C-123	Same as above
	Specific gravity and absorption	ASTM C-127 or ASTM C-129	Same as above
	Chlorides	ASTM C-1411	Same as above
	Potential reactivity	ASTM C-289	Same as above
	Soundness	ASTM C-88	Same as above
Admixtures	Chemical composition	Infrared spectro-photometry, pH, and solids content in accordance with ASTM C-494	Each Shipment
Concrete	Mixer uniformity	ASTM C-94	Initially and every six months
	Sampling	ASTM C-172	
	Cylinders	ASTM C-31	
	Compressive strength	ASTM C-39	One set of 2 cylinders daily for each test age for each 50 cu. yd. or portion thereof and for each class of concrete
	Slump	ASTM C-143	First batch placed each day and every 50 cu. yd. or portion thereof for each class of concrete
	Temperature		Same as above
	Unit weight/yield	ASTM C-138	Weekly
Casting	Proportions on pipe wash out test		Weekly
Mortar	Hardened mortar absorption	ASTM C-497 Method A	Weekly
Slurry	Proportions	Specific gravity	Daily
	Application rate	Discharge nozzle flow	Initially
Pre-stressing	Tension Test	ASTM A-370 Supplement IV	Tests shall be applied to each 10,000-pound lot with samples representing one test for each coil, and not less than every fifty consecutive pipes wrapped. If any sample test indicates defective product, each coil within the lot or heat shall be tested. If any additional tests indicate any defective product, the entire heat shall be rejected.
	Wrapping test	ASTM A-370 Supplement IV	Same as above
	Torsion test	ASTM E-558	Same as above

D) Proof of Design Test - Prior to the start of manufacture, one section of the highest class of each size of pipe shall be fabricated in accordance with the approved design and the requirements of this specification. At age five (5) to seven (7) days after completion, each section shall be subjected to a hydrostatic test.

During this test, the pressure shall be raised from eighty (80%) of the $P_?$ (internal pressure required to overcome all compression in the concrete) to $P_?$ in twenty (20 psi) pound per square inch increments pausing at least five (5) minutes at each increment.

At the $P_?$ pressure, the pressure shall be raised in ten (10 psi) pound per square inch increments to the working plus surge pressure, pausing at least five (5) minutes at each increment.

At the working plus surge pressure, there shall be no coating crack exceeding three thousandths (0.003") of an inch at any location nor a coating crack in the barrel exceeding two thousandths (0.002") of an inch by one (1') foot long, nor any evidence of delamination. The barrel is defined as the coated portion of pipe exclusive of area six (6") inches from the spigot shoulder and twelve (12") inches from the bell face.

It shall be permissible to keep the exterior of the pipe wet for a period not exceeding forty-eight (48) hours prior to test. Before the test shall commence and during the entire period of the testing, the coating shall be in a surface dry condition.

During the first week of production, two (2) additional sections of pipe of the highest class of each size shall be selected at random by the Engineer and subjected to the hydrostatic test. Failure to meet the hydrostatic test requirements shall be cause for reducing the pressure rating of each pipe class to a class that can be shown to meet the criteria established.

If in the judgment of the Engineer, additional test are warranted because of variations in design, materials, manufacturing or handling/storage methods, they shall be conducted as directed in accordance with the above procedures.

The Contractor/Manufacturer shall provide means or equipment, meeting OSHA requirements, to the Engineer, to safely inspect the pipe during the hydrostatic testing.

E) Manufacturer's Plant Inspection

1. Manufacturer's Inspection - In addition to all other hydrostatic tests, the Engineer shall select at random one (1) of the pipe produced each day for hydrostatic testing. When less than ten (10) pipes are produced in a day, one (1) pipe shall be selected from each lot of twenty (20) pipes manufactured, for hydrostatic test. The pipe shall be tested at age five (5) to seven (7) days to the working plus surge pressure for a period of time sufficient to determine the coating crack behavior. Pipes developing coating cracks shall be rejected and further testing required to establish acceptable performance in the opinion of the Engineer.

   Prior to final inspection by the Engineer, the manufacturer shall conduct a complete inspection and place an appropriate stamp on the lining indicating the pipe to be complete and ready for shipment.

2. Engineer's Inspection - In-Process examination by the Engineer will encompass all phases of manufacturing and testing, and will include but not be limited to the following, for each section of pipe at the indicated stages of pipe production:

   a. Cylinder Prior to Casting Concrete. - (1) Number of leaks at first pressure test. Excessive repairs in the opinion of the Engineer shall be cause for rejection; (2) Dents or indentations; (3) Surface dirt or contamination; (4) Advanced corrosion. Pits exceeding ten (10%) percent thickness of the sheet shall be cause for rejection.

   b. Pipe Cores Prior to Pre-stressing. - (1) Voids and patching; (2) Offsets and bulges which

may cause bridging and gaps under wire; (3) Damage or cracking in core concrete.

c. Pre-stressing Pipe Core Prior to Coating. - (1) Adequacy of slurry coverage; (2) Clearance between pre-stress wires; (3) Proper position and number of pre-stress wires;

d. After Coating and Curing. - All pipe, fittings and specials shall be inspected for cracks, delaminations and spalls. Inspection in the areas listed above shall also be routinely included in the manufacturer's quality control program.

The Engineer's examination shall include but not be limited to: (1) Joint ring dimensions and roundness (manufacturer shall provide templates, if necessary); (2) Mortar coating defects such as cracks, delaminations, spalls, coating thickness, soft areas and foreign matter; (3) Marking and identification.

F) Field Inspection - After shipment to the job site and prior to installation, the pipe may be re-inspected by the Engineer for cracks, delaminations, spalls or other defects. In addition, the coating may be "sounded", using a ball peen hammer having a head weight of not more than one (1-lb) pound, over its entire exterior surface at the spacing of approximately one (1') foot both circumferentially and longitudinally to locate any hollow or drummy areas which may indicate a delamination or void.

526.05.02 – HYDROSTATIC PRESSURE TESTING AND DISINFECTION

Hydrostatic pressure testing and disinfection shall be accomplished in accordance with Sections 522 and 523.

526.07 – BASIS OF PAYMENT

Payment shall be made pursuant to Section 505.

SECTION 527 – STEEL PIPE

527.01 – DESCRIPTION

This section covers steel pipe and fittings, for pressure applications, intended to be used for conveyance of raw or potable water, in sizes forty-eight (48") inches and larger when specified on plans and specifications.

527.02 – MATERIALS

527.02.01 – GENERAL

All steel pipe and fittings shall meet the requirements of ASTM A-572, Grade 52 or ASTM A-139, Grade C, and conform to the requirements of the following standards listed below or as modified herein.

AWWA M11,	Steel Pipe - A Guide for Design and Installation
AWWA C-200,	Steel Water Pipe 6 inch and Larger
AWWA C-209,	Cold - Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
AWWA C-214,	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C-206,	Field Welding of Steel Water Pipe
AWWA C-602,	Cement - Mortar Lining of Water Pipelines - 4 inch and Larger - In Place
AWWA C-208,	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C-207,	Steel Pipe Flanges for Waterworks Service - Sizes 4" through 154"
AWWA C-205,	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4" and Larger - Shop Applied
AWWA C-210,	Liquid Epoxy Coatings Systems for the Interior and Exterior of Steel Water Pipelines

AWWA C-213,	Fusion Bonded Epoxy Coating for Interior or Exterior Pipeline Coating
ASTM A-193,	Alloy Steel and Stainless Steel - Bolting Materials for High Temperature Service
ASTM A-139,	Electric-Fusion (Arc) - Welded Steel Pipe (sizes 4 inch and over)
ASTM A-370,	Mechanical Testing of Steel Products
ASTM A-673,	Sampling Procedure for Impact Testing of Structural Steel
ASTM C-150,	Portland Cement

527.02.02 – SUBMITTALS

The Contractor shall submit the following. No pipe, special sections and fittings shall be manufactured until shop drawings have been reviewed and approved by the Engineer.

Review and approval of the Contractor submittals, by the Engineer, shall not be construed in any way as relieving the Contractor and the manufacturers of their responsibilities for manufacturing steel pipe and fittings as described herein.

A) General - Detail drawings of pipes, specials, fittings, and joints, with design calculations for fittings and specials.

B) Laying Schedule - Detail tabulated pipe-laying schedules corresponding to the numbers or identification painted on the pipes, specials and fittings.

C) Certification - Type "A" and "D" certification for pipe, specials, fittings, gaskets, and lining material pursuant to, but not limited to, applicable standards in Section 527.02.01. A registered professional engineer shall certify the affidavits of compliance and test reports.

D) Guides - The manufacturer's pipe installation guide, standard pipe material repair guide, and written quality control manual.

E) Mill Test Reports - Mill test reports of steel plates, sheets or coils used in the fabrication of pipe, specials, fittings and appurtenances.

F) Copies - The Contractor shall provide eight (8) copies of all submittals requested herein.

527.02.03 – MANUFACTURER

Pipe shall be the product of one manufacturer that has had not less than five (5) years successful experience manufacturing pipe of the particular type and size indicated. Pipe manufacturing operations (pipe, fittings, lining, and coatings) shall be performed at one (1) location. The manufacturer's plant shall be certified under S.P.F.A. quality certification program for steel pipe and accessory manufacturing.

527.02.04 – DESIGN BASIS

A) General - All steel pipe and fittings are designed in accordance with AWWA M11 or as modified herein, and shall conform to minimum wall thickness in Sections 527.02.05 and 527.02.06. For buried pipes, the design satisfies internal pressure, deflection, and buckling requirements. Buckling loads are made up of hydrostatic and earth loads plus live load or internal vacuum.

B) Depth of Cover - The minimum design depth of cover shall be ten (10') feet. The assumed depth of cover for design purposes shall be fifteen (15') feet for burial depths of ten (10') to fifteen (15') feet, twenty (20') feet for burial depths of fifteen (15') to twenty (20') feet, twenty-five (25') for depth of twenty (20') to twenty-five (25') feet, thirty (30') feet for depth of twenty-five (25') to thirty (30') feet, and the actual cover for depths over thirty (30') feet. Pipe to be installed inside a casing shall be designed for full cover including live load (a single H-20 or Railroad E-80) neglecting the casing.

C) Allowable Stresses - The hoop stress shall not exceed (50%) fifty percent of minimum specified yield strength for both working pressure, and combined working pressure plus surge pressure conditions.

D) Deflection - The allowable deflection for the specified mortar lined and flexible coated system, is three (3%) percent, for both shop lined and field applied lining and coating system. Deflections are determined based on the following:

a. Deflection lag factor = 1.0
b. Bedding Constant = 0.10
c. Modulus of soil reaction, E' = 1000 psi
d. Earth load considered is prism of ordinary clay backfill with a unit weight of one hundred and twenty (120 pcf) pound per cubic foot, compacted to ninety (90%) percent density (ASTM D-698).
e. A highway live loading of AASHTO HS-20 truck, or railroad live loading of Cooper Axle E-80.

E) Buckling -

a. Buried Installations - The controlling load for buried pipes is determined from the greater of hydrostatic and earth loads plus vacuum or hydrostatic and earth load plus live load with a factor of safety of 2.5 or 3.0 as determined in accordance with Section 6.3 of AWWA M-11. It is assumed that the groundwater level is equal to natural ground surface and the ground is fully saturated.

b. Unburied Installations - For unburied pipes, the internal collapsing vacuum pressure is used in determining the minimum wall thickness in accordance with equation 4-2 of AWWA M-11 for a factor of safety of 1.5 against buckling. The Possion's ratio is 0.30 and modulus of elasticity is 30 x 10^6 psi.

c. Vacuum Pressure - For both buried and unburied installations, the internal collapsing vacuum pressure is taken as 14.7 psi.

527.02.05 – MINIMUM WALL THICKNESS FOR BURIED INSTALLATIONS

Unless otherwise specified, steel pipe and fittings for buried installations, including boring, tunneling and micro and small diameter tunneling, shall have a minimum thickness of 0.375 inches and shall be not less than the minimum thickness, in inches, shown in the following tables.

For boring, tunneling, and micro and small diameter tunneling installations, the minimum pipe design shall be equal to or greater than the minimum pipe design on either side of the installation.

The minimum design pressure is equal to one hundred fifty pounds per square inch working pressure plus one hundred pounds per square inch surge pressure.

A) Pipe Nominal Size: 48 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.3750	0.3750	0.3750	0.3750	0.5000
	RR	0.3750	0.3750	0.3750	0.4375	0.5625
300	HWY	0.3750	0.3750	0.3750	0.3750	0.5000
	RR	0.5375	0.3750	0.3750	0.5375	0.5625
350	HWY	0.5375	0.5375	0.5375	0.5375	0.5000
	RR	0.5375	0.5375	0.5375	0.5375	0.5625
400	HWY	0.5000	0.5000	0.5000	0.5000	0.5000
	RR	0.5000	0.5000	0.5000	0.5000	0.5625

B) Pipe Nominal Size: 54 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.3750	0.3750	0.3750	0.5375	0.5625
	RR	0.5375	0.3750	0.3750	0.5000	0.6250
300	HWY	0.5375	0.5375	0.5375	0.5375	0.5625
	RR	0.5375	0.5375	0.5375	0.5000	0.6250
350	HWY	0.5000	0.5000	0.5000	0.5000	0.5625
	RR	0.5000	0.5000	0.5000	0.5000	0.6250
400	HWY	0.5652	0.5625	0.5625	0.5625	0.5625
	RR	0.5625	0.5625	0.5625	0.5625	0.6250

C) Pipe Nominal Size: 60 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.5375	0.5375	0.5375	0.5375	0.6250
	RR	0.5375	0.5375	0.5375	0.5625	0.6875
300	HWY	0.5000	0.5000	0.5000	0.5000	0.5260
	RR	0.5000	0.5000	0.5000	0.5625	0.6875
350	HWY	0.5625	0.5625	0.5625	0.5625	0.6250
	RR	0.5625	0.5625	0.5625	0.5625	0.6875
400	HWY	0.6250	0.6250	0.6250	0.6250	0.6250
	RR	0.6250	0.6250	0.6250	0.6250	0.6875

D) Pipe Nominal Size: 66 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.5000	0.5000	0.5000	0.5000	0.6875
	RR	0.5000	0.5000	0.5000	0.6250	0.7500
300	HWY	0.5000	0.5000	0.5000	0.5000	0.6875
	RR	0.5000	0.5000	0.5000	0.6250	0.7500
350	HWY	0.6250	0.6250	0.6250	0.6250	0.6875
	RR	0.6250	0.6250	06250	0.6250	0.7500
400	HWY	0.6875	0.6875	0.6875	0.6875	0.6875
	RR	0.6875	0.6875	0.6875	0.6875	0.7500

E) Pipe Nominal Size: 72 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.5000	0.5000	0.5000	0.5625	0.7500
	RR	0.5625	0.5000	0.5000	0.6250	0.8125
300	HWY	0.5625	0.5625	0.5625	0.5625	0.7500
	RR	0.5625	0.5625	0.5625	0.6250	0.8125
350	HWY	0.6250	0.6250	0.6250	0.6250	0.7500
	RR	0.6250	0.6250	0.6250	0.6250	0.8125
400	HWY	0.7500	0.7500	0.7500	0.7500	0.7500
	RR	0.7500	0.7500	0.7500	0.7500	0.8125

F) Pipe Nominal Size: 78 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.5625	0.5625	0.5625	0.6250	0.8125
	RR	0.6250	0.5625	0.5625	0.6875	0.8750
300	HWY	0.6250	0.6250	0.6250	0.6250	0.8125
	RR	0.6250	0.6250	0.6250	0.6875	0.8750
350	HWY	0.6875	0.6875	0.6875	0.6875	0.8125
	RR	0.6875	0.6875	0.6875	0.6875	0.8750
400	HWY	0.8125	0.8125	0.8125	0.8125	0.8125
	RR	0.8125	0.8125	0.8125	0.8125	0.8750

G) Pipe Nominal Size: 84 inches

Design Pressure (psi)	Live Load Condition	Maximum Depth of Cover (feet)				
		10	15	20	25	30
250	HWY	0.6250	0.5625	0.5625	0.6250	0.8750
	RR	0.5260	0.5625	0.5625	0.7500	0.9375
300	HWY	0.6250	0.6250	0.6250	0.6250	0.8750
	RR	0.6250	0.6250	0.6250	0.7500	0.9375
350	HWY	0.7500	0.7500	0.7500	0.7500	0.8750
	RR	0.7500	0.7500	0.7500	0.7500	0.9375
400	HWY	0.8750	0.8750	0.8750	0.8750	0.8750
	RR	0.8750	0.8750	0.8750	0.8750	0.9375

527.02.06 – MINIMUM WALL THICKNESS FOR UNBURIED INSTALLATIONS

Unless otherwise specified, steel pipe and fittings for unburied installations shall have a minimum thickness of 0.375 inches and shall be not less than the thickness, in inches, shown in the following table:

Pipe Nominal Size (inch)	Design Pressure (psi)			
	250	300	350	400
48	0.3750	0.3750	0.5375	0.5000
54	0.5375	0.5375	0.5000	0.5625
60	0.5375	0.5000	0.5625	0.6250
66	0.5000	0.5000	0.6250	0.6875
72	0.5625	0.5625	0.6250	0.7500
78	0.5625	0.6250	0.6875	0.8125
84	0.6250	0.6250	0.7500	0.8750

527.02.07 – SPECIALS AND FITTINGS

The specials and fittings shall be fabricated in accordance with AWWA C-200. Fittings shall meet the requirements of AWWA C-208 for dimensions. All tees, laterals and outlets shall be designed in accordance with AWWA M11. The specials and fittings shall be provided in accordance with approved submittals or as shown on the plans.

527.02.08 – JOINTS

A) General - Pipe joints shall be made with flanges, sleeve couplings, or lap welded slip joints.

B) Flanges - The flanges for steel pipe, specials and fittings shall be in accordance with AWWA C-207 Class E with bolthole drillings as for Class 125 cast iron flanges. All flanged joints shall be made with single-piece, red rubber gaskets one eighth (? ") inch thick. Gaskets shall be full face for exposed installation and ring type or full faced for buried services meeting AWWA C-207 requirements. Flange nuts and bolts shall be of stainless steel and shall meet the requirements of ASTM A-193, Grade B7.

C) Sleeve Couplings - All sleeve couplings, except as shown on the plans, shall be restrained with tie rods and shall be designed for pipe design pressure and maximum allowable stress not to exceed sixty-five (65%) percent of minimum yield strength of steel used. Harnessed joints shall be designed in accordance with AWWA M-11. See below for approved sleeve couplings.

Dresser Style 38
Rockwell Steel Coupling 511
Smith-Blair

D) Lap-Welded Slip Joints - Welding of pipe joints shall be done in accordance with the requirements of AWWA C-206. Buried pipe, specials, fittings and tied joints, except as shown or noted on the plans shall have full size, single fillet lap-welded slip joints, welded inside and outside. All welds shall be sound and free from embedded scale or slag. The welded joints shall have tensile strength across the weld not less than that of the thinner of the connected sections and shall be leakfree.

The type and use of welding electrodes for the carbon steel shall meet the requirements of AWS B2.1. During welding of pipe sections, coating shall be protected to avoid damage to the coating by hot weld splatters. No welding ground shall be made on coated part of the pipe. All field welding shall be done in accordance with the requirements of AWWA C-206.

527.02.09 – EXTERIOR COATING

A) Pipe and Specials - The exterior of steel pipe and specials shall be coated and wrapped with prefabricated, multi-layer, cold-applied tapes by mechanical methods and tested in accordance with the requirements of AWWA C-214.

The tape coating system shall be a minimum of three (3) layers with a total thickness of eighty (80) mils. The three layers shall consist of a primer, twenty (20) mil thick inner layer and two (2) thirty (30) mil thickness layers outer layers.

The properties of the entire system shall conform to the appropriate values used in Tables 1, 2 and 3 of AWWA C-214. The field joints shall be coated with cold-applied tapes in accordance with the requirements of AWWA C-209.

The bell shall provide for a two (2") inch lap with three fourths (¾") inch allowable pull for a required one inch (1") minimum lap. Shop applied exterior coating shall be held back four inches (4") each end.

B) Connections, and Fittings - The exterior of connections and fittings for steel water pipelines shall be primed and wrapped with prefabricated cold-applied tape coating in accordance with the requirements of AWWA C-209. The thickness of prefabricated tape coating shall be two (2) thirty-five (35) mil layers.

527.02.10 – INTERIOR LINING

The interior of steel pipe, specials and fittings shall be cement mortar lined. The thickness of cement

mortar lining shall be one-half (0.50") inch.

Field linings shall be placed mechanically in accordance with AWWA C-602. Shop applied lining shall be in accordance with AWWA C-205.

Portland Cement for cement mortar lining shall be in accordance with the requirements of ASTM C-150, Type I cement.

Field joints shall be made in accordance with the requirements of AWWA C-205, Appendix A.

The interior of all outlets and connections smaller than six (6") inches shall be painted with liquid epoxy in accordance with the requirements of AWWA C-210. Shop applied interior coating shall be held back four inches (4") on both ends.

527.02.11 – CONNECTIONS

A) General - Air valves, blow-offs, manholes, outlets and shut-off line valves shall be designed and manufactured to meet the combined working and surge pressures of the pipe.

B) Connection to Other Pipe Materials - When connecting steel pipe to either gray or ductile cast-iron pipe, or to steel-reinforced concrete pipe, an electrically insulating joint shall be used. The insulating joint can be accomplished with an insulating gasket with sleeves and washers on a flanged connection or with an insulating sleeve-type flexible coupling.

   Any valves or other ferrous equipment connected to steel pipe shall be encapsulated in polyethylene sheeting in accordance with these specifications, or coated with a coating compatible with the steel pipe coating. Similar precautions are not necessary when connecting to nonmetallic pipe, such as asbestos-cement or plastic.

C) Flanged Connections - Attachment of flanges shall be in accordance with AWWA C-207. Outlet nozzles shall be as short as possible.

D) Blow-Off and Air Valve Connections - Connections to the pipe for blow-offs and air valves shall be shop welded thread lets, half couplings or flanged nozzle with reinforcing collar in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division I, Paragraph UG-37 and AWWA M11. An outlet less than six (6") inches in diameter shall be lined with epoxy paint in accordance with the requirements of AWWA C-210.

E) Manhole and Outlet Connections - Manhole and outlet connections shall be fabricated and designed in accordance with AWWA M11.

F) Air-Release and Air-And-Vacuum Valves - Air-release valves and air-and-vacuum valves, if not installed directly over the pipe, may be located adjacent to the pipeline. A horizontal run of pipe shall connect the air valve and the pipeline. The connecting pipe shall rise gradually to the air valve to permit flow of the air to the valve for venting.

527.04 – CONSTRUCTION METHODS

The City retains the right to inspect the pipe, specials and fittings, all work performed and materials furnished at the manufacturer's plant and at the project site and to independently monitor the fabrication of the pipe, specials and fittings. Such inspection shall not relieve the Contractor or the manufacturer of their responsibility to furnish material and perform the work in accordance with these specifications.

527.05 – TESTING

527.05.01– HYDROSTATIC PRESSURE TESTING AND DISINFECTION

Field Testing shall be accomplished in accordance with Section 522 and Section 523.

527.05.02 – SOURCE QUALITY CONTROL

A) Hydrostatic Test - Each length of pipe shall be shop tested hydrostatically to a pressure which will induce a hoop stress equal to at least seventy-five (75%) percent of the minimum yield stress of steel used. The test requirements shall be in accordance with AWWA C-200, Section 3.4.

The fittings, specials and appurtenances shall be hydrostatically tested to a pressure not less than that for the steel pipe. Non-destructive testing in accordance with AWWA C-200, Section 4.3 may be substituted for the hydrostatic test when approved by the Engineer.

Test reports of the hydrostatic testing of steel pipe, specials and fittings shall be submitted to the Engineer on a weekly basis during production.

B) Plant Welding - Quality control tests of production welds during the manufacture of steel pipe shall be conducted in accordance with the requirements of AWWA C-200, Section 3.3.5.

C) Field Welding - At the beginning of work, a yield point determination of a welded joint shall be made by an independent testing laboratory. When directed by the Engineer, welded test specimens shall be furnished for testing. All costs for laboratory testing shall be borne by the Contractor. Use of back up welding strips or rings for shop welds shall not be permitted.

D) Welder Qualifications - All welding shall be done by ASME qualified welders. Welders shall meet the general requirements of Section 9 of ASME Boiler and Pressure Vessel Code.

E) Holiday Tests - The Contractor shall conduct an electrical inspection of all wrapped surfaces. The electrical inspection shall be conducted in accordance with the requirements of AWWA C-209 and C-214.

527.07 – BASIS OF PAYMENT

Payment shall be made pursuant to Section 505.

SECTION 528 – STEEL CASING PIPE

528.01 - DESCRIPTION

This section covers steel pipe intended to be used as a casing pipe for boring and micro and small diameter tunneling installations.

528.02 – MATERIALS

528.02.01 – SUBMITTALS

When requested, the Contractor shall submit the following, provided that all applicable requirements are met, and that visual inspection at destination shows the workmanship and condition of material to be satisfactory.

A) Type "A" certification for pipe

B) Shop drawings of pipe, joints and seams

C) Documentation of manufacturer's on-going quality control program.

528.02.02 – GENERAL

A) General - Steel pipe shall conform to ASTM A-139, Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over). The steel material shall be new, smooth wall, carbon steel, Grade B, with minimum sixty thousand (60,000 psi) pounds per square inch tensile strength, and minimum thirty-five thousand (35,000 psi) pounds per square inch yield strength.

The pipe shall be straight seam pipe, seamless pipe, or spiral weld pipe. For spiral weld pipe, the spiral shall be one hundred (100%) percent welded, and the weld's height over the outside wall surface shall be equal to or less than three-sixteenths (3/16") inch. All steel pipe shall be square cut and shall have a roundness such that the difference between the major and minor outside diameters shall not exceed one (1%) percent of the specified nominal outside diameter or one-fourth (¼") inch, whichever is less. The outside circumference must be within plus or minus (±) one (1%) percent of the nominal circumference or within plus or minus (±) one-half (½") inch, which is less. The pipe shall have a maximum allowable straightness deviation in any ten (10') foot length of one-eighth (?") inch. Steel pipe joints shall be continuously welded with an approved butt weld. The welds shall attain the full strength of the pipe and shall result in a fully watertight section. The welded joints shall conform to the requirements of AWWA C-206.

B) Boring (Micro and Small Diameter Tunneling) Installations

a. Casing Pipe Size - Steel casing pipe shall have the follow minimum inside diameters:

Pipe Nominal Size (inches)	Casing Pipe Inside Diameter (inches)
4	8 to 10
6	10 to 12
8	14 to 16
10	16 to 18
12	18 to 20
15	20 to 22
18	24 to 26
24	31 to 33
27	33 to 36
30	36 to 42
36	42 to 48
42	54 to 60
48	60 to 66

b. Casing Pipe Thickness - Steel casing pipe shall be the following minimum thickness, in inches, for the indicated maximum depth of cover(s), in feet:

OUTSIDE DIAMETER (inches)	UNDER HIGHWAY		UNDER RAILROAD	
	Wall Thickness (inches)	Maximum Cover (feet)	Wall Thickness (inches)	Maximum Cover (feet)
? 12¾	0.188	30	0.250	30
16	0.250	30	0.281	30
18	0.250	30	0.322	30
20	0.250	30	0.344	30
24	0.250	30	0.406	30
30	0.322	30	0.469	30
36	0.375	30	0.531	30

OUTSIDE DIAMETER (inches)	UNDER HIGHWAY		UNDER RAILROAD	
	Wall Thickness (inches)	Maximum Cover (feet)	Wall Thickness (inches)	Maximum Cover (feet)
42	0.375	25	0.531	30
48	0.438	25	0.531	25
54	0.438	25	0.531	20
60	0.438	25	0.531	20
66	0.438	20	0.531	20

528.07 – BASIS OF PAYMENT

Payment shall be made pursuant to the appropriate Section of 505 or 254.

SECTION 529 – RESTRAINED JOINTS

529.01 – DESCRIPTION

This section covers restrained joints intended to be used to control unbalanced thrust forces when called for on the plans or specified.

529.02 – MATERIALS

A) Ductile Iron Pipe - Restrained joints shall be American Lok-Ring or approved equal. Retainer glands shall not be permitted. Flanged joints shall be used for above ground installations.

B) Steel Pipe - No restraint shall be required for welded joints.

C) PVC Pipe - Restraint mechanism shall be same as that specified for ductile iron pipe in part A).

D) Pre-stressed Concrete Cylinder Pipe - Restrained joints shall be welded, clap type harness, or snap ring type harness. Approved manufacturers are shown in Section 524.02.06.

529.06 – METHOD OF MEASURMENT

Payment for "Restrained Joints" shall be made at the unit price bid per each for each size. The price established shall be full compensation for all materials, labor, tools, equipment and incidentals necessary to complete this item of work. Flanged joints shall not be paid for separately but shall be included in the price bid for "Waterline Pipe" pursuant to Section 505.

529.07 – BASIS OF PAYMENT

Restrained joints shall be paid as per Section 505.07.

SECTION 530 – CLOSURE PIECES

530.01 – DESCRIPTION

This section covers pipe closure pieces intended to be used for connecting water lines where a standard connection (joint) cannot be made.

530.02 - MATERIALS

530.02.01 – GENERAL

The pressure rating of closure pieces shall be equal to or greater than the pressure rating of the water main.

530.02.02 – TYPES

Unless otherwise specified or called for on the plans the following requirements shall be adhered to:

A) Ductile Iron Pipe - Closure pieces shall be either solid sleeve joints meeting the requirements of ANSI/AWWA C-110/A21.10.

B) PVC Pipe - Closure pieces shall be mechanical joint ductile iron fitting as specified in Part A above.

C) Steel Pipe - Closure pieces shall be sleeve coupling, double-butt weld, or butt strap joint meeting the requirements of Section 527 and AWWA M11.

D) PCCP - Closure pieces shall be follower ring or welded. Standard length shall be six (6') feet and shall not be less than a minimum of two (2') feet. When necessary, double spigot adapter may be used to convert a bell end on a pipe section to a spigot end to facilitate proper alignment and closure of the pipe sections. The spigot ends shall not be more than one inch (1") out of line or grade. Closure with restrained joints shall be used when the pipe has restrained joints.

530.07 – METHOD OF MEASUREMENT

Payment for "Closure Piece" shall be made at the unit price bid per linear foot for each size. The price established shall be full compensation for furnishing and installing of all materials including closure piece assembly, repair kits, labor, tools, equipment and incidentals necessary to complete this item of work.

530.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) CLOSURE PIECE LF.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 531 – THRUST COLLARS

531.01 – DESCRIPTION

This section covers thrust collars intended to be used, with pre-stressed concrete cylinder pipe, to transmit thrust forces into undisturbed soil adjacent to the thrust collars.

531.04 – CONSTRUCTION METHODS

All construction shall be in accordance with the Standard Detail for Thrust Collars when called for on the plans or as directed by the Engineer. Concrete thrust block shall be cast around steel thrust collar after pipe is installed.

531.06 – METHOD OF MEASUREMENT

Payment for "Thrust Collars" shall be made at the unit price bid per each for each size. The price established shall be full compensation for all material including the steel thrust collar (fitting), labor, tools, equipment, and incidentals necessary to complete this item of work.

Payment for the concrete "Thrust Block" shall be made pursuant to Section 518.

531.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) THRUST COLLARS EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and

incidentals, and for performing the work in accordance with these specifications.

SECTION 532 - TAPPING SLEEVES

532.01 - DESCRIPTION

This section covers tapping sleeves intended to be used for tapping water mains.

532.02 - MATERIALS

Tapping sleeves shall be manufactured in accordance with AWWA C-110 and equipped with gaskets made in accordance with AWWA C-111. Tapping Sleeve shall be Ductile Iron or Steel, Mechanical Joint and shabby be manufactured by the following:

Following is a list of approved manufacturers or equal:

American Cast Iron Pipe Company	JCM Model 414, 439, 459
Smith Blair	Model 623
Ford Meter Box Company	Model 3490 Mechanical Joint by Power Seal Pipeline Products Corporation
Mueller Stainless Steel	H304SS or H304MJ

All Steel Tapping Sleeves must have Fusion-Bonded Epoxy Coating and Type 304 Stainless Steel Bolts and Nuts.

532.04 – CONSTRUCTION METHODS

The installation shall conform to the recommendation of the manufacturer of the pipe being tapped.

532.06 – METHOD OF MEASUREMENTS

Payment for "Tapping Sleeve" shall be made at the unit price bid per each for each size. The price established shall be full compensation for furnishing and placing of all materials including tapping sleeve, labor, tools, equipment, and incidentals necessary to complete this item of work.

532.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) TAPPING SLEEVE EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 533 – TAPPING SADDLES

533.01 – DESCRIPTION

This section covers tapping saddles used for tapping water mains.

533.02 – MATERIALS

Tapping saddle shall be manufactured in accordance with AWWA C-110 and equipped with gaskets made in accordance with AWWA C-111.

533.04 – CONSTRUCTION METHODS

A) General - Tapping saddles shall have a body with a threaded outlet, seal, and suitable means for attachment to the main. The body shall be made to conform to the outside configuration of

the main. Tapping saddles shall be designed to provide a drip-tight connection when used as a service connection to the main. The materials used to produce tapping saddles shall comply with Section 510.

B) Three-quarter (¾") inch to one inch (1") services - Tapping saddles shall be required when tapping other than cast iron or ductile iron pipe. Saddles shall be brass or stainless steel. Saddles may be required on older cast-iron and ductile-iron as directed by the Engineer. Tapping saddles shall be the same size as the service line. The reducing of tapping saddles shall not be allowed.

C) One and one-half (1 ½") inch and larger services - One and one-half (1½") inch and larger tapping saddles shall be ductile iron, stainless steel or approved equal. Three (3") inch and larger taps shall require solid back tapping saddles. Four-bolt epoxy-coated alloy bolts shall be required. No shop coat bolts shall be allowed. No strap tapping saddles shall be allowed.

533.06 – METHODS OF MEASUREMENTS

Payment for "Tapping Saddle" shall be made at the unit price bid per each for each size. The price established shall be full compensation for furnishing and placing all materials, including tapping saddle, labor, tools, equipment and incidentals necessary to complete this item of work.

533.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) TAPPING SADDLE EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 534 - CORROSION MONITORING SYSTEM

534.01 - DESCRIPTION

This section covers corrosion monitoring system intended to provide protection against corrosion for PCCP, and steel waterlines, when called for on the plans or specified.

534.01.01 - GENERAL

The contractor shall provide corrosion engineering services and shall design, furnish, and install a corrosion monitoring system for steel or embedded type pre-stressed concrete cylinder pipe. All design, installation, and testing shall be consistent with sound corrosion engineering practice as determined by the Engineer. The corrosion engineer designing the system shall be NACE certified.

534.01.02 - REQUIREMENTS

A) Steel Cylinder Bonding - For PCCP, bonds shall be provided between the steel cylinders of adjacent pipe sections and all non-insulating joints as necessary to assure electrical continuity except where electrical isolation is necessary or required. The joint bonds shall be designed with sufficient slack to allow for some joint displacement and rotation.

Two steel bonding clips per joint shall be placed at the spring line of the pipe. The increase in electrical resistance due to the joint bonds per one hundred (100') feet of pipe shall not exceed two hundred and fifty (250%) percent when compared to the electrical resistance of one hundred (100') feet of pipe when calculated as follows:

$$I = \left(1 + \frac{R_B}{R_p}\right)100$$

Where:

I = percent increase in electrical resistance

R_B = resistance in ohms of the joint bonds per 100 feet of pipe

R_p = resistance in ohms per 100 feet of pipe when calculated as follows:

$$R_p = \frac{0.2158}{W_p}$$

W_p= weight of steel in 1 foot length of pipe

The effective resistance of parallel circuit, pre-stress wire path and cylinder path, shall be used as R_p for embedded cylinder pre-stressed concrete pipe.

Bonds shall consist of insulated copper or steel cable metallurgically welded or brazed to adjacent cylinders. All bare copper and steel shall be insulated by approved means.

B) Pre-stress Wire Bonding - For PCCP, intermediate bonds for pre-stress wire of embedded cylinder shall also be provided as required to minimize attenuation. The intermediate bonds shall be in the form of steel straps embedded in the outer surface of the concrete core directly upon which the pre-stress wire is tightly wound. The size and number of straps shall be designed to provide uniform current distribution to all embedded metallic surfaces of the pipe.

C) Electrical Isolation - Electrical isolation in the form of either flexible or rigid insulating fittings as specified herein shall be provided as required to obtain electrical discontinuity at:

1. The beginning and end of all portions of the pipeline to be monitored.
2. Joints where the line-pipe is joined to steel manifolds or steel pipe.
3. Joints where steel or ductile iron or nonferrous metals are joined to structures other than air valves, blo-off valves, and turnouts.
4. All points where ductile iron is joined to PCCP.

D) Flexible Insulating Fittings - Flexible insulating fittings required shall be plastisol or epoxy coated adapter units or approved equal.

E) Rigid Insulating Fittings - Rigid insulating fittings required shall be flanged joints with full-faced neoprene phenolic gaskets, polyethylene sleeves and steel washers backed with insulating micata washers or an approved equal.

F) Corrosion Test Stations - Corrosion test stations shall be installed meeting the following requirements:

1. Locations
   a. All buried line crossings.
   b. The beginning and end of the portions of the pipeline to be monitored.
   c. Both sides of insulated fittings.

d. Intermediate locations along the line, such that test stations are no more than 1200 feet apart.

e. Casing and carrier pipe.

f. Corrosion stations shall be installed on both the carrier pipe and the casing at both ends of the metallic casings.

2. Types

a. Two-Wire Type - Test stations may be of the two-wire type with one of the wires being No. 6 AWG or larger such that it can be used for bonding. The other wire, for determining pipe-to-soil potentials, shall be No. 12 AWG or larger. Both leads shall be continuous (without splices) and laid with sufficient slack to prevent stress. The leads shall be insulated with 600-volt rated solution suitable for direct burial. Prior to backfilling, the insulation shall be inspected for defects. All defects shall be repaired by approved methods.

b. Flush Type - Test stations may be of the flush type (terminals below grade) or above-surface type, protected as required for permanency. The flush type shall be installed in developed, urban areas (streets, alleys, sidewalks, etc.) and above-surface type (mounted on a post) shall be installed in undeveloped open areas; where possible, test stations shall be located at or closely adjacent to clearly identifiable topographical features (fences, line, road, intersection, section line, etc.) of the pipeline right of way.

G) Testing - The contractor shall perform tests as required to determine the following, and to correct corrosion monitoring system to comply with these specifications.

a. Pipeline electrical continuity.
b. Effectiveness of insulating joints.
c. Test station integrity.
d. Static pipe-to-soil potentials at each test station.
e. Soil resistivity at each test station.

534.06 – METHOD OF MEASUREMENT

Payment for Corrosion Monitoring System shall be made at the unit price per lump sum. Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

534.07 – BASIS OF PAYMENT

Unless otherwise called out on plans, the item measured as provided above will be paid for at the contract unit price bid:

CORROSION MONITORING SYSTEM L.S.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 590 - WATER CONSTRUCTION STANDARD BID ITEMS

590.01 - DESCRIPTION

This section covers Standard Bid Items used in the contract documents for the construction of waterlines and their appurtenances. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	DESCRIPTION	UNIT
505	(SIZE) (TYPE) WATERLINE PIPE (JOINT TYPE) (NOM WALL THICK)	L.F.
505	FITTINGS (SIZE AND TYPE)	LBS.
505	FITTINGS (SIZE AND TYPE)	EA.
510	WATER SERVICE LINE CONNECTION (SIZE)	EA.
511	WATER SERVICE LINE SINGLE (SIZE)	EA.
511	WATER SERVICE LINE DOUBLE (SIZE)	EA.
511	WATER SERVICE LINE SHORT(SIZE)	EA.
511	WATER SERVICE LINE LONG (SIZE)	EA.
511	WATER SERVICE LINE EXTRA LONG (SIZE)	EA.
512	METER RELOCATION (SIZE)	EA.
513	WET CONNECTION (SIZE)	EA.
514	(SIZE) TAP	EA.
516	FIRE HYDRANT	EA.
517	REMOVAL OF FIRE HYDRANT	EA.
518	THRUST BLOCK	EA.
519	BLOW-OFF CONNECTION (SIZE)	EA.
520	(SIZE) (TYPE) VALVE AND VALVE BOX	EA.
520	(SIZE) (TYPE) VALVE AND VAULT	EA.
522	HYDROSTATIC PRESSURE TESTING AND DISINFECTION	L.SUM
524	DUCTILE IRON PIPE (SIZE)	L.S.
529	RESTRAINED JOINT (SIZE)	EA.
530	CLOSURE PIECE (SIZE)	EA.
531	THRUST COLLARS (SIZE)	EA.
532	TAPPING SLEEVE (SIZE)	EA.
533	TAPPING SADDLE (SIZE)	EA.

SECTION 591 - WATERLINE CONSTRUCTION STANDARD DETAILS

591.01 - DESCRIPTION

This section covers Standard Details used as a supplement to the plans and specifications for the construction of waterlines and their appurtenances.

I D NUMBER	TITLE
SD NO. 1	STANDARD DETAIL FOR INSTALLATION OF RIGID PIPES
SD NO. 2	STANDARD DETAIL FOR INSTALLATION OF FLEXIBLE PIES
SD NO. 3	STANDARD DETAIL FOR INSTALLATION OF DUCTILE IRON PIPES
SD NO. 4	STANDARD DETAIL FOR PLAIN CONCRETE CRADLE
SD NO. 5	STANDARD DETAIL FOR REINFORCED CONCRETE CRADLE
SD NO. 6	STANDARD DETAIL FOR PLAIN CONCRETE ARCH
SD NO. 7	STANDARD DETAIL FOR REINFORCED CONCRETE ARCH
SD NO. 8	STANDARD DETAIL FOR EMBEDMENT PLUG
SD NO. 9	STANDARD DETAIL FOR INSTALLATION OF SUBDIVISION METER
SD NO. 10	STANDARD DETAIL FOR INSTALLATION OF SUBDIVISION METER
SD NO. 11	STANDARD DETAIL FOR INSTALLATION OF SUBDIVISION METER
SD NO. 12	STANDARD DETAIL FOR SERVICE REPLACEMENT
SD NO. 13	STANDARD DETAIL FOR BORING
SD NO. 14	STANDARD DETAIL FOR COMBINATION DETECTOR AND METER PIT
SD NO. 15	STANDARD DETAIL FOR METER PIT COVER
SD NO. 16	STANDARD DETAIL FOR FIRE HYDRANT NOZZLE THREADS
SD NO. 17	STANDARD DETAIL FOR GUARD POST
SD NO. 18	STANDARD DETAIL FOR DETECTOR CHECK WITH HYDRANT AND STANDPIPE
SD NO. 19	STANDARD DETAIL FOR DETECTOR CHECK AND STANDPIPE
SD NO. 20	STANDARD DETAIL FOR DOUBLE DETECTOR CHECK
SD NO. 21	STANDARD DETAIL FOR INSTALLATION OF FIRE HYDRANT
SD NO. 22	STANDARD DETAIL FOR INSTALLATION OF FIRE HYDRANT ON EXISTING MAIN
SD NO. 23	STANDARD DETAIL FOR METER PIT FOR DOUBLE DETECTOR CHECK
SD NO. 24	STANDARD DETAIL FOR TAPPING SLEEVE BLOCKING
SD NO. 25	STANDARD DETAIL FOR DRIVEWAY AND PAVING CUT PERMANENT REPAIR
SD NO. 26	STANDARD DETAIL FOR REMOVAL OF FIRE HYDRANTS
SD NO. 27	STANDARD DETAIL FOR REVERSE TAP
SD NO. 28	STANDARD DETAIL FOR 1" & 2" AIR VACUUM VALVES, ¾" AIR RELEASE VALVES
SD NO. 29	STANDARD DETAILS FOR 2" BLOW-OFF
SD NO. 30	STANDARD DETAILS FOR CAST IRON VALVE BOX AND LID
SD NO. 31	STANDARD DETAILS FOR THRUST BLOCKS
SD NO. 32	STANDARD DETAILS FOR 4" AIR VACUUM AND RELEASE VALVE
SD NO. 33	STANDARD DETAILS FOR SERVICE REPLACEMENT
SD NO. 34	STANDARD DETAILS FOR INSTALLATION OF SUBDIVISION METER
SD NO. 35	STANDARD DETAILS FOR INSTALLATION OF SUBDIVISION METER
SD NO. 36	STANDARD DETAILS FOR INSTALLATION OF SUBDIVISION METER
SD NO. 37	STANDARD DETAILS FOR REMOVING AND REPLACING ALLEY AND SIDEWALK PAVEMENT