

City of Columbia, Missouri
Columbia Utilities Department
701 East Broadway
Columbia Missouri 65205
573-874-2489

SANITARY SEWER PUMP STATION DESIGN REQUIREMENTS AND STANDARD SPECIFICATIONS

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Approved:

David A. Sorrell, P.E.
Columbia Utilities Assistant Director

Date

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SANITARY SEWER PUMP STATION DESIGN REQUIREMENTS AND STANDARD SPECIFICATIONS

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DIVISION I

**PUMP STATION
DESIGN REQUIREMENT**

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1.0 GENERAL

The following are the standard specifications for pump stations to be installed and connected to the City of Columbia's sanitary sewer collection system. The purpose of these specifications is to provide a minimum standard for pump stations that complies with the guidelines set out by the Missouri Department of Natural Resources and incorporates the most cost effective and reliable design for maintenance and operation.

Sewage pump stations shall consist of a wet well, sewage pumps, control systems, electrical systems (normal and emergency), superstructures, site security, grading and access. The contractor shall be responsible for extending all necessary utilities to the pump station site (electrical, phone etc.).

Sanitary sewer pump stations will only be considered when the thorough study of all alternatives clearly indicates the impracticability of gravity collection and disposal.

All pump stations shall be equipped with a minimum of 8 hours of emergency storage or an emergency generator.

2.0 ENGINEERING REPORT

All pump station plans shall be accompanied by an engineering report. The following information shall be included in the report:

2.1 TITLE PAGE - Title page should include the project name, date, developer/owner's name and engineering firm preparing plans.

2.2 SEWER SYSTEM INFORMATION

A. Introduction

1. Type, location and size of development
2. Number of and range in size of lots or buildings to be serviced

B. Existing Sewer System

1. Location and type of gravity system the force main will discharge into.
2. Hydraulic capacity of receiving gravity system.
3. Future of sanitary sewer service
4. State whether the entire development will be serviced by the proposed phase or if several phases will be involved.
5. State the number of lots this phase will encompass initially and finally if future phases are to be constructed.

2.3 PUMP STATION AND FORCE MAIN DESIGN CALCULATIONS

A. N_b = Number of specified types of buildings
 N_p = Number of persons per unit
 $P_e = N_b \times N_p$

B. Average Daily Flow (ADF)

1. Average Daily Flow (GPD) = $P_e \times 100$ gal/person/day
2. Average Daily Flow (GPM) = Flow (GPD) / 1440 (Min/Day)

C. Peak Daily Flow (PDF)

1. Peaking Factor (PF) = $\frac{18 + \sqrt{\frac{P_e}{1000}}}{4 + \sqrt{\frac{P_e}{1000}}}$
2. Peak Daily Flow (GPD) = PF X ADF (GPD)

3. Peak Daily Flow (GPM) = PF X ADF (GPM)

D. Total Dynamic Head (TDH)

1. Static Head (Hs)

Eh = Maximum force main elevation

E1 = Wet well low water elevation

Es = Eh - E1

2. Loss (Lf) due to friction in force main

Length = Total equivalent length of force main and piping within pump station

Lf = Length x Friction Factor

3. Hazen-Williams C-factor of 120 shall be used for computation of friction losses.

4. TDH = Hs + Lf

E. Force Main

1. Volume of Storage (Vs)

2. Velocity Produced in Force Main

3. Maximum Operating Pressure

(a) Size air release valves (if applicable)

(b) Retention time of force main (at initial flows and at design flows)

F. Storage Requirements

1. Volume of storage (Vs)

Vs = ADF (GPD) x (hours of storage required / 24 hours per day)

2. Dimensions of storage facility.

G. Buoyancy Checks - A buoyancy check shall be performed for the pump station wet well and the retention chamber.

2.4 CYCLE TIMES

The design fill time and minimum pump cycle time shall be evaluated in sizing the wet well. The effective volume of the wet well shall be based on the design average flow determined and a filling time not to exceed thirty (30) minutes, unless the pumping station is designed to provide flow equalization. The pump manufacturer's duty cycle recommendations shall be utilized in selecting the minimum cycle time.

A. Volume (Vr) of water in wet well needed to turn primary pump on

1. Elevation difference (E5) between primary pump on elevation (E3) and pump off elevation (E4)

$$E5 = E3 - E4$$

2. Volume (Vpf) of water per vertical foot in the wet well

A = the inside area of the wet well

$$Vpf = A \times 7.481 \text{ gal/ft}^3$$

3. $Vr = E5 \times Vpf$

4. For constant speed pumps the minimum pump cycle volume (Vr_{min}) shall be based on the formula:

$$Vr_{min} = \frac{T * Q}{4}$$

Where:

Vr_{min} = minimum pump cycle volume, gallons

T = required time between starts, minutes

Q = pump discharge capacity, gallons per minute

B. Cycle Time for ADF

1. Time (Tf) required for volume in wet well to reach Vr

$$Tf = Vr/ADF \text{ (GPM)}$$

2. Time (Tp) required for pump to return water level to the pump off elevation $Tp = Vr/(CSR - ADF) \text{ (GPM)}$

Where:

CSR = the Constant Speed Rating or the pump's operating point

3. The pump is on for one pumping cycle of Tp and off for 2 storage cycles of Tf plus one pumping cycle of Tp because pumps alternate

4. Total Cycle Time

Pump ON for Tp

Pump OFF for (2) Tf + Tp

C. Cycle Time for PDF

1. Time (Tf) required for volume in wet well to reach Vr

$$Tf = Vr/PDF \text{ (GPM)}$$

2. Time (Tp) required for pump to return water level to the pump off elevation $Tp = Vr/(CSR - PDF) \text{ (GPM)}$

- 3. Total Cycle Time:
 - Pump ON for T_p
 - Pump OFF for $(2) T_f + T_p$

D. Septicity – When the station is expected to operate at a flow rate less than 0.5 times the design average flow for longer than twelve (12) hours at a time, the design shall assess measures to prevent septicity due to long holding times in the wet well.

2.5 LISTING OF RESULTS FROM THE DESIGN CALCULATIONS TO BE PRESENTED IN THE FOLLOWING ORDER:

- A. Number of Lots or Buildings
- B. Population Equivalent, P_e
- C. Average Daily Flow in GPM
- D. Peak Daily Flow in GPM
- E. The Volume of the Retention Chamber (8-hour minimum, may require 24 hours in some cases)
- F. Static Head
- G. Total Dynamic Head
- H. The Pump Selected (including type manufacturer, model number, size, Hp, RPM, phase and GPM)
- I. Volume of Wet Well, V_r and $V_{r_{min}}$
- J. Total Cycle Time for Average Daily Flow
 - Number of Minutes ON (Pumping Time)
 - Number of Minutes OFF (Fill Time)
- K. Total Cycle Time for Peak Daily Flow
 - Number of Minutes ON (Pumping Time)
 - Number of Minutes OFF (Fill Time)
- L. Size and Length of Force Main
- M. Velocity Maintained in Force Main
- N. Force Main Retention Time (at initial flows and at design flows)

O. Air Release Valve Sizing Calculations (if applicable)

P. Maximum Force Main Operating Pressure

2.6 COST EFFECTIVE ANALYSIS

Consultant shall perform a cost effective analysis for all proposed pump stations and expansions of existing City-owned pump stations. Cost analysis shall compare the construction, operation and maintenance costs and any applicable salvage values over a 20-year period between proposed pump station and a reasonable gravity sewer alternative. Operation and maintenance costs that must be considered include: labor, electrical, equipment replacement and routine maintenance.

Pump stations will only be considered a viable option if the cost analysis clearly shows that the gravity sewers are not economically feasible.

2.7 PUMP PERFORMANCE CURVES

Pump performance curves shall be included with the engineering report.

3.0 PUMP REQUIREMENTS

At least 2 pumps shall be provided. If only 2 units are provided, they shall have the same capacity. Each shall be capable of handling flows in excess of the estimated daily peak flow (GPM). Where more than 2 units are provided, each shall be designed to fit maximum flow conditions and must be of such capacity that with any one unit out of service the remaining units will have capacity to handle maximum sewage flows.

3.1 GENERAL

- A. Sewage pumping stations may be either suction-lift type or submersible. When total suction lift exceeds 20 feet, only submersible-type pumps will be permitted.
- B. Submersible-type grinder pumps will only be acceptable for pump stations utilizing 10-horse power pumps or smaller.
- C. Pumps less than 2-horse power are not acceptable.
- D. Pumps must be 3-phase.
- E. Pumps handling raw wastewater shall be capable of passing solid spheres of at least three (3") in diameter. Pump suction and discharge piping shall be at least four inches (4") in diameter. Exceptions to this requirement may be granted on a case-by-case basis when the design includes piping with a diameter at least one inch (1") greater than the solid sphere passed and equivalent protection from clogging is provided (grinder pumps, etc.)
- F. The pump discharge piping diameter shall be determined as follows:

<u>Individual Pump Output</u>	<u>Pipe Diameter</u>
50 GPM and Below	2"
51 to 80 GPM	3"
81 GPM and Above	4" Minimum

- G. The pump discharge piping diameter and material shall be uniform from the pump discharge base to the common header tee.
- H. The common header and force main pipe diameter shall be sized to produce a minimum flow of 2 F.P.S. with one pump running and a maximum flow of 8 F.P.S. from the combined output of 2 pumps.

3.2 ACCEPTABLE MANUFACTURERS

- A. Suction lift-type pumps shall be Smith & Loveless, Gorman-Rupp, or approved equal.
- B. Submersible non-clog solids handling pumps shall be Flygt, A.B.S. Co., Myers, Fairbanks Morse, KSB or approved equal.
- C. Submersible grinder pumps shall be manufactured by the Flygt Co., A.B.S. Co., Myers, Hydromatic, KSB or approved equal.

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4.0 PIPING AND VALVES

4.1 DISCHARGE PIPING

The piping from the individual pump discharge bases, through the valving assembly and out to the force main, shall be in accordance with the following:

A. Four-inch Diameter Piping and Larger:

1. Piping - The discharge piping shall be ductile iron Class 53 or greater A.N.S.I. A-21.51 (AWWA C151) with rigid radius grooves for end preparation in accordance with AWWA C606.
2. Fittings - Fittings shall be ductile iron, ASTM A-536, Grade 65-45-12, or cast iron, ASTM A-48, conforming to the requirements of AWWA C110 for center to end dimensions, AWWA C153 or AWWA 21.10/AWWA C110 for wall thickness, and AWWA C606 rigid radius grooving dimensions for end preparation. Fittings shall be cement lined and have a universal primer coating.
3. Mechanical Couplings - Mechanical couplings shall be ductile iron conforming to ASTM A536, Grade 65-45-12 with a universal primer coating as manufactured by Victaulic (style 31, style 75 or style 307), or approved equal. Couplings shall incorporate gaskets that are specially made to conform to ductile iron pipe surfaces and 304 stainless steel nuts and bolts.
4. Transition Fittings:
 - a. Grooved to Flanged - The connection of grooved pipe and fittings to flanged pipe and fittings shall be facilitated with flange adapters as manufactured by Victaulic (style 341 Vic-Flange) or approved equal. The flange adapters shall be ductile iron conforming to ASTM A-536, Grade 65-45-12, with a universal primer coating. Gaskets shall have properties as designated by ASTM D-2000 and shall be suitable for the required service. Use 304 stainless steel bolts and nuts on all flange adapters and flanged components.
 - b. Force Main Connection - The ductile iron pipe shall be extended at least 4 feet from the outside of the valve vault. The force main shall then be connected to the ductile iron pipe with a mechanical coupling. The coupling shall be a MEGALUG Mechanical Joint Restraint or approved equal.

B. Three-inch Diameter Piping and Smaller:

1. Piping - The discharge piping shall be ASTM 1785 schedule 80 PVC roll grooved pipe in accordance with AWWA C606.

2. Fittings - Fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, and have AWWA C606 grooving dimensions for end preparation. Fittings shall have a Tnemec or approved equal 140 outside coating and inside lining.
3. Mechanical Couplings - Mechanical couplings shall be rigid and cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, alkyd enamel finish, with gaskets conforming to ASTM D-2000 as manufactured by Victaulic (style 07, Zero Flex) or approved equal. Couplings shall utilize 304 stainless steel bolts and nuts.

C. Transition Fittings:

1. Grooved to Flanged - The connection of grooved pipe and fittings to flanged pipe and fittings shall be facilitated with flange adapters as manufactured by Victaulic (style 741 Vic-Flange) or approved equal. The flange adapters shall be ductile iron conforming to ASTM A-536, Grade 65-45-12, with a universal primer coating. Gaskets shall have properties as designated by ASTM D-2000 and shall be suitable for the required service. Use 304 stainless steel bolts and nuts on all flange adapters and flanged components.
2. Force Main Connection - The schedule 80 PVC pipe shall be extended at least 4 feet from the outside of the valve vault. The force main shall then be connected to the schedule 80 PVC pipe. The force main shall be connected to the schedule 80 pipe by means of a solvent well schedule 80 PVC coupling.

4.2 DISCHARGE RISERS

- A. PVC - When plastic pipe is utilized for the pump discharge riser and the riser exceeds 6 feet in length, stainless steel support braces must be installed between the riser and wet well wall. The braces shall be placed at a maximum spacing of 6 feet.
- B. DIP - When ductile iron pipe is utilized for the pump discharge riser and the riser exceeds 8 feet in length, stainless steel support braces must be installed between the riser and wet well wall. The braces shall be placed at a maximum spacing of 8 feet.

4.3 FORCE MAIN REQUIREMENTS

Force mains shall meet the following criteria:

- A. Velocity - A cleaning velocity of at least 2 feet per second shall be maintained when one pump is running and a maximum of 8 feet per second

shall not be exceeded when both (all) pumps are running.

- B. Combination Air Valve - A combination air valve shall be placed at high points in the force main to prevent air pockets and protect the force main from negative pressures that may develop.
- C. Isolation Valves – A force main shall have valves spaced at no more than one thousand five hundred feet intervals to facilitate initial testing and subsequent maintenance and repairs.
- D. Termination - Force mains shall discharge to a gravity sewer in a manner that smoothly directs the force main flow into the gravity sewer flow and minimizes turbulence. Corrosion protection for the upstream manhole and two downstream manholes shall be provided in accordance with the City of Columbia Street, Storm Drain and Sanitary Sewer Specification Section 510.2. Force mains shall be connected to a gravity sewer as per the Standard Details.
- E. Thrust Blocks - The force main shall be fitted with permanent thrust blocks at all bends, tees, plugs, fittings or other significant changes in direction. Thrust blocks shall be constructed as per the Standard Details. Thrust block locations shall be given on both plan and profile views on the construction plans.
- F. Clean-outs - The need for clean-outs on the force main shall be determined during plan review by the City of Columbia. As a general guideline, clean-outs will not be required on force mains under 1800 feet in length. If clean-outs are required, refer to the Standard Details.
- G. Force Main Pressure Test - Contractor shall fill and pressure test the force main. The minimum required test pressure shall be the maximum force main operating pressure plus 50 psi. (City representative shall be present during this test).
- H. Tracer Wire - A green-coated number 12 AWG copper tracer wire shall be installed the entire length of the force main as per the Standard Details. The tracer wire shall be accessible from the surface at intervals not to exceed 1000. The tracer wire shall be extended into all valve vaults (pump station valve vault, air release vault, clean-out valves, etc.) a minimum of 5 feet, from each direction. If valve vault spacing exceeds 1000 feet, then tracer wire access vaults shall be provided as necessary. The tracer wire access vaults shall be constructed as per the Standard Details. The wire shall be neatly rolled and placed on a stainless steel hook so that it does not interfere with normal operation. When wet well mounted pumps are utilized or when a pump station valve vault is not utilized, a tracer wire access vault shall be provided within 10 feet of the pump station wet well.
- I. Utility Marking Tape - A detectable underground utility marking tape shall be

installed the entire length of the force main as per the Standard Details. The tape shall consist of a 35 gauge (0.00035") solid aluminum foil core encased between 2 layers of plastic. The tape shall have an overall minimum thickness of 5.0 mil (0.005"). The aluminum foil must be visible from both sides. No inks or printing shall extend to the edges of the tape. All printing shall be encased to avoid ink rub off. Tape shall be green in color and conform to the following requirements:

Property	Method	Value
Thickness	ASTM D2103	5.0 mils (nominal)
Tensile strength	ASTM D-882	22 lbs/in width (4400 psi)
Elongation	ASTM D-882	<50% at break
Printability	ASTM D2578	>40 dynes/cm ²

J. Pipe Material - The force main pipe shall have a pressure rating greater than the system's maximum operating pressure plus 50 psi. D.I.P., PVC and HDPE are acceptable materials. The project plans or specifications shall state the SDR Ratio, Pressure Rating and National Standard of the proposed force main material.

K. Protection of Water Supplies

1. Force mains shall be laid at least ten feet (10') (3.0 m) horizontally from any existing or proposed water main. The distances shall be measured edge-to-edge. In cases where it is not practical to maintain a ten-foot (10') (3.0 m) separation, the Utility department may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such a deviation may allow installation of the force main closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one (1) side of the sewer and at an elevation so the bottom of the water main is at least eighteen inches (18") (46 cm) above the top of the force main.
2. If it is impossible to obtain proper horizontal and vertical separation as described above, the force main must be constructed of slip-on or mechanical joint pipe or continuously encased and be pressure tested to one hundred fifty pounds per square inch (150 psi) (1,034 kPa) to assure watertightness

L. Stream Crossings

1. Force mains shall meet the same requirements of construction near streams and aerial crossings as gravity sewers as specified in Section 500.20 of the City of Columbia Street, Storm Drain, and Sanitary Sewer Specifications and Standards.

4.4 COMBINATION AIR VALVES

A combination air valve shall be installed on any high points or "knees" of the force main, as deemed necessary by the City Engineer. The combination air valves shall be single or dual body style and specifically manufactured for wastewater applications. The body and cover of the valve shall be constructed of heavy-duty cast iron that has a pressure rating greater than or equal to the force main pipe material. Bolts, pipe, nipples and plugs shall be Type 316 stainless steel. Street elbows shall be stainless steel or bronze. Isolation and flush valves shall be threaded ball valves with bronze bodies, stainless steel ball and operating lever, and nylon seats.

Combination air valves shall be attached to the force main by means of a stainless steel pipe nipple threaded to a cast-iron mechanical joint (m.j.) x m.j. x tap tee. (Combination air valves on force mains smaller than 6 inches will require additional support.)

Combination air valves shall be placed in a vault as per the Standard Details. Acceptable combination air valve manufacturers are Val-Matic, APCO Valve, or approved equal.

4.5 PLUG AND CHECK VALVES

- A. Approved shut-off and check valves shall be placed on the discharge line of each pump. The check valves shall be located between the shut-off valve and the pump. Approved shut-off valves shall be placed on the force main as necessary. The shut-off and check valves shall be installed horizontally and located in accordance with the Standard Details.
- B. All valves shall be rated so as to withstand normal working pressure plus allowances for water hammer.
- C. Shut-off Valves - The valves shall be located so that each pump may be isolated from the common discharge header.
 1. 3 Inches and Larger - Shut-off valves 3 inches and larger shall be eccentric plug type valves with a resilient faced plug suitable for required service. Valves shall have self-lubricating stainless steel bearings and bearing grit seals. The port shall be circular, have a minimum flow area of 81% of the full pipe area, minimum 90% pipe diameter and be able to pass a cleaning pig when fully open. Flow direction shall be indicated on

the valve body.

2. Body - The shut-off valves shall be cast iron body, ASTM A 126 Grade B or ductile iron per ASTM, Grade 65-45-12, and have a universal primer coating. The bonnet shall be ductile-iron material per ASTM A-536, Grade 65-45-12. Grooved valves shall comply with AWWA C-509 and AWWA C-606 requirements.
3. Plugs - Shut-off valve plugs shall be made of cast iron ASTM A 126 Class B or ductile iron ASTM A-536 covered with a Buna-N Rubber compound. The seats are to be a corrosion-resistant alloy such as 304 stainless steel. Flanged valves shall be in accordance with ANSI B 16.1 Class 125 standards. Grooved valves shall be in accordance with AWWA C606. Sleeve-type bearings shall be utilized in both the upper and lower trunnions. Bearings shall be corrosion resistant and have a low coefficient of friction.
4. Operators - 3-inch to 4-inch shut-off valves shall be provided with a 2-inch square operating nut and wrench head. Valves at the pump station and pump station valve vault that are larger than 4 inches shall be provided with a manual gear operator sized so that the maximum rim pull required is not more than 80 lbs. Valves installed on the force main that are larger than 4 inches shall be provided with a 2-inch square operating nut and wrench head.
5. Sealing requirements - Shut-off valves 3 inches to 6 inches shall provide positive and reverse flow sealing up to 175 psi. Shut-off valves 8 inches to 12 inches shall provide sealing up to 175 psi and reverse sealing up to 50 psi. Shut-off valves larger than 12 inches shall provide positive sealing up to 150 psi and reverse sealing up to 50 psi. These valves have a preferred direction of shut off, and it is the responsibility of the contractor to see that they are properly installed.

Acceptable manufacturers are Clow, Dezurik, Victaulic Series 365 Vic-Plug or approved equal.

6. Smaller than 3 Inches - Shut-off valves smaller than 3 inches shall be ball- type shut-off valves. The valve body shall be ductile iron, ASTM A-395, Grade 65-45-12. The ball and stem shall be Type 316 stainless steel. The valve shall be a standard port, end-entry valve designed for 600 psi, minimum. The valve shall provide a drip free seal. The valves must be provided with a 2-inch square operating nut and wrench head or a concentric tee handle.

Acceptable manufacturers are Victaulic, or approved equal.

- D. Check valves shall be of the swing check type with ASTM A-126 Class B cast-iron body. Check valves shall be either flanged or grooved end type. All fasteners shall be 304 or 316 stainless steel.

2 inches to 3 inches check valve - Acceptable manufacturers are Victaulic (Series 712) Val-Matic or approved equal.

3 inches and larger check valves - Acceptable manufacturers are Victaulic (Series 317), Val-Matic or approved equal.

4.6 BY-PASS PUMP PIPING

All pump stations shall be equipped with a by-pass pump arrangement as per the Standard Details.

- A. Pump stations with a force main that is 4 inches or smaller shall be equipped with a 3-inch by-pass arrangement.
- B. Pump stations with a force main that is 6 inches or larger shall be equipped with a 6-inch by-pass arrangement.

4.7 VALVE CHAMBER DRAIN VALVE

A 4-inch drain pipe shall be installed from the valve vault to the pump vault. The drain pipe shall be ductile iron Class 53 or greater. A flapper-style back-water check valve shall be installed on the valve vault drain line as per Standard Details.

4.8 WET WELL VENT

The wet well structure shall be vented with 4-inch Sch. 40 stainless steel or aluminum vent pipes (refer to detail drawings). The vents shall be covered with a stainless steel or aluminum screen to reduce nuisance insects and debris from entering the wet well.

5.0 INTERIOR

5.1 SLIDE RAILS

All pump lifting slide rails shall be made of 316 or 304 stainless steel pipe. Slide rails shall be installed and sized per manufacturer's instructions. The slide rails shall be firmly braced to the wet well wall with stainless steel support brackets placed at a maximum spacing of 8 feet.

5.2 LIFTING CHAIN

Pump lifting chain, clevises and shackles shall be made of 316 or 304 stainless steel. The chain shall be sized to accommodate the installed pump weight, but shall not be sized smaller than 3/16-inch stainless steel diameter links.

5.3 BOLTS

All field installed bolts, nuts, and washers used inside either the pump or valve chamber shall be made of 316 or 304 stainless steel.

5.4 FASTENERS

All concrete fasteners used for installation of braces, brackets or boxes shall be stainless steel Wej-It type stud anchors. Anchor holes shall be drilled to the manufacturer's recommended depth. Anchors shall be Hilti Quick Bolt Two or an approved equal. Pump base anchor studs shall be sized as per pump manufacturer's recommendation.

5.5 FLOATS AND SETTINGS

- A. Pump floats shall consist of a mercury tube switch sealed in a corrosion resistant polypropylene housing with a minimum of 18 gauge, 2-wire, SJOW/A jacketed cable. The cable must be of sufficient length to reach the junction box with no splices and to allow removal of the float without entering the wet well. The level controls shall be suspended so that adjustment or replacement may be done without the use of any tools or without entering the wet well. The floats shall be UL/CSA listed.
- B. Floats shall not be located near the flow of the incoming sanitary lines.
- C. Sewage shall not rise to the level of the incoming gravity lines or the 8-hour retention pipe during normal pump operation for either single or double pump operation.
- D. All floats shall be located away from the turbulence of the incoming flow.

- E. The following levels shall guide the setting of float levels.
 - 1. Off Float -The pump shall have water covering the top of the pump volute at the off level.
 - 2. First Pump - No Less than one foot above top of pump motor.
 - 3. High Level Alarm - No less than 2 feet above the top of pump motor.
 - 4. Lag Pump - No less than 2 feet above top of pump motor and no more than one inch below the 8-hour retention line and at least one foot below the invert of the incoming sewer.
- F. Float leads and pump cords shall be suspended with stainless steel kellum grips from the bracket supplied by the pump manufacturer. The bracket shall be attached to the wet well hatch frame or firmly bolted to the concrete immediately below the hatch frame. The bracket shall be positioned so that float leads and pump cords are easily accessible without entering the wet well.
- G. Float wires shall be neatly routed away from the pump access hatch opening then through the chamber access conduit, without excessive wire strain or pull. Wire length on all float wires shall be such that each float may be adjusted to the bottom of the station wet well.
- H. Installed pump top and bottom elevations as well as the float elevations shall be shown on the pump station interior drawing.

5.6 ACCESS HATCHES

All pump and valve chambers shall be provided with aluminum access hatches as follows:

- A. The access hatches shall be of aluminum construction rated for a 300 lbs. per square foot loading. Door size shall be as indicated on the drawings. The access frame and cover shall be flush with the top of the concrete with hinged and flush-locking mechanism, upper guide holder and level sensor cable holder. Frame shall be securely placed, mounted above the pumps. Hatches shall be equipped with form skirts, sized for the slab top thickness. Doors shall be provided with padlock lugs.
- B. Hatches shall be provided with fall protection grating rated for a 300 lbs per square foot loading. Grating shall be aluminum construction with a hold open device that locks the grate in the fully open 90 degree position.
- C. Hatches shall be Bilco TypeJ-AL or JD-AL, or Halliday model W1S or W2S, or approved equal.

- D. All access hatch construction materials and appurtenances shall be manufactured from stainless steel, aluminum or brass.

5.8 PRESSURE SENSORS

Pressure sensors, if required, may be of the full-flange design with thru bolt holes or one piece wafer style with carbon steel flanges. Sensors shall clamp between standard ANSI pipeline flanges. All exposed surfaces to be epoxy painted or of a non-corrosive material. Sensor shall be flow thru design with flexible Buna-N elastomer sensing ring around the full circumference.

Gauges to be 2 1/2-inch dial, Span Model 220 with 1/4-inch connection.

Pressure switches shall have Nema-7 Housings with Single Pole Double Throw, snap-action switching elements. Switches shall be wired normally closed, with adjustable pressure settings. The pressure range shall be specified for each specific installation. Switches shall be, "NEO-DYN Model 132P4-8C6."

Accessory piping to be 1/2-inch or 1/4-inch Parker Hex stainless steel with reducing fittings where necessary to connect instruments. Pressure sensors shall be "Red Valve" Series 40 flanged wafer sensors EVR type PES or approved equal.

5.9 PUMP CHAMBER INSPECTION

Following placement of the wet pit pumps and prior to allowing water in to the pump station, the pump station floor will need to be inspected by the City. The pit floor must be clean and dry for this inspection. The contractor/developer shall be responsible for arranging this inspection with the City.

6.0 STRUCTURAL REQUIREMENTS

6.1 STRUCTURE DESIGN

The pump station structure shall consist of a wet well and a valve chamber, if required, constructed of either pre-cast or poured in place reinforced concrete design. All structure top elevations shall be located a minimum of one foot above the 100-year flood elevation or one foot above the highest historical flood elevation, whichever is highest.

The distance between the pump station structure and all potable water sources should be one hundred feet (100') and shall be at least fifty feet (50').

6.2 CONCRETE SPECIFICATIONS

All requirements on cast-in-place concrete shall be in accordance with the City of Columbia Street and Storm Drainage Specifications and Standards, Section 250 Concrete Structures.

6.3 ACCESS HATCHES

Access hatches shall be cast in the top sections of each chamber.

6.4 PIPE & CONDUIT ENTRIES

"A-lock" or "Z-lock" gaskets embedded in the concrete castings is the preferred method of entry. Other methods may be allowed provided that:

- A. Entry methods do not affect structural integrity.
- B. All entries must be a minimum of one foot from section joints.
- C. Areas around pipe shall be grouted as to be leak-proof.

6.5 WET-WELL FLOOR

A poured concrete invert shall be installed to minimize solids accumulation.

6.6 VALVE CHAMBER

- A. Valve chambers are required on all pump stations that utilize submersible pumps.
- B. The valve chamber floor shall be sloped with a 3-sided invert towards the 4-inch drain pipe using a 2-inch fillet.
 - 1. Valve chamber shall be sized and configured as per the Standard Details.

6.7 PIPING DESIGN

- A. The standard pump station piping arrangements called out in this design book have proven themselves to be of sound design in typical pump station installations. Special bracing or water hammer protection devices have not been included or called for; however, when the surrounding terrain or station site is such that extreme hydraulic conditions may be created, it is the responsibility of the engineer to anticipate such conditions and design for the probability of excessive pressure, stress and/or movement in the piping system. The engineer shall be responsible for including whatever restraints, relief valves or surge protection, deemed necessary for the protection of the valve and piping system.
- B. Valve Chamber Piping Supports - After discharge piping and valves have been installed in the valve chamber, adjustable pipe cradle jacks shall be placed under the valves and tee, so that they have a 10-inch clearance between the floor and valve flanges. The supports shall be firmly bolted to the valve chamber floor.

6.8 RETENTION CHAMBER

An 8-hour minimum sewerage retention must be provided. Both the pump chamber and the incoming gravity system are not to be considered for the 8-hour calculations.

Retention shall be installed below ground with an access manhole located at the upstream end. The connection between the retention chamber and the wet well wall shall be made with an 8-inch PVC or ductile iron pipe. The retention tank must be a dedicated system; it may not be used as part of the gravity system. The retention chamber and connecting line shall be laid with a minimum 1% slope.

7.0 ELECTRICAL

7.1 PUMP CONTROL PANEL

- A. GENERAL SPECIFICATIONS - The intent of this specification is to provide a complete, integrated Pump Control System as described herein. It shall be factory assembled, wired and tested. The panel manufacturer shall supply 4 sets of AutoCAD As-Wired drawings upon completion of construction. Two copies of these drawings shall be provided inside the pump control panel and the other 2 sets given to the City's representative.

An equipment data tag shall be permanently affixed on the inside of the exterior door with the station designation, power source, pump horsepower, and pump full load amps. In addition to the label requirements of UL 508A, an engraved legend plate shall be permanently affixed on the inside of the exterior door with the name, address and telephone number of the service representative for the pumps and control panel.

The wet well is classified as a Class I, Division 1 or 2, Group D hazardous location per NFPA Article 820. All applicable installation procedures per NEC, ANSI, EPA, and all other codes and laws for this installation requirement shall be followed. Intrinsically safe barriers shall be provided for the float switches located in the wet well. All pump and control conduits entering or exiting the pump control panel shall have explosion proof conduit seals suitable for Class I, Division 1 or 2, Group D environments. These seals shall be provided and installed by the installing contractor.

1. Quality Assurance - The pump control panel shall be supplied by the pump manufacturer and fabricated by a current UL 508A Listed industrial control panel manufacturer. The panel manufacturer shall show its UL follow-up service procedure file number on submittals. All devices within the panel shall be UL listed and/or recognized where applicable and shall be mounted and wired in accordance with the most current edition of UL508 and NFPA. The panel manufacturer shall have a minimum of 5 years' experience manufacturing systems specifically for wastewater applications.

The pump control system(s) shall be fully tested by the factory prior to shipment. It shall include testing of both power and control devices as well as all control functions. A final inspection shall be performed prior to shipment and a copy of this form shall be provided with the panel.

The panel shall be designed with the following features to operate the specified pumps. The pumps, pump control panel and related accessories shall be supplied by the pump supplier to insure compatibility and assure matching controls to pumps.

2. Basic Operation - The pumps shall be operated automatically or manually as a pump down, lead/lag, common off system. Each pump shall be controlled primarily through a "Hand-Off-Auto" 3-position maintained selector switch. Control function requirements are further defined in the control section of these specifications.
3. Position Commands:
 - a. OFF - In this position the applicable pump will not run under any circumstance.
 - b. HAND - In this position the applicable pump shall run without regard for the level sensing commands and will rely on operator discipline to run and stop.
 - c. AUTO - In this position both pumps shall be controlled by float switches. These switches will sense the appropriate level in the wet well and initiate start and stop commands to the pumps. All floats shall be interposed with intrinsically safe UL. Listed relays installed per NEC Article 504, ANSI/ISA-RP12.6 and all other applicable codes.
4. Pump Sequence - A total of 4 mercury level sensors shall be provided with sufficient length cord to run between the sensors and the junction box unspliced. The 4 levels shall act as:
 - LEVEL 4 - High Level Alarm
 - LEVEL 3 - Start Lag Pump; both pumps running
 - LEVEL 2 - Start Lead Pump; shall alternate on each call
 - LEVEL 1 - Off; all pumps stop
5. Utility Power - Utility power to the panel shall be 480 volts, 3 phase, 60hz. It is the responsibility of the contractor to bring the necessary utility power to the pump station site.
6. Wet Well - The wet well is classified as a Class I, Division 1, Group D hazardous location as per NFPA Article 820 recommendation.

B. CONTROL PANEL ENCLOSURE

1. General - A UL Listed and NEMA Type 4X enclosure properly sized to contain the required components shall be used. The enclosure shall be constructed of 14 GA stainless steel body and door(s) with continuous stainless steel piano hinge. A dripshield shall be welded on the top of the enclosure; screws to secure the dripshield shall not be allowed. Welded on mounting feet shall be provided; they shall be oversized to readily accommodate mounting the panel on 1 5/8-inch strut. All hardware shall be corrosion resistant. A 3-point latch with nylon rollers and padlock

provisions on handle shall be provided. Oil-resistant door gasketing around all 4 sides of opening shall be applied. A painted white enamel steel mounting panel shall be provided for mounting of components. All hardware shall be corrosion resistant. Voltage identification labels and comprehensive warning labels shall be provided. To maintain the environmental rating of the specified equipment and enclosure, install in the openings only certified or recognized devices with the same integrity as the enclosure, in compliance with the installation instructions of the device. The enclosure with the installed inner swing door shall be NEMA Type 4X and UL Type 4X. The enclosure shall be designed specifically for municipal waste water applications.

2. Enclosure Accessories - The enclosure shall also provide for and include the following mechanical and electrical facilities:
 - a. Inner Swing Panel - Provision of a "dead front" feature shall be provided using a full size hinged inner door to mount all operator devices. Material shall be 0.125 inch aluminum with turned down flanges on all 4 sides for added rigidity. The inner door and components shall have a "dead back" feature in order to avoid accidental shock hazard. The inner door shall be large enough to fill the entire opening of the enclosure. The screws used to secure the inner swing door mounting hardware to the enclosure shall be UL and NEMA Type 4X rated/listed and shall not violate the environmental integrity of the enclosure. Mounting hardware which penetrates the enclosure and violates the environmental rating of the enclosure shall not be allowed. All hardware shall be corrosion resistant. Quarter-turn latches shall be provided for securing the inner door in the closed position; captive screws are not acceptable. In addition, an inner door handle shall be provided for operator convenience.
 - b. Condensation Heater - A 100 watt (minimum), 120 VAC heater shall be provided to protect the enclosure from the harmful effects of condensation corrosion and low temperatures. The heater shall be complete with an adjustable thermostat. Branch protection shall be provided.
 - c. Work Light - A 12-inch fluorescent work light with a safety lens shall be mounted inside the top of the control panel without penetrating the panel outer skin with screws or fasteners. The light shall be operated with an on/off switch mounted on the inner door.

C. HIGH VOLTAGE SECTION

1. Main Lug Only - A power distribution block sized for the incoming power conductors shall be provided for the main power connection. A separate fused service entrance disconnect switch shall be provided and installed

- by the contractor. The disconnect switch shall be have padlock provisions.
2. Individual Branch Disconnect and Short Circuit Protection - Each pump motor shall be provided with a combination circuit breaker motor starter. Circuit breakers shall be thermal magnetic, "E" frame or better and rated for 14,000 AIC at 480 VAC. Starters shall be NEMA rated. Starters smaller than Size 1 and half sizes will not be allowed. Coils and contacts shall be replaceable without removing the motor starter from the enclosure. Overloads shall be ambient compensated, quick trip (Class 10) type. Overload reset operators shall be provided to reset the overloads without opening the enclosure door.
 3. Power Distribution System - Associated with this installation will require the individual branch disconnect and short circuit protection to have a UL interrupting rating of 14 kA at 460 VAC.
 4. Control Power - The 120 VAC, single-phase power shall be derived from a properly sized transformer.
 - a. Control power shall have an over current protection device suitable interrupting requirements of the system. Fused disconnect shall be provided in accordance with NEC and the system requirements.
 5. Lightning Arrester - The system shall be protected by a lightning arrester for the electrical service and shall be capable of handling up to 600vac. It shall be parallel MOV design and provide protection for Category C Transient Surges as defined in ANS/IEEE C62.41 without degradation of components. The arrester shall provide protection between each phase line and the ground line. The arrester shall be UL listed as a secondary surge arrester, UL category OWHX. The enclosure shall be molded UV resistant polycarbonate or equal material. All electrical connectors shall be sealed in a UL component recognized epoxy to exclude moisture, dirt and corrosion. A 1/2-inch conduit nipple and lock nut shall be provided. Leads shall be color-coded and a minimum of 18 inches long. It shall be provided loose for mounting on the exterior of the utility service entrance disconnect by the installing contractor.
 6. Ground Lugs - Ground lugs shall be provided for both incoming service and for each motor.
 7. Three-Phase Power Monitor - A UL recognized 3-phase power monitor shall interrupt the control power in the event of phase loss, phase reversal, low voltage and phase unbalance. It shall have primary fuse protection. Contacts shall be rated for 15A resistive at 120 VAC. The 3-phase power monitor shall automatically reset when proper power is re-applied.

8. Components - Operator control devices shall be 22mm, NEMA and UL listed for Types 1, 12, 3R, 4 and 4X. Contact blocks shall be self wiping and color- coded bridge type rated at 10A and must have a rated insulation of 600V. Terminal connections shall be suitable for two 14 AWG control wires. All control and time delay relays shall be DPDT rated 10A @ 120 VAC, 8-pin socket mount type. Sockets shall have pressure plate terminals that accept two 14 AWG wires and shall be rated a minimum of 300V. All terminal blocks supplied shall be box lug type rated at the proper voltage/ampereage and shall accept two 14 AWG wires.

D. CONTROL SECTION

1. General - All control wiring shall be minimum 16 AWG, MTW and shall be color-coded in accordance with all applicable codes and laws. Spiral wrap, tie wrap, fasteners and wire duct shall be provided as required for aesthetics and safety.

All components mounted on the door shall be wired with insulated connectors (where "finger proof" terminals are not provided) to prevent accidental shock hazards. All components on the backpanel shall be mounted on DIN rail or fastened via drilled and tapped screws to facilitate easy component replacement. Pop rivets shall not be allowed. Ammeter loops shall be provided between the disconnect switch and combination starter for better heat dissipation and an easy means of meter reading.

Self-adhesive Brady BMX-C + System vinyl cloth printed adhesive wire markers shall be supplied at both ends of every wire. All components on the backpanel shall be identified by a Brady BMX-C + System metallized polyester printed adhesive label. Dymo labels are not acceptable. These labels shall include all pertinent data applicable to ratings and sizes. Components on the door of the enclosure shall be identified with custom engraved plastic legend plates. Voltage identification labels and comprehensive warning labels shall also be provided.

2. Alternating Relay - An 8-pin socket mount DPDT alternating relay shall alternate each pump on each successive start command. It shall be complete with LED indicating lights showing the status of the internal relay and a lead selector toggle switch which will allow the alternation to be canceled and omit a disabled pump. Contacts shall be rated 10A at 120VAC.

3. Mode Select - Method of operation shall be by a 3-position green illuminated maintained "Hand-Off-Auto" selector switch for each pump which shall provide for mode selection and run indication.
4. Pump Thermal Trip and Seal Leak Detection - A temperature monitoring relay shall be supplied for all pumps. One relay shall be provided for each pump. The relay shall monitor the stator temperature of the pump motor. Over temperature shall be detected by a normally closed low temperature switch mounted on the stator. An over temperature condition will cause immediate shutdown and the pump(s) shall remain locked out until manually reset. The over temperature function shall incorporate a bistable relay that retains its position during power failures. LED's located on the relay shall indicate thermal trip.

Seal leakage detection shall be provided for all submersible pumps. Seal leakage shall be detected by a resistive float switch in the seal cavity. Detection of a seal leak occurring within the motor chamber shall not shutdown or lockout the pump. LED's located on these relays shall indicate a seal leak condition.

An over temperature pilot light and a seal failure pilot light shall be provided on the inner door for each pump.

5. Elapsed Time Meters(s) - A 6-digit non-resettable type hour meter shall be provided for each pump to record hours of operation. These shall be wired with insulated connectors to prevent accidental shock hazards.
6. Intrinsically Safe Relay(s) - ISR relays will be provided per Article 504 of the N.E.C. and ANSI/ISA-RP12.6. These relays shall be interfaced with each float switch. Intrinsically safe relays shall be UL 913 listed and shall be 8-pin socket mount style.
7. Convenience Outlet - A 15A GFI duplex outlet shall be provided. It shall be mounted on the inner swing door. A dedicated 15A circuit breaker shall be provided for this outlet.
8. Start Delay - A time delay relay shall be provided to delay the start of the lag pump. This relay shall be adjustable from 1 to 10 seconds and shall be an 8-pin socket mount type with contact ratings as previously specified.
9. Alarms - A weatherproof red flashing incandescent alarm light and a horn rated 90dB at ten feet shall be provided to indicate a high level alarm condition. Alarm power shall be derived from the 120V control power and battery backup. They shall be mounted on the exterior of the pump control panel or fiberglass pump cover and shall be UL recognized for NEMA 4 to maintain the environmental rating of the enclosure. The alarm shall be activated by the level four mercury level

sensor (high water sensor) or a power failure.

10. Dialer - An automatic phone dialer shall be provided and placed inside the control panel. The dialer shall be a solid state component capable of dialing from 1 to 8 phone numbers, each up to 30 digits in length. Unit shall have battery backup and be capable of utilizing standard pulse dialing or Touch Tone DTMF. If the control power fails, the dialer shall internally generate and automatically annunciate a power failure alarm. Unit shall be capable of being configured locally or remotely from a standard touch-tone phone.

A pump failure alarm shall occur if a pump is called and the motor starter does not energize within 5 seconds. A pump failure alarm shall also occur if the pump is operating and the motor starter de-energizes for any reason other than as required by the automatic level control. The pump failure timer shall be factory adjustable in one-second increments.

Acceptable manufactures are Microtel "DIALSTAT", Sensaphone model 800 or approved equal.

- a. Phone Line - The dialer is to operate on a standard rotary pulse or Touch Tone "dial-up" phone line and is to be F.C.C. approved. A regular private line is to be provided by the contractor. Connection to the telephone is through an industry standard 4-pin modular jack (RJ-11).
- b. Power - Dialer shall be powered by a dedicated 15-amp circuit. Dialer shall have battery backup.
- c. Alarm Channels
 - i. A minimum of 4 alarm channels is required
 - ii. Channel 1 shall indicate pump #1 failure
 - iii. Channel 2 shall indicate pump #2 failure
 - iv. Channel 3 shall indicate high wet well level
 - v. Channel 4 - Spare or pump 3 fail if needed

E. CONTROL PANEL ACCESSORIES

1. Junction Box - A UL Listed NEMA Type 4X, Explosion Proof enclosure shall be provided for connection of the floats and pumps. It shall contain tubular screw type terminal blocks for floats, pump power and control leads. In addition, it shall have intrinsically safe circuit provisions per NEC Article 504 and ANSI/ISA-RP12.6 and be provided complete with heavy wall fittings and sealing compound. This will be supplied mounted to the Mounting Rack and wired to the pump control panel. The appropriate seal packing and compound shall be provided loose for the installing contractor. The conduits between the pump control panel and

the junction box and the wet well and junction box shall be sealed by the installing contractor AFTER start-up tests have been completed. The installing contractor must seal the conduit between the junction box and the wet well with a removable mechanical duct seal.

2. Transfer Switch - Pump stations that are not equipped with back-up generators shall be provided with a thermal magnetic normal power main circuit breaker and emergency power main circuit breaker for transferring power between the utility and the portable generator. The 2 circuit breakers shall be mechanically interlocked to prevent both breakers from being in the "ON" position at the same time. The normal power circuit breaker shall be sized according to system load per the NEC. Generator size, generator receptacle size and system load shall be considered when sizing the emergency power main circuit breaker. Both circuit breakers shall be rated for a minimum of 10,000 AIC at 240 VAC or 14,000 AIC at 480 VAC.

Pump stations equipped back up generators shall be provided with an automatic transfer switch to switch from utility power to generator power. The switch shall be properly sized for the load served as dictated by NEC and the manufacturer. The switch shall be certified to meet the latest adopted transfer switch standards as defined by UL. Acceptable manufacturers are ASCO, Zenith, Russ Electric or approved equal.

3. Generator Receptacle - A generator receptacle shall be mounted on the side of the control panel. It shall have male contacts and include the required poles to properly interface with the generator system voltage requirements. The generator receptacle shall be suitable for connections in an outdoor environment. The generator receptacle shall be a model CROU ARE6425 RCPT ASSEM-S22 as manufactured by Crouse-Hinds.

7.2 THREE-PHASE MOTORS

All pumps shall utilize be 3-phase motors. Single phase motors shall not be acceptable. Pump stations shall be served by utility supplied 3-phase power. The use of single phase power and a phase converter will only be considered when the cost of having 3-phase power brought to the pump station exceeds twice the cost of single phase power and a phase converter. If a phase converter is to be used, submitted plans shall detail the converter installation. All phase converter installations shall meet the following requirements:

- A. Only converters using a static phase shift method of conversion will be acceptable. Rotary-type converters are unacceptable.
- B. All wiring ahead of the 3-phase panel shall be protected with single phase fusing sized to meet the total single phase amperage; conductors shall be sized based on single phase amperage and fusing.

- C. Converters shall be sized to operate the total installed pump station amperage with all pumps running.
- D. The converter shall be a Ronk "Add-a-phase", manufactured by Ronk Electrical Industries, Inc. (or approved equal). The converter shall be housed in a locking NEMA-3R rain-tight stainless steel enclosure.

7.3 STATION INTERIOR WIRING

The following electrical requirements shall be followed for wiring installed in the station interior:

- A. All pump power, control leads and level control float leads shall be hung with stainless steel kellum grips from the bracket supplied by the pump manufacturer. The bracket shall be bolted to the inside of the wet pit hatch frame or firmly bolted to the concrete immediately below the hatch frame, immediately below the hatch cover. The bracket shall be located so as not to interfere with the pump chamber entrance steps. All wires shall be neatly passed from the bracket to the raceway.
- B. Passage of the pump and float wires from the pump chamber to the junction box shall be made through a length of conduit installed between the junction box and pump chamber. The power lead for each pump shall be placed in separate conduit. All of the float leads shall be placed in one conduit.
- C. There shall be no electrical connections made in the pump chamber. All wiring shall run unbroken from the pump chamber to the junction box through the conduit and spliced inside of the junction box.

7.4 FIELD WIRING SPECIFICATIONS

Control panel wiring shall be as follows:

- A. All wiring installed on the line and load side of the electric meter shall be THHN copper wire.
- B. Electric service to the station shall be sized to provide the maximum total station amperage with all installed pumps running under a fully loaded condition.
- C. All pump station control panels shall be provided with a minimum 100-amp service.

7.5 CONDUIT SPECIFICATIONS

- A. All conduit installed between the pump chamber to the junction box shall be

2-1/2-inch diameter (minimum).

- B. A separate conduit shall be provided for the power leads of each pump. One conduit shall be provided for the float leads.
- C. All conduit running to or from the control panel, should be run underground at a minimum depth of 30 inches below finished grade.
- D. All below ground conduit shall be PVC schedule 80 conduit.
- E. Conduit installed above grade may be PVC schedule 80 or stainless steel conduit. Galvanized steel conduit will not be acceptable.

7.6 MOUNTING RACK

The station pump control panel and junction box shall be mounted on one prefabricated stainless steel structure. The panel shall be placed as follows:

- A. The structure shall be firmly anchored to the top of the pump chamber as shown in the Standard Details. The structure shall be anchored with six 3/8-inch stainless steel Wej-It type stud anchors. Anchor holes shall be drilled to the manufacturer's recommended depth. Anchors shall be Hilti Quick Bolt Two or approved equal.

7.7 EMERGENCY GENERATOR

- A. Pump stations with pumps equal to or greater than 20 hp shall be equipped with a complete and operable emergency/standby electric generating system. The equipment shall be new, factory tested, and delivered ready for installation. The packaged engine generating system shall include, but not limited to, diesel engine, generator, main circuit breaker, controls, fuel tank, exhaust piping, exhaust silencer, batteries, battery charger, weather/sound enclosure and other miscellaneous items needed to provide a complete operational system that is capable of automatic start-stop operation. The generator shall be sized so that all the pumps and appurtenances contained in the pump station can run simultaneously.
- B. Acceptable manufacturers are Caterpillar, Onan, Kohler or approved equal.

8.0 FENCING

8.1 GENERAL

A galvanized chain-link fence surrounding the pump station site shall be provided as specified herein and as shown on the standard details. The fence shall be 7 feet high (minimum) with a 12-foot wide single cantilever sliding gate.

Fencing shall be located so that:

- A. There is a 10-foot space between all pump station equipment (control panel, pump vault, valve vault, emergency storage, emergency generator, etc) and the fence perimeter.
- B. The cantilever sliding gate shall be located so that service vehicles have a direct and unobstructed path to the valve vault and pump chamber. Access gate shall not be placed over a manhole.

8.2 MATERIAL SPECIFICATIONS

A. Chain Link Fabric

1. Chain-link fabric shall be a 2-inch mesh woven from No. 9 gauge aluminum-coated steel or aluminum-zinc alloy-coated steel conforming to ASTM A491 or F1345. The fabric shall have a height of 72 inches, 20-1/2 diamond count, with the bottom selvage twisted and the top selvage knuckled. Aluminum-coated steel fabric shall be given a clear organic coating after fabrication. Aluminum-zinc alloy coating on the steel fabric shall be not less than 0.6 ounce per square foot of uncoated wire surface.

B. Fence Framework

1. General - Galvanized steel, ASTM F1083 or ASTM A123, with not less than 1.8 ounces of zinc per square foot of surface, or steel conforming to ASTM A569 externally triple-coated with hot-dip galvanizing at 1.0 ounce per square foot, chromatic conversion coating and clear acrylic polyurethane and coated internally with zinc-rich coating.
2. Fittings and Accessories - Unless otherwise noted, all fence fittings and accessories shall be galvanized according to ASTM A153, with zinc weights per Table I.
3. Gate Posts - 4.000 inches O.D. at 9.12 pounds per foot.
4. End, Corner, Angle or Pull Post - 2.375 inches O.D. at 3.65 pounds per foot.

5. Line Post and Gate Frame - 1.9 inches O.D. at 2.72 pounds per foot.
6. Top Rail - 1.66 inches O.D. at 2.27 pounds per foot.
7. Braces:
 - a. HORIZONTAL BRACE - 1.66 inches O.D. at 2.27 pounds per foot.
 - b. DIAGONAL BRACE - 3/8-inch diameter rod equipped with adjustable tightener

C. Fasteners

The chain-link fabric shall be securely fastened to all terminal posts by a 1/4" x 3/4" tension bars with heavy 11-gauge pressed steel bands at 14-inch maximum spacing, to line posts with 9-gauge wire clips at 14-inch maximum spacing, to the top rail with 9-gauge tie wires at 24-inch maximum spacing and to the bottom tension wire using 11-gauge galvanized hog rings at a 24-inch maximum spacing.

D. Barbed Wire and Supporting Arms

1. Barbed Wire - Barbed wire shall consist of 2 strands of 2-wire aluminum-coated steel conforming to ASTM A585-81, Type I (with barbs spaced on 5-inch centers).
2. Supporting Arms
 - a. One supporting arm shall be placed on each line and pull post.
 - b. Single arm at 45 degrees with vertical, sloping to outside of fence.
 - c. Integral with post top and designed as a weather-tight closure cap.
 - d. Constructed for attaching 2 rows of barbed wire to each arm.
 - e. Designed for 200 pound minimum pull-down load.
 - f. Malleable iron or pressed steel.

E. Bottom Tension Wire

The bottom tension wire shall be a No. 7 gauge aluminum-coated steel conforming to ASTM A824, Type I. The tension wire shall be placed at the bottom of the chain-link fabric and stretched tight with galvanized turnbuckles.

F. Post Tops

The post tops shall be designed as a weather-tight closure cap for the tubular posts.

G. Cantilever Sliding Gate

The cantilever sliding gate shall be manufactured according to ASTM F-1184 Type II (current edition).

1. Gate frame to be fabricated by welding, vertical and horizontal members located no greater than 8 ft. apart. The length of back frame support section shall be a minimum of 40% of the opening. Welded joints are to be protected by applying zinc-rich paint in accordance with ASTM A780. Gates should be designed to open or close by applying an initial pull force no greater 40 lbs.
2. Match chain link fabric to that of the fence system. Positive locking latch fabricated of galvanized pressed steel shall be provided. Provide safety protective guards for the top and bottom external rollers
3. Horizontal top and bottom steel pipe "track" members: 2.375 in. O.D. at 3.65 pounds per foot.
4. Vertical and internal members: 1.900 in. O.D. at 2.72 pounds per foot.

H. Protective Electrical Ground

Continuous fence shall be grounded at each corner post and at intervals not exceeding 500 feet, as per the Standard Details.

I. Pump Station Sign

Each pump station shall be provided a sign in accordance with the Standard Details. The sign shall be securely fastened to the chain-link fence at a location clearly visible from the pump station access road and approved by the City.

8.3 INSTALLATION

A. Fence

1. Follow general contour of ground and properly align.
2. Posts
 - a. Set in concrete bases as indicated on Standard Details.
 - b. Temporarily brace until concrete base has set.
 - c. Install plumb and in straight alignment.
 - d. Install pull posts every 300 feet if no corner posts are encountered in

that distance.

- e. Install pull posts at changes in direction of 10 degrees to 30 degrees.
- f. Install corner posts at changes in direction of 30 degrees or more.
- g. Install pull posts at all abrupt changes in grade.

3. Post Bracing

- a. Install braces for each end, pull and gate post and each side of each corner post.
- b. Install after concrete has set.
- c. Install so posts are plumb and in straight alignment when diagonal brace is under tension.

4. Tension Wire

- a. Weave through the fabric and tie to each post with a minimum 9-gauge galvanized wire.

5. Chain-Link Fabric

- a. Stretch taut with equal tension and each side of posts.

6. Stretcher Bars

- a. Install at each pull, end and gate post and on each side of corner posts.

7. Barbed Wire

- a. Attach 2 rows to each barbed wire supporting arm. Pull wire taut and fasten securely to each arm.
- b. Install 2 rows above the fabric and on extended gate end members of swing gates.

8. Fasteners

- a. Install nuts for tension bands and hardware bolts on inside face of the fence and peen ends of bolts or score threads to prevent removal of nuts.

B. Gates

1. Install plumb and level.
2. Install all hardware, framing, supports, and appurtenances as required for gate.
3. Install keepers, ground-set items, and flush plate in concrete for anchorage as shown on Standard Details.
4. Adjust and lubricate as necessary for smooth operation.

C. Repairing Damaged Coatings

1. All damaged coatings shall be repaired in the shop or field by re-coating with compatible and similar coating as per manufacturer's recommendations.

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9.0 PAVING

9.1 STATION AREA

The entire area inside the pump station fence shall be paved with crushed aggregate on a 4-mil polyethylene sheeting placed over the entire enclosed area. This sheeting will have one-inch diameter perforations spaced not more than 2 feet in each direction. Prior to placing the aggregate, the ground surface shall be sloped so as to permit surface water to drain away from the station.

A. AGGREGATE

The entire area shall be paved with 8 inches of crushed aggregate placed in 2 layers. The bottom 5 inches shall be 2 1/2-inch surface rock, as specified below. The top 3 inches shall be one-inch surface rock. The aggregate shall be composed of durable particles of rock and percentage of deleterious substances shall not exceed 12%. The aggregate shall comply with the following requirements:

Kind of Material	Percent Passing				
	Sieve Sizes				
	2 1/2"	2"	1"	3/8"	#10
1" surface			100%	65% max	5-25%
2 1/2" Surface	90-100%	80-100%	20-55%		

9.2 STATION ACCESS ROAD

Any pump station located farther than 7 feet from the center of the pump chamber to the edge of a public street or road shall have a 12-foot wide paved access road provided to the station. The access road shall be constructed as per the Standard Details and in accordance with the applicable sections of the City of Columbia Street, Storm Drain and Sanitary Sewer Specifications.

- A. The access road shall be designed to limit the access road grade to a 12% maximum.
- B. The access road will be required to have a turn around area as shown on the Standard Details when at least one of the following apply:
 - 1. The access road exceeds 75 feet in length.
 - 2. The access road exceeds a 3% grade.
 - 3. The access road does not travel to the pump station in a straight line.

10.0 INSPECTION/ACCEPTANCE PROCEDURES

Before final approval of or acceptance of any pump station by the City, there shall be field inspections made by the City's representative. The field inspections shall show that the pump station is fully operable and all necessary appurtenances have installed and constructed in accordance with the plans, designs and specifications approved by the Sewer Utility Department before the start of the construction.

If requested by the City, representatives from the pumping equipment manufacturer and the installing electrical contractor shall be present at the pump station site for final inspection.

Upon completion and prior to acceptance of the installation, the contractor shall subject all the pumping equipment to operating tests as outlined in section 10.4 of this specification to demonstrate satisfactory performance of the equipment. If tests do not demonstrate satisfactory performance of the equipment, deficiencies shall be corrected and equipment shall be retested.

Since sufficient wastewater to test the pump may not be available when the water test is scheduled, the contractor shall arrange to obtain water, at the contractor's own expense, from the public water supply for the test. The minimum quantity of water to be pumped for the test is equivalent to 1.5 minutes of continuous pumping at rated pump capacity for each pump operating alone. Each pump shall be tested a minimum of 2 times.

10.1 FINAL INSPECTION

The final inspection shall be arranged through the Sewer Utility Department, Engineering Division. Pump stations shall only be considered as acceptable for operation and/or maintenance by the City upon written confirmation by the Sewer Utility Department, Engineering Division.

10.2 FINAL GRADING AND SEEDING

All ground surrounding the pump station must be graded, seeded as per the Section 520 of the Sanitary Sewer Specifications and Standards for the City of Columbia, Missouri. Final acceptance of the pump station will not be given until this an effective erosion control has been demonstrated.

10.3 SITE TESTING

All pump station equipment shall be tested at start-up. At a minimum each pump started with the voltage, current and other significant parameters being recorded. The manufacturer shall provide a formal test procedure and forms for recording data. The pump tests shall be performed by the contractor in the presence of City representatives. The City reserves the right to require representatives from the pumping equipment manufacturers to be present for

these tests. The recorded data shall be submitted to the Sewer Utility Department, Engineering Division in conjunction with the as-built electrical schematics before the pump station inspection is called for.

10.4 CONSTRUCTION, OPERATION AND MAINTENANCE

It is the responsibility of the developer to construct the pump station according to the approved construction plans. When the pump station has received construction approval and all operation manuals, specification literature, and electrical diagrams have been received, the pump station and related appurtenances will be accepted by the City of Columbia for operation and maintenance.

10.5 WARRANTY

In addition to the equipment manufacturer's general warranties, the contractor shall warrant the pump station and related appurtenances to be free from defects in materials and workmanship for a period of not less than one year from the date of the City of Columbia's final written acceptance of said pump station.

10.6 FINAL ACCEPTANCE

The following documentation must be submitted to the Sewer Utility Department, Engineering Division before a final inspection will be scheduled:

- Four (4) sets of as-built wiring and piping schematics of the pump station site and any station access areas.
- Four (4) sets of operation and maintenance manuals.
- Warranty documents.

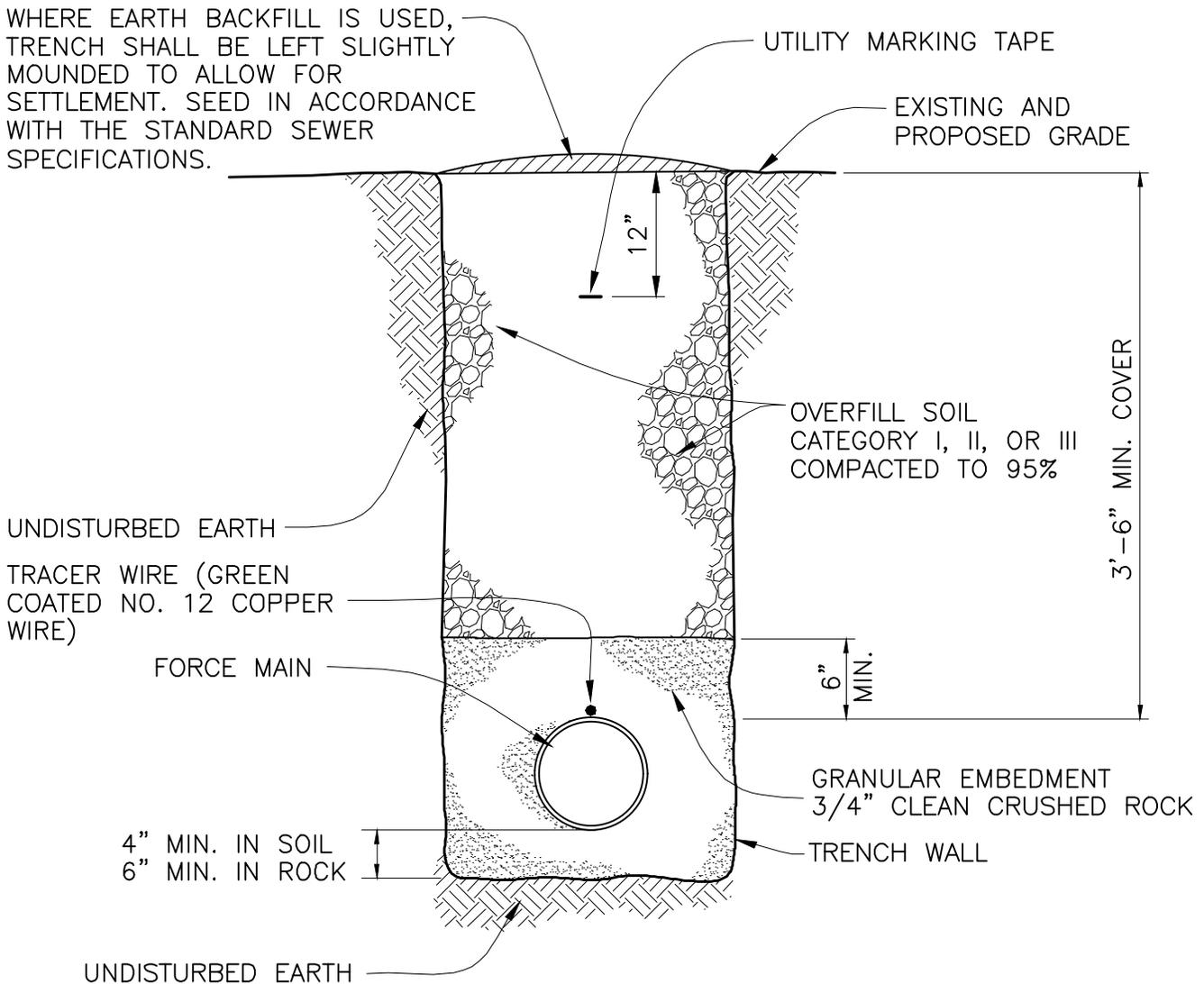
The City will not issue a written letter of acceptance or maintenance responsibility until such time that all of the above documentation has been received and a final inspection has been performed.

DIVISION II

DESIGN STANDARD

DRAFT

WHERE EARTH BACKFILL IS USED, TRENCH SHALL BE LEFT SLIGHTLY MOUNDED TO ALLOW FOR SETTLEMENT. SEED IN ACCORDANCE WITH THE STANDARD SEWER SPECIFICATIONS.



UNDISTURBED EARTH
 TRACER WIRE (GREEN COATED NO. 12 COPPER WIRE)

FORCE MAIN

4" MIN. IN SOIL
 6" MIN. IN ROCK

UNDISTURBED EARTH

UTILITY MARKING TAPE

EXISTING AND PROPOSED GRADE

OVERFILL SOIL CATEGORY I, II, OR III COMPACTED TO 95%

3'-6" MIN. COVER

6" MIN.

GRANULAR EMBEDMENT 3/4" CLEAN CRUSHED ROCK

TRENCH WALL

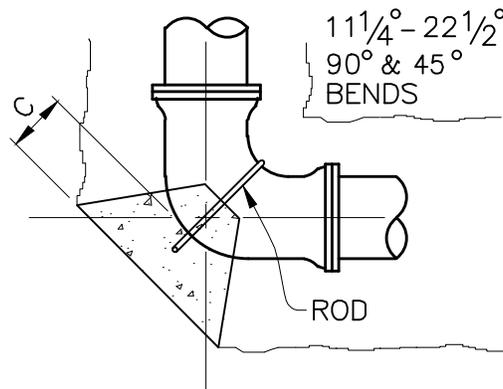
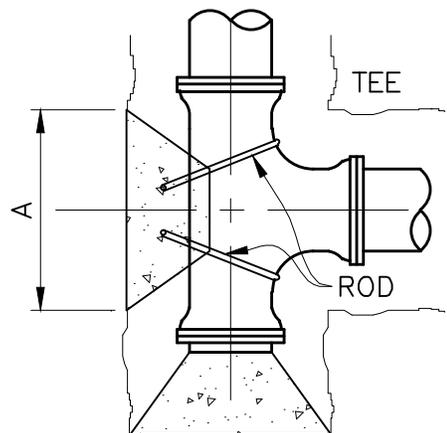
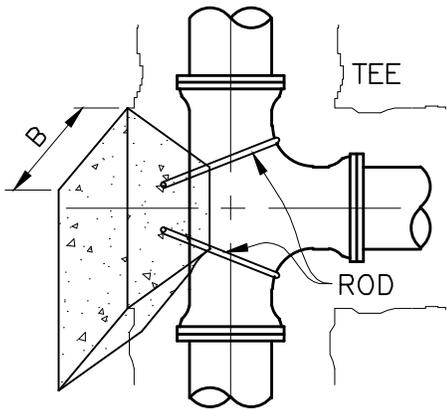
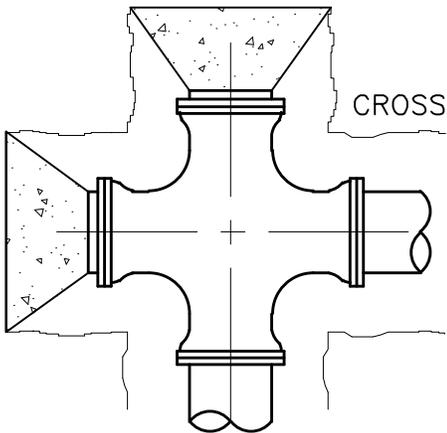
Approved	1/01/18
Date	
Revisions	



FORCE MAIN INSTALLATION

TABLE A

BEND	SIZE					
	4" & 6"	8"	10"	12"	16"	
TEE OR PLUG	A	1'-8"	3'-2"	3'-6"	4'-2"	5'-5"
	B	1'-2"	1'-4"	1'-6"	1'-0"	2'-6"
	C	8"	9"	10"	1'-10"	1'-2"
11 1/4°	A	6"	7"	8"	8"	1'-3"
	B	1'-2"	1'-4"	1'-6"	1'-8"	2'-0"
	C	7"	8"	8"	8"	9"
22 1/2°	A	8"	1'-4"	1'-5"	1'-10"	2'-8"
	B	1'-2"	1'-4"	1'-6"	1'-8"	2'-0"
	C	8"	9"	10"	11"	1'-2"
45°	A	1'-3"	2'-3"	2'-8"	3'-2"	4'-1"
	B	1'-2"	1'-4"	1'-6"	1'-10"	2'-6"
	C	8"	9"	10"	11"	1'-2"
90°	A	2'-3"	3'-7"	5'-0"	5'-10"	7'-7"
	B	1'-2"	1'-4"	1'-6"	1'-10"	2'-6"
	C	8"	9"	10"	1'-0"	1'-2"



NOTES:

1. ALL B&C DIMENSIONS TO BE AS REQUIRED TO REACH UNDISTURBED EARTH BUT NOT LESS THAN LISTED ON THRUST BLOCK TABLE.
2. CAST-IN-PLACE CONCRETE SHALL BE IN ACCORDANCE WITH THE "CITY OF COLUMBIA STREET AND STORM DRAINAGE SPECIFICATIONS AND STANDARDS," SECTION 250 CONCRETE STRUCTURES.
3. DIMENSIONS A, B, C, APPLY TO ALL BEND CONDITIONS SHOWN.
4. INSTALL PLUGS AT ALL RUNS OR BRANCHES DISCONTINUED FOR FUTURE SERVICES.
5. ALL BENDS, TEES, PLUGS, FITTINGS OR OTHER SIGNIFICANT CHANGES SHALL BE BRACED WITH POURED CONCRETE THRUST BLOCK AS SHOWN ON THIS DETAIL.
6. ALL PLUGS SHALL BE SEPARATED FROM THE CONCRETE THRUST BLOCK BY A 5 MIL LAYER OF PLASTIC SHEETING.

FOR HORIZONTAL ALIGNMENT

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Date	
Revisions	

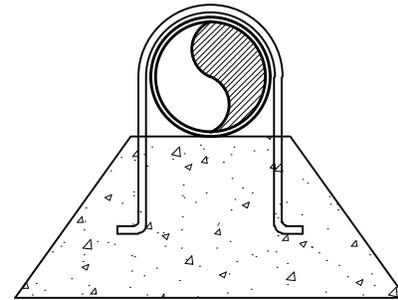
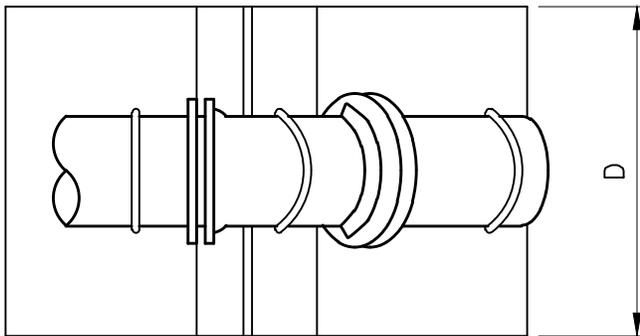


HORIZONTAL THRUST BLOCK

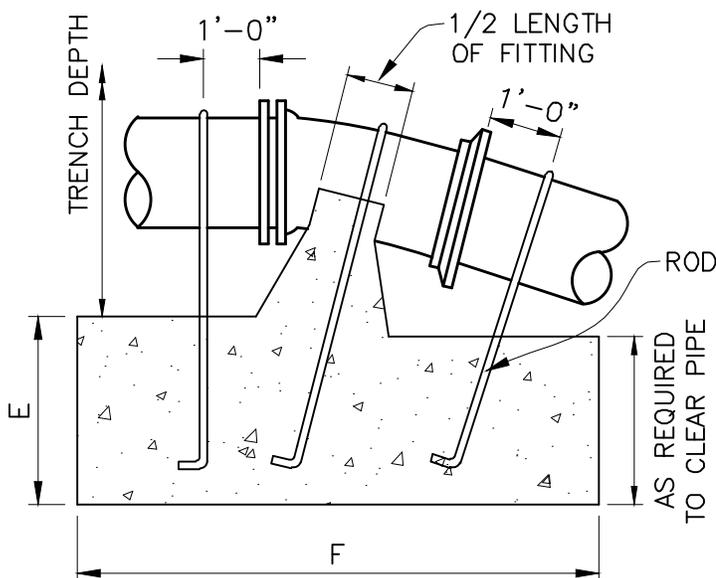
BEND	SIZE					
	4" & 6"	8"	10"	12"	16"	
11 1/4°	D	1'-6"	1'-9"	2'-0"	3'-0"	3'-6"
	E	1'-3"	1'-6"	1'-9"	2'-0"	2'-3"
	F	2'-0"	2'-6"	2'-9"	3'-0"	4'-0"
22 1/2°	D	2'-0"	3'-4"	3'-8"	4'-0"	4'-4"
	E	1'-9"	2'-3"	2'-6"	2'-6"	2'-6"
	F	2'-6"	2'-8"	3'-10"	4'-0"	5'-6"
45°	D	2'-6"	3'-0"	4'-0"	4'-6"	5'-2"
	E	2'-6"	2'-9"	3'-0"	3'-6"	4'-0"
	F	3'-0"	4'-0"	4'-6"	4'-9"	6'-6"

PIPE SIZE	ROD SIZE (IN)			NO. REQ'D.
	45°	22 1/2°	11 1/4°	
4" & 6"	1/2	1/2	1/2	3
8"	1/2	1/2	1/2	3
10"	3/4	3/4	3/4	3
12"	3/4	3/4	3/4	3
16"	3/4	3/4	3/4	3

THIS TABLE APPLIES TO VERTICAL & HORIZONTAL THRUST BLOCKS.



ROD DETAIL



FOR VERTICAL ALIGNMENT

NOTES:

1. ALL POURED CONCRETE SHALL BE LAID ON UNDISTURBED EARTH AFTER EXCAVATION ACCORDING TO DIMENSION INDICATED ON THRUST BLOCK TABLE OR IT SHALL BE LAID THE FULL WIDTH OF TRENCH FROM UNDISTURBED WALL BUT NOT LESS THAN LISTED ON THRUST BLOCK TABLE.
2. ALL POURED CONCRETE SHALL BE IN ACCORDANCE WITH "CITY OF COLUMBIA STREET & STORM DRAINAGE SPECIFICATIONS & STANDARDS", SECTION 250 CONCRETE STRUCTURES.
3. ALL RODS TO BE 316 OR 304 STAINLESS STEEL.

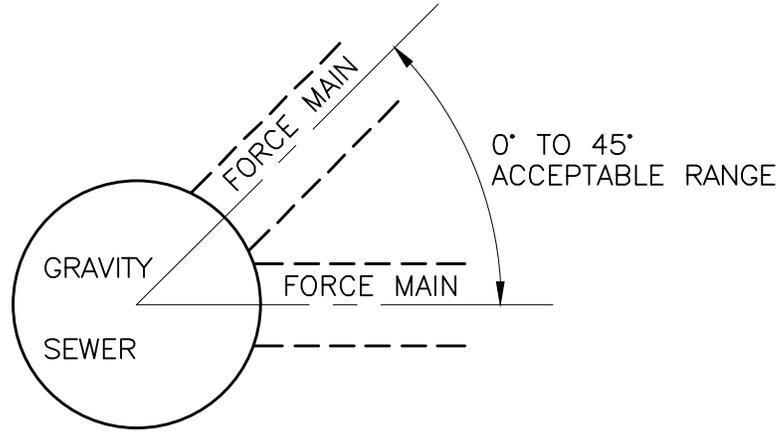
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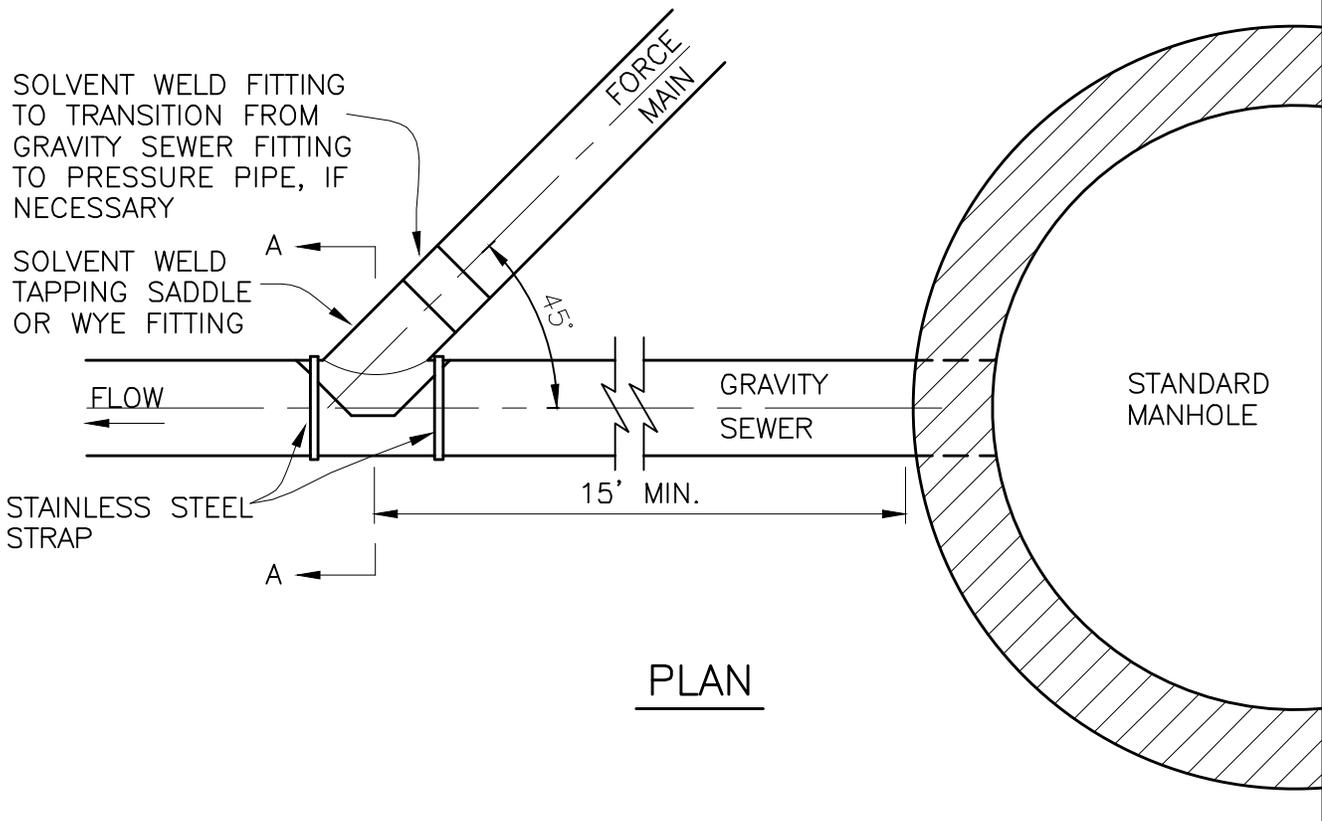
VERTICAL
THRUST BLOCK

NOTE:

1. THRUST BLOCKING REQUIRED AT FORCE MAIN TERMINATION.
2. CORROSION PROTECTION FOR THE UPSTREAM MANHOLE AND TWO DOWNSTREAM MANHOLES SHALL BE PROVIDED IN ACCORDANCE WITH SECTION 510.2 OF THE CITY OF COLUMBIA STREET, STORM DRAIN AND SANITARY SEWER SPECIFICATIONS.



SECTION A-A

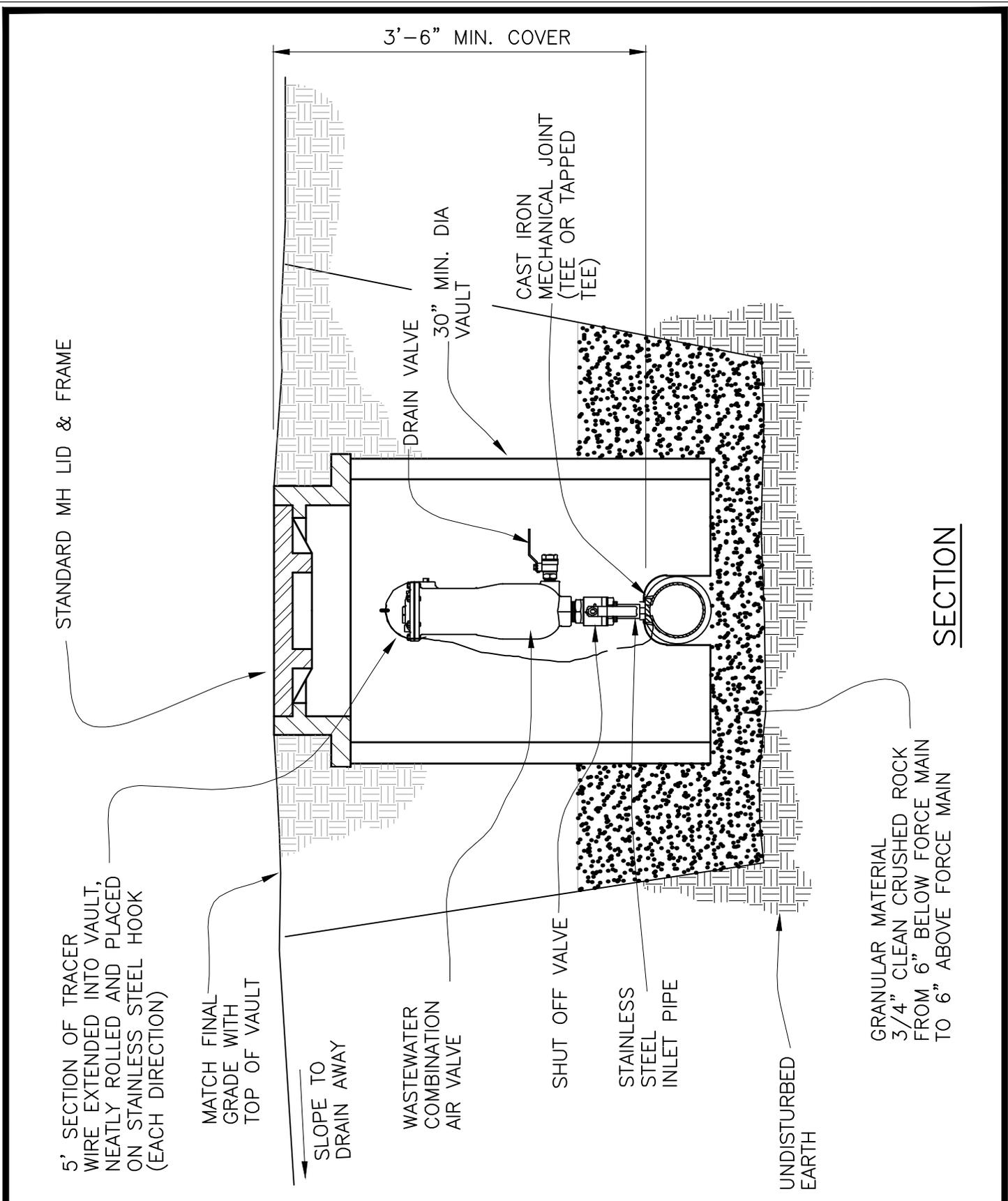


PLAN

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FORCE MAIN TERMINATION



SECTION

GRANULAR MATERIAL
 3/4" CLEAN CRUSHED ROCK
 FROM 6" BELOW FORCE MAIN
 TO 6" ABOVE FORCE MAIN

STANDARD MH LID & FRAME

5' SECTION OF TRACER
 WIRE EXTENDED INTO VAULT,
 NEATLY ROLLED AND PLACED
 ON STAINLESS STEEL HOOK
 (EACH DIRECTION)

MATCH FINAL
 GRADE WITH
 TOP OF VAULT

SLOPE TO
 DRAIN AWAY

WASTEWATER
 COMBINATION
 AIR VALVE

SHUT OFF VALVE

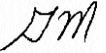
STAINLESS
 STEEL
 INLET PIPE

UNDISTURBED
 EARTH

3'-6" MIN. COVER

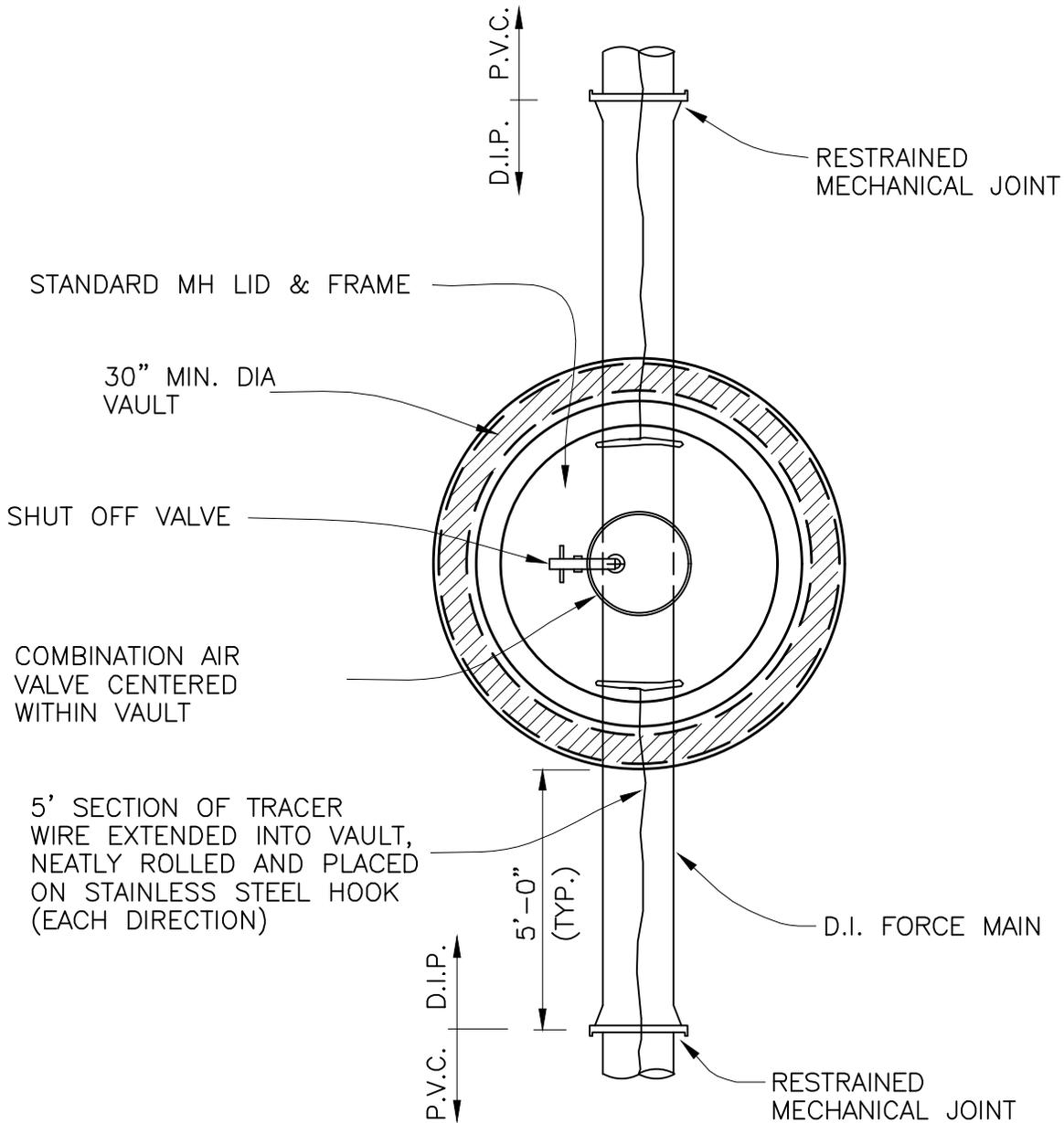
DRAIN VALVE
 30" MIN. DIA
 VAULT

CAST IRON
 MECHANICAL JOINT
 (TEE OR TAPPED
 TEE)

	5/02/01
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COMBINATION AIR VALVE VAULT (SECTION VIEW)

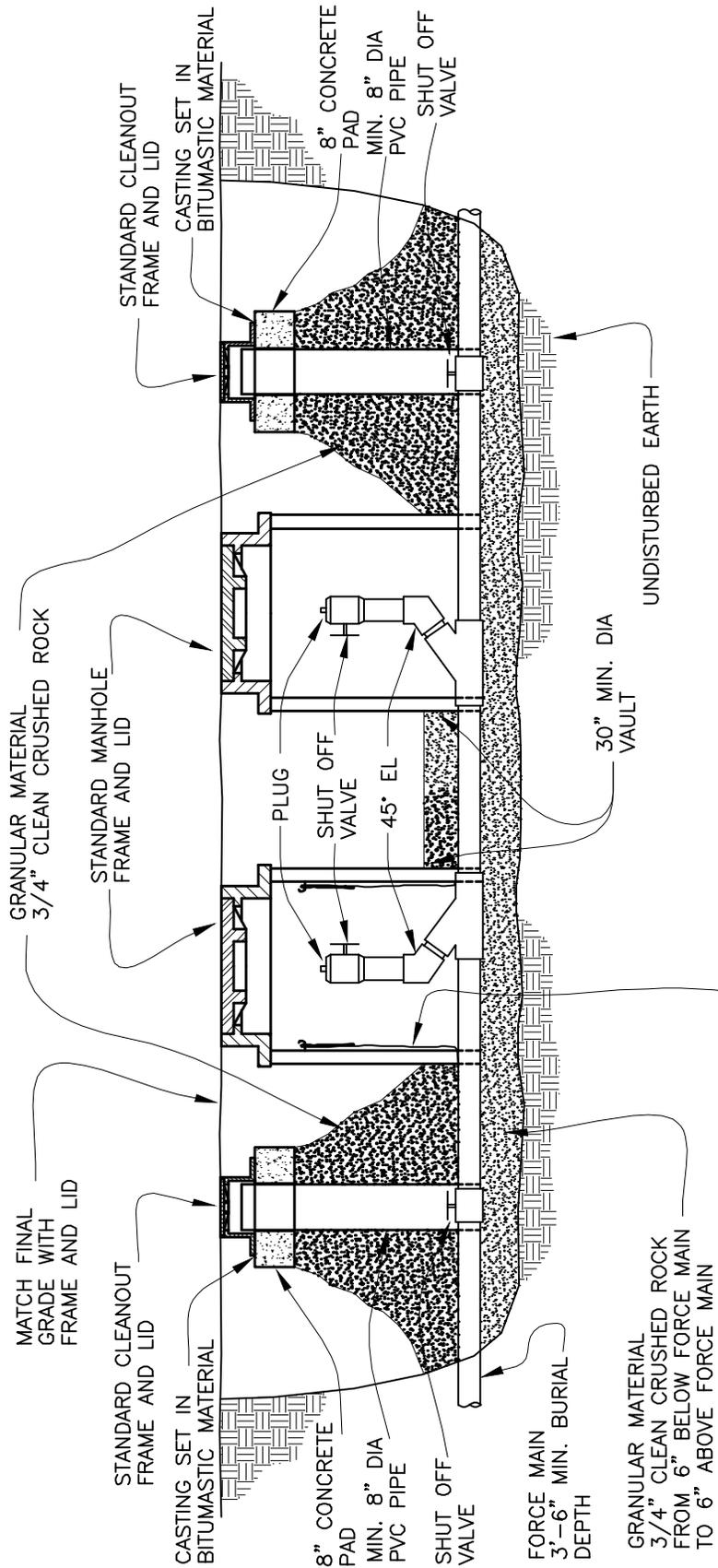


PLAN

<i>JM</i>	5/02/01
Approved	Date
Revisions	



COMBINATION AIR VALVE VAULT (PLAN VIEW)



5' SECTION OF TRACER WIRE EXTENDED INTO VAULT, NEATLY ROLLED AND PLACED ON STAINLESS STEEL HOOK (EACH DIRECTION)

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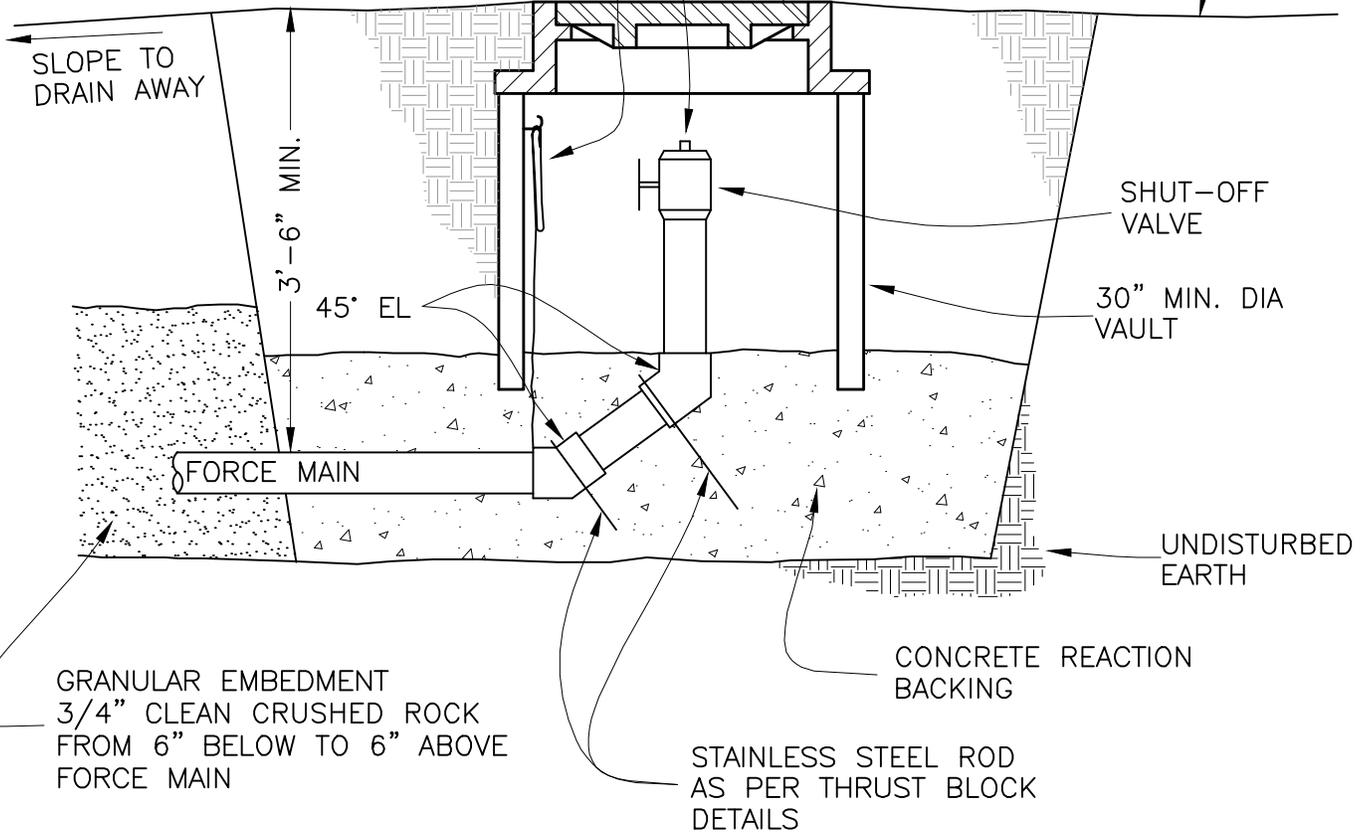
IN LINE CLEAN OUT

5' SECTION OF TRACER
WIRE EXTENDED INTO VAULT,
NEATLY ROLLED AND PLACED
ON STAINLESS STEEL HOOK

MATCH FINAL
GRADE WITH
TOP OF VAULT

PLUG

STANDARD MH
LID & FRAME



SLOPE TO
DRAIN AWAY

3'-6" MIN.

45° EL

FORCE MAIN

SHUT-OFF
VALVE

30" MIN. DIA
VAULT

UNDISTURBED
EARTH

CONCRETE REACTION
BACKING

GRANULAR EMBEDMENT
3/4" CLEAN CRUSHED ROCK
FROM 6" BELOW TO 6" ABOVE
FORCE MAIN

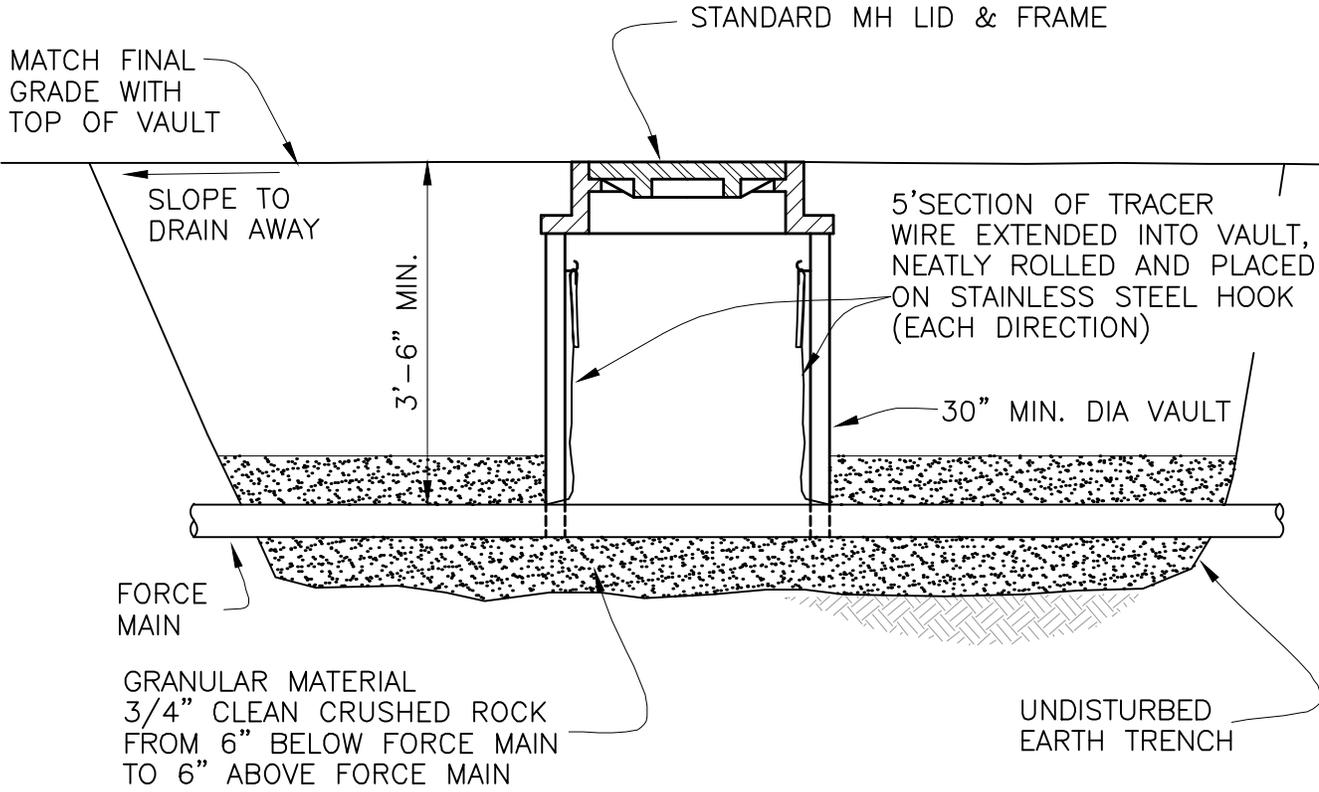
STAINLESS STEEL ROD
AS PER THRUST BLOCK
DETAILS

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Date	
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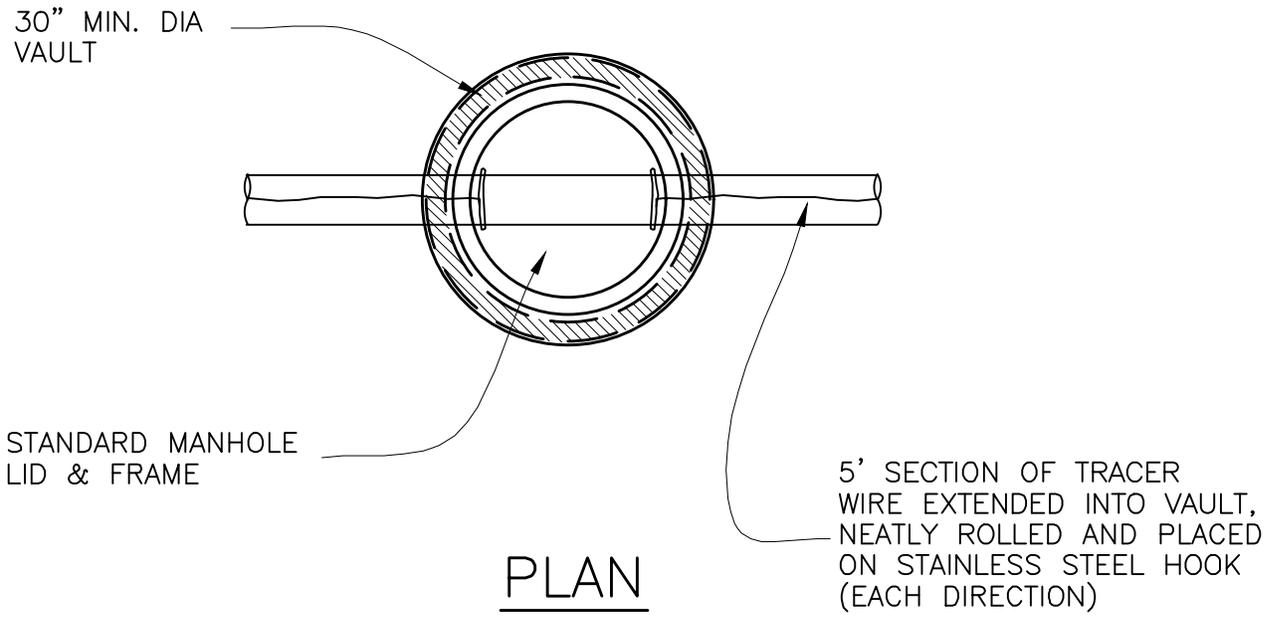


END OF LINE
CLEAN OUT

08



SECTION

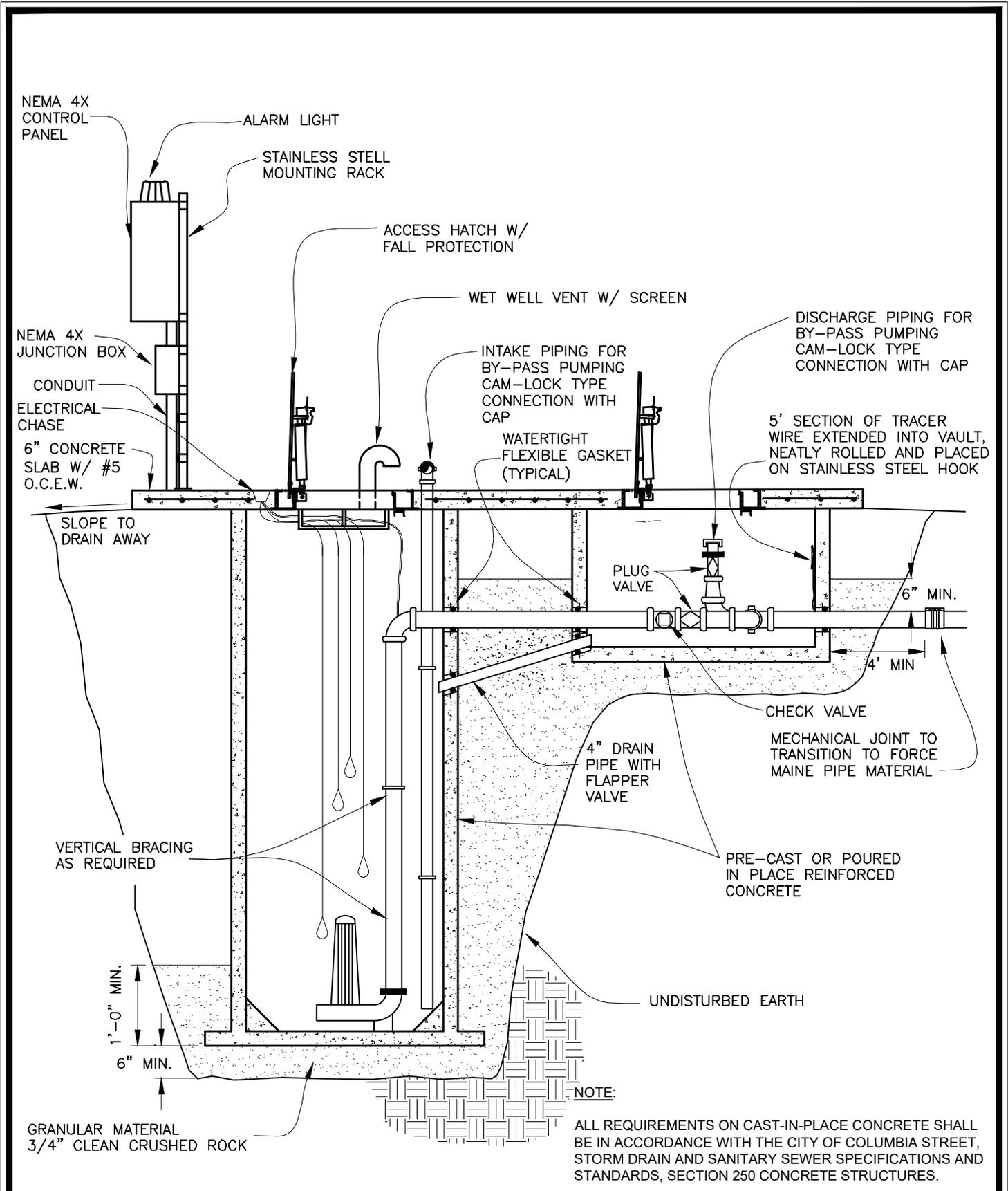


PLAN

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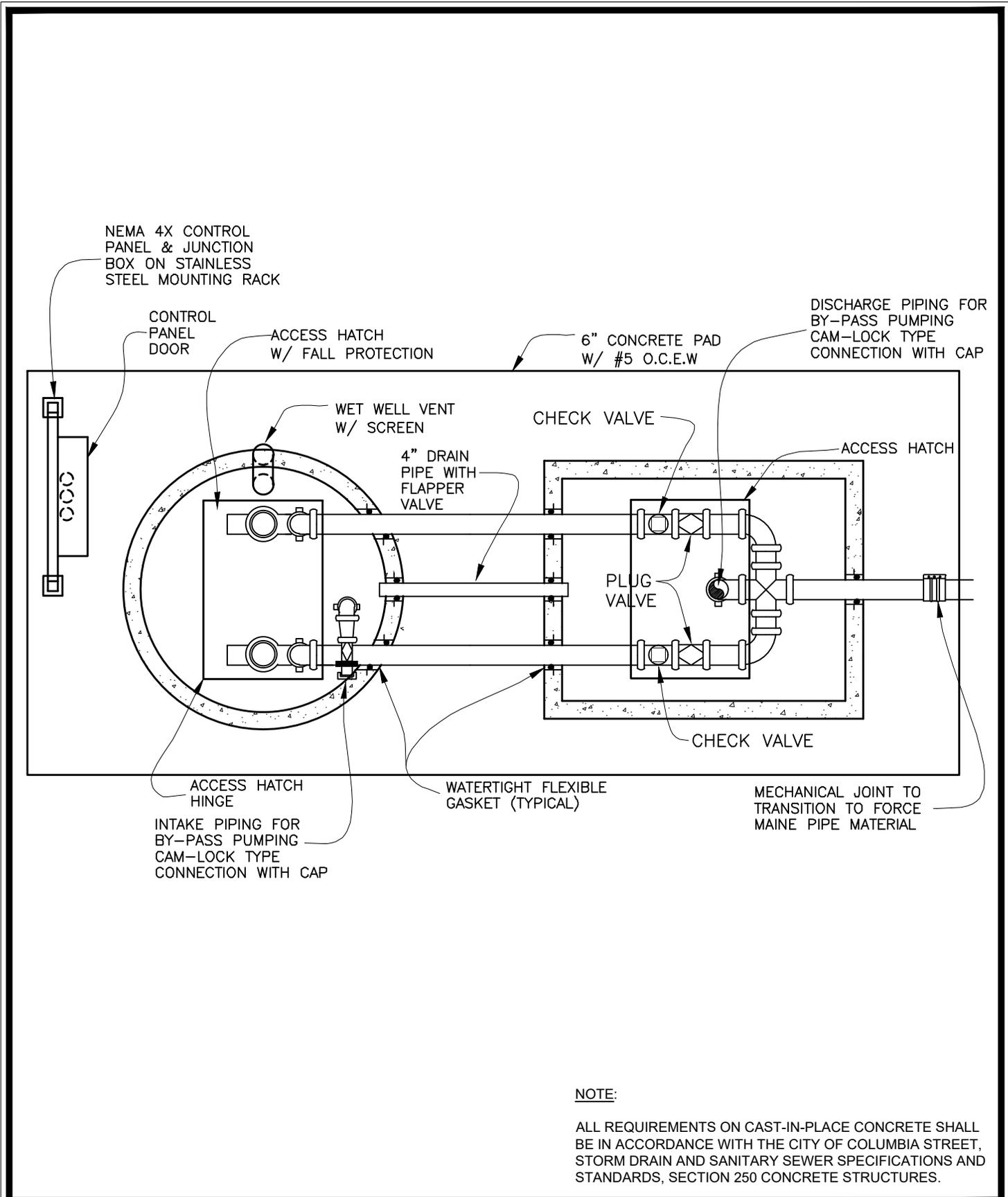
TRACER WIRE ACCESS VAULT



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SUBMERSIBLE LIFT STATION - SECTION



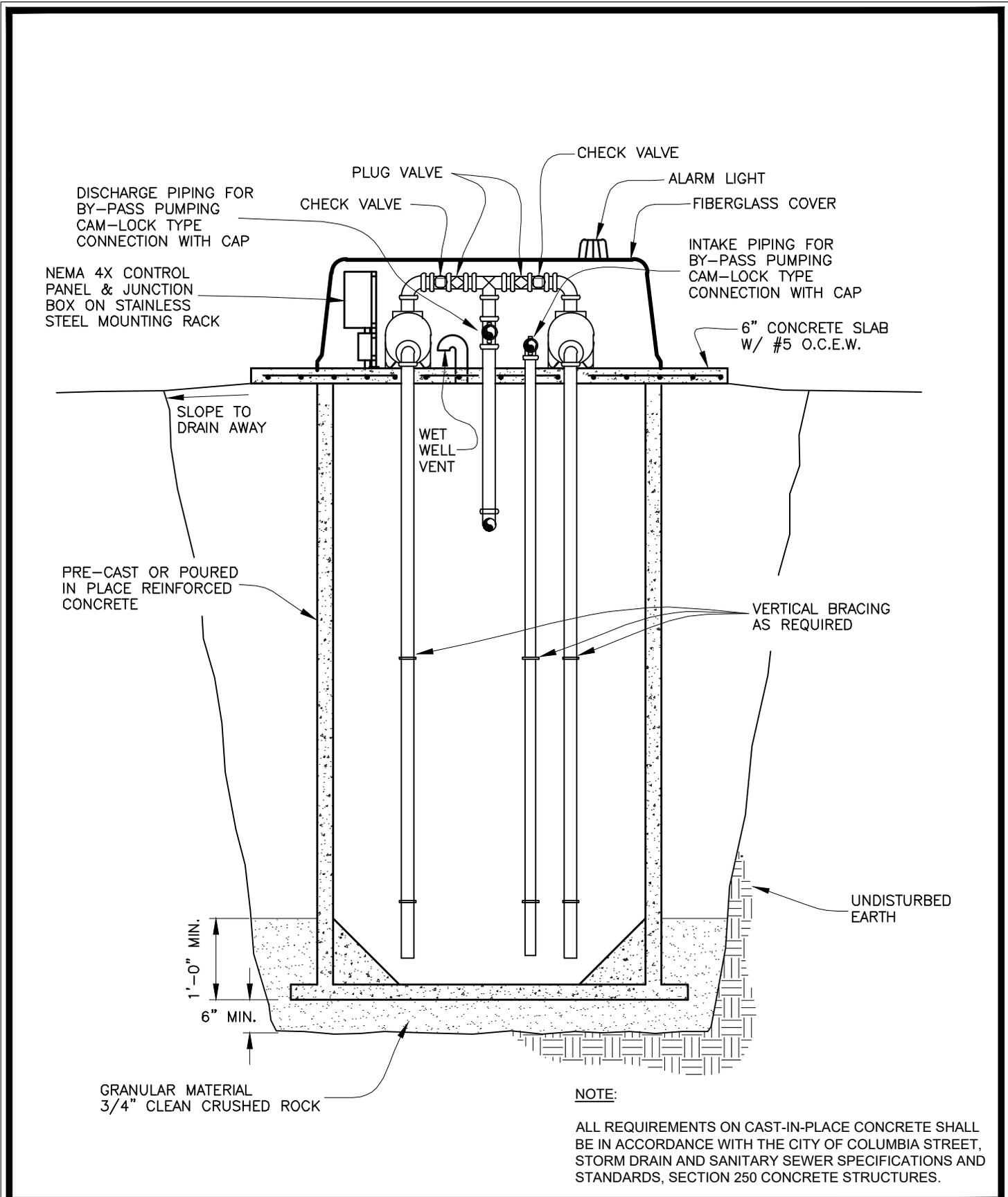
NOTE:

ALL REQUIREMENTS ON CAST-IN-PLACE CONCRETE SHALL BE IN ACCORDANCE WITH THE CITY OF COLUMBIA STREET, STORM DRAIN AND SANITARY SEWER SPECIFICATIONS AND STANDARDS, SECTION 250 CONCRETE STRUCTURES.

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Date	
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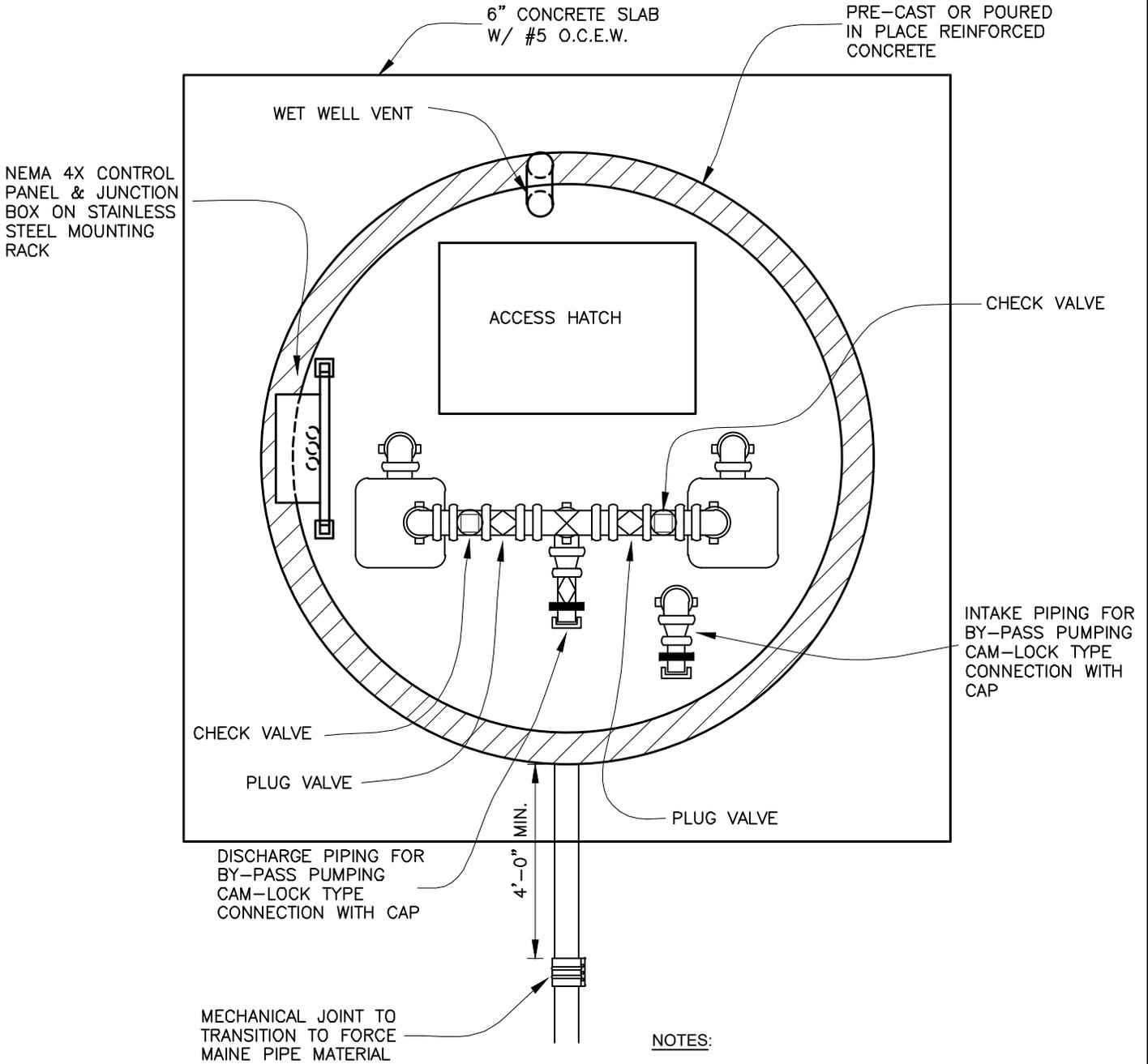
SUBMERSIBLE LIFT STATION - PLAN



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Date	
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SUCTION-LIFT LIFT STATION - SECTION



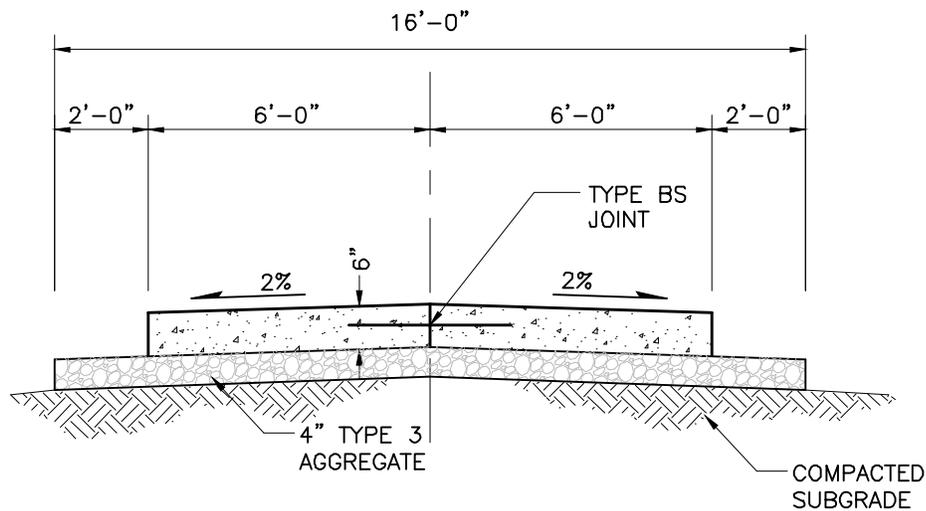
NOTES:

1. ALL REQUIREMENTS ON CAST-IN-PLACE CONCRETE SHALL BE IN ACCORDANCE WITH THE CITY OF COLUMBIA STREET, STORM DRAIN AND SANITARY SEWER SPECIFICATIONS AND STANDARDS, SECTION 250 CONCRETE STRUCTURES.
2. FIBERGLASS COVER NOT SHOWN.

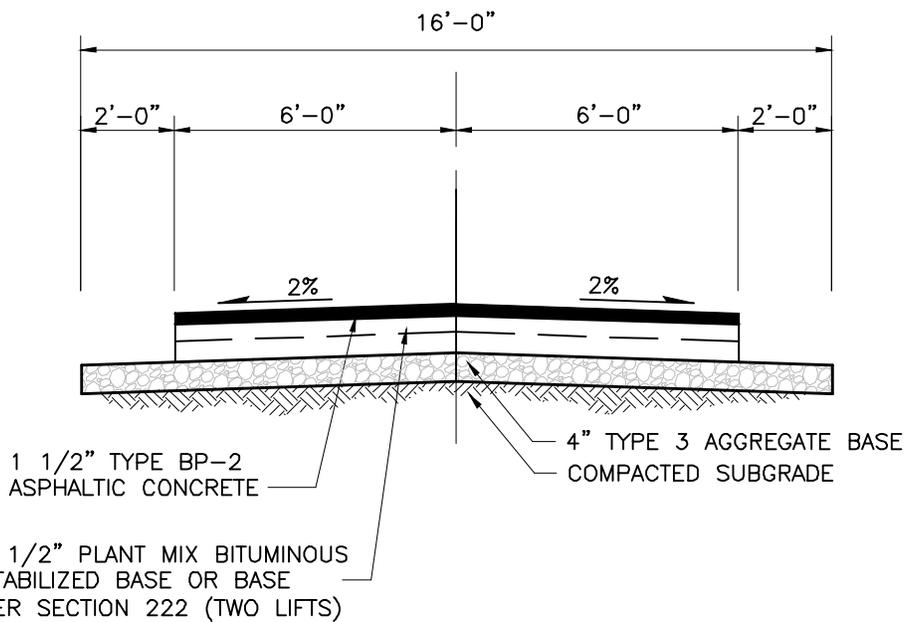
Approved	1/01/18
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Revisions	



SUCTION-LIFT LIFT STATION - PLAN



CONCRETE PAVEMENT



ASPHALTIC PAVEMENT

NOTES:

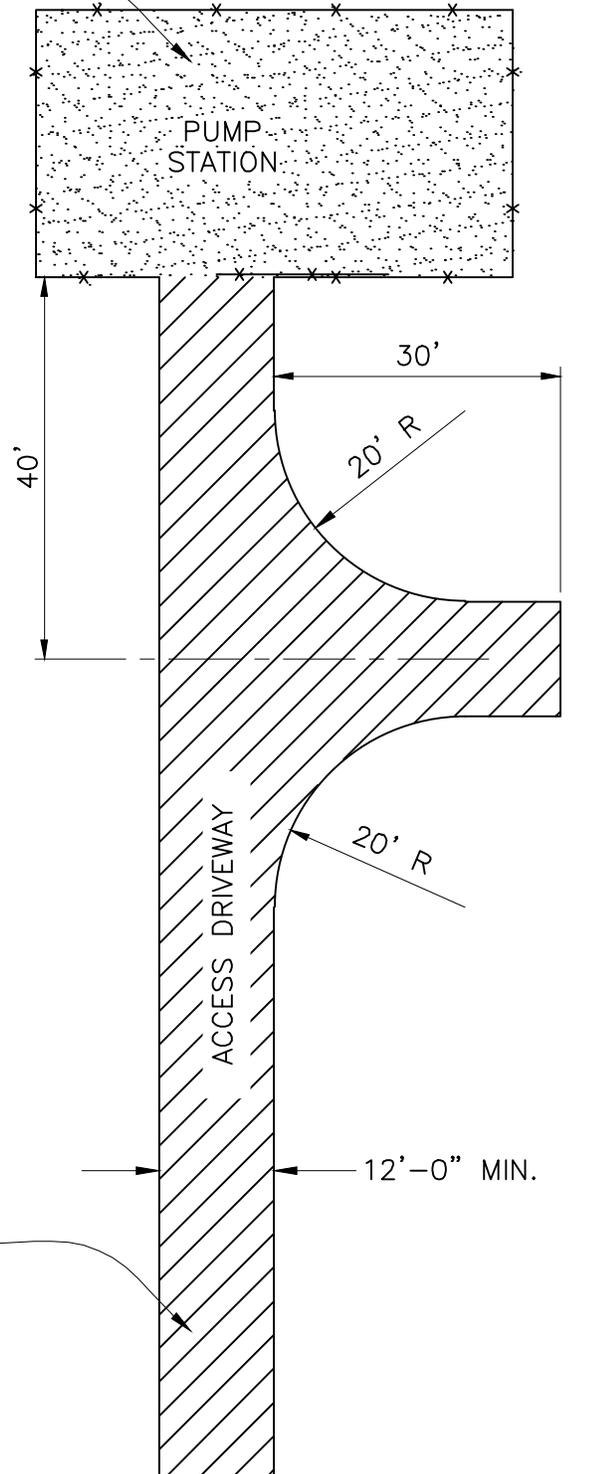
1. CONSTRUCTION OF PUMP STATION ACCESS DRIVE SHALL COMPLY WITH ALL APPLICABLE SECTIONS OF THE CITY OF COLUMBIA STREET, STORM DRAIN AND SANITARY SEWER SPECIFICATIONS AND STANDARDS.
2. ALL P.C. CONCRETE SHALL BE MoDOT PAVEMENT CONCRETE.
3. SEE DETAIL 200.01 FOR JOINT DETAILS.

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**PUMP STATION ACCESS
DRIVEWAY CROSS SECTION**

8" OF CRUSHED
AGGREGATE PAVEMENT



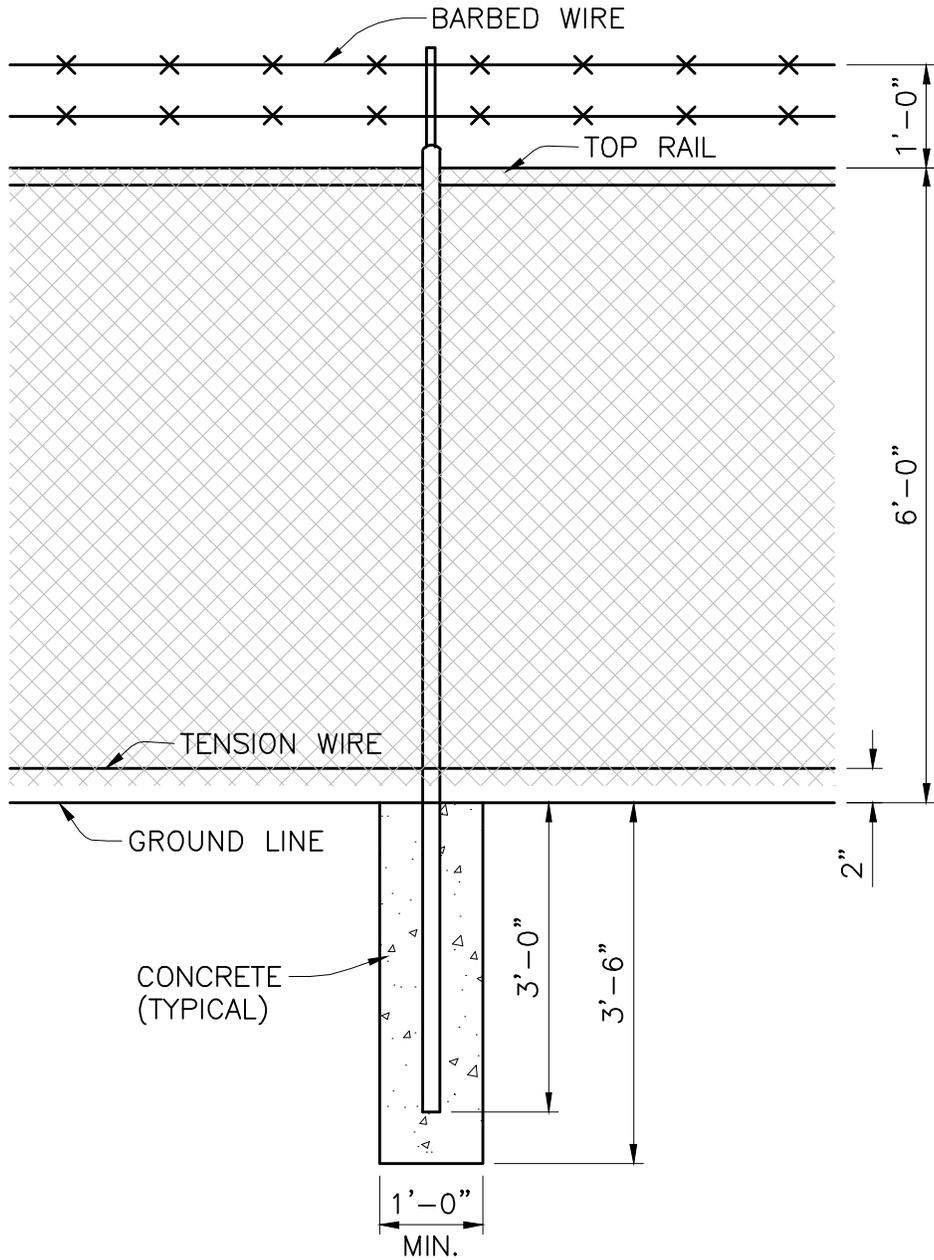
DRIVEWAY SHALL
BE PAVED PER
DETAIL 14

PUBLIC STREET

ACCESS DRIVEWAY & TURN AROUND AREA

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Date	
Revisions	

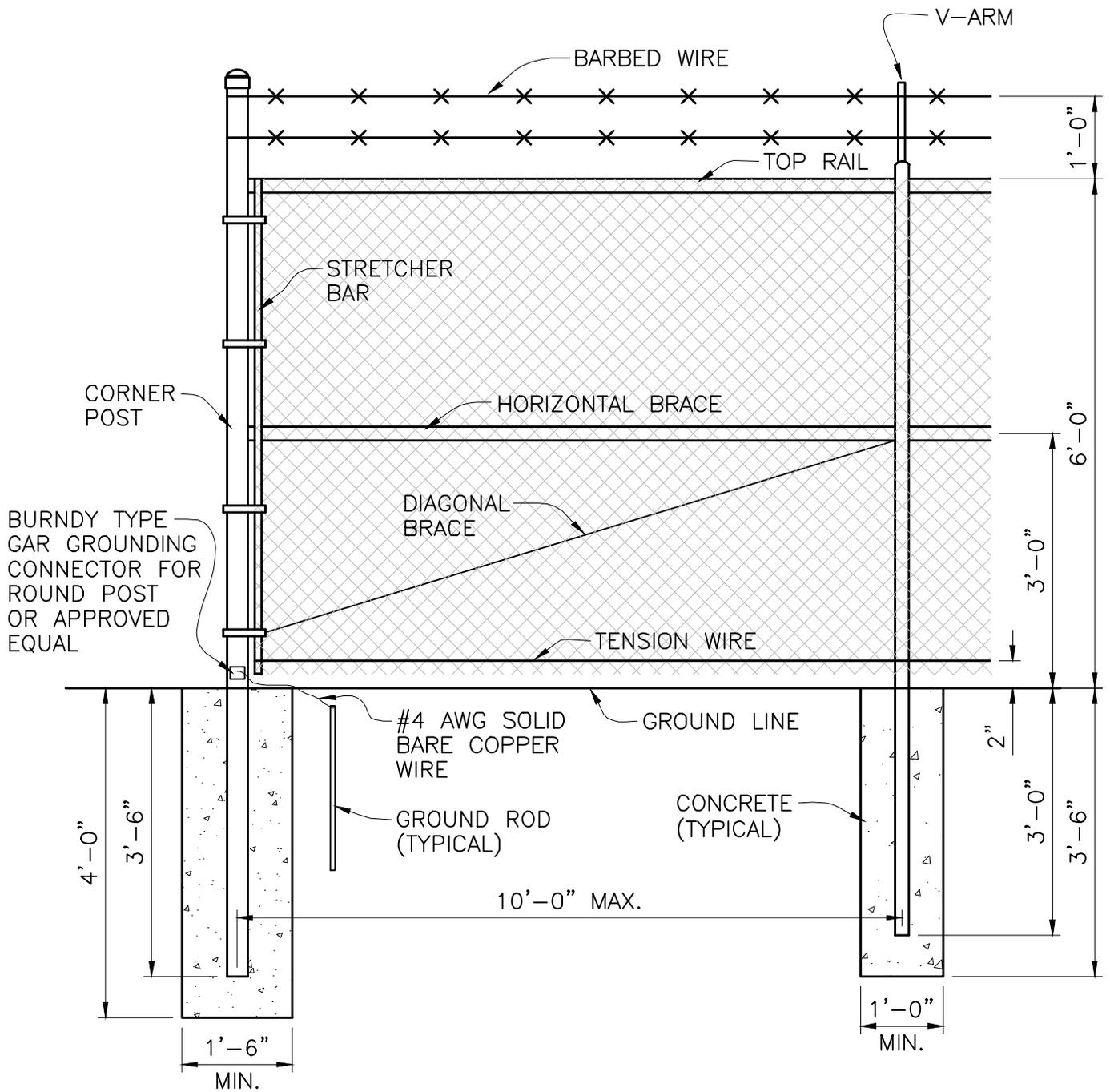




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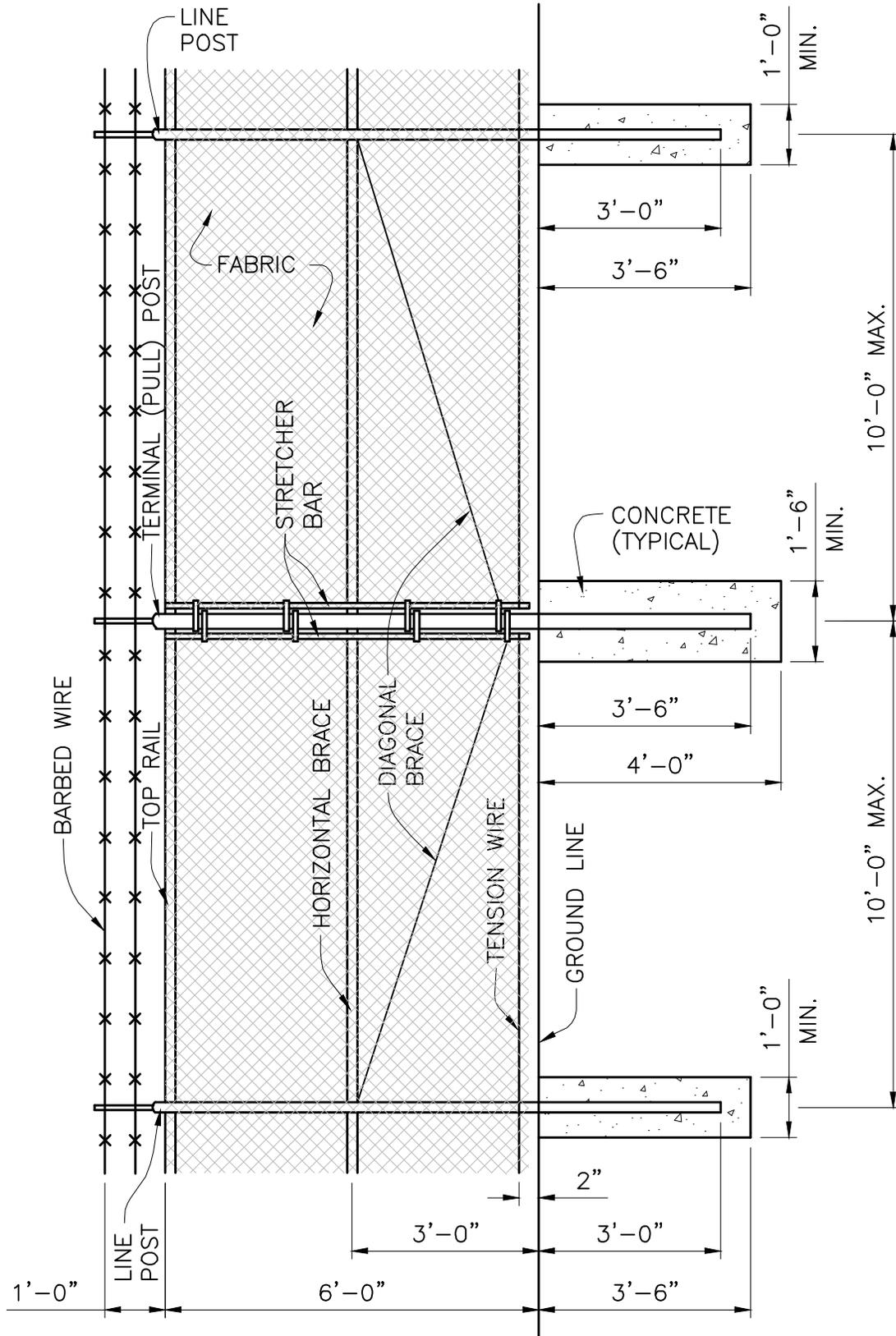
STANDARD LINE POST



Approved	1/01/18
Date	
Revisions	



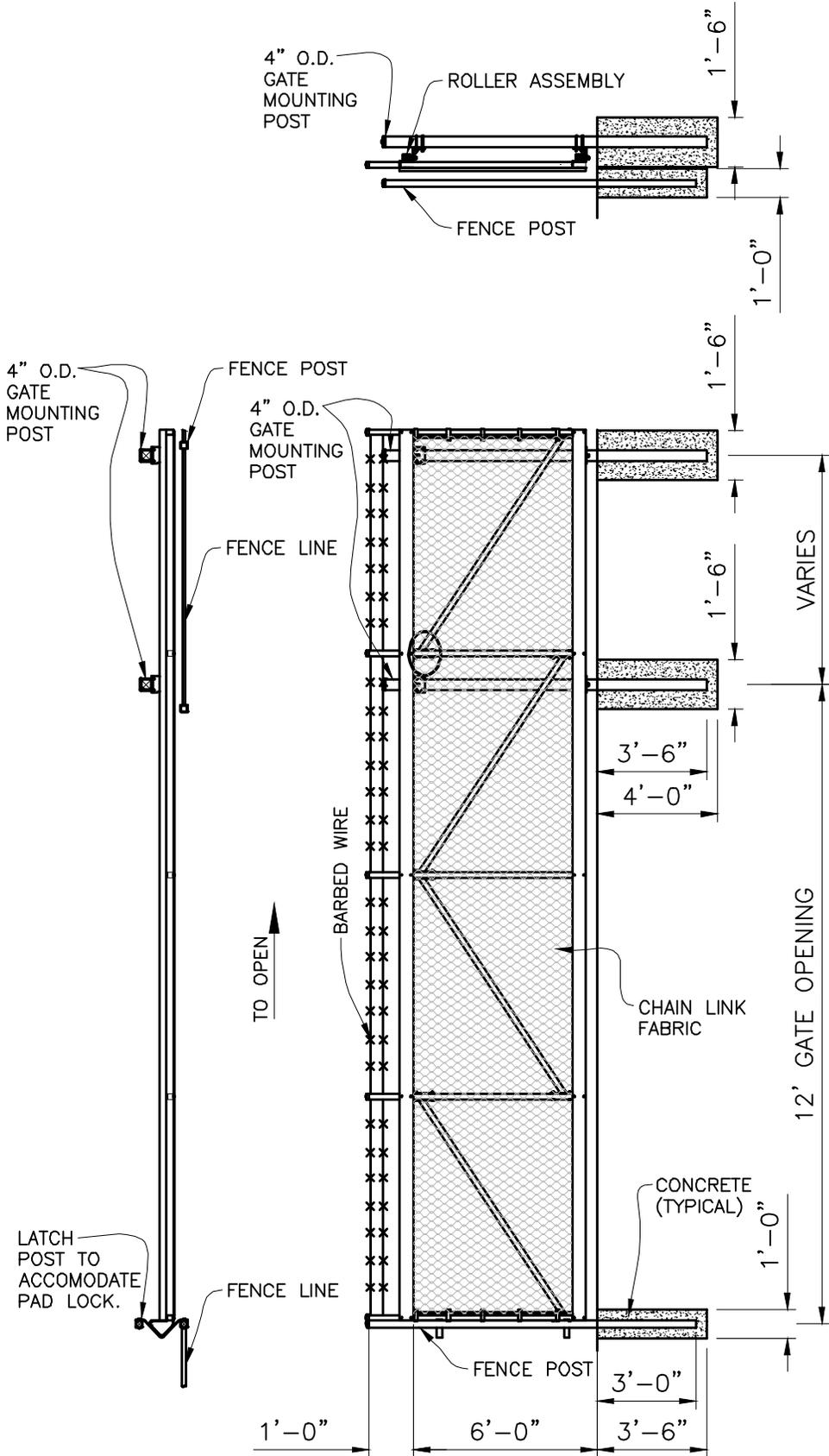
STANDARD CORNER



Approved	1/01/18
Date	
Revisions	



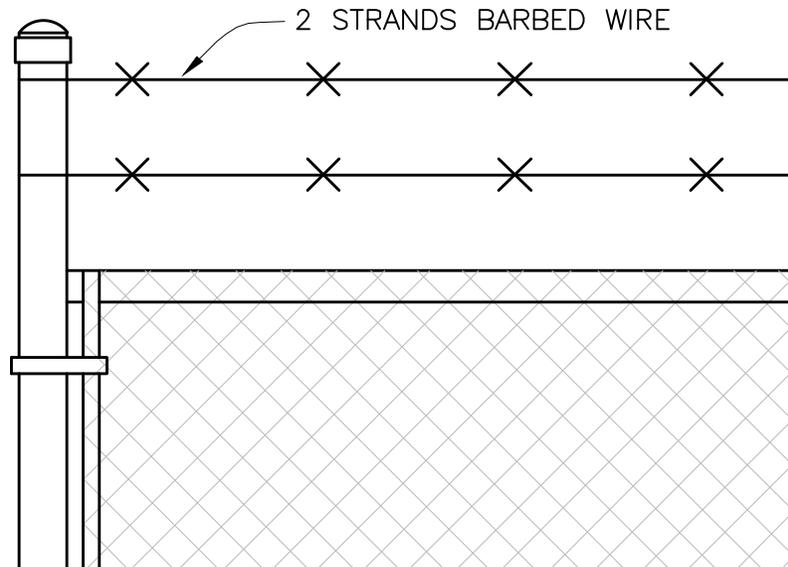
STANDARD PULL POST



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Date	
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CANTILEVER SLIDING GATE



BARBED WIRE – 2 STRANDS, 12 1/2 GAUGE WIRE WITH 14 GAUGE 4 POINT BARBS SPACED APPROXIMATELY 6 INCHES APART. ALL WIRE SHALL BE ALUMINUM COATED WITH A MINIMUM COATING OF 0.25 OUNCES PER SQUARE FOOT OF SURFACE AREA.

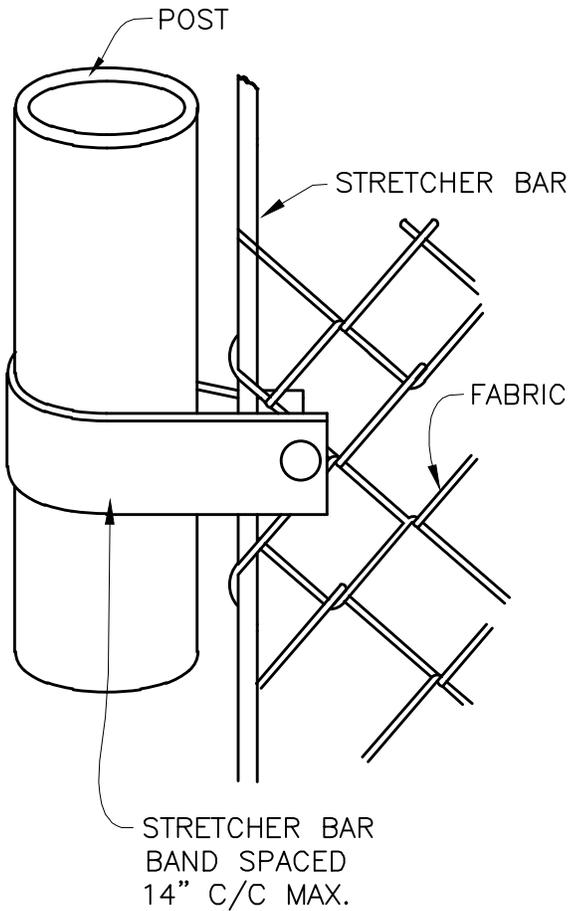
BARBED WIRE SHALL BE DIRECTLY ATTACHED TO EACH CORNER AND GATE POST. BARBED WIRE SHALL BE ATTACHED TO EACH LINE POST AND PULL POST WITH A SUPPORTING ARM. SUPPORTING ARM SHALL SLOPE TO THE OUTSIDE OF THE FENCE AT A 45° ANGLE.

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Date	
Revisions	

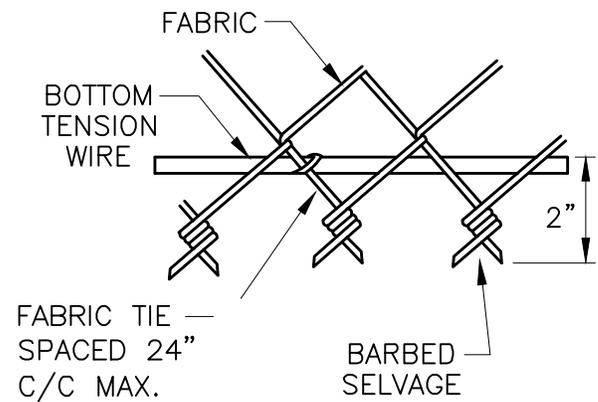
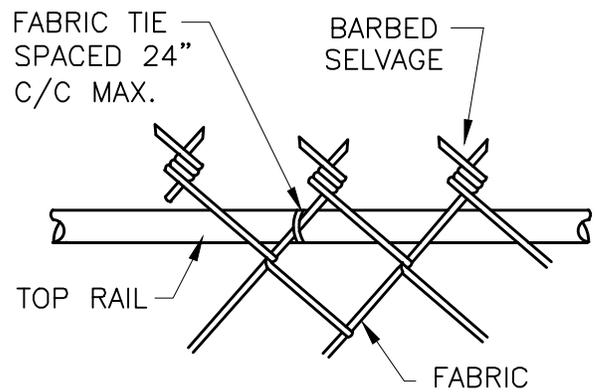


BARBED WIRE

21



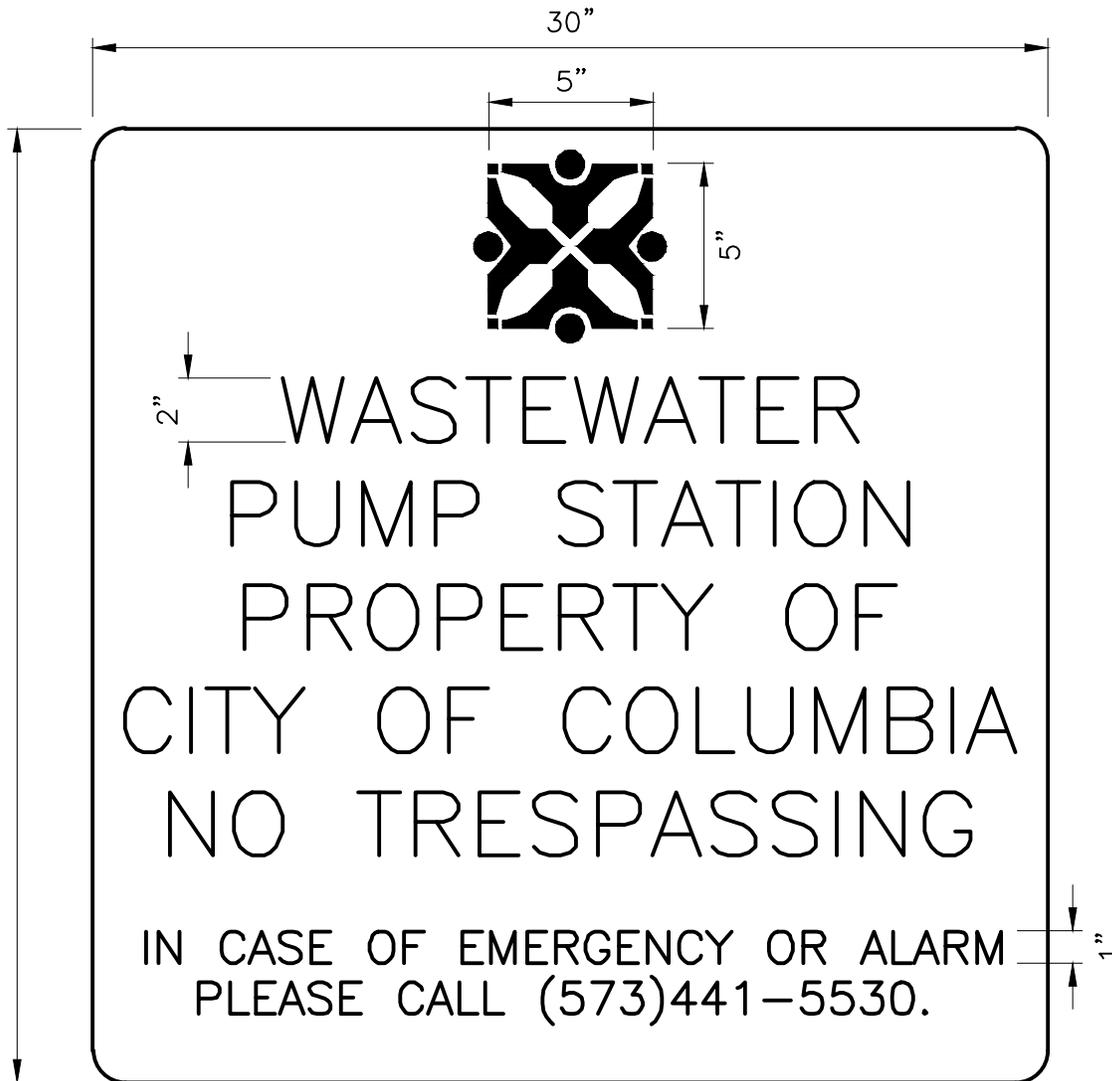
METHOD OF FASTENING STRETCHER BAR TO POST



METHOD OF TYING FABRIC TO TENSION WIRES

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Date	
Revisions	





BLOCK LETTERS ON WHITE BACKGROUND
SIGN PANEL SHALL BE STANDARD GAUGE ALUMINUM SHEETS
SIGN SHALL BE FIELD LOCATED

_____	1/01/18
Approved	Date
Revisions	



SIGN

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