SECTION 221116 - DOMESTIC WATER PIPING

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section Includes:

Copper tube and fittings.

Ductile-iron pipe and fittings.

Galvanized-steel pipe and fittings.

Stainless steel piping and fittings.

CPVC piping.

PEX tube and fittings.

PEX-AL-PEX tube and fittings.

PEX-AL-HDPE tube and fittings.

PVC pipe and fittings.

Piping joining materials.

Encasement for piping.

Transition fittings.

Dielectric fittings.

* + - 1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are submitted and tabbed (for combined submittals).
				4. Product Data:

Pipe and tube.

Fittings.

Joining materials.

Transition fittings.

USE PARAGRAPH BELOW WITH EPD REQUIREMENT WHEN PROJECT ESTIMATE IS $1M OR MORE.

* + - * 1. Submit an Environmental Product Declaration (EPD) from the manufacturer for steel pipe within this specification section, if available. A statement of the contractor’s good faith effort to obtain the EPD shall be provided if not available.

Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

Retain "Coordination Drawings" paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
				2. System purging and disinfecting activities report.
				3. Retain "Field quality-control reports" Paragraph below if Contractor is responsible for field quality-control testing and inspecting.
				4. Field quality-control reports.
			1. FIELD CONDITIONS

Retain this article if interruption of existing water service is required.

* + - * 1. Interruption of Existing Water Service: Do not interrupt service to facilities occupied unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

Notify Director’s Representative no fewer than 7 days in advance of proposed interruption of service.

Do not interrupt service without written permission from Director’s Representative.

1. PRODUCTS
	* + 1. PIPING MATERIALS

See "Writing Guide" Article in the Evaluations for a discussion of how this Section is organized and the most efficient way to revise this Section. See "Piping Materials and Standards" Article in the Evaluations for a discussion of piping materials covered by referenced standards.

* + - * 1. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.[**Include marking "NSF-pw" on piping.**]
			1. COPPER TUBE AND FITTINGS

Tube in "Drawn-Temper Copper Tube" paragraph below is generally available in NPS 1/8 to NPS 12 (DN 6 to DN 300). Drawn-temper copper tube is commonly referred to as "hard" copper tube.

* + - * 1. Drawn-Temper Copper Tube: [**ASTM B88, Type K**] [**ASTM B88, Type L**].

Tube in "Annealed-Temper Copper Tube" paragraph below is generally available in NPS 1/8 to NPS 12 (DN 6 to DN 300). Annealed-temper copper tube is commonly referred to as "soft" copper tube.

* + - * 1. Annealed-Temper Copper Tube: [ASTM B88, Type K] [ASTM B88, Type L].

Fittings in "Cast-Copper, Solder-Joint Fittings" paragraph below are generally available in NPS 1/4 to NPS 12 (DN 8 to DN 300).

* + - * 1. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

Fittings in "Wrought-Copper, Solder-Joint Fittings" paragraph below are generally available in NPS 1/4 to NPS 8 (DN 8 to DN 200).

* + - * 1. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

Flanges in "Bronze Flanges" paragraph below are generally available in NPS 1/2 to NPS 12 (DN 15 to DN 300).

* + - * 1. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

Unions in "Cast Copper Unions" paragraph below are generally available in NPS 1/4 to NPS 4 (DN 8 to DN 100).

Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

Wrought Copper Unions: ASME B16.22.

Grooved, Mechanical-Joint, Copper Tube Appurtenances:

Grooved-End, Copper Fittings: ASTM B75 copper tube or ASTM B584 bronze castings.

Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting, EPDM-rubber gasket, UL classified per NSF 61 and NSF 372, and rated for minimum [**180 deg F**] <**Insert temperature**>, for use with ferrous housing and steel bolts and nuts; 300 psig minimum CWP pressure rating.

Fittings in "Copper Tube, Pressure-Seal-Joint Fittings" paragraph below are generally available in NPS 1/2 to NPS 4 (DN 15 to DN 100).

* + - * 1. Copper Tube, Pressure-Seal-Joint Fittings:

Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.

Minimum 200-psig working-pressure rating at 250 deg F.

Fittings in "Copper Tube, Push-on-Joint Fittings" paragraph below are generally available in NPS 1/2 to NPS 2 (DN 15 to DN 50).

* + - 1. DUCTILE-IRON PIPE AND FITTINGS

Pipe in "Mechanical-Joint, Ductile-Iron Pipe" paragraph below is available in NPS 3 to NPS 64 (DN 80 to DN 1600).

* + - * 1. Mechanical-Joint, Ductile-Iron Pipe:

AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

Fittings in "Standard-Pattern, Mechanical-Joint Fittings" paragraph below are available in NPS 3 to NPS 48 (DN 80 to DN 1200).

* + - * 1. Standard-Pattern, Mechanical-Joint Fittings:

AWWA C110/A21.10, ductile or gray iron.

Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

Fittings in "Compact-Pattern, Mechanical-Joint Fittings" paragraph below are available in NPS 3 to NPS 24 (DN 80 to DN 600).

* + - * 1. Compact-Pattern, Mechanical-Joint Fittings:

AWWA C153/A21.53, ductile iron.

Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

Pipe in "Push-on-Joint, Ductile-Iron Pipe" paragraph below is available in NPS 3 to NPS 64 (DN 80 to DN 1600).

* + - * 1. Push-on-Joint, Ductile-Iron Pipe:

AWWA C151/A21.51.

Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

Fittings in "Standard-Pattern, Push-on-Joint Fittings" paragraph below are available in NPS 3 to NPS 48 (DN 80 to DN 1200).

* + - * 1. Standard-Pattern, Push-on-Joint Fittings:

AWWA C110/A21.10, ductile or gray iron.

Gaskets: AWWA C111/A21.11, rubber.

Fittings in "Compact-Pattern, Push-on-Joint Fittings" paragraph below are available in NPS 3 to NPS 24 (DN 80 to DN 600).

* + - * 1. Compact-Pattern, Push-on-Joint Fittings:

AWWA C153/A21.53, ductile iron.

Gaskets: AWWA C111/A21.11, rubber.

Pipe in "Plain-End, Ductile-Iron Pipe" paragraph below is available in NPS 3 to NPS 64 (DN 80 to DN 1600).

* + - * 1. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

Fittings and couplings in "Appurtenances for Grooved-End, Ductile-Iron Pipe" paragraph are available in NPS 4 to at least NPS 24 (DN 100 to DN 600).

* + - * 1. Appurtenances for Grooved-End, Ductile-Iron Pipe:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1988) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Shurjoint; a part of Aalberts Integrated piping Systems](http://www.specagent.com/Lookup?uid=123457169232).

[Star Pipe Products](http://www.specagent.com/Lookup?uid=123457169233).

[Victaulic Company](http://www.specagent.com/Lookup?uid=123457169234).

Or equal.

Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A47, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions that match pipe.

Couplings in "Mechanical Couplings for Grooved-End, Ductile-Iron-Piping" subparagraph below are available in NPS 4 to NPS 24 (DN 100 to DN 600). Other AWWA pipe size couplings in NPS 3 to NPS 36 (DN 80 to DN 900) are also available.

Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:

AWWA C606 for ductile-iron-pipe dimensions.

Ferrous housing sections.

EPDM-rubber gaskets suitable for hot and cold water.

Bolts and nuts.

Minimum Pressure Rating:

NPS 14 to NPS 18: [**250 psig** ] <**Insert value**>.

N20 inch to 46 inch: [**150 psig**] <**Insert value**>.

* + - 1. GALVANIZED-STEEL PIPE AND FITTINGS

Galvanized-steel pipe and fittings corrode over time. They rust from the inside out. Galvanized-steel pipes can corrode to the point where the pipes are completely restricted. Corrosion also occurs in steel that is connected directly to copper or brass.

Pipe in "Galvanized-Steel Pipe" paragraph below is available in NPS 1/8 to NPS 26 (DN 6 to DN 650).

* + - * 1. Galvanized-Steel Pipe:

ASTM A53, [**Type E**] <**Insert type**>, [**Grade B**] <**Insert grade**>, Standard Weight.

Include ends matching joining method.

Nipples in "Galvanized-Steel Pipe Nipples" paragraph below are available in NPS 1/8 to NPS 12 (DN 6 to DN 300).

* + - * 1. Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53 or ASTM A106, Standard Weight, seamless steel pipe with threaded ends.

Fittings in "Galvanized, Gray-Iron Threaded Fittings" paragraph below are available in NPS 1/4 to NPS 12 (DN 8 to DN 300).

* + - * 1. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

Unions in "Malleable-Iron Unions" paragraph below are available in NPS 1/8 to NPS 4 (DN 6 to DN 100).

* + - * 1. Malleable-Iron Unions:

ASME B16.39, Class 150.

Hexagonal-stock body.

Ball-and-socket, metal-to-metal, bronze seating surface.

Threaded ends.

Flanges in "Flanges" paragraph below are available in NPS 1 to NPS 96 (DN 25 to DN 2400).

* + - * 1. Flanges: ASME B16.1, Class 125, cast iron.
				2. Appurtenances for Grooved-End, Galvanized-Steel Pipe:

ASTM Fittings for Grooved-End, Galvanized-Steel Pipe: Galvanized, ASTM A47, malleable-iron casting; ASTM A106, steel pipe; or ASTM A536, ductile-iron casting; with dimensions matching steel pipe.

AWWA C606 covers couplings in NPS 3/4 to NPS 24 (DN 20 to DN 600) in "AWWA Fittings for Grooved-End, Galvanized-Steel Pipe" subparagraph below.

AWWA Fittings for Grooved-End, Galvanized-Steel Pipe:

AWWA C606 for steel-pipe dimensions.

Ferrous housing sections.

EPDM-rubber gaskets suitable for hot and cold water.

Bolts and nuts.

Minimum Pressure Rating:

NPS 8 and Smaller: [**600 psig**] <**Insert value**>.

NPS 10 and NPS 12 : [**400 psig**] <**Insert value**>.

NPS 14 to NPS 24: [**250 psig**] <**Insert value**>.

* + - 1. STAINLESS STEEL PIPING
				1. Potable-water piping and components shall comply with NSF 61 and NSF 372.

Pipe in "Stainless Steel Pipe" paragraph below is available in NPS 1/8 to NPS 30 (DN 6 to DN 750).

* + - * 1. Stainless Steel Pipe: ASTM A312, with wall thickness as indicated in "Piping Applications" Article.
				2. Stainless Steel Pipe Fittings: ASTM A815.

Fittings and couplings in "Appurtenances for Grooved-End, Stainless Steel Pipe" paragraph below is available in NPS 1 to NPS 24 (DN 25 to DN 600).

* + - * 1. Appurtenances for Grooved-End, Stainless Steel Pipe:

Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.

AWWA C606 covers couplings in NPS 3/4 to NPS 24 (DN 20 to DN 600) in "Mechanical Couplings for Grooved-End, Stainless Steel Pipe" subparagraph below.

Mechanical Couplings for Grooved-End, Stainless Steel Pipe:

AWWA C606 for stainless steel-pipe dimensions.

Stainless steel housing sections.

Stainless steel bolts and nuts.

EPDM-rubber gaskets suitable for hot and cold water.

Minimum Pressure Rating:

NPS 8 and Smaller: [**600 psig**] <**Insert value**>.

NPS 10 and NPS 12: [**400 psig**] <**Insert value**>.

NPS 14 to NPS 24: [**250 psig**] <**Insert value**>.

Fittings in "Stainless Steel Piping, Pressure-Seal-Joint Fittings" paragraph below are currently available from Viega in NPS 1/2 to NPS 4 (DN 15 to DN 100). Victaulic and Grinnell currently offer pressure-seal joints for NPS 1/2 to NPS 2 (DN 15 to DN 50) but use their grooved fittings lines to cover NPS 2-1/2 (DN 75) and larger.

* + - * 1. Stainless Steel Piping, Pressure-Seal-Joint Fittings:

Material: Type 316 stainless steel, ASTM A312, Schedule 10.

Fittings: Type 316 stainless steel with EPDM O-ring seal in each end, and approved for potable water applications.

Listing: Uniform Code-ES LC1002 or UL Classified in accordance with ANSI/NSF 61 and 372.

Design Consultant to review code references and verify that the referenced sections/tables are current. Note that code references shall be based on the current version of the Uniform Code.

Minimum 200-psig working-pressure rating at 250 deg F.

* + - 1. CPVC PIPING
				1. CPVC Pipe: ASTM F441, with wall thickness as indicated in "Piping Applications" Article.

Fittings in "CPVC Socket Fittings" subparagraph below are available in NPS 1/4 to NPS 6 (DN 8 to DN 150).

CPVC Socket Fittings: [ASTM F438 for Schedule 40] [and] [ASTM F439 for Schedule 80].

Fittings in "CPVC Threaded Fittings" subparagraph below are available in NPS 1/4 to NPS 6 (DN 8 to DN 150).

CPVC Threaded Fittings: ASTM F437, Schedule 80.

Piping in "CPVC Piping System" paragraph below is available in NPS 1-1/2 and NPS 2 (DN 40 and DN 50).

* + - * 1. CPVC Piping System: ASTM D2846, SDR 11, pipe and socket fittings.

Tubing in "CPVC Tubing System" paragraph below is available in NPS 1/4 to NPS 2 (DN 8 to DN 50).

* + - * 1. CPVC Tubing System: ASTM D2846, SDR 11, tube and socket fittings.
			1. PEX TUBE AND FITTINGS

Tubing in this article is available in NPS 1/8 to NPS 6 (DN 6 to DN 150). The Section Text limits PEX tubing to NPS 1 (DN 25) for use with metal fittings specified.

* + - * 1. Tube Material: PEX plastic according to ASTM F876[**and ASTM F877**].

Retain "Fittings" or "Push-Fit Fittings" paragraph below, or both. If retaining both, indicate where fittings are used in "Joint Construction" Article. Fittings below are generally available in NPS 3/8 to NPS 1 (DN 10 to DN 25).

* + - * 1. Fittings: [ASTM F1807, metal insert and copper crimp rings] [ASTM F1960, cold expansion fittings and reinforcing rings].
				2. Push-Fit Fittings: ASSE 1061, push-fit fittings.
				3. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.
			1. PEX-AL-PEX TUBE AND FITTINGS

Tubing in this article is available in NPS 1/2 to NPS 1 (DN 50 to DN 100)

* + - * 1. Tube Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F1281.

See discussion in the Evaluations about oxygen barrier in "Oxygen Barrier" paragraph below. The referenced standard is the only standard used by plastic-tubing manufacturers that describes how to test and measure oxygen diffusion in plastic tubes. It is a German national standard and is available in English; see the Evaluations for information about where it can be obtained.

* + - * 1. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
				2. Fittings: ASTM F1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).
			1. PEX-AL-HDPE TUBE AND FITTINGS
				1. Tube Material: ASTM F1986 tubing.
				2. Fittings for PEX-AL-HDPE Tube: ASTM F1986, metal-insert type with copper or stainless steel crimp ring and matching PEX-AL-HDPE tube dimensions.
			2. PVC PIPE AND FITTINGS

Pipe in this article is available in NPS 1/8 to NPS 24 (DN 6 to DN 600).

* + - * 1. PVC Pipe: ASTM D1785, with wall thickness as indicated in "Piping Applications" Article.

Fittings in "PVC Socket Fittings" paragraph below are available in NPS 1/8 to NPS 12 (DN 6 to DN 300).

* + - * 1. PVC Socket Fittings: [ASTM D2466 for Schedule 40] [and] [ASTM D2467 for Schedule 80].

Fittings in "PVC Schedule 80 Threaded Fittings" paragraph below are available in NPS 1/8 to NPS 6 (DN 6 to DN 150).

* + - * 1. PVC Schedule 80 Threaded Fittings: ASTM D2464.
			1. PIPING JOINING MATERIALS
				1. Pipe-Flange Gasket Materials:

AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.

Full-face or ring type unless otherwise indicated.

* + - * 1. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
				2. Solder Filler Metals: ASTM B32, lead-free alloys.
				3. Flux: ASTM B813, water flushable.
				4. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
			1. ENCASEMENT FOR PIPING
				1. Standard: ASTM A674 or AWWA C105/A21.5.
				2. Form: [**Sheet**] [**or**] [**tube**].
				3. Color: [Black] [or] [natural] <Insert color>.
			2. TRANSITION FITTINGS
				1. General Requirements:

Same size as pipes to be joined.

Pressure rating at least equal to pipes to be joined.

End connections compatible with pipes to be joined.

* + - * 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

Couplings in "Sleeve-Type Transition Coupling" paragraph below are available in NPS 1/2 to NPS 144 (DN 15 to DN 3600).

* + - * 1. Sleeve-Type Transition Coupling: AWWA C219.

Fittings in "Plastic-to-Metal Transition Fittings" paragraph below are available in at least NPS 1/2 to NPS 2 (DN 15 to DN 50).

* + - * 1. Plastic-to-Metal Transition Fittings:

Description:

[**CPVC**] [**or**] [**PVC**] one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.

One end with threaded brass insert and one solvent-cement-socket[**or threaded**] end.

Unions in "Plastic-to-Metal Transition Unions" paragraph below are available in NPS 1/2 to NPS 4 (DN 15 to DN 100).

* + - * 1. Plastic-to-Metal Transition Unions:

Description:

[**CPVC**] [**or**] [**PVC**] four-part union.

Brass[**or stainless steel**] threaded end.

Solvent-cement-joint[**or threaded**] plastic end.

Rubber O-ring.

Union nut.

* + - 1. DIELECTRIC FITTINGS

Use of Dielectric unions are not recommended. Although they are good in theory, they have proven to be problematic in the field due to leakage problems, and improper gasket material section for each specific piping application. Use paragraph below for threaded or soldered piping as required.

* + - * 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
				2. Valves: Bronze ball valve with end connections and pressure rating to match associated piping.

Unions in "Dielectric Unions" paragraph below are available in at least NPS 1/2 to NPS 2 (DN 15 to DN 50).

* + - * 1. Dielectric Unions:

Standard: ASSE 1079.

Revise pressure rating and temperature in "Pressure Rating" subparagraph below to suit Project, or insert other options for specific applications.

Pressure Rating: [125 psig minimum at 180 deg F] [150 psig] [250 psig] <Insert value>.

End Connections: Solder-joint copper alloy and threaded ferrous.

Flanges in "Dielectric Flanges" paragraph below are available in at least NPS 1-1/2 to NPS 4 (DN 40 to DN 100).

* + - * 1. Dielectric Flanges:

Standard: ASSE 1079.

Factory-fabricated, bolted, companion-flange assembly.

Revise pressure rating in "Pressure Rating" subparagraph below to suit Project, or insert other options for specific applications.

Pressure Rating: [**125 psig**  minimum at **180 deg F**] [**150 psig**] [**175 psig**] [**300 psig**] <Insert value>.

End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

Flanges in "Dielectric-Flange Insulating Kits" paragraph below are available in at least NPS 1/2 to NPS 48 (DN 15 to DN 1200).

* + - * 1. Dielectric-Flange Insulating Kits: Consisting of dielectric sleeves and washers, and dielectric gasket.

Standard: ANSI Class 150.

Nonconducting materials for field assembly of companion flanges.

Revise pressure rating in "Pressure Rating" subparagraph below to suit Project, or insert other options for specific applications.

Pressure Rating: [150 psig] <Insert value>.

Temperature Rating: [250 deg f] <Insert value>.

Gasket: Full faced Neoprene.

Bolt Sleeves: Mylar.

Washers: Double Phenolic washers.

Nipples in "Dielectric Nipples" paragraph below are available in at least NPS 1/2 to NPS 4 (DN 15 to DN 100).

* + - * 1. Dielectric Nipples: Nipples with inert non-corrosive thermoplastic linings are not acceptable.

Standard: IAPMO PS 66.

Electroplated steel nipple complying with ASTM F1545.

Revise pressure rating and temperature in "Pressure Rating and Temperature" subparagraph below to suit Project, or insert other options for specific applications.

Pressure Rating and Temperature: [300 psig at 225 deg F] <Insert values>.

End Connections: Male threaded or grooved.

1. EXECUTION
	* + 1. PIPING APPLICATIONS
				1. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
				2. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

Retain "Fitting Option" paragraph below unless prohibited by authorities having jurisdiction.

* + - * 1. Fitting Option: brazed joints may be used on aboveground copper tubing.

This article is organized to first present the service and pipe size or size range; then to present optional piping materials and joining methods. Retain the services and sizes and size ranges applicable to Project; then retain the selected piping materials and joining methods. Coordinate selection of piping materials and joining methods with piping materials described in Part 2.

Retain " one of" option in first paragraph below to allow Contractor to select piping materials from those retained. Piping for this application matches exterior underground water-service piping specified in Section 221113 "Facility Water Distribution Piping."

* + - * 1. Under-building-slab, domestic water, building-service piping, [3 inch and smaller] <Insert pipe size range>, shall be[ one of] the following:

Annealed-temper copper tube, [**ASTM B88, Type K**] [**ASTM B88, Type L**]; [wrought-copper, solder-joint fittings; and brazed joints.

Retain " one of" option in first paragraph below to allow Contractor to select piping materials from those retained. Piping for this application matches exterior underground water-service piping specified in Section 221113 "Facility Water Distribution Piping."

* + - * 1. Under-building-slab, domestic water, building-service piping, [4 inch to 8 inch and larger] <Insert pipe size range>, shall be[ one of] the following:

Annealed-temper copper tube, [**ASTM B88, Type K**] [**ASTM B88, Type L**]; wrought-copper, solder-joint fittings; and brazed joints.

Caution: Ductile-iron piping in first two subparagraphs below must be installed with restrained joints.

Mechanical-joint, ductile-iron pipe; [standard-] [or] [compact-]pattern, mechanical-joint fittings; and mechanical joints.

Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

Retain " one of" option in first paragraph below to allow Contractor to select piping materials from those retained. Piping for this application matches exterior underground combined water-service and fire-service-main piping specified in Section 221113 "Facility Water Distribution Piping."

* + - * 1. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, [6 inch to 12 inch] <Insert pipe size range>, shall be[ one of] the following:

Caution: Ductile-iron piping in first two subparagraphs below must be installed with restrained joints.

Mechanical-joint, ductile-iron pipe; [**standard-**] [**or**] [**compact-**]pattern, mechanical-joint fittings; and mechanical joints.

Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

Retain " one of" option in first paragraph below to allow Contractor to select piping materials from those retained.

* + - * 1. Under-building-slab, domestic water piping, [2 inch and smaller] <Insert pipe size range>, shall be[ one of] the following:

[Drawn-temper] [or] [annealed-temper] copper tube, ASTM B88, Type L; [wrought-copper, solder-joint fittings; and brazed] [copper pressure-seal-joint fittings; and pressure-sealed] joints.

Retain " one of" option in first paragraph below to allow Contractor to select piping materials from those retained.

* + - * 1. Aboveground domestic water piping, [2 inch and smaller] <Insert pipe size range>, shall be[ one of] the following:

Drawn-temper copper tube, [**ASTM B88, Type L**] [**ASTM B88, Type M**]; [cast-] [or] [wrought-]copper, solder-joint fittings; and [brazed] [soldered] joints.

Drawn-temper copper tube, [ASTM B88, Type L]; copper pressure-seal-joint fittings; and pressure-sealed joints.

CPVC, Schedule 40 ;socket fittings; and solvent-cemented joints.

Tubing in first three subparagraphs below is available only in NPS 1 (DN 25) and smaller.

PEX tube, 1 inch and smaller.

Fittings for PEX tube:

ASTM F1807, metal insert and copper crimp rings.

ASTM F1960, cold expansion fittings and reinforcing rings.

ASSE 1061, push-fit fittings.

Retain " one of" option in first paragraph below to allow Contractor to select piping materials from those retained.

* + - * 1. Aboveground domestic water piping, [2-1/2 inch to 4 inch] <Insert pipe size range>, shall be[ one of] the following:

Drawn-temper copper tube, [**ASTM B88, Type L**] [**ASTM B88, Type M**]; [cast-] [or] [wrought-]copper, solder-joint fittings; and [brazed] [soldered] joints.

Drawn-temper copper tube, [**ASTM B88, Type L**] [**or**] [**ASTM B88, Type M**]; copper pressure-seal-joint fittings; and pressure-sealed joints.

Drawn-temper copper tube, [**ASTM B88, Type L**] [**or**] [**ASTM B88, Type M**]; grooved-joint, copper-tube appurtenances; and grooved joints.

* + - * 1. CPVC, [**Schedule 40**] [**Schedule 80**]; socket fittings; and solvent-cemented joints.

CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.

Retain " one of" option in first paragraph below to allow Contractor to select piping materials from those retained.

* + - * 1. Aboveground domestic water piping, [5 inch to 8 inch] <Insert pipe size range>, shall be[ one of] the following:

Drawn-temper copper tube, [**ASTM B88, Type L**] [**ASTM B88, Type M**]; [cast-] [or] [wrought-]copper, solder-joint fittings; and [brazed] [soldered] joints.

Drawn-temper copper tube, [**ASTM B88, Type L**] [**or**] [**ASTM B88, Type M**]; grooved-joint, copper-tube appurtenances; and grooved joints.

Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.

Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

Stainless steel [**Schedule 10**] [**Schedule 40**] pipe, grooved-joint fittings, and grooved joints.

Schedule 40 pipe fittings in first subparagraph below are available only in NPS 6 (DN 150) and smaller.

CPVC, Schedule 40;socket fittings; and solvent-cemented joints.

Retain " one of" option in paragraph below to allow Contractor to select piping materials from those retained.

* + - * 1. Aboveground, combined domestic water-service and fire-service-main piping, [6 inch to 12 inch] <Insert pipe size range>, shall be [one of] the following:

Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.

Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

Stainless steel [**Schedule 10**] [**Schedule 40**] pipe, grooved-joint fittings, and grooved joints.

* + - 1. INSTALLATION OF PIPING

Coordinate piping installations and specialty arrangements with schematics on Drawings. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
				2. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
				3. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
				4. Install underground [**copper tube**] [**and**] [**ductile-iron pipe**] in PE encasement according to ASTM A674 or AWWA C105/A21.5.

Retain first paragraph below if booster pumps are not required.

* + - * 1. Install water-pressure-reducing valves downstream from shutoff valves.
				2. Install domestic water piping level [with 0.25 percent slope downward toward drain] and plumb.

Retain first paragraph below if water meters are inside the building.

* + - * 1. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

Retain first paragraph below if piping is required to withstand seismic design loads.

* + - * 1. Install seismic restraints on piping.
				2. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
				3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
				4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
				5. Connect runouts to the upper quadrant of the main and run upward at not less than 45 degrees before extending laterally.
				6. Install piping to permit valve servicing.
				7. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
				8. Install piping free of sags and bends.
				9. Install fittings for changes in direction and branch connections.
				10. Install PEX tubing with loop at each change of direction of more than 90 degrees.
				11. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
				12. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump.

Retain first paragraph below if hot-water circulation pumps are controlled by thermostats.

* + - * 1. Install thermostats in hot-water circulation piping.
				2. Install thermometers on inlet and outlet piping from each water heater.
				3. Install sleeves for piping penetrations of walls, ceilings, and floors.

Retain first paragraph below for piping that penetrates an exterior concrete wall or concrete slab.

* + - * 1. Install sleeve seals for piping penetrations of concrete walls and slabs.
				2. Install escutcheons for piping penetrations of walls, ceilings, and floors.
			1. JOINT CONSTRUCTION
				1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
				2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
				3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

Apply appropriate tape or thread compound to external pipe threads.

Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

* + - * 1. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
				2. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
				3. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
				4. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
				5. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
				6. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. [Square cut] [Roll] groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
				7. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
				8. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.

CPVC Piping: Join according to ASTM D2846 Appendix.

PVC Piping: Join according to ASTM D2855.

If PEX is retained in Part 2, retain one of two "Joints for PEX Tubing, ASTM" or "Joints for PEX Tubing, ASSE" paragraphs below, or both. If retaining both, indicate where each type is to be used in "Piping Applications" Article.

* + - * 1. Joints for PEX Tubing, ASTM: Join according to ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.
				2. Joints for PEX Tubing, ASSE: Join according to ASSE 1061 for push-fit fittings.
				3. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.
			1. INSTALLATION OF TRANSITION FITTINGS
				1. Install transition couplings at joints of dissimilar piping.
				2. Transition Fittings in Underground Domestic Water Piping:

Fittings for 1-1/2 inch and Smaller: Fitting-type coupling.

Fittings for 2 inch and Larger: Sleeve-type coupling.

* + - * 1. Transition Fittings in Aboveground Domestic Water Piping 2 and Smaller: Plastic-to-metal transition [**fittings**] [**or**] [**unions**].
			1. INSTALLATION OF DIELECTRIC FITTINGS
				1. General Requirements: Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

Joining Dissimilar Threaded Piping: Make up connection with a threaded coupling or with companion flanges.

Joining Dissimilar Non-Threaded Piping: Make up connection with adapters recommended by the manufacturers of the piping to be joined.

Joining Galvanized Steel Pipe and Copper Tubing: Make up connection with a dielectric connector.

* + - * 1. Dielectric Fittings for [2 inches] <Insert pipe size> and Smaller: Use dielectric [couplings] [couplings or nipples] [nipples] [unions].
				2. Dielectric Fittings for [2-1/2 inch to 4 inch] <Insert pipe size range>: Use dielectric [flanges] [flange kits] [nipples].
				3. Dielectric Fittings for [5 inch] <Insert pipe size> and Larger: Use dielectric flange kits.
			1. INSTALLATION OF HANGERS AND SUPPORTS

Retain first paragraph below for projects in areas that require seismic restraints.

* + - * 1. Install hangers for [**copper**] [**ductile iron**] [**galvanized steel**] [**and**] [**stainless steel**] [**tubing**] [**and**] [**piping**], with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				2. Install vinyl-coated hangers for [**CPVC**] [**PVC**] [**and**] [**PP**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				3. Install vinyl-coated hangers for PEX tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				4. Support horizontal piping within [12 inches] <Insert dimension> of each fitting.
				5. Support vertical runs of [copper] [ductile iron] [galvanized steel] [and] [stainless steel] [tubing] [and] [piping] to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				6. Support vertical runs of [CPVC] [PVC] [and] [PP-R] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				7. Support vertical runs of PEX tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
			1. CONNECTIONS

Coordinate piping installations and specialty arrangements with schematics on Drawings. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. Drawings indicate general arrangement of piping, fittings, and specialties.
				2. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
				3. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
				4. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

Domestic Water Booster Pumps: Cold-water suction and discharge piping.

Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for 2-1/2 inch and larger.

* + - 1. IDENTIFICATION
				1. Identify system components.
			2. ADJUSTING
				1. Perform the following adjustments before operation:

Close drain valves, hydrants, and hose bibbs.

Open shutoff valves to fully open position.

Open throttling valves to proper setting.

Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.

Adjust calibrated balancing valves to flows indicated.

Remove plugs used during testing of piping and for temporary sealing of piping during installation.

Remove and clean strainer screens. Close drain valves and replace drain plugs.

Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

Check plumbing specialties and verify proper settings, adjustments, and operation.

* + - 1. FIELD QUALITY CONTROL

Retain "Perform the following tests and inspections" paragraph below to require Contractor to perform tests and inspections.

* + - * 1. Perform the following tests and inspections:

Portions of testing and inspecting requirements in this article are taken from model plumbing codes. Verify requirements are applicable to location of this Project.

Piping Inspections:

Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections, and arrange for reinspection.

Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

Piping Tests:

Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

Retain first subparagraph below for hydrostatic testing if required for manufacturer's piping warranty.

Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.

Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

Prepare reports for tests and for corrective action required.

* + - * 1. Domestic water piping will be considered defective if it does not pass tests and inspections.
				2. Prepare test and inspection reports.
			1. CLEANING

Portions of disinfecting requirements in this article are taken from model plumbing codes; revise if requirements vary by authorities having jurisdiction.

* + - * 1. Clean and disinfect potable domestic water piping as follows:

Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

Flush piping system with clean, potable water until dirty water does not appear at outlets.

Fill and isolate system according to either of the following:

Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

Repeat procedures if biological examination shows contamination.

Submit water samples in sterile bottles to authorities having jurisdiction.

Retain first paragraph below if disinfection of non-potable domestic water piping is required by authorities having jurisdiction.

* + - * 1. Clean non-potable domestic water piping as follows:

Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

Use purging procedures prescribed by authorities having jurisdiction or if methods are not prescribed, follow procedures described below:

Flush piping system with clean, potable water until dirty water does not appear at outlets.

Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

* + - * 1. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
				2. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION