SANITARY SEWER ENGINEERING STANDARDS AND SPECIFICATIONS

Castle Pines North
METROPOLITAN DISTRICT

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7404 Yorkshire Drive
Castle Pines, CO 80108
Phone: 303-688-8550

Prepared By:
Kennedy/Jenks Consultants, Inc.
143 Union Boulevard, Suite 600
Lakewood, CO 80228
Phone: 303-985-3636

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SANITARY SEWER SYSTEM STANDARDS AND SPECIFICATIONS

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1. PURPOSE AND GENERAL REQUIREMENTS

1.1 Purpose

These Standards provide information to all those interested in the requirements of the design and construction of sanitary sewer systems within the Castle Pines North Metropolitan District (District). These Standards present technical specifications for the design and installation of sanitary sewers and should be used in conjunction with the District Rules and Regulations by any firm or individual planning design or construction of sanitary sewer systems within the District. In all cases in these specifications where reference is made to "District Engineer" or "Engineer", the "District Engineer" or "Engineer" shall mean any representative of the Consulting Engineer firm or other individual designated by the District to provide construction observation of the sewer system construction.

1.2 General Requirements

1.2.1 All plans for sanitary sewer main extensions, improvements, and changes shall be submitted to the District Manager. All plans must be reviewed by the District Manager and the District Engineer.

(a) All plans to be reviewed must be accompanied by four (4) sets of the standard District "Application for Main Line Extension". These shall be processed by the Owner/Developer and presented to the District Manager prior to plan approval. When construction has been completed and accepted by the District, the applications shall be dated and signed by the District Manager and approved by the District Engineer. The probationary acceptance and warranty period shall begin at that time.

No taps will be allowed, nor "Connection Permits" issued, until sanitary sewer main construction has been accepted by the District and all applicable fees have been paid.

(b) Plans to be reviewed must be accompanied by one (1) copy of the AutoCAD files, version 2011 or older.

(c) Plans to be reviewed must be accompanied by three (3) sets of the recorded plat(s). One copy shall be retained by the District Manager, one copy delivered to the District Engineer, and one copy delivered to the District Attorney.

(d) If any sewer main is to be constructed outside of a public right-of-way, the construction plans must be accompanied by a request for acceptance of sewer easements in accordance with Section 15 of these specifications.

1.2.2 A preconstruction meeting must be arranged by the Contractor and held prior to the start of any work. The District Engineer, District Manager, Contractor, the Owner or Owner's Engineer, Owner's Surveyor, Owner's Soils Consultant, and County and/or City representatives shall be represented at this meeting. The meeting shall be held at the District office at 7404 Yorkshire Drive or at such place at the District Manager shall direct.

1.2.3 All Contractors must notify the District Engineer and District Manager at least 48 hours prior to the start of construction.

1.2.4 Approved plans and a copy of these specifications must be kept on the job site by the Contractor at all times.

1.2.5 No work shall be backfilled (including bedding material above the spring line of the pipe) until construction has been reviewed by the District Engineer.

1.3 Special Requirements

The requirements listed below are unique to the District and must be strictly followed. No exceptions will be allowed.

1.3.1 Installation in Rock – The District contains areas with rock that cannot be excavated using traditional methods. At the District's discretion, additional requirements may be implemented for the installation of sanitary sewer mains in these areas.

1.3.2 Easements – All easements for sanitary sewer mains must be a minimum of 30-feet in width and follow the standards in Section 15.

1.3.3 Underdrains – Underdrains are allowed in sanitary sewer pipe trenches, but they must be installed per District detail drawing 3S, and they must be drained to storm sewer facilities. Underdrains may not enter sanitary sewer manholes or pipes at any point. The District does not inspect, maintain, or assume ownership of any underdrains.

1.3.4 Installation at depths greater than 15 feet or in unpaved R.O.W. or easements – Bedding shall be ¾-inch crushed rock in lieu of squeegee or sand. Pipe shall be AWWA C900 DR14 PVC or AWWA C905 DR18 PVC in lieu of ASTM SDR 35 PVC.

1.3.5 Swimming Pools – The District will review swimming pool designs on a case-by-case basis, specifically how each pool is connected to the District's water and sanitary sewer system. In general, the engineer is to provide documentation for how the pool will be drained for maintenance. The procedure for draining the pool will most likely include a surge tank and/or restrictor plate to limit the flows to Plum Creek Water Reclamation Authority (PCWRA). The plan for draining the pool will need to be submitted to PCWRA for review and approval.

2. LOCATION OF SANITARY SEWER LINES

2.1 Sewers in Streets

2.1.1 When the sewers are placed in streets, they shall generally be placed as follows:

- On streets running north and south, the sewer line shall be placed 10’ (ten feet) west of the centerline of the street.
- On streets running east and west, the sewer line shall be placed 10’ (ten feet) south of the centerline of the street.
- On streets shaped as a “U” or on streets having unusually sharp turns, the sewer line will conform to the above specifications as near as is practical, but the final location shall be as determined by the Engineer or his representatives. Curvelinear sewer mains shall not be allowed without prior approval by the District Engineer. Designs must attempt to minimize the use of manholes.
- In no case shall the sewer line be installed closer than 3’0” to the lip of the pan or gutter.
- A minimum horizontal distance of 10’ (ten feet) shall be maintained between sanitary sewer mains and potable water mains.
- A minimum vertical distance of 18” (eighteen inches) shall be maintained at utility crossings between sanitary sewer and other utilities.

2.2 Sewers in Easements

2.2.1 When sanitary sewer mains are placed in easements, they shall be placed per the standards in Section 15. Concrete collars and steel marker posts (per District detail drawing 15S) must be installed on all valve boxes and manhole ring and covers located within easement areas.

2.3 Sewer Services

2.3.1 Services shall be located a minimum of 5-feet from property lines.

2.3.2 Sewer services and underdrain shall be located on the down-hill side from water services.

2.3.3 Sewer services and underdrain shall be located a minimum of 10-feet horizontally from water services.

2.3.4 All sewer service line locations shall have an “X” chiseled in the curb where curbs are present.

2.3.5 Variations from these standards must be approved by the District Engineer prior to plan approval.

3. DESIGN CRITERIA

3.1 Flow Development Criteria

3.1.1 Sanitary sewer lines shall be designed to transport average and peak sewage flows. Average and peak flow development criteria presented in the following section are minimum criteria. Castle Pines North Metropolitan District reserves the right to modify flow criteria, at any time, for the design of specific projects. Flow development criteria for proposed uses not covered in this section shall be determined by the District on a case by case basis.

3.1.2 Definitions: SFE is a "Single Family Equivalent"; ADF is "Average Daily Flow"; Q_{avg} is "Average Flow"; PF is "Peak Factor"; Q_{peak} is "Peak Flow"; I/I is "Inflow and Infiltration".

3.1.3 The tabulation below provides the Average Daily Flow (ADF) rates that shall be applied to compute the wastewater flows associated with the various types of land use within the development.

TABLE 3.1

Sanitary Sewer System – Average Daily Flow (ADF)

Land Use	Typical ADF/Unit	Typical SFEs/Unit
Single Family Residential and Duplexes	200 gpd/dwelling unit	1.00/dwelling unit
Multi-Family Residential (Townhomes and Condos)	150 gpd/dwelling unit	0.75/dwelling unit
Retail/Offices	0.1 gpd/SF	0.0005/SF
Hotels/Motels	75 gpd/room	0.375/room
Restaurants	1.5 gpd/SF	0.0075/SF
Car Washes	5,000 gpd/acre	25.0/acre
Industrial/Other Commercial	600 gpd/acre	3.0/acre
Churches (with day care or preschool)	600 gpd/church	3.0/church
Irrigated Land	0 gpd/acre	0.0/acre
Rates for Typical Douglas County School Sizes:		
Elementary (10 ac, 675 students)	3,375 gpd/school	16.88/school
Middle (25 ac, 850 students)	8,500 gpd/school	42.50/school
High (50 ac, 1700 students)	17,000 gpd/school	85.00/school

3.1.1 Peak sanitary sewer flows shall be calculated as follows:

Equation 3.1: Q_{avg} = ADF x SFEs

Equation 3.2: Q_{peak} = (Q_{avg} x PF) + I/I

Equation 3.3: $PF = 3.65/(Q_{avg})^{0.168}$ Maximum PF = 5.0
Q_{avg} in MGD

Equation 3.4: I/I = 10% of Q_{avg}

3.2 Hydraulic Design

3.2.1 No public sewer shall be smaller than 8" (eight inches) in diameter. Lines shall be designed to provide peak flow velocities between two feet per second (2 fps) minimum and ten feet per second (10 fps) maximum using Manning's Formula.

3.2.2 For lines without services: The maximum design flow depth at peak flow shall not exceed seventy-five percent (75%) of the internal pipe diameter.

3.2.3 For lines with services: The maximum design flow depth at peak flow shall not exceed fifty percent (50%) of the internal pipe diameter.

3.2.4 Hydraulic characteristics shall be calculated for each reach of the sanitary sewer system to show conformance with these Specifications. Table 3.2 outlines minimum and generally acceptable maximum slopes for sanitary sewer lines.

TABLE 3.2

Nominal Pipe Diameter (Inches)	Minimum Slope Feet per Hundred	Maximum Slope Feet Per Hundred (at d/D = 0.80)
4	2.0	20.0
6	1.0	12.0
8	0.50	10.0
10	0.35	6.0
12	0.25	4.0
15	0.20	3.0
18	0.20	2.0

3.2.5 The minimum slopes indicated in Table 3.2 are absolute minimums.

3.2.6 Where it is necessary to design or install sewers with greater slope than the maximum indicated in Table 3.2, special provisions shall be made to protect against pipe displacement and erosion. Prior approval must be obtained from the District Engineer in any case involving such slopes. Larger sizes require approval of the District Engineer.

3.2.7 All dead-end sanitary sewer lines shall have a minimum slope of one percent (1%).

3.2.8 A design report shall be submitted which shows average flows, peak flows, and other pertinent information at all changes in sewer size and points of connection to the existing sanitary sewer system as follows:

TABLE 3.3 – Design Report Criteria

Symbol	Description
Q_{peak}	Peak Sanitary Sewer Flow (ft^3/sec)
Q_{avg}	Average Sanitary Sewer Flow (ft^3/sec)
V_{peak}	Peak Flow Velocity (ft/sec)
V_{avg}	Average Flow Velocity (ft/sec)
d_{peak}	Peak Flow Depth in Line (inches)
d_{avg}	Average Flow Depth in Line (inches)
d/D_{peak}	Ratio of Peak Flow Depth to Inside Pipe Diameter
S	Slope of Sanitary Sewer Line (ft/100 ft)
n	Manning's "n" = 0.011 for PVC
PF	Peak Factor per Equation 3.3
Development	Number and type of total planned units tributary to the point of connection

3.2.9 Sanitary sewer system layout shall provide a system of lines which generally increase in diameter from higher to lower areas within the basin. Once a line size is increased at any point in the system, it shall not be reduced in size at any downstream location, regardless of available line slope.

3.3 Lift Stations and Force Mains

3.3.1 Lift stations and force mains shall be avoided.

3.3.2 If required, lift stations and force mains shall be designed by a registered professional engineer and design information, including construction plans, shall be submitted for approval by the District.

3.3.3 Design parameters for lift stations and force mains shall be prepared in conjunction with the District if the facilities are to be turned over to the District for operation and maintenance.

4. SANITARY SEWER PIPE

The pipe for sanitary sewer mains installed at depths equal to or less than 15-feet and installed in paved R.O.W. shall be ASTM SDR 35 PVC. The pipe for sanitary sewer mains installed at depths greater than 15-feet or installed in unpaved R.O.W. or easements shall be AWWA C900 DR14 PVC (6" through 12") or AWWA C905 DR18 PVC (14" through 24"). The pipe for force mains shall be AWWA C900 DR14 PVC.

4.1 **Concrete Pipe** – Concrete pipe will not be allowed for sanitary sewer mains.

4.2 **Ductile Iron Pipe** – Ductile Iron Pipe will not be allowed for sanitary sewer mains.

4.3 **SDR 35 PVC (Polyvinyl Chloride) Pipe**

4.3.1 ASTM D3034, SDR 35 Type PSM, Ploy (Vinyl Chloride) (PVC) material; inside nominal diameters 4-inches through 15-inches, bell and spigot style rubber ring sealed gasket joint.

(a) Fittings: ASTM D3034, PVC.
(b) Joints: ASTM F477, elastomeric gaskets.

4.3.2 ASTM F679, Poly (Vinyl Chloride) (PVC) material; inside nominal diameters 18-inches through 48-inches, T-1 or T-2 wall, bell and spigot style rubber ring sealed gasket joint.

(a) Fittings: ASTM F679, PVC.
(b) Joints: ASTM F477, elastomeric gaskets.

4.4 **C900 PVC (Polyvinyl Chloride) Pipe**

4.4.1 AWWA C900 DR14 Poly Vinyl Chloride (PVC) material; inside nominal diameters 4-inches through 12-inches, bell and spigot style rubber ring sealed gasket joint.

(a) Fittings: AWWA C907, PVC.
(b) Joints: ASTM D3139, compression gasket ring.

4.4.2 AWWA C905 DR18 Poly Vinyl Chloride (PVC) material; inside nominal diameters 14-inches through 48-inches, bell and spigot style rubber ring sealed gasket joint.

(a) Fittings: AWWA C907, PVC.
(b) Joints: ASTM D3139, compression gasket ring.

4.5 **Straightness** – Maximum allowable ordinate as measured from the concave side of the pipe shall not exceed 1/16" per foot of length.

4.6 **Internal Diameter** – Pipe shall be so constructed that the initial internal vertical diameter does not decrease by more than five percent (5%) in order to provide the complete hydraulic carrying capacity conceived by the Design Engineer. Refer to Section 11, "Testing and Review" for deflection testing and lamping procedures.

4.7 Pipe Installation and Field Testing

4.7.1 Pipe shall be installed in full compliance with the recommended practice for "Underground Installation of Flexible Thermoplastic Sewer Pipe" ASTM D-2321 and in accordance with the provisions of Section 9 of these Specifications.

4.7.2 Testing shall be conducted as detailed in Section 11, "Testing and Review".

4.8 Bedding and Backfill Materials

4.8.1 Bedding: Well-Graded Sand or Squeegee (Class A bedding) shall be used for sanitary sewer lines installed at depths equal to or less than 15-feet and installed in paved R.O.W. as specified in Section 8 - Trenching, Bedding and Backfill.

4.8.2 Bedding: 3/4-inch Crushed Rock (Class B bedding) shall be used for sanitary sewer lines installed at depths greater than 15-feet or installed in unpaved R.O.W. or easements as specified in Section 8 - Trenching, Bedding and Backfill. Install Geotextile Fabric over rock bedding prior to backfill.

4.8.3 Backfill: As specified in Section 8 - Trenching, Bedding and Backfill.

4.9 Connection Joint

The connecting joint shall be full circumference compression coupling and shall conform to the requirements outlined in ASTM C-594 for chemistry, weight and permissible variations in dimensions. This joint shall be used when connecting two different pipe materials or as a sewer line repair clamp.

4.9.1 Shear Ring – All couplings shall have an adjustable stainless steel shear ring.

4.9.2 Bushings – Bushings shall be used as required when changing pipe materials. The bushing shall be made of the same material as the compression coupling.

4.10 Underdrain

When an underdrain system is recommended by the project's Geotechnical Engineer, the use of the sanitary sewer trench for a pipe/gravel underdrain system is permitted.

Foundation perimeter pipe is prohibited from connecting to a service pipe or main line pipe and a positive method shall be used to prevent water, collected in foundation perimeter drains, from flowing through the service line trench to the sanitary sewer trench.

Sump pumps and foundation perimeter drains are prohibited from connecting directly or indirectly as through a floor drain, or any other means, to the sanitary sewer line.

5. MANHOLES

5.1 General

5.1.1 Manholes shall be designed to promote smooth, continuous flow between adjacent reaches of sanitary sewer lines.

5.1.2 Minimum inside drop from the upstream invert to the downstream invert shall be 0.2-feet.

5.1.3 Maximum inside drop from upstream invert to downstream invert shall be 12-inches.

5.1.4 Where manholes are designed to collect flows from two or more incoming lines, the design "in" inverts shall be set to keep the largest incoming line (i.e. line contributing the largest flow) lower in the manhole than the other incoming lines. The other, generally smaller incoming line(s) shall enter the manhole a minimum of 0.1-foot higher than the invert of the largest line.

5.1.5 Where new sewer lines are proposed to connect to the District's interceptor lines (i.e. lines 15-inches in diameter or greater), the crown of the incoming line shall match the crown of the interceptor.

5.1.6 All manholes shall be a minimum of 48-inches in diameter and shall be installed at the end of each sewer line, at all changes in grade, size or alignment and at all intersections.

5.1.7 Manholes shall be installed at distances not greater than 400-feet for sewers 15" inside diameter and less, and 500-feet for sewers 18" to 30" inside diameter. Longer spacing may be permitted, with prior approval of the District Engineer, in sewer lines of larger diameter.

5.1.8 Sanitary sewer lines shall be designed so the minimum angle between any upstream line and the downstream line is ninety degrees (90°).

5.2 Precast Concrete Manholes - Designed in accordance with ASTM C478.

5.2.1 Barrel Sections – shall be constructed of precast concrete. All concrete shall be mixed using Type II cement.

5.2.2 Base – The base on all manholes shall be a minimum of 8" thick, and the overall outside dimensions shall be one foot (1') greater than the outside dimensions of the manhole constructed thereon. The base shall be constructed of Class A concrete per Section 5.5. The Contractor shall be responsible for taking and testing cylinders of requested by the District Engineer.

Base reinforcing steel shall be in accordance with the details on the District drawing "Precast Manhole".

Precast base sections are permitted, however, precast inverts are NOT permitted. Inverts shall have semicircular bottom conforming to the inside contour of the adjacent sewer sections.

5.2.3 Transition Sections – Precast eccentric cones. Concentric cones not allowed. Alternate flat top sections permitted with District approval only.

5.2.4 Riser Section – Precast riser rings only. Adjust to final grade with a minimum 3-inches to a maximum 12-inches vertical distance.

5.2.5 Grout – Non-metallic, Non-shrink grout consisting of Portland cement, sand and admixtures required to meet project conditions. Apply in accordance with the District detail drawing "Precast Manhole".

5.2.6 Loading – AASHTO H-20.

5.2.7 Dimensions – Provide manhole sections with the following dimensions:

Pipe Diameter	Manhole Diameter (I.D.)
4" to 18"	4'-0"▲
21" to 48"	5'-0"
54"	6'-0"

▲Whenever more than a two-way manhole of maximum pipe I.D. is required, the manhole must be increased to next largest diameter. (i.e. 18" x 18" x 18", requires 5'-0" I.D. manhole)

5.2.8 Premolded Joint Compound:

(a) A flexible plastic joint sealing compound shall be used on the tongue and groove between each manhole section to provide a watertight joint.
(b) Acceptable Manufacturers

1. Ramnek
2. Rubbernek
3. Conseal

5.2.9 Waterstop Gasket – Provide waterstop gasket in accordance with ASTM C443 cast integrally in manhole wall at pipe penetration locations.

5.2.10 Coatings (new manholes)

(a) Exterior Coatings: Required in High Groundwater Areas.

i. Exterior of manhole structures shall be coated with a waterproof bituminous membrane, or equal.
ii. The membrane shall be applied after the outside and inside of the joints are grouted.
iii. The Contractor shall submit material specifications for the exterior coating to the District for review prior to construction.
iv. The exterior coating shall be applied per manufacturer's recommendations.

(b) Interior Coatings: Required on entire interior manhole area for drop manholes and outfall manholes.

i. Acceptable Products: Strong-Seal, Kerneos Sewpercoat

ii. See Section 5.8 for more information and for manhole rehabilitation.

5.2.11 Intermediate platforms – required on all manholes 20-feet and deeper.

5.2.12 Flat Top Transition Section – shall only be installed with prior approval by the District.

5.3 Manhole Steps

5.3.1 Plastic steps shall be firmly embedded in the walls of all manholes. Copolymer Polypropylene plastic manhole step with ½-inch grade 60 steel reinforcement only.

5.3.2 Maximum distance from ground surface to first step is 20-inches. Remaining steps are 12-inches apart on center.

5.3.3 Dimensions – Minimum width: 14-inches; Minimum cross section: 0.875-inches of solid material.

5.3.4 Install step a minimum of 3 3/8-inches in a preformed hole or cast-in-place as part of the manhole section.

5.3.5 Acceptable Manufacturers: M.A. Industries, Model PS-2-PF

5.3.6 Refer to District detail drawings 4S and 6S for more specific details.

5.4 Frames and Covers

5.4.1 Frames and Covers shall be cast iron in accordance with ASTM A48, Class 35, unless otherwise specified herein.

5.4.2 Dimensions: Provide frames and covers with the following dimensions or as indicated on the approved construction drawings.

Manhole Diameter (I.D.)	Frame and Cover
4'-0"	24"
5'-0"	30"
6'-0"	30" / 24" x 36" frame and cover

5.4.3 24-inch standard Frame and Cover: Weight: 400 pounds

(a) Acceptable Manufacturer's

i.	Neenah Foundry	Model R-1706
ii.	D&L Supply	Model A-1161
iii.	Construction Castings	Model J-1161

5.4.4 30-inch standard Frame and Cover: Weight: 600 pounds

(a) Acceptable Manufacturer's

i.	Neenah Foundry	Model R-1798
ii.	D&L Supply	Model A-1361
iii.	Construction Castings	Model J-1361

5.4.5 24-inch Locking Frame and Cover: Weight: 450 pounds

(a) Acceptable Manufacturer's

i.	Neenah Foundry	Model R-1916-F
ii.	D&L Supply	Model A-1925
iii.	Construction Castings	Model J-1925

5.4.6 24 x 36-inch Double Frame and Cover: Weight: 655 pounds

(a) Acceptable Manufacturer's

i.	Neenah Foundry	Model R-1740-D2
ii.	D&L Supply	Model A-1425
iii.	Construction Castings	Model J-1425
iv.	Deeter Foundry	Model 1191

5.4.7 Cover Pattern – City of Denver, Colorado Standard.

5.4.8 Lettering – Cover marked SEWER with 1 1/8-inch letters, raised 1/8-inch for all sanitary sewer manholes.

5.4.9 Lifting notch shall be ¾-inch in length.

5.4.10 All bearing surfaces shall be machined.

5.4.11 Elevation

(a) Pavement – Set and adjust ring and cover to match finished pavement grade elevation or per City / County / State requirements.
(b) Unimproved areas – Set and adjust ring and cover to 6-inches above finished grade. Install concrete collar around the ring and cover and marker post per District detail 16S and Section 5.5 of these specifications.

5.5 Cast-In-Place Concrete for Manholes

5.5.1 Quality Assurance

(a) Perform Work in accordance with ACI 301.
(b) Acquire cement and aggregate from one source for Work.
(c) Conform to ACI 305 when concreting during hot weather.
(d) Conform to ACI 306.1 when concreting during cold weather.

5.5.2 Concrete Materials

(a) Cement – All Cement used shall be Type II Portland cement conforming to the requirements of ASTM C150.

(b) Aggregates

i. Fine Aggregates: Fine aggregates shall consist of natural sand or a blend of natural sand and crushed sand provided the quantity of crushed sand is not more than 50% of the total sand by dry weight.
ii. Coarse Aggregates: Coarse aggregates shall consist of gravel or crushed stone and shall conform to the grading and quality requirements of ASTM

C33 for Size No. 467, No. 57, or No. 67. Nominal maximum size of coarse aggregate shall comply with ACI 318.

iii. If the aggregates used are known to be reactive with high alkali cement, as determined by ASTM C295, or if the reactivity of the aggregate is not known, the use of low alkali cement is required to assure adequate protection from alkali aggregate reaction.

(c) Water – The batch mixing water and mixer washout water shall conform to the requirements of ASTM C94.

5.5.3 Admixtures

(a) Air Entrainment – An air-entraining agent shall be used in all concrete. The agent used shall be in accordance with ASTM C260 and shall be added to the batch in accordance with ASTM C94.

(b) Chemical – Chemical admixtures that do not contain calcium chloride and that conform to ASTM C494 for concrete may be used. All chemical admixtures shall be compatible with the cement and all other admixtures in the batch.

(c) Fly Ash – Fly ash may be used in the concrete mixes. Additions to the mix will be on a cement substitution basis. The fly ash shall conform to ASTM C618. Fly Ash content shall not exceed 20% by weight.

5.5.4 Concrete Proportions

(a) Class A Concrete (4,000 psi)

i. Class A concrete shall be molded and cured in compliance with ASTM C31.

ii. Class A concrete shall be used for structural concrete including manhole bases and inverts, and pipeline encasements.

iii. Class A concrete shall conform to the following requirements:

Unit	Measurement
Compressive Strength (28 day)	4,000 psi
Water/Cement Ratio	0.50 by weight (maximum)
Air Entrained	4 to 7percent
Slump -	2 inches (minimum) 4 inches (maximum)

(b) Class B Concrete (2,500 psi)

i. Class B concrete shall be molded and cured in compliance with ASTM C31.

ii. Class B concrete shall be used exclusively for abandoning manholes and sewer lines per Section 9 of these specifications and for concrete collars and marker posts in unpaved easements.

iii. Class B concrete shall conform to the following requirements:

Unit	Measurement
Compressive Strength (28 day)	2,500 psi
Water/Cement Ratio	0.63 by weight (maximum)
Air Entrained	4 to 7percent
Slump -	2 inches (minimum) 4 inches (maximum)

5.5.5 Concrete Reinforcement

(a) All deformed reinforcing bars shall conform to ASTM A615, Grade 40 or 60.

(b) All welded steel wire fabric shall conform to ASTM A185 except that the weld shear strength requirement shall be extended to include a wire size differential up to and including six gages.

5.5.6 Preparation – All equipment used in mixing and transporting concrete shall be clean. All debris, water or ice shall be removed from places to be occupied by the concrete.

5.5.7 Formwork

(a) Forms shall produce shapes, lines and dimensions of the concrete structures as shown on the District detail drawings.
(b) Forms shall be made of wood, metal or other acceptable material. The forms shall produce a smooth concrete finish to the tolerances described in ACI 301.
(c) Forms shall be mortar tight and braced or tied to maintain its proper position and shape during and after concrete placement. Embedded metal ties with snap-off ends shall be used for internal form ties. Ordinary wire ties will not be allowed.
(d) The District Engineer, prior to pouring concrete, shall review forms.
(e) Forms shall be removed in a manner that will insure the integrity of the structure and its surfaces.

5.5.8 Placing Concrete

(a) Place concrete in accordance with ACI 301.
(b) Notify Engineer minimum 24 hours prior to commencement of concrete operations.
(c) Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.

5.5.9 Concrete Finishing – Concrete surface finishing for manhole benches shall be a brushed non-skid surface in accordance with ACI 301. Manhole inverts shall have a smooth, trowel finish.

5.5.10 Curing and Protection

(a) Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

(b) Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

5.6 Drop Manholes

5.6.1 Drop manhole bases shall be constructed large enough to form a base for the concrete encasing the sewer pipe drop entering the bottom of the manhole. The drop entering the manhole shall be completely encased in concrete up to the spring line of the pipe of the main sewer line.

5.6.2 All manholes in which the drop is 12-inches or greater must be constructed with an outside drop. The maximum amount of vertical drop allowable in a drop manhole shall be 10 feet.

5.6.3 A cleanout must be placed in the manhole at the level of the main sewer line.

5.6.4 All drop manholes shall be constructed in accordance with District details 18S and 19S. Inside drops may be allowed with prior approval by the District. Refer to District details 30S – 32S.

5.6.5 All drop manholes must be completely lined in accordance with Section 5.8.

5.7 Service Connection to Manholes

In general, sewer service lines will not be allowed to connect to manholes. Certain exceptions, however, may be made by the District. One service line will be allowed to connect to a manhole located on the end of a sewer main in a cul-de-sac. The service line must be installed prior to placing the manhole base. No sewer service shall connect to the main line closer than 5' to the uphill manhole. Refer to District detail drawing 11S.

5.8 Manhole Rehabilitation and Lining

5.8.1 Liner Material:

(a) Acceptable Liner Systems

i. Strong-Seal Liner System: Strong-Seal High Performance Mix. Fiber-reinforced, spray-applied, cementitious mortar.
ii. Kerneos Sewpercoat
iii. SprayWall by SprayRoq
iv. Sewer Shield Composite Liner System by Environmental Coatings, C-120 Calcium Aluminate Cement with Sewer Shield 100 Novolac Epoxy Coating
v. Warren Environmental Composite Liner System, Strong-Seal Profile Mix with Warren Environmental S301 Epoxy Coating
vi. Mainstay Composite Liner System by Madewell, ML-72 Cement Mortar with DS-6 Epoxy Coating

5.8.2 Patching Material:

(a) Rapid-setting, fiber-reinforced, high-early-strength, corrosion-resistant, hand-mixed and hand-applied, calcium aluminate based cementitious material.

(b) Acceptable Manufacturers: Strong-Seal Systems Corporation, Strong-Seal QSR.

5.8.3 Infiltration Control Material:

(a) Rapid-setting, high-early-strength, hand-applied, cementitious material.

(b) Acceptable Manufacturers: Strong-Seal Systems Corporation, Strong-Seal Strong-Plug.

5.8.4 Cementitious Grout: Cementitious grout, volume stable.

(a) Minimum Compressive Strength, ASTM C 109: 250 psi at 28 days.

5.8.5 Water: Clean and potable. Test nonpotable water in accordance with ASTM C 94.

5.8.6 Surface Preparation: Per manufacturer's recommendations.

5.8.7 Invert Repair: Using patching material per manufacturer's recommendations.

5.8.8 Manhole Liner Installation: Apply liner material in accordance with manufacturer's instructions. Do not apply liner material to the manhole rim nor to the seam between the riser sections and the rim.

5.8.9 **Application to Existing Concrete Manholes:**

(a) Install liner material per manufacturer's instructions for a *structural* application.

i. Pure Calcium Aluminate Products (Strong-Seal and Sewpercoat): Apply approved pure calcium aluminate cement to a minimum thickness of 1-inch (above original profile build back).

ii. Composite Liner System: Apply approved calcium aluminate cement to a minimum thickness of 1-inch (above original profile build back). Apply approved epoxy or polyurethane coating to a minimum thickness of 125 mils.

iii. Stand-alone Epoxy or Polyurethane System: Apply approved epoxy or polyurethane to a minimum thickness of 250 mils.

5.8.10 **Application to New Precast Concrete Manholes:**

(a) Install liner material per manufacturer's instructions for a *non-structural* application (corrosion protection only).

i. Pure Calcium Aluminate Products (Strong-Seal and Sewpercoat): Apply approved pure calcium aluminate product to a minimum thickness of 1-inch.

ii. Epoxy or polyurethane: Apply approved epoxy or polyurethane to a minimum thickness of 125 mils.

5.8.11 **Thickness of Liner Materials**

(a) During application of liner materials, applicator shall perform wet gauge testing at periodic intervals, minimum of one test every vertical and horizontal foot in accordance with ASTM D4414. Owner's representative may also perform wet gauge testing at their discretion. Add material as necessary.

(b) During application, Contractor shall verify thickness of liner materials using application rate and material used.

5.8.12 Curing: Cure materials in accordance with manufacturer's instructions.

5.8.13 Field Quality Control

(a) Leaks: Visually verify absence of leaks.

(b) Exfiltration Test: Perform exfiltration test.

i. Manholes Maximum of 6 Feet Deep: Manhole rehabilitation is acceptable if water loss is maximum of 1 inch in five minutes.
ii. Manholes Over 6 Feet Deep: Manhole rehabilitation is acceptable if water loss is maximum of 1 inch plus 1/8 inch for each additional foot of depth in five minutes.

(c) Vacuum Test: Perform vacuum test in accordance with ASTM C 1244-93. Vacuum test shall not be performed earlier than 7 days after application.

(d) Epoxy or Polyurethane Coatings:

i. Perform Holiday Test per ASTM G62-87 (rev. 1998) on 100% of the liner surface. Contractor shall perform holiday test prior to restoration of service with test equipment appropriate for liner material. Voltage to be set at a minimum of 100 volts per mil of liner thickness (i.e. 12,500 volts for 125 mils). After identification of pinholes, thin areas, and other imperfections, re-apply liner material and make repairs to liner material per manufacturer's instructions. Retest. Repeat until no holidays are identified.
ii. Adhesion Testing: A minimum of 10% of the manholes coated shall be tested for adhesion/bond of the coating to the substrate. Testing shall be conducted in accordance with ASTM D4541 as modified herein. Engineer shall select the manholes to be tested. A minimum of three (3) 20 mm dollies shall be affixed to the coated surface at the cone area, mid section, and at the bottom of the structure. The adhesive used to attach the dollies to the coating shall be rapid setting with tensile strengths in excess of the coating product and permitted to cure in accordance with manufacturer recommendations. The coating and dollies shall be adequately prepared to receive the adhesive. Failure of the dolly adhesive shall be deemed a not-test and require retesting. Prior to performing the pull test, the coating shall be scored to within 30 mils of the substrate by mechanical means without disturbing the dolly or bond within the test area. Two (2) of the three (3) adhesion pulls shall exceed 200 psi or concrete failure with more than 50% of the subsurface adhered to the coating. Should a structure fail to achieve two (2) successful pulls as described above, additional testing shall be performed at the discretion of the Engineer. Any areas detected to have

inadequate bond strength shall be evaluated by the Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by the Contractor.

5.8.14 Protection

(a) Do not allow traffic for a minimum of 24 hours after final application of liner material or as recommended by the manufacturer.

6. CLEANOUTS

Cleanouts on public sewer lines will not be permitted. Cleanouts may be installed on private sewer services per the local plumbing code under the following guidelines: (See Drawing 14S)

6.1 At all change in direction requiring horizontal or vertical bends.

6.2 Not more than 100’ of continuous sewer line shall be installed without at least one cleanout.

6.3 Cleanouts shall be located such that all portions of the line can be cleaned by rodding and jetting.

7. ENCASEMENT AND CASINGS

7.1 Concrete Encasements

Concrete encasements shall be installed with prior approval by the District Engineer under the following conditions:

7.1.1 Where sewer lines are at a depth too shallow to sustain traffic load or any other load to which they are subjected.

7.1.2 At all locations where infiltration is likely to be high.

7.1.3 At locations where horizontal movement of the sewer mains may be experienced, i.e., in streambeds with less than 5' of cover.

7.1.4 At potable water supply crossings where 18" vertical clearance is not achieved. Refer to Section 10 of these specifications.

7.1.5 At any location designated by the District.

7.1.6 At any other locations as considered necessary by the Design Engineer.

All concrete encasements shall use Class A concrete per Section 5 and shall be reinforced in accordance with the details in District detail drawing 23S, "Concrete Encasement". All concrete encasements shall be of a length to completely span the condition encountered or as directed by the District. Unless so designed, encasements are for the purpose of pipeline protection and are not to be considered a structural beam. Therefore, special attention to a good foundation and compaction effort for the encasement must be provided.

7.2 Pipe Casings

Pipe casings shall be used where bores are required under special rights-of-way by the approving agency. All pipe casings shall be constructed to conform with District detail drawings 24S and 25S, the Colorado Highway Department Standards, and the requirements of any other governing agency.

8. TRENCHING, BEDDING, AND BACKFILL

8.1 Trenching

8.1.1 General

(a) Excavation for pipelines, fittings, and appurtenance shall be open trench to the depth and in the direction necessary for the proper installation of the same as shown on the approved District detail drawings or as otherwise approved by the District Engineer.

(b) Any water which may be encountered or may accumulate in the excavation shall be pumped out or otherwise removed as necessary to keep the bottom of the excavation free and clear of water during the progress of the work. Refer to Section 8.2.9, Dewatering.

(c) Grading and Stockpiling – The Contractor shall control grading in a manner to prevent water from running into excavations. Obstruction of surface drainage shall be avoided and means shall be provided whereby storm and wastewater can be uninterrupted in existing gutters, other surface drains or temporary drains.

8.1.2 Procedure

(a) All existing asphalt or concrete surfacing shall be saw cut vertically in a straight line, and removed from the jobsite prior to starting the trench excavation. This material shall not be used in any fill or backfill.

(b) Remove lumped subsoil and rock up to ½ cu yd, measured by volume. Remove larger material and dispose.

(c) Do not advance open trench more than 400 feet ahead of installed pipe. The trench shall not be backfilled until the Engineer reviews the pipe and bedding installation.

(d) Trench width shall not be more than 16-inches nor less than 12-inches wider than the outside diameter of the pipe for proper placement and densification of the bedding and backfill material and assembly of pipe and appurtenances.

(e) Excavate trenches to depth indicated on District detail drawings. Provide uniform and continuous bearing and support for bedding material and pipe.

(f) Provide trench stabilization and support per applicable regulations.

(g) Trim excavation. Hand trim for bell and spigot pipe joints to provide continuous support of pipe in trench. Remove loose matter. Do not rest pipe on bells.

(h) Excavated material shall not be placed closer than 2-feet from the top edge of the trench. Heavy equipment should not be used, or placed, near the sides of the trench unless the trench is adequately braced.

(i) Surplus Excavation Material: All surplus excavation shall be removed from the jobsite and disposed of properly. If the surplus excavation is disposed of on

private property, written permission shall be obtained from the property owner and a copy given to the District Engineer.

8.1.3 Safety Precautions

(a) All excavations shall be performed, protected and supported as required for safety and in the manner set forth in the operation rules, orders and regulations.

(b) Prepare excavation protection plan (for 20 foot cuts and deeper) under direct supervision of Professional Engineer experienced in design of this Work and licensed in the State of Colorado.

(c) Bracing Excavations

i. All excavations shall be properly supported in the manner as required by Occupational Safety and Health Administration or as required by State laws and Municipal ordinances and as may be necessary to protect life, property or the work.
ii. Excavations shall be so braced, sheeted and supported that they will be safe, and the ground alongside the excavation will not slide or settle. Excavation shall be so braced or sheeted so as to provide conditions under which workmen ay work safely and efficiently at all times.
iii. The sheeting, shoring and bracing shall be so arranged as not to place any stress on portions of the completed work until the general construction thereof has proceeded far enough to provide ample strength.
iv. Care shall be exercised in the drawing or removing of sheeting, shoring, bracing and timbering to prevent the caving or collapsing of the excavation faces which are being supported and to prevent damage to completed work.

8.2 Bedding

8.2.1 General

(a) Furnish all bedding material from a single source throughout the work unless otherwise approved.

(b) Standard Bedding: Well-graded sand or squeegee (Class A bedding). Limits of bedding material shall be from 6-inches below the bottom of the pipe to 12-inches above the top of the pipe.

(c) Special Bedding for Sanitary Sewer with Underdrain: Refer to District detail drawing 3S.

(d) Special Bedding for Sanitary Sewer installed at depths greater than 15-feet or installed in unpaved R.O.W. or easements: Use ¾-inch crushed rock (Class B bedding) in lieu of squeegee or sand. Install Geotextile Fabric over Class B bedding prior to backfill.

(e) Bedding shall be compacted by vibrating, tamping, or a combination thereof, to 70% relative density for well-graded sand or squeegee material as determined by ASTM D 4253 and D 4254.

8.2.2 Clean, free draining, well-graded sand or squeegee sand (Class A)

Well-Graded Sand

Sieve Size	Percent Passing
3/8 inch	100
No. 4	70 to 100
No. 8	36 to 93
No. 16	20 to 80
No. 30	8 to 65
No. 50	2 to 30
No. 100	1 to 10
No. 200	0 to 5

Squeegee Sand

Sieve Size	Percent Passing
3/8 inch	100
No. 200	0 to 5

8.2.3 ¾-Inch Crushed Rock Bedding (Class B)

(a) 3/4-inch Crushed Rock Bedding shall be used for all pipelines at depths greater than 15 feet, for all pipelines installed in unpaved R.O.W. or easements, and for all precast concrete vaults unless otherwise approved by the District.

(b) Clean, crushed aggregate, conforming to ASTM D448, No. 67:

Sieve Size	Percent Passing
1 inch	100
3/4 inch	90 to 100
3/8 inch	20 to 55
No. 4	0 to 10
No. 8	0 to 5

8.2.4 Flow Fill

(a) Flow fill shall be used as bedding and/or backfill only as directed by the District Engineer.

(b) Flow Fill or Flowable Concrete Backfill, shall be molded and cured in compliance with ASTM D4832.

(c) Flow Fill shall conform to the following requirements:

Unit	Measurement
Compressive Strength (28 day)	100 psi (minimum) 200 psi (maximum)
Air Entrained	5 percent
Slump -	6 inches (minimum) 8 inches (maximum)

(d) Flash Fill may be used in place of flow fill with prior approval by the governing agency.

8.2.5 Geotextile Fabric

(a) Non-woven, non-biodegradable, needle punched geotextile comprised of polypropylene fibers.

Apparent Opening Size	70	U.S. Sieve
Permittivity	1.8	sec^{-1}
Permeability	0.26	cm/sec
Flow Rate	135	$gal/min/ft^2$
Grab Tensile Strength	120	lbs
Grab Tensile Elongation	50	%
Trapezoid Tear Strength	50	lbs
Mullen Burst Strength	240	psi
Puncture	70	lbs

(b) Acceptable Manufacturers: TC Mirafi; Model 140N

8.2.6 Foundations in Poor Soil

If excessively wet, soft, spongy, unstable or similarly unsuitable material is encountered at the surface upon which the bedding material is to be placed, the unsuitable material shall be removed to a depth as determined in the field by the District and in accordance with the District detail drawing 2S.

8.2.7 Stabilization Rock

(a) Stabilization Rock shall be used in areas of unstable subgrade per District detail drawing 2S.

(b) Uniformly graded rock ranging from ¾ inch to 1-½ inch.

Sieve Size	Percent Passing
2 inches	100
3/4 inch	0 to 10

8.2.8 Pipe Clearance in Rocks

Ledge rock, boulders and large stones shall be removed to provide a clearance of at least 6” (six inches) below and on the side of the pipe and fittings.

8.2.9 Dewatering

(a) Trenches shall be kept free from water during pipe laying. Method of dewatering shall provide for a completely dry foundation at the final lines and grades of the excavation.

(b) Dewatering shall be accomplished by the use of sump pumps or well points. All water shall be disposed of in a suitable manner without being a menace to

public health or causing public inconvenience in accordance with all applicable permits.

(c) Dewatering operation shall continue until it is safe to allow the water table to rise in the excavations. Pipe trenches shall contain enough bedding and backfill to prevent flotation of the pipe.

(d) Comply with Colorado Department of Public Health and Environment, Water Quality Control Division and local City and County requirements.

(e) It is the Contractor's responsibility to obtain all necessary Storm Water Discharge Permits.

8.2.10 Bedding Procedure

The pipe shall be carefully bedded as shown in the District bedding details. The Contractor shall be responsible for accurately shaping the pipe subgrade to fit the bottom of the pipe for the width shown on the bedding details.

Each joint shall be recessed in bedding material as required by the bedding detail in such a manner as to relieve the bell or coupling of the pipe of all load and to insure continuous bearing along the pipe barrel upon the pipe subgrade.

8.3 Backfill

8.3.1 All trenches shall be backfilled after pipe, fittings and appurtenances have been installed, reviewed and accepted by the District. Bedding shall be installed in accordance with Section 8.2.

8.3.2 Whenever a compaction requirement is specified herein, the optimum moisture content and Standard Proctor density shall be determined in accordance with ASTM D-698.

8.3.3 Backfill shall be compacted by vibrating, tamping, or a combination thereof, to 90% of maximum dry density for cohesive soils in easements or open space outside of right-of-ways and 95% of maximum dry density for cohesive soils in right-of-ways as determined by ASTM D698 or as required by the governing authority.

8.3.4 Compaction shall be done by use of vibratory equipment, tamping rollers, pneumatic tire rollers or other mechanical tampers of the type and size approved by the District Engineer.

8.3.5 Contractor to employ placement method that does not disturb or damage the pipe or its coating and shall be kept as close to the pipe laying operation as practical.

8.3.6 Any damage to the pipe as a result of Contractor's operation shall be repaired and/or replaced.

8.3.7 The backfill shall be placed in horizontal layers of such depths as are considered proper for the type of compacting equipment being used in relation to the backfill material being placed.

8.3.8 Backfilling shall be accomplished in the zone in layers not to exceed 3' (three feet).

8.3.9 All backfill material shall be subject to the approval of the District.

8.3.10 Each layer shall be evenly spread, properly moistened and compacted to the specified density in Section 8.3.3.

8.3.11 Backfill trenches to contours and elevations as indicated on the approved construction drawings.

8.3.12 Backfilling procedures shall conform to the additional requirements, if any, of the appropriate governing agencies or private right-of-way agreements.

8.3.13 Import Backfill

(a) Material of perishable, spongy, frozen, or otherwise improper nature shall not be used in backfilling, and no material greater than 4" (four inches) in any dimension shall be placed within 1' (one foot) of any pipe, manhole or structure.

(b) If the excavated material is not suitable for backfill, as determined by the District Engineer and project Geotechnical Consultant, suitable backfill material shall be hauled in and utilized, and the rejected material hauled away and disposed of properly.

(c) The removal and replacement limits and quantity of import backfill material shall be coordinated and accepted by the District Engineer and Geotechnical Consultant and governing authority prior to proceeding with the installation.

(d) All excess import or on-site backfill shall be hauled away and disposed of properly.

8.3.14 Flow Fill: Flow fill shall be used as bedding and/or backfill only as directed by the District Engineer. Refer to Section 8.2.4.

8.4 Compaction Testing

8.4.1 Frequency

(e) At a minimum, frequency of compaction testing shall comply with the following:

- Within Right-of-Ways: Per State, County and / or City requirements.
- Outside Right-of-Ways and within easements:

  One test per lift per 250 feet of trench or 250 cubic yards of fill material, whichever controls.

  One test at each vault, valve box, and service connection.

(f) Testing at Various Depths. Test from 1-foot below surface grade to no deeper than 2-feet above the pipe.

8.4.2 Procedure

(a) As required by the District, compaction tests will be taken by an approved testing laboratory at locations designated by the District or the governing authority.

(b) All expenses involved in these tests will be borne by the Developer/Owner.

(c) Copies of test results will be forwarded to the District Engineer.

(d) In all cases where the tests indicate compaction less than that required in these specifications, additional compaction and tests will be required until these specifications are met.

(e) Final acceptance of the lines by the District will be contingent upon satisfactory results.
(f) No testing of the sewer main will be allowed until satisfactory compaction is obtained.

8.5 Final Cleanup

8.5.1 After backfill and compaction has been completed, the right-of-way shall be dressed smooth and left in a neat and presentable condition to the satisfaction of the District and City/County.

9. INSTALLATION OF SANITARY SEWER PIPE AND MANHOLES

9.1 Installation of the Sanitary Sewer Pipe

9.1.1 General – Install pipe, fittings, and accessories in accordance with ASTM D2321 and Manufacturer's recommendations. Seal joints watertight. All pipe shall be laid without break from structure to structure, with the bell ends of the pipe upgrade. Pipe shall be laid to the line and grade shown on the approved plans and in such a manner as to form a close concentric joint with the adjoining pipe and prevent sudden offsets of the flow line. The interior of the sewer pipe shall be cleaned of all dirt and superfluous material of all descriptions as the work progresses.

At all times when pipe laying is not in progress, the open end of the pipe shall be closed with a tight fitting cap or plug to prevent the entrance of foreign matter into the pipe. These provisions shall apply during the noon hour as well as overnight. In no event shall the sewers be used as drains for removing water which has infiltrated into the trenches.

9.1.2 Alignment and Grade – Lay pipe to slope gradients as indicated on the approved construction drawings. Pipe shall be laid without break, upgrade from structure to structure, with the bell ends of pipe upgrade.

Whenever obstructions not shown on the plans are encountered during the progress of the work and interfere to such an extent that an alteration in the approved plans is required, the project Engineer shall submit revised drawings and details for District review.

9.1.3 Placing of Sewer Pipe in the Trench – When placing sanitary sewer pipe in the ditch, the ASTM specification for installing sewer pipe shall be used. Pipe shall be laid true to line and grade as shown on approved construction drawings.

To assure a true line and grade, the Contractor shall use laser equipment. A centerline grade string and plumb-bob shall be used to assure the sewer pipe is kept in line. A grade rod shall be used to assure accurate grade on the invert of the sewer pipe. The quality of the grade rod shall be acceptable to the District.

All pipe shall be protected during handling against impact shocks and free fall and no pipe shall be placed in the sewer line that has been damaged while lowering into the ditch. Bell holes shall be dug under the bells of all pipe, regardless of the type of bedding used in the ditch and the entire length of barrel of all sewer pipe shall rest firmly on the bedding material used in the ditch and the weight of the sewer pipe in no case shall be supported by the bells of the pipe.

After lowering into the ditch, both the bell and spigot shall be thoroughly cleaned and free from any foreign material.

Other sanitary sewer pipe joints shall be joined using lubricants, primers, adhesives, solvents, etc., recommended by the manufacturers. All factory fabricated joints shall be placed, fitted, joined and adjusted in such a

workmanlike manner as to obtain the degree of water tightness required and in compliance with recommended methods of manufacturer, and as required by the District.

9.1.4 Pipe Fittings

(a) General – Pipe fittings shall include branches of every type (service laterals), PVC caps/plugs, and plumber's plugs. Fittings shall be furnished and installed at the locations, to the grades and of type and size shown on the plans and in conformance with these specifications. Service wyes shall be installed in accordance with District detail drawings 11S, 12S, and 13S.

(b) Branches (Service Laterals)

i. Branches of type shown on the approved plans shall be furnished with connections of the sizes specified and shall be securely and completely fastened to the barrel of the pipe in the process of manufacture.
ii. In the case of pipe 15" or greater in diameter, in addition to other fastening material of approved quality, there shall be a reinforcing collar of cement mortar around the outside of the joint, and there shall be no exposure of cement mortar on the interior surface of the pipe.
iii. Wyes of size specified on the approved plans shall be installed for all sewer house connections and for future sewer house connections as shown on the approved plans, or specified in these specifications.
iv. Wyes, tees, and other types of branches shall be furnished and installed along with the sewer main. **Saddle taps shall only be used with prior approval by the District.**
v. The longitudinal barrel of branch fittings to be placed in line and grade with the sanitary sewer mains shall be of the same diameter, quality and type as said sewer.
vi. Unless otherwise specified, the branch of wye fittings shall be inclined upward at an angle not greater than 45º from a horizontal line.
vii. Wye branches shall have their axes approximately 45º (unless otherwise specified on the approved plans) to the longitudinal axis of the pipe, measured from the socket end.
viii. No wye or tee shall be placed closer than 5 feet, in the downstream side, to the centerline of any structure.
ix. **Tee branches are only permitted with prior approval by the District and/or District Engineer.** Tee branches shall have their axis perpendicular to the longitudinal axis of the pipe.
x. All branches shall terminate in sockets and the barrel of the branch shall be of sufficient length to permit making a proper joint when the connecting pipe is inserted in the branch socket.
xi. The quality of pipe fittings shall conform to the applicable provisions of these specifications, Section 4.
xii. Joints for fittings shall conform to the applicable pipe material and Section 4.
xiii. Trenching, bedding, and backfill for branches shall conform to Section 8 of these specifications.
xiv. The Contractor shall hand tamp the backfill under every wye branch when installed.

(c) Plugs/Caps – PVC plugs and/or caps are to be placed on the end of sewer services or sewer line stub-outs for testing. The plug/cap may be PVC solvent

welded to the pipe or it may be a gasket fitting. The connection must be able to withstand air testing per Section 11 of these standards.

(d) A "Plumber's Plug" shall be installed during construction at each tie-in manhole to the existing sewer system. The plug shall be removed only after testing and flushing of the new sewer system is complete per Section 11.

9.1.5 Pipe at Manholes or Structures – Pipe joint of the same inside diameter as the adjoining pipe shall be placed at the inlet and outlet to each manhole or structure as shown on the District detail drawings.

Pipe bells shall not be cast into manholes or structures. The bell shall be cut off so that no recess or offset appears on the exposed face from the inside wall of the pipe to the outside wall of the pipe. (To be a plain end, flush with the inside wall of the manhole or structure.)

9.2 Installation of Manholes

9.2.1 Excavate for manhole installation in accordance with Section 8, "Trenching, Bedding and Backfill."

9.2.2 Install and seal precast sections in accordance with ASTM C478.

9.2.3 Grout all inside joints and riser rings to top of manhole barrel. Do not grout frame to concrete.

9.2.4 Install manholes plumb.

9.2.5 Backfill manhole excavation in accordance with Section 8, "Trenching, Bedding and Backfill."

9.2.6 Pavement: Set and adjust ring and cover to match finished pavement grade elevation or per City / County / State requirements.

9.2.7 Unimproved areas: Set and adjust ring and cover to 6-inches above finished grade or as indicated on the approved construction drawings. Place concrete collar around manhole ring and marker post per District detail drawing 16S and Section 5.5 of these specifications.

9.2.8 Inverts:

(a) Precast inverts shall not be allowed.
(b) Class A concrete per Section 5.
(c) Inverts shall have semicircular bottom conforming to the inside contour of the adjacent sewer sections.
(d) Finishing for manhole inverts shall be a smooth trowel surface.
(e) Invert deflectors shall be curved in shape to provide smooth flow transitions per District detail drawing 5S.
(f) Minimum angle between the centerline of any incoming pipe and the centerline of any outgoing pipe shall be 90-degrees.
(g) Invert Elevation Drop: Minimum: 0.2-foot, Maximum: 1.0-foot.
(h) Benches shall slope 2" per foot toward center of manhole base. Use a broom finish.

9.2.9 Drop Manholes: Differences in elevations in excess of 1.0 vertical feet will require use of an outside drop manhole. Inside drops may be allowed with prior approval by the District. Refer to District details 30S – 32S.

9.3 Bypass Pumping

9.3.1 The estimated peak sanitary sewer flow rate in the existing sanitary sewer main must be stated on the approved construction plans.

9.3.2 Bypass pumping shall be performed in a manner so as not to create a public nuisance or health hazard and shall conform to current Colorado Department of Public Health practices. The Contractor shall supply and operate equipment for pumping gat the listed flow rates with provisions for 100% backup pumping capacity on site during pumping operation. Discharge line locations and street crossings shall be coordinated with the appropriate governing agency.

9.4 Manhole Markers – In all instances where sewer lines are installed out of pavement, manhole markers shall be installed to designate manhole locations. The markers shall conform to the District detail drawing 16S. The markers shall be placed as directed by the District.

9.5 Abandonment of Existing Sewer Lines

9.5.1 Flow fill or Class B Concrete: In accordance with Section 8 – Trenching, Bedding and Backfill and Section 5 – Manholes.

9.5.2 Class A Bedding: In accordance with Section 8 – Trenching, Bedding and Backfill.

9.5.3 Pavement: In accordance with City/County/State Standards.

9.5.4 Abandonment

(a) Pipelines

i. Jet Cleaning: 100% of existing sanitary sewer line to be abandoned.
ii. Pipe: Remove approximately 5 linear feet at abandonment point.
iii. Plug: PVC or plumber's plug with concrete encasement per District Detail 21S "Pipe Abandonment".

(b) Manholes

i. Insert sand bags or plumber's plug at each end of the pipe to be abandoned.
ii. Fill manhole base with flow fill or Class B Concrete to a level equal to the top of the inflow pipe.
iii. Remove and dispose of Frame and Cover.
iv. Remove and dispose of cone section.
v. Fill manhole barrel and transition sections with Class A bedding.
vi. Landscaped areas:

- Place compacted backfill on top of Class A bedding up to existing ground level.
- Compact to 90% of maximum dry density for cohesive soils outside of pavement limits.

vii. Paved areas:

- Place 12-inch thick concrete cap on top of Class A bedding to accommodate pavement restoration.
- Compact to 95% of maximum dry density for cohesive soils within pavement limits.
- Pavement Restoration: In accordance with City/County/State Standards.

9.6 Project Record Documents

9.6.1 Maintain on site one (1) full size set of approved construction plans for record documents.

9.6.2 Ensure entries are complete and accurate, enabling future reference by District Engineer.

9.6.3 Store record documents separate from documents used for construction.

9.6.4 Record information concurrent with construction progress at least once per week for most current and accurate results.

9.6.5 Legibly mark each item to record actual construction including:

(a) Measured pipe lengths and sizes.
(b) Measured horizontal and vertical locations of fittings and appurtenant items, referenced to permanent surface improvements.
(c) Measured depths of manhole inverts in relation to finish rims.
(d) Measured locations of services and stub outs.
(e) Field changes of dimension and detail.
(f) Details not on original construction drawings.

9.6.6 Submit documents to the District Engineer.

10. PROTECTION OF WATER SUPPLIES

10.1 Water Supply Inter-Connections

There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable water supply.

10.2 Relation to Water Works Structures

While no general statement can be made to cover all conditions, it is generally recognized that sewers must be kept remote from public water supply wells or other water supply sources and structures in accordance with the applicable health department standards.

10.3 Relation to Water Mains

Sewers shall be located a minimum of 10 feet horizontally from existing or proposed water mains (centerline distance). Where sewer lines cross water mains, the sewer pipe shall be a minimum of 18" clear distance vertically below the water main. If this clear distance is not feasible, the crossing must be designated and constructed so as to protect the water main.

For example:

PVC sewer pipe with reinforced concrete encasement. Encasement shall be in accordance with the District detail drawing 23S "Concrete Encasement" and extend a distance of 10 feet either side of the water main. Refer to Section 7 of these specifications.

In all cases, suitable backfill or other structural protection shall be provided to preclude settling and/or failure of the higher pipe.

11. TESTING AND REVIEW

11.1 Materials Testing Prior to Construction

The Contractor shall provide upon request written certification from the manufacturer that the materials (pipe, manholes, etc.) to be used for the project meet or exceed the corresponding ASTM Standards.

The materials for the project shall be stamped or labeled for ASTM and industry standards.

All pipe, manholes and other materials shall be subject to review by the District. The purpose of the review shall be to reject any materials that fail to conform to the requirements of these specifications, or that may have been damaged during transportation and/or in subsequent handling.

11.2 Testing After Construction

11.2.1 The following tests on the PVC gravity pipe and fittings shall be performed at the expense of the Developer and/or Contractor:

(a) Low Pressure Air Testing: 100% of new system. To be completed per Uni-B-6-98 or latest version.

(b) Jet Cleaning: 100% of new system.

(c) Lamp Testing: 100% of new system. To be completed by District personnel after jet cleaning by Developer/Contractor.

(d) Deflection Testing: 100% of new system. Pull calibrated mandrel equal to 95% of the base inside diameter through the pipe from manhole to manhole. Repair any refusal areas.

(e) Video Inspection: 100% of new system. Provide DVD or CD to the District.

11.2.2 General – It is the intent of the sewer specifications that the completed sewer pipes of all types, along with the manholes and other appurtenances, shall be watertight.

The District requires each section of sewer between two successive manholes to be tested for leakage and/or infiltration. These tests shall be performed subsequent to acceptance of compaction test results by the District.

Even though a section may have previously passed the leakage or infiltration test, each section of sewer may be tested subsequent to the last backfill compacting operation in connection therewith, wherein the opinion of the District Engineer, heavy compaction equipment or any of the operations of the Contractor or others may have damaged or affected the required watertight integrity of the pipe, structure and appurtenances. The Contractor shall furnish all materials required for the tests. Tests shall be made in the presence of the District.

If the leakage and/or infiltration rate as shown by the tests specified herein is greater than the amount specified, the pipe sections shall be repaired or, if necessary, the pipe shall be removed and re-laid by the Contractor. The sewer will not be considered acceptable until the leakage and/or infiltration rate, as determined by test, is less than the allowable.

The Contractor shall air test for leakage except where, in the opinion of the District, excessive groundwater is encountered, then the infiltration test shall be made.

11.2.3 Low Pressure Air Testing

(a) 100% of new system.

(b) Test procedure:

i. This recommended practice defines the proper procedures for acceptance testing of installed gravity sewer pipe, using low-pressure air. This recommended practice does not cover the testing of manholes.

ii. Only lines tested after backfilling to final grade will be considered for acceptability. However, this test may be used by the Contractor as a presumptive test to determine the condition of the lines prior to backfilling.

iii. The Contractor shall furnish all the necessary equipment and be responsible for conducting all low-pressure air tests. In addition, the Contractor is responsible for any necessary repair work on sections that do not pass the test. No sealant shall be used for repairs.

iv. All costs necessary to conduct air testing shall be borne by the Developer/Contractor.

v. The District representative shall schedule and witness all low-pressure air tests, and the District shall make a final decision as to the acceptability of the Contractor's work.

vi. Equipment

- Plug Design – Either mechanical of pneumatic plugs may be used. All plugs shall be designed to resist internal testing pressures without the aid of external bracing or blocking. However, the Contractor shall internally restrain or externally brace the plugs to the manhole wall as an added safety precaution throughout the test.
- Single Control Panel – To facilitate test verification by the District, all air used shall pass through a single, above-ground, control panel.
- Equipment Controls – The above-ground air control equipment shall include a shut-off valve, pressure regulating valve, pressure relief valve, input pressure gauge, and a continuous monitoring pressure gauge having a pressure range from 0 psi to at least 10 psi. The continuous monitoring gauge shall be no less than 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of ±0.04 psi.
- Separate Hoses – Two separate hoses shall be used to: (1) connect the control panel to the sealed line for introducing low-pressure air, and (2) a separate hose connection for constant monitoring of air pressure build-up in the line.
- Pneumatic Plugs – If pneumatic plugs are utilized, a separate hose shall also be required to inflate the plugs from the above-ground control panel.
- Relief Valve – All pressurizing equipment used for low-pressure air testing shall include a regulator or relief valve set no higher than 9 psig to avoid

over-pressurizing and displacing temporary or permanent plugs. The pressure in the test section shall be continuously monitored to make certain that it does not at any time exceed 9 psig. (It may be necessary to apply higher pressure at the control panel to overcome friction in the air supply hose during pressurization).

vii. Line Preparation

- Laterals, Stubs, and Fittings – During sewer construction, all service laterals, stubs, and fittings into the sewer test section shall be properly capped or plugged so as not to allow for air loss that could cause an erroneous air test result.

viii. Procedure

- Plug Installation and Testing – The Contractor shall seal test all plugs before use. Seal testing may be accomplished by laying one length of pipe on the ground and sealing it at both ends with the plugs to be checked. The sealed pipe should be pressurized to 9 psig. The plugs shall hold against this pressure without bracing and without any movement of the plugs out of the pipe. No persons shall be allowed in the alignment of the pipe during plug testing.

  After a manhole-to-manhole reach of pipe has been backfilled to final grade, prepared for testing, and the specified waiting period has elapsed, the plugs shall be placed in the line at each manhole and secured.

  The Contractor shall plug the upstream end of the line first to prevent any upstream water from collecting the test line.

  When plugs are being placed, the pipe adjacent to the manhole shall be visually inspected to detect any evidence of shear in the pipe due to differential settlement between the pipe and the manhole.
- Line Pressurization – Low pressure air shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average back pressure of any groundwater above the pipe, but not greater than 9.0 psig. If groundwater is present, refer to "Determination of Ground Water Elevation and Air Pressure Adjustment" in this section.
- Pressure Stabilization – After a constant pressure of 4.0 psig (greater than the average groundwater back pressure) is reached, the air supply shall be throttled to maintain that internal pressure for at least 2 minutes. This time permits the temperature of the enterin air to equalize with the temperature of the pipe wall.
- Timing Pressure Loss – When temperatures have been equalized and the pressure stabilized at 4.0 psig (greater than the average groundwater back pressure) the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less that 3.5 psig (greater than the average back pressure of any groundwater over the pipe). At a reading of 3.5 psig, or any convenient observed pressure reading between 3.5 psig and 4.0 psig (greater than the average groundwater back pressure), timing shall commence with a stop watch or other timing device. A predetermined required time for a specified pressure drop shall be used to determine the lines acceptability. A pressure drop of 0.5 psig is specified. Refer to Table 11.1.

- Determination of Line Acceptance – If the time shown in Table 11.1 for the designated pipe size and length elapses before the air pressure drops 0.5 psig, the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued once the prescribed time has elapsed even though the 0.5 psig drop has not occurred.
- Determination of Line Failure – If the pressure drops 0.5 psig before the appropriate time shown in Table 11.1 has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.
- Line Repair or Replacement – If the section fails to meet these requirements, the Contractor shall determine, at his own expense, the source or sources of leakage. He shall repair or replace all defective materials and/or workmanship to the satisfaction of the District Engineer. The extent and type of repair which may be allowed, as well as results, shall be subject to the acceptance of the District Engineer. The completed pipe installation shall then be retested and required to meet the requirements of this test.

ix. Determination of Groundwater Elevation and Air Pressure Adjustment

- Applicability – The requirements of this Section shall only apply where groundwater is known to exist or is anticipated above the sewer line to be tested.
- Pipe Nipple Installation – During manhole installation, a one-half inch diameter threaded pipe nipple shall be installed through the manhole wall directly on top of one of the sewer pipes entering the manhole. The threaded end of the nipple shall exceed no more than two inches on the inside of the manhole. The total length of the nipple shall exceed the manhole wall thickness by no less than four inches. The pipe nipple shall be non-corrosive and resistant to chemicals common in domestic sewage. Special attention shall be given to providing a permanent, watertight seal around the pipe nipple at the manhole wall. The pipe nipple shall be sealed with a threaded one-half inch cap. Every manhole need not have a pipe nipple. A few key manhole locations shall be sufficient to establish a groundwater profile for the test area. The District Engineer shall assist the Contractor in selecting appropriate manholes for pipe nipple installation.
- Ground Water Elevation – Immediately before air testing, the groundwater level shall be determined by removing the threaded cap(s) from the nipple(s) nearest the section to be tested, blowing air through the pipe nipple(s) to remove any obstructions, and the connecting clear plastic tube(s) to the pipe nipple(s). Each plastic tube shall be held vertically to allow groundwater to rise in it. After the water level in the tube has stopped rising, a measurement of the height in feet of water over the invert of the sewer pipe shall be taken. If the section to be tested is not immediately adjacent to an installed pipe nipple, the groundwater height shall be estimated based upon nearby height readings and the pipe's invert elevation.
- Air Pressure Adjustment – The air pressure correction, which must be added to the 3.5 psig normal test starting pressure, shall be calculated by dividing the average vertical height, in feet of groundwater above the invert of the sewer pipe to be tested by 2.31. The result gives the air pressure correction in pounds per square inch to be added.

- Maximum Test Pressure – In no case should the starting test pressure exceed 9.0 psig. If the average vertical height of groundwater above the pipe invert is more than 12.7 feet, the section so submerged may be tested using 9.0 psig as the starting test pressure. The 9.0 psig limit is intended to further ensure workman safety and falls within the range of pressure gauges normally used.
- Re-Sealing of Pipe Nipples – After the groundwater height has been determined, each pipe nipple shall be recapped and sealed to prevent any future infiltration.

x. Test Times: Per Uni-B-6-98 or latest version.

Time Test Calculation (Ramseier's equation): $T = 0.085\ DK / 2Q$
(Refer to Table 11.1)

T = Shortest time, in seconds, allowed for the air pressure to drop 0.5 psig.
K = 0.000419 DL, but not less than 1.0.
Q = 0.0015 cubic feet/minute/square feet of internal surface.
D = Nominal pipe diameter in inches
L = Length of pipe being tested, in feet.

To facilitate the proper use of this recommended practice for air testing, the following table is provided. Table 11.1 contains specified minimum times required for a 0.5 psig pressure drop from a starting pressure of at least 3.5 psig greater than the average back pressure of any groundwater above the pipes invert.

xi. Testing Main Sewers With Lateral Sewers – If lateral sewers are included in the test, their lengths shall be ignored for computing required test times.

In the event a test section fails to pass the air test when lateral sewers have been ignored, the test time shall be recomputed to include all lateral sewers using the following formula:

$$T = \frac{0.085}{2} \times \frac{D1^2L1+D2^2L2+ \ldots+Dn^2Ln}{D1L1+D2L2+ \ldots+DnLn} \times \frac{K}{Q}$$

Where:
T = Shortest time, in seconds, allowed for the air Pressure to drop 0.5 psig.
K = 0.000419 (D1L1+D2L2+…+DnLn), but less than 1.0
Q = 0.0015 cu.ft./min./sq. ft. of internal surface

D1, D2 = Nominal diameters of the different size pipes being tested.
L1, L2 = Respective lengths of the different size pipes being tested.

If the recomputed test time is short enough to allow the section tested to pass, then the section shall be presumed to be free of defects and comply with this specification.

TABLE 11.1
MINIMUM SPECIFIED TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015

Pipe Diameter (in.)	Minimum Time (min:sec)	Length for Minimum Time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	0.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7.05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23
42	19:54	57	20.942 L	34:54	52:21	69:49	87:15	104:42	122:10	139:37	157:04
48	22:47	50	27.352 L	45:35	68:23	91:11	113:58	136:46	159:33	182:21	205:09
54	25:31	44	34.618 L	57:42	86:33	115:24	144:15	173:05	201:56	230:47	259:38
60	28:20	40	42.738 L	71:14	106:51	142:28	178:05	213:41	249:18	284:55	320:32

Note: If there has been no leakage *(zero* psig drop) after one hour of testing the test section shall be accepted and the test complete.

11.2.4 Jet Cleaning

(a) 100% required for all new sewer systems prior to “Lamping” by District.

(b) Preparation
   i. Flush and clean pipeline interiors to remove sludge, dirt, sand, stone, grease, and other materials from pipe to ensure clear view of interior conditions.
   ii. Intercept flushed debris at next downstream manhole by use of weir or screening device. Remove, and dispose of debris from system off site.
   iii. When necessary, furnish materials, labor, equipment, power, maintenance, to implement a temporary bypass pumping system around work area for time required to complete TV inspection.

(c) All costs associated with jet cleaning shall be borne by the Developer/Contractor.

11.2.5 Lamp Testing

(a) 100% of new system.

(b) After the pipe has been installed, tested for leakage, backfilled, manholes raised to grade, and the trenches compacted, the District will "lamp" all lines.

(c) All lines shall be flushed and manholes cleaned by the Contractor prior to "lamping".

(d) At the request of the District, the line will be "balled" at the Developer's/Contractor's expense to remove dirt, rocks, or other foreign matter not removed during the flushing operations.

11.2.6 Deflection Testing

(a) 100% of new system.

(b) Pull calibrated mandrel equal to 95% of the base inside diameter through the pipe from manhole to manhole. Repair any refusal areas.

(c) The Contractor shall be required to install the pipe in such a manner so that the diametric deflection of the pipe shall not exceed 5 percent and the materials surrounding he pipe shall be compacted to the required Standard Proctor Densities outlined in ASTM D-2321.

(d) All pipelines constructed of flexible materials shall be measured for vertical ring deflection by an accredited, independent testing company at the expense of the Owner or Developer. Maximum ring deflection of the pipeline under load shall be limited to 5 percent of the vertical internal pipe diameter. All pipe exceeding this deflection shall be considered to have reached the limit of its serviceability and shall be re-laid or replaced prior to final acceptance.

(e) All costs associated with deflection testing shall be borne by the Developer/Contractor.

11.2.7 Video Inspection of Pipelines

(a) Submit completed compact discs or DVDs, identified by number, project name, street name, right-of-way property name, and manhole numbers. Discs become property of the District.

(b) Submit cleaning and television inspection logs for each section of sewer line to be inspected.

(c) If required, submit a specific detailed description of proposed bypass pumping system to include written description of plan and addressing quantity, capacity, and location of pumping equipment. Submit spill plan to address any spills that might occur.

(d) Qualifications: Video inspection of pipelines to be completed by a Company specializing in performing work of this section with minimum three (3) years documented experience.

(e) Media

i. Compact Discs or DVDs formatted for Windows Media Player or media player approved by the District.

ii. Audio track containing simultaneously recorded narrative commentary describing in detail condition of pipeline interior.

(f) Contents of Video Inspection

The following information, to the extent it can be reasonably determined, is to be recorded visually on the CDs or DVDs, and video logs.

i. Date: The date on which the videotaping was performed at the beginning of each segment.
ii. Manhole to Manhole: The manhole identification number for both the upstream and downstream manholes at either end of the videotaped segment.
iii. Direction of Video: Relative to flow direction, indicate whether the camera is facing upstream or downstream.
iv. Continuous Digital Counter: A digital counter to designate the distance from the "upstream" manhole.
v. Street Name: The street name which contains the video segment and/or the nearest cross street.
vi. Service Identification: Identification of all taps by size, type, and pipe entrance location. As previously established, a clock reference is also preferred.
vii. Root Intrusion: Identification of all types of root structures (hair, string, chunk) encountered by severity (minor, moderate, or severe) and location.
viii. Addresses: If services are encountered which have roots in or around the sewer service, the street address from which the service is believed to originate.
ix. Cracks: Identification of all cracks (spiral, lateral, beam) by type, severity, location and footage.
x. Broken Pipe: Identification of all broken pipe other than cracks by location, cause if known (i.e., improper installation of service, encroachment of other utility, etc.), severity, and footage.
xi. Sags: Identification of all sags greater than one inch (1") by beginning/start, best estimate of depth of sag (greatest point), and ending footage. If the segment has a number of sags or one, long, continuous sag, view the apparent length and depth of the sag. Once convinced as to the extent of the sag, suck the sag down by the use of the jet cleaning unit so the condition of the pipe wall can be viewed. Also identify any apparent high spots.
xii. Grease: Audible identification of all forms of grease accumulation apparent within the pipe by severity, location and footage.
xiii. Infiltration: Identification of all forms of infiltration (or exfiltration) by estimation of flow volume (GPM), possible source, visible calcium deposits, and footage.
xiv. Vertical/Horizontal Offset Joints: Identification of all joints which appear to be offset from original alignment, severity, location, and footage.
xv. Wide Joints: Identification of all joints which appear to have a wider separation of bell and spigot than normal, by width and footage.
xvi. Oval/Deformed Pipe: If PVC or other flexible pipe material exists which may deflect and sustain noticeable failure, identification of shape of pipe (i.e., egg shaped, non-circular, etc.), footage, and location.
xvii. Percent Deterioration: Identify severity of deterioration.

xviii. Lens Height: Indication whether the camera has been lowered, and the reason. Otherwise, the camera should be set as close to the center of the pipe as possible.

xix. Size and Type (Material): A best estimate of the inside pipe diameter and type of material for each pipe segment. If possible, note specifically unusual, as well as standard, types of pipe (e.g., sliplined, PVC, concrete, clay, etc.).

(g) Examination: Verify location of sewer pipelines to be inspected.

(h) Preparation: Flush and clean pipeline interiors per Section 11.2.4 of these specifications.

(i) Closed-circuit TV Camera System

i. Utilize cameras specifically designed and constructed for closed-circuit sewer line inspection. Utilize camera equipment with pan and tilt capability to view each lateral connection at multiple angles.

ii. Utilize camera capable of moving both upstream and downstream; minimum 1,000 feet horizontal distance with one setup; direct reading cable position meter.

(j) Procedures

i. Color Video: Since color provides better contrast and detail, no black and white video will be accepted.

ii. Video (Travel) Speed: To the extent practicable, the speed range at which all segments will be videotaped will be a maximum of 1 Ft/Sec, and a minimum of ½ Ft/Sec. Should variance from these parameters occur, it must be noted on the audio, and the reason for the variance. It is recognized that variance from the minimum speed according to the condition of the pipe is not a serious problem, but that exceeding the maximum velocity can reduce the viewability of the video, and may be grounds for request of re-videotaping the specified segment.

iii. Counter Variance:

- Variance of counter/as-built distance shall not exceed the following:

TABLE 11.2

As-Built Distance	Variance
0 - 100 feet	2%
101 - 200 feet	2%
201 - 300 feet	3%
301 - 400+ feet	3%

- If the as-built distance and counter distance have a greater difference than specified by the variance, the Contractor shall either verify recorded as-built distance or re-video the entire segment.

iv. Lens Obstruction: If the lens is obstructed by a foreign object or by fog (e.g., water spray, mist, etc.), attempt to clear the lens of the obstruction. If

attempts fail and additional videotaping would produce the same results, continue to videotape the extent of the segment; otherwise, re-video all or the portion which had not been viewed.

v. Lighting: Ensure that the illumination level inside the pipe is high enough to identify clearly the condition of the interior circumference. If segments are not already visible, a request will be made to re-video the segment. If there are outside contributing factors which make the pipe impossible to illuminate, identify such on video log.

vi. Skips in Video: If a portion of the video segment is not recorded (such as through malfunction of equipment), the segment must either be entirely re-videotaped from the beginning of the skip to the end, or the entire segment must be re-videotaped. Such corrective action will be at the Contractor's expense.

vii. Video Footage: Properly identify footage from "upstream" manhole (i.e., as-built footage is from center of manhole to center of manhole). State location of beginning of video segment and correlate counter to this footage (i.e., beginning of pipe segment would be 2 feet, center of manhole would be 0 feet).

11.2.8 Vacuum Testing (Manholes)

Vacuum testing shall be required in areas of high groundwater. The District Engineer shall determine if vacuum testing is required based on the project geotechnical report and field conditions during construction.

(a) Manholes shall be tested for tightness by a vacuum test as specified and in accordance with ASTM C924.
(b) All pipes entering and exiting the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
(c) The test head shall be placed at the top of the manhole and the seal inflated in accordance with the manufacturer's recommendations.
(d) A vacuum of 10-inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head shall be closed, and the vacuum pump shut-off. The time shall be measured for the vacuum to drop to 9-inches of mercury.
(e) The manhole will be declared unacceptable if the time to drop from 10-inches of mercury to 9-inches of mercury is less than the time shown in the following table (Table 11.3):

TABLE 11.3

DEPTH (FT) (Vertical Length of Manhole)	TIME (sec)		
	4'-0" Dia.	5'-0" Dia.	6'-0" Dia.
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81

If the manhole fails the initial tests, the manhole shall be repaired and re-tested until a satisfactory test is obtained.

(f) All costs associated with vacuum testing shall be borne by the Developer/Contractor.

11.2.9 Infiltration Testing

(a) Only to be used in areas of excessive groundwater and at District's request.
(b) If, in the construction of a section between structures, excessive groundwater is encountered, the test for leakage described in section 11.2.3 shall not be used, but instead, the end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of groundwater shall be discontinued for at least three days after which the section shall be tested for infiltration.
(c) The infiltration shall not exceed 0.04 gallons per hour, per inch of diameter, per 100 feet of main-line sewer being tested or as indicated in Table 11.4 and does not include the length of house laterals entering that section.
(d) Where any infiltration in excess of this amount is discovered before completion and acceptance of the sewer, the sewer shall be immediately uncovered and the amount of infiltration reduced to a quantity within the specified amount of infiltration before the sewer is accepted, at the expense of the Contractor.
(e) Should, however, the infiltration be less than the specified amount, the Contractor shall stop any individual leaks that may be observed.
(f) The Developer and/or Contractor shall furnish all labor and materials for making the tests required at his expense. All tests must be completed before street or trench is resurfaced.

TABLE 11.4 Allowable Limits of Infiltration 50 Gal/Inch Dia/Mi//Day or 0.04 Gal/Inch Dia/100'/Hr	
Diameter of Sewer (Inches)	Infiltration Gal/Hr/100' (Gallons)
8	0.32
10	0.40
12	0.48
15	0.60
18	0.72
21	0.84
24	0.96
27	1.08
30	1.20
36	1.44

TABLE 11.5 Allowable Limits of Infiltration for Manhole Structures	
Diameter of Manhole (Inches)	Infiltration Gal/Vertical ft/Hr
41	0.02
48	0.02
60	0.03
72	0.04

SUPPLEMENT TO SECTION 11

SAMPLE TESTING REPORTS FOR SANITARY SEWER

SEWER AIR
TEST REPORT

Date: _____

Client/Owner: _____ Job No: _____

Project Name: _____ Contractor: _____

Location: _____ Time Begin: _____ Time End:_____

Weather: _____ Testing Req: _____% of Project

Required Testing Completed _____% Failed _____% Passed _____ %

The following representatives were in attendance:

Name	**Company**

Pipe Under Test				Spec. Time			Field Test Operations Data			
Upstream MH No.	Downstream MH No.	Diameter (IN)	Length (FT)	Refer to UNI-B-6 (min/sec)	Pressure Raised (psig)	Time for Pressure Stabilize	Start Test Pressure (psig)	Stop Test Pressure (psig)	Elapsed Time (min/sec)	Pass or Fail (P or F)

If a section fails, the following should be completed:

Identify section(s) failed: _____

Description of leakage: _____

Leak (was/was not) located. Method used: _____

Corrective action: _____

For corrections refer to test no. _____ Retest date: _____

Contractor: _____

Field Administrator: _____

DEFLECTION TEST REPORT
(SEWER)

Date: _____

Client/Owner: _____ Job No: _____

Project Name: _____ Contractor: _____

Location: _____ Time Begin: _____ Time End:_____

Weather: _____ Testing Req: _____% of Project

Required Testing Completed _____% Failed _____% Passed _____ %

The following representatives were in attendance:

Name	**Company**

From MH to MH	**Pipe Size**	**Pipe Footage**	**Passed/Failed**	**Comments**

Total Footage Tested: _____ Total Footage on Project: _____

Contractor: _____

Field Administrator: _____

SEWER LAMPING &
SYSTEM REVIEW

Date: _____

Client/Owner: _____ Job No: _____

Project Name: _____ Contractor: _____

Location: _____ Time Begin: _____ Time End:_____

Weather: _____ Testing Req: _____% of Project

Required Testing Completed _____% Failed _____% Passed _____ %

The following representatives were in attendance:

Name	**Company**

Remarks:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Field Administrator: _____

12. GREASE AND SAND/OIL INTERCEPTORS

12.1 General

All restaurants, cafeterias, supermarkets, bakeries, food processing, or other food preparation facilities shall have a grease interceptor installed on the sewer service line. The grease interceptor sizing and location shall be determined by the Owner's Engineer based on the criteria outlined below. All calculations shall be submitted to the District for review. Construction, ownership and maintenance of the grease interceptor shall be the Owner's responsibility. Bypasses are not permitted around grease interceptors.

Facilities which discharge any quantities of sand, oil or other inert debris into the sanitary sewer service shall have a sand and oil interceptor installed on the sewer service line. Examples of such facilities include, but are not limited to: automobile service stations, mechanical repair shops, car washes, garden nurseries, warehouses, and parking garages with floor drains. The sizing and location of the sand and oil interceptor shall be determined by the Owner's Engineer based on the criteria outlined below. All calculations shall be submitted to the District for review. Construction, ownership and maintenance of the sand and oil interceptor shall be the Owner's responsibility. Bypasses are not permitted around sand and oil interceptors.

In all cases, sand, oil and grease interceptors shall be located on the service line outside the building served, upstream of the location where human waste enters the service, and so installed and connected as to be easily accessible for inspection and cleaning. The District will determine whether a sand, oil, and grease interceptor is required whenever a new service line is proposed, and whenever an existing service line changes ownership or intended use. If the District determines that an existing facility needs to have a sand, oil, and/or grease interceptor installed, the Owner shall be required to provide the interceptor at his own cost, even if the interceptor was not originally required on the service line.

12.2 Engineering Review

Two (2) sets of plans and specifications, including complete mechanical and plumbing sections with interceptor detail and calculation shall be submitted to the District for review prior to construction. This submittal will be accompanied by a narrative explanation of the operation or process from which the interceptor will be receiving drainage. Interceptor designs must meet the criteria set forth in the following paragraphs and in accordance with the appropriate sections in the District's Rules and Regulations.

12.3 Criteria

When determining the minimum size of interceptor required, the following will be considered. It is the Owner's and/or Owner's Engineer's responsibility to determine the adequate size of the interceptor.

(a) The minimum size of the grease interceptor shall be based on the maximum number of meals served at maximum periods of the day (either breakfast, lunch or dinner). Volume, in gallons, of the interceptor shall be 2-1 /2 gallons times the number of meals served.

Grease interceptors shall conform to the "Commercial Grease Interceptor Detail." The interceptor selection shall be based on the required capacity of the

interceptor. Minimum capacity of 750 gallons unless otherwise approved by the District. If the interceptor must be installed within the building due to space limitations, prior written authorization must be obtained from the District.

(b) An alternate method of determining the size of a grease interceptor is to multiply seating capacity times a turnover constant of 2.0 times 2-1 /2 gallons.

Note: Seating capacity can be approximated, using 10 sq. ft. of dining area per person.

(c) Commercial sand and oil interceptors shall conform to the "Commercial Sand and Oil Interceptor Detail," unless the District has accepted an alternative. Minimum capacity of 500 gallons unless otherwise approved by the District.

12.4 Connections

(a) All drains from the kitchen, food preparation, and dishwashing areas shall be connected to the grease interceptor.

(b) Garbage grinders not connected to the grease interceptor shall not be used for disposal of grease. However, the District, at its discretion, may require any garbage grinder to go through the grease interceptor.

(c) All drains from automotive servicing areas, etc., will be connected to sand and oil interceptors.

12.5 Maintenance

The responsibility of cleaning and maintaining the grease interceptor in efficient operating condition shall be the Owner's and/or lessee's responsibility. Grease interceptor shall be accessible and shall be reviewed on a periodic basis by representatives of the District.

13. CONSTRUCTION PLAN REVIEW AND APPROVAL PROCEDURES

The following procedures have been developed by the Castle Pines North Metropolitan District in order to coordinate and unify the submittal, review, and approval of construction plans and specifications.

13.1 General

13.1.1 All plans shall be in compliance with the Engineering Standards and Specifications of the Castle Pines North Metropolitan District.

13.1.2 The Owner/Developer is responsible for payment to the District of all fees and charges associated with the plan review process including the charges of the District Engineer and the District's legal advisor.

13.1.3 No construction may take place until the easements are fully-executed and recorded.

13.1.4 No construction may take place until the plans have been approved and a preconstruction meeting has been held.

13.1.5 Plans and specifications are approved for a one-year period only. If construction has not begun within this one-year period, or if it has been halted and not re-started prior to expiration of the approval period, the plans must be resubmitted for review and approval.

13.2 Submittal and Review Procedures

13.2.1 Pre-Design Conference

(a) The Owner, Developer, or Design Engineer may request a pre-design conference by contacting the District Manager. This conference is not required but will be held upon the request of the Owner, Developer, or Design Engineer.

13.2.2 Submittals

(a) Preliminary sewer plans, along with AutoCAD files saved in version 2011 or older on CD, shall be submitted in two (2) copies to the District Manager. The plans will be reviewed by the District Engineer for compliance with the District's standards and specifications as well as for compliance with the District's integrated sewer system. The approval of plans will also be subject to the ability of the District to operate and maintain the proposed facilities in an efficient, economical manner.

(b) Four (4) original sets of the District's "Application for Main Line Extension" shall be submitted to the District Manager prior to plan review completion.

(c) All easement information, in accordance with these Specifications, shall be submitted to the District Manager/Engineer as part of the plan review.

(d) The Design Engineer shall submit hydraulic sizing calculations upon request.

13.2.3 Upon completion of the District's review of preliminary plans, one copy of the plans will be returned to the Design Engineer for required revisions. A conference may be scheduled by the District Manager and Engineer to discuss the needed revisions if it is deemed necessary or if it is requested by the Design Engineer.

13.2.4 When all revisions have been completed, two (2) copies of the revised plans shall be submitted to the District Engineer who will coordinate the review with other review agencies.

13.2.5 If no further revisions are required, eight (8) additional prints of the approved plans shall be submitted to the District Engineer.

13.2.6 If further revisions are required, one (1) copy of the plans, redlined to indicate needed revisions, shall be returned to the Design Engineer. After revisions are complete, two (2) copies of the revised plan with the redlined copy of the plan shall be submitted to the District Manager.

When the plan is ultimately accepted, ten copies of the plan shall be submitted to the District Engineer. AutoCAD files saved in version 2011 or older on CD shall be submitted with the final plan sets.

13.2.7 Upon final acceptance of construction plans, the reviewed drawings shall be held by the District Manager/Engineer and released at the preconstruction meeting. NO construction may take place until a preconstruction meeting has been held.

14. CONVEYANCE AND ACCEPTANCE PROCEDURE

14.1 Upon receipt of plans for review and approval, the Engineer shall send four (4) copies of the Conveyance and Acceptance application to the Developer for execution. Four (4) original copies are required. The District Engineer will hold all four (4) copies of the form completed by the Developer.

14.2 Upon completion of the plan review and receipt of the four (4) original Conveyance and Acceptance applications, the plans will be approved.

14.3 Prior to the expiration of the probationary period (refer to Section 16.7), the utility lines shall be inspected for final acceptance and maintenance by the District Engineer and Manager. The Developer and his Contractor shall correct any deficiencies observed during the final inspection, within the time period set by the District personnel or the District Engineer.

14.4 Upon final acceptance, the District Manager will distribute executed Conveyance and Acceptance forms. Copies will be distributed as follows:

Developer	- 1 Copy
District Engineer	- 1 Copy
District Manager	- 1 Copy
District Attorney	- 1 Copy

15. SEWER EASEMENTS

Easements are required wherever a sewer main is not in a public right-of-way. All easements shall be prepared according to the following specifications:

15.1 Areas where sewer mains are installed in easements, the sewer mains shall be located within the easements as shown on the approved construction plans.

15.2 All sewer main easements must be a minimum of thirty feet (30') in width.

15.3 No sewer main shall be located less than ten feet (10') from the edge of an easement without prior approval by the District.

15.4 All easements granted to the Castle Pines North Metropolitan District shall be prepared according to procedures outlined in the "Easement Preparation and Submittal Procedures and Checklist" located at the end of this Section.

15.5 Plans for sanitary sewer main construction within easements shall not be authorized for construction prior to the acceptance of the easements by the Castle Pines North Metropolitan District, nor prior to the easements being fully executed and recorded.

15.6 Concrete collars and steel marker posts (per District detail drawing 15S) must be installed on all valve boxes and manhole ring and covers located within easement areas. Prior to the acceptance of sewer mains within easements, the Contractor must have installed all necessary concrete collars and marker posts.

Easement Preparation and Submittal Procedures and Checklist
Castle Pines North Metropolitan District

These procedures have been prepared in order to provide general guidelines for the submittal of information necessary for the preparation of water and sewer easements within the Castle Pines North Metropolitan District. This information generally includes legal descriptions and drawings, an overall easement drawing, and a Title Commitment. Information contained herein should be used in conjunction with the District's water and sewer specifications.

All information required in the submittal section of these procedures must be presented to the District prior to the approval and release of construction plans. Submittals must be accompanied by this form, with Part A completed by the easement Grantor or his designated representative.

Submittals

The following information shall be submitted to the District Manager in three (3) copies:

1. The Castle Pines North Metropolitan District easement preparation checklist with the appropriate sections completed by the easement Grantor or his designated representative.

2. Copy of the preliminary/final plat for the project.

3. A legal description of each easement. A separate legal description is required for each separate ownership.

4. A drawing of each easement on an 8 ½-inch by 11-inch sheet showing distances and bearings, north arrow, ties to recognized land corners, and the acreage and square footage of the proposed easement. A separate drawing is required for each legal description.

5. A title commitment or title policy on the entire tract of land to be developed. The document must be current.

6. A boundary survey of the tract of land to be developed showing the location of the proposed easement(s) as well as the location of all structures, ditches, existing easements and other encumbrances explained in the title commitment.

7. A title commitment on all offsite easements specific to the easement legal description.

8. A boundary survey of the off-site easements indicating the relationship of off-site easements to the proposed development. Encroachments and/or encumbrances on the proposed off-site easements, such as existing easements, ditches, and structures, must be indicated on the drawing.

Checklist

PART A (to be completed by Grantor or his Engineer)

1. Please type or print the name of the Grantor for each easement exactly as the Grantor's name appears on the Deed by which the Grantor took title to the property. If the Grantor is a corporation, please list the state of organization and the names of all general partners.

Easement No.	Name, Title, Address, and Telephone Number of Grantor(s)
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2. Please list and describe special provisions that should be included in the easement documents. Include such things as existing storm sewer, irritation systems, etc. located within the proposed easement boundaries. License Agreements may be necessary for these encroachments.

Easement No.	Special Provisions
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PART B (to be completed by the District Engineer)

1. Please provide the following information:

Easement No.	Grantor	Width & Type of Easement

2. The easement legal descriptions, drawings, and proposed locations of utilities have been compared and reviewed, and are recommended for acceptance.

District Engineer _____ Date _____

PART C (to be completed by the District Manager)

1. Please state any special considerations or time restraints which should be brought to the attention of the District's Attorney. Include a brief background statement describing location and extend of development as well as proposed points of connection to existing mains.

2. I have reviewed the proposed easements and recommend that they be accepted by the District.

District Manager _____ Date _____

PART D (to be completed by the District's Attorney)

1. Please provide the following information:

Easement No.	Date Recorded	County	Reception No.

2. Copies of all easements have been forwarded to:

_____ Grantor(s)

_____ District Manager (with copy of checklist)

_____ District Engineer (with copy of checklist)

16. PRECONSTRUCTION AND CONSTRUCTION PROCEDURES

16.1 Preconstruction Meeting

The Contractor shall be responsible for arranging a preconstruction meeting prior to the start of any construction. The District Manager, District Engineer, Contractor, Owner, Owner's Engineer, surveyor, soils consultant, and County and/or City representatives must be represented at this meeting.

The Contractor shall be responsible for notifying the District Engineer and District Manager at least 48 hours prior to the start of any construction. If work is suspended for any period of time after initial start-up, the Contractor must notify the District Engineer 24 hours prior to start.

16.2 Construction Water

16.2.1 The Developer/Contractor is responsible for obtaining the necessary permits and paying the necessary fees to the District for construction water. Contact the District at 303-688-8550 to obtain a meter for the project and pay the required fees.

16.2.2 Fees include:

- One-time, refundable deposit to obtain a meter
- Monthly charge for use of meter
- Consumption charges based on gallons used from meter readings.

16.2.3 All water to be used in backfill and compaction, site cleanup, dust control measures, flushing sewer lines, etc., shall be obtained from a fire hydrant specified by the District. All water shall be obtained through the District's meter.

16.2.4 All water used to flush sewer and water mains shall be disposed of properly by the Contractor per local and/or State laws and regulations. The Contractor is responsible for obtaining all necessary discharge permits from the appropriate governing agencies.

16.2.5 Contractors completing work on behalf of the District will not be required to pay the monthly meter fee. However, payment of the meter deposit and consumption charges will be required.

16.3 Locating Existing Sewer Lines

16.3.1 Prior to the start of any work, where sewer mains are to be installed into existing District sewer systems, the nearest manhole to the point of connection shall be plugged with a plumbers plug on the outlet side by the Contactor. This plug shall remain in place until acceptance of construction by the District. Its purpose is to prevent any mud, water, or other materials from entering the existing line during construction. The Contractor shall be responsible for pumping and cleaning manholes and removing the plug.

16.4 Pipeline Backfill

16.4.1 No pipe or appurtenance shall be backfilled, nor covered with bedding material, above the spring line of the pipe prior to the review by the District. Arrangements shall be made by the Contractor to assure that all construction is reviewed by the District Engineer prior to backfilling. Any pipe covered prior to review and acceptance shall be excavated by the Contractor to allow for review. This shall be done at no expense to the District.

16.5 Record Drawings

16.5.1 The Contractor is responsible for maintaining as-built drawings to include all distances between manholes and locations of wyes or service tees. The Contractor shall record all deviations from the construction drawings.

16.5.2 As-built drawings must be reviewed by the District Engineer before probationary acceptance.

16.5.3 The as-builts should be 22-inches by 34-inches. Required sets include one (1) copy of black line prints and two (2) copies of reproducible mylar prints.

16.5.4 One (1) copy of the AutoCAD files (with as-built information), saved in version 2011 or older on CD, must be submitted to the District Engineer.

16.6 Construction Observation

16.6.1 General

(a) The District and/or District Engineer shall decide any and all questions that may arise as to the quality and acceptability of the materials furnished and the work performed. The District and/or District Engineer shall decide all questions which may arise as to the interpretation of the District Standards and Specifications. The District Engineer, acting as the District's representative, is not a guarantor of the construction Contractor's obligations and performance of the Contract.

(b) Observation of work in progress and on-site visits are not to be construed as a guarantee by the District Engineer and the District of the Contractor's contractual commitment.

(c) The District Engineer and the District are not responsible for safety in, on, or about the project site, nor compliance by the appropriate party of any regulations relating thereto.

(d) The District Engineer and the District, exercise no control of the safety or adequacy of any equipment, building components, scaffolding, forms, or other work aids used in or about the project and do not supervise the Contractor or his forces.

16.6.2 Overtime

(e) Any construction observation performed at times other than between the hours of 7:30 AM and 5:00 PM, Monday through Friday or on holidays that may fall on

a weekday shall be done at the Contractor's expense. The cost will be based on the current billing rate for a Field Administrator. The minimum charge for weekend (Saturday or Sunday) or holiday observation shall be four (4) hours per day. The District Engineer shall determine whether or not overtime construction observation is necessary.

16.7 Construction Probationary Period

16.7.1 All Construction, including labor, materials and settlement of backfill, shall be guaranteed by the Owner/Developer for a period of two (2) years from the date of acceptance of construction by the District Manager and District Engineer. During the probation period, the expense of any repairs or maintenance to the lines, appurtenances, and facilities shall be the responsibility of the Owner/Developer. The District reserves the right to insure proper operation of its system and to perform any cleaning, repairs or other maintenance during the probationary period at the expense of the Owner/Developer.

16.7.2 The Owner/Developer shall be responsible for the proper alignment and cleanliness of all valve boxes and manholes during the probationary period or until the street paving has been completed, whichever is longer. Written notification of any deficiencies discovered during this period will be provided by the District Manager or District Engineer. If the deficiencies are not corrected within the prescribed time limits, the corrections shall be completed by the District at the complete expense of the Owner/Developer.

17. ACCEPTANCE AND RELEASE FOR TAPS

A main shall be accepted by the District and released for taps when the following conditions have been met:

17.1 The main and all appurtenances have been installed to the satisfaction of the District Engineer.

17.2 All pertinent notes and measurements have been made by the Contractor on the record drawings. One (1) set of half-size black line prints with two (2) sets of half size reproducible mylar prints of the record drawings have been submitted to, and approved by, the District Engineer. One (1) copy of the AutoCAD files saved in version 2011 or older on CD has been submitted to the District Engineer.

17.3 The sewer main has passed all required field testing per Section 11 of these specifications.

17.4 All compaction test results required by the District Engineer have been submitted.

17.5 All easements have been submitted and recorded with the County.

18. SEWER SERVICES

18.1 General

18.1.1 A separate sewer service will be required for each user of the system unless otherwise approved by the District.

18.1.2 No connection to a Castle Pines North Metropolitan District owned sewer main, or approved stub out, shall be allowed prior to the purchase of a District tap permit, or "Connection Permit."

Tap permits will not be issued prior to District acceptance of the sewer main to be tapped.

18.1.3 Service lines shall be a minimum of 4-inches diameter. Refer to Section 3 for minimum slopes.

18.1.4 Sewer wyes (or tees with prior approval by District) shall be used to make the connection on the District's sewer mains whenever possible. Wyes shall be installed during the construction of the sewer main in compliance with Section 9.1.4. The location of all sewer wyes shall be shown on the as-constructed drawings.

Wherever wyes are not used, connections shall be made by mechanical tap using a service saddle approved by Castle Pines North Metropolitan District (and per District detail drawing 13S). Prior approval by the District is required for the installation of saddle taps.

18.2 Location

18.2.1 Sewer services shall be located a minimum of ten feet (10') from water services and will generally be located on the downhill side of the water service. Service lines shall be installed in a continuous straight line perpendicular to the main and shall enter the property a minimum distance of five feet (5') from the nearest lot corner. The main to be tapped must extend a minimum distance of fifteen feet (15') along the front lot line of the property to be served.

(a) Services shall be laid at a minimum slope per Uniform Plumbing Code and per Section 3 of these specifications. 4-inch services shall be laid at 2.0% minimum (¼" per foot).

(b) Services shall be installed to 10-feet inside the lot.

(c) Services shall be plugged at the end of the line with an airtight / watertight plug. Plugs shall be able to withstand the internal pressure of leakage testing per Section 11.

(d) Service plugs shall be marked with a 2x4 piece of lumber, painted green, extending above ground at least 24-inches.

18.2.2 Refer to District detail drawing 12S for the permitted location and for the spacing of taps.

18.2.3 Service lines shall generally have 6-feet of cover and in no case shall the line be less than 4.5-feet deep.

18.2.4 In general, sewer service lines will not be allowed to connect to manholes. However, one service line will be allowed to connect to a manhole located at the end of a cul-de-sac street by use of a main line stub out per District detail drawing 11S.

18.2.5 Cleanouts shall be installed every 100 feet (100') and at every bend in the service line and per the current Uniform Plumbing Code. See District detail drawing 14S. Refer to Section 6 of these specifications.

18.2.6 All sewer service lines shall have an "X" cut or chiseled in the curb where concrete curb and gutter is present.

18.3 Materials

18.3.1 Pipe – Sewer service pipe shall meet material requirements established in these specifications. In general, service pipe shall match the pipe type installed for the sewer main (SDR 35 PVC service on an SDR 35 PVC main; C900 PVC service on a C900 PVC main).

18.3.2 Fittings – Sewer tap fittings and materials shall meet material requirements established in these specifications.

18.3.3 Tapping Saddles (Only to be used with prior approval by District) – Tapping saddles shall be fabricated to insure that not protrusions of the saddle will extend into the sewer being tapped and shall fit the contour of the sewer. The saddles shall be PVC with double wire bands per District detail drawing 13S.

18.3.4 Joint Material – Joints between existing wyes or tees and sewers shall be watertight. All saddles shall be joined to the sewer main by use of an epoxy material and double wire bands accepted by the Castle Pines North Metropolitan District.

18.4 Construction

18.4.1 Damaged Conditions – If damaged sewer line wyes or tees are encountered, these wyes or tees shall be permanently repaired so as to prevent dirt, roots, or groundwater from entering the sewer.

Concrete encasement of sewer lines will not be construed as a watertight fabrication and shall not be substituted as a formed joint nor will it be used to repair damaged joints or pipe.

18.4.2 Saddle Connections (Only to be used with prior approval by District) – Saddle connections shall be smooth and placed on a round machine-drilled hole in the sewer main. The machine-drilled hole shall be of such a size to provide one-eighth inch (1/8") clearance between the outside of the saddle and the hole. This space shall be completely filled with epoxy-joint material. The

allowable space between the shoulder or the saddle and the face of the sewer main shall be one eighth inch (1/8") thick and this space shall also be filled with epoxy joint material. Construct per District detail drawings 13S.

18.4.3 Backfill and Paving – Backfill material, compactive effort, and paving requirements for sewer connections will conform to Castle Pines North Metropolitan District Sanitary Sewer System Specifications and to the requirements of Douglas County and/or City of Castle Pines.

18.4.4 Street Repair – Street repair or replacement work which results from sewer line or manhole placement shall meet minimum Douglas County and/or City of Castle Pines Standards. Substandard or deficient repair/replacement of paving etc. shall be re-done at the expense of the owner of the building sewer etc. The guarantee period for such work covers a period of two (2) years from the date of completion.

19. CASTLE PINES NORTH METRO DISTRICT GENERAL SANITARY SEWER NOTES

The following general notes shall be included on all construction plans for sanitary sewer improvements:

1. All sanitary sewer system plans and construction shall conform to the current Castle Pines North Metropolitan District Specifications, Douglas County and/or City of Castle Pines Standards, and shall be subject to construction observation by District personnel or representatives. Copies of the District's Specifications may be obtained from the District. The Owner, his Engineer or Contractor, shall schedule a pre-construction meeting with the District at least 48 hours prior to the start of construction. Construction plans, reviewed and signed by the District Manager and District Engineer, will be distributed at the pre-construction meeting. No construction will be permitted until all easements are signed and recorded and the pre-construction meeting has been held.

2. The pipe for sanitary sewer mains installed at depths equal to or less than 15-feet and installed in paved R.O.W. shall be ASTM SDR 35 PVC. The pipe for sanitary sewer mains installed at depths greater than 15-feet or installed in unpaved R.O.W. or easements shall be AWWA C900 DR14 PVC (6” through 12”) or AWWA C905 DR18 PVC (14” through 24”).

3. The pipe for force mains shall be AWWA C900 DR14 PVC.

4. The bedding for sanitary sewer mains installed at depths equal to or less than 15-feet and installed in paved R.O.W. shall be squeegee or well-graded sand. The bedding for sanitary sewer mains installed at depths greater than 15-feet or installed in unpaved R.O.W. or easements shall be ¾-inch crushed rock with Geotextile Fabric installed over the rock bedding prior to backfill.

5. 5-foot diameter manholes with intermediate platforms are required on all manholes 20-feet and deeper.

6. No connection to a Castle Pines North Metropolitan District owned sewer main, or approved stub out, shall be allowed prior to the purchase of a District tap permit, or “Connection Permit.” Tap permits will not be issued prior to District acceptance of the sewer main to be tapped.

7. Probationary acceptance of the new sanitary sewer mains will not be considered until all requirements for acceptance have been met, including

    - Sanitary sewer trench compaction test results
    - Record drawings.

8. The sanitary sewer system will be tested in accordance with the District Specifications.
    - Low pressure air test - 100% of the new system.
    - Video inspection - 100% of the new system.
    - Lamp and deflection test the new system upon request by the District.

9. Prior to installation of sanitary sewer mains, road construction must have progressed to at least the "sub-grade" stage. Manhole rims shall be set at an elevation relative to the pavement, in accordance with the appropriate City, County, or State Highway Department

Standards. Whether or not the manhole is in a paved or unpaved area, a minimum of four-inches (4") of concrete riser rings shall be used to adjust rim elevations to final grade. The maximum acceptable vertical adjustment utilizing riser rings is twelve inches (12").

10. Existing pipe at the point of connection shall not be "broken out" and no service connections will be made until the new system is accepted.

11. The Contractor shall verify existing manhole inverts at proposed points of connection, prior to construction staking.

12. The Contractor shall take care to properly shape all manhole inverts and benches in accordance with District Specifications. Manhole inverts shall be constructed with a smooth trowel finish, and benches finished with a light broom, non-skid finish.

13. All sewer service line locations shall have an “X” chiseled in the curb where curbs are present.

14. The District does not inspect, maintain, or assume ownership of any underdrains.

15. The District, its representative, and/or the District Engineer, is not a guarantor of the construction Contractors' obligations and performance of contract.

16. Observations of work in progress and on-site visits are not to be construed as a guarantee by the District or District Engineer, of the Contractors' performance.

17. The District and/or District Engineer, is not responsible for safety in, on, or about the Project site, nor for compliance by the appropriate party of any regulations relating thereto.

18. The District and/or District Engineer, exercises no control of the safety or adequacy of any equipment, building components, scaffolding, forms, or any other work aids used in or about the project, or in the superintending of the same.

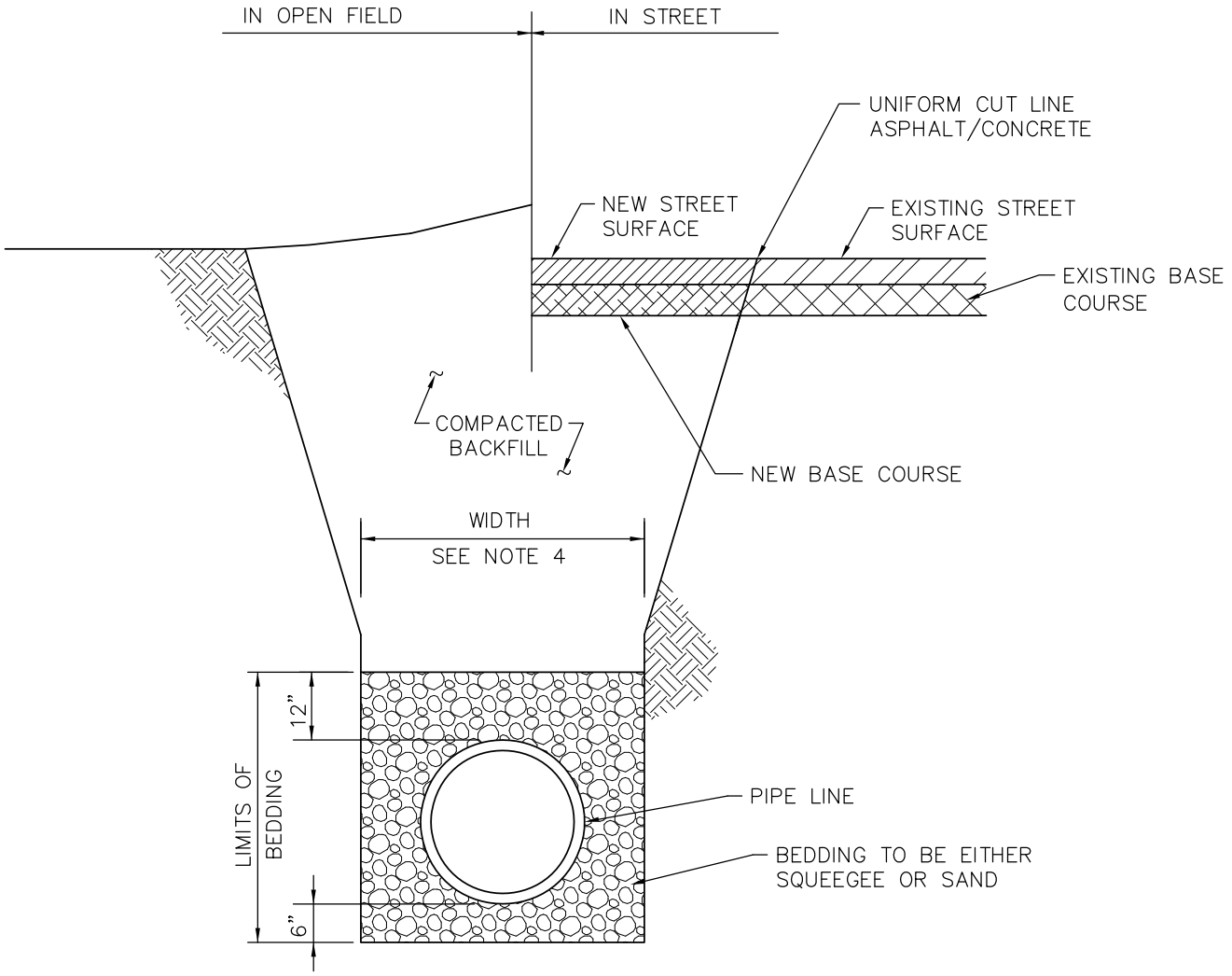
19. All new mains must be jetted prior to probation and again prior to final conveyance and acceptance by the District. Costs of jetting will be the responsibility of the Developer. The Contractor will be responsible for all pumping associated with the line jetting.

20. All new mains must be video-inspected prior to probation and again prior to final conveyance and acceptance by the District. Costs of video inspection will be the responsibility of the Developer.

21. The invert elevations of all existing pipes where connections are to be made must be field-verified prior to construction.

20. DETAIL DRAWINGS

Detail No.	Detail Name
1S	Standard Bedding for Sanitary Sewer
2S	Special Bedding for Sanitary Sewer Lines
3S	Bedding for Sanitary Sewer with Underdrain
4S	Precast Manhole
5S	Manhole Base and Deflector
6S	Plastic Manhole Step
7S	24” Manhole Ring and Cover
8S	24” Manhole Ring and Bolt Down Cover
9S	Stub-Out Manhole
10S	Connection to Existing Manhole
11S	Service Connection to Dead End Manhole
12S	Service Connection to New Construction
13S	Connect to Existing Sanitary Sewer
14S	In-Line Sanitary Sewer Cleanout (4”)
15S	Steel Marker Post
16S	Carsonite Marker Post
17S	Redwood Marker Post
18S	Outside Drop Structure for Sewer 15” and Smaller
19S	Outside Drop Structure for Sewer 18” and Larger
20S	Pipe Repair
21S	Pipe Abandonment
22S	Manhole Abandonment
23S	Concrete Encasement
24S	Pipe Casing and Sled – Redwood Runners
25S	Pipe Casing and Sled – Glass Reinforced Polyester Runners
26S	Not Used
27S	Commercial Grease Interceptor (2 sheets)
28S	Commercial Sand and Oil Interceptor (2 sheets)
29S	Not Used
30S	Inside Manhole Drop Connections
31S	Inside Manhole Drop Bowl
32S	Inside Manhole Drop Connection Bracket



TYPICAL TRENCH SECTION

NOTES:

1. TRENCH TO BE BRACED OR SHEETED AS NECESSARY FOR THE SAFETY OF THE WORKMEN AND PROTECTION OF OTHER UTILITIES IN ACCORDANCE WITH APPLICABLE LOCAL, STATE AND FEDERAL SAFETY REGULATIONS.
2. PIPE SHALL BE BEDDED FROM 6" BELOW THE BOTTOM OF THE PIPE TO 12" ABOVE THE TOP OF THE PIPE.
3. TRENCH WIDTH SHALL NOT BE MORE THAN 16" NOR LESS THAN 12" WIDER THAN THE LARGEST OUTSIDE DIAMETER OF THE PIPE.
4. COMPACTION FOR THE TOP 2.5 FT. OF TRENCH ZONE SHALL BE 95% S.P.D. IN STREET R.O.W., 90% S.P.D. OUTSIDE R.O.W. THE REMAINDER OF THE TRENCH SHALL BE 90% S.P.D.
5. MINIMUM PIPE COVER TO BE 5' BELOW FINAL STREET GRADE.
6. PIPE AND BEDDING FOR SANITARY SEWER MAINS INSTALLED AT DEPTHS GREATER THAN 15-FEET OR INSTALLED IN UNPAVED R.O.W. OR EASEMENTS: AWWA C900 DR14 PVC PIPE OR AWWA C905 DR18 PVC PIPE WITH 3/4-INCH CRUSHED ROCK BEDDING AND MIRAFI FABRIC INSTALLED OVER THE BEDDING PRIOR TO BACKFILL.

STANDARD BEDDING FOR SANITARY SEWER

Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

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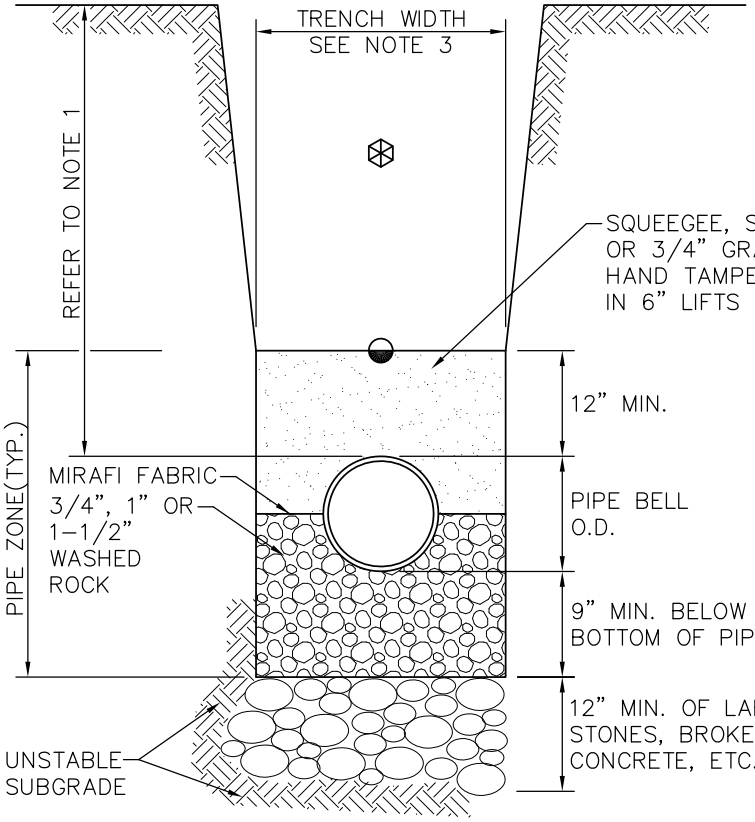
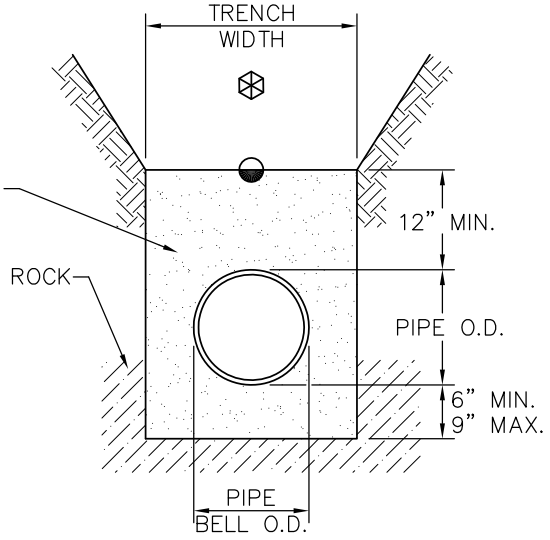
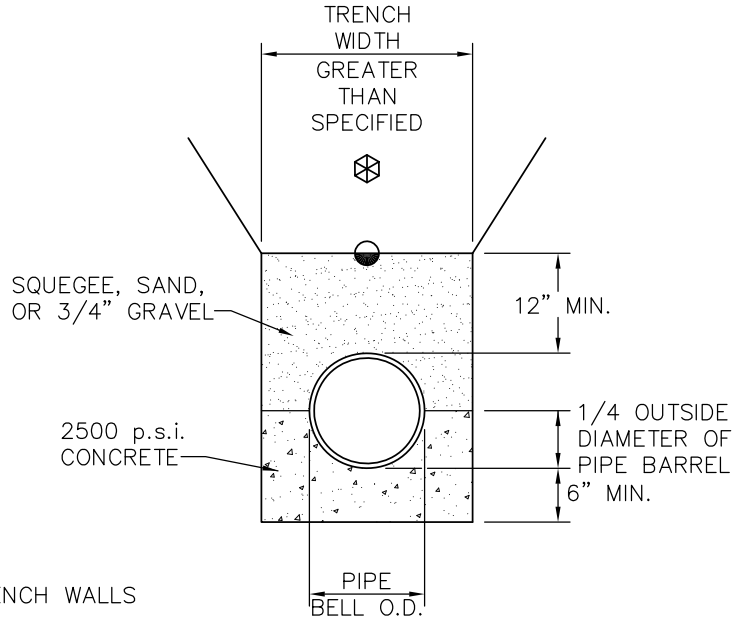


UNSTABLE SUBGRADE



PIPE BEDDING IN ROCK



TRENCH OVERWIDTH

MACHINE COMPACTED TRENCH BACKFILL

LIMITS OF SLOPING OR BENCHING OF TRENCH WALLS

UNDISTURBED GROUND

NOTES:
1. MIN. PIPE COVER TO BE 5' BELOW FINAL STREET GRADE.
2. THE TRENCH SHALL BE IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, AND FEDERAL SAFETY REGULATIONS.
3. TRENCH WIDTH SHALL NOT BE MORE THAN 16 INCHES NOR LESS THAN 12 INCHES WIDER THAN THE LARGEST OUTSIDE DIAMETER OF THE PIPE LAID THEREIN (BELL OR COUPLING O.D. IF APPLICABLE).

SPECIAL BEDDING FOR SANITARY SEWER LINES

Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

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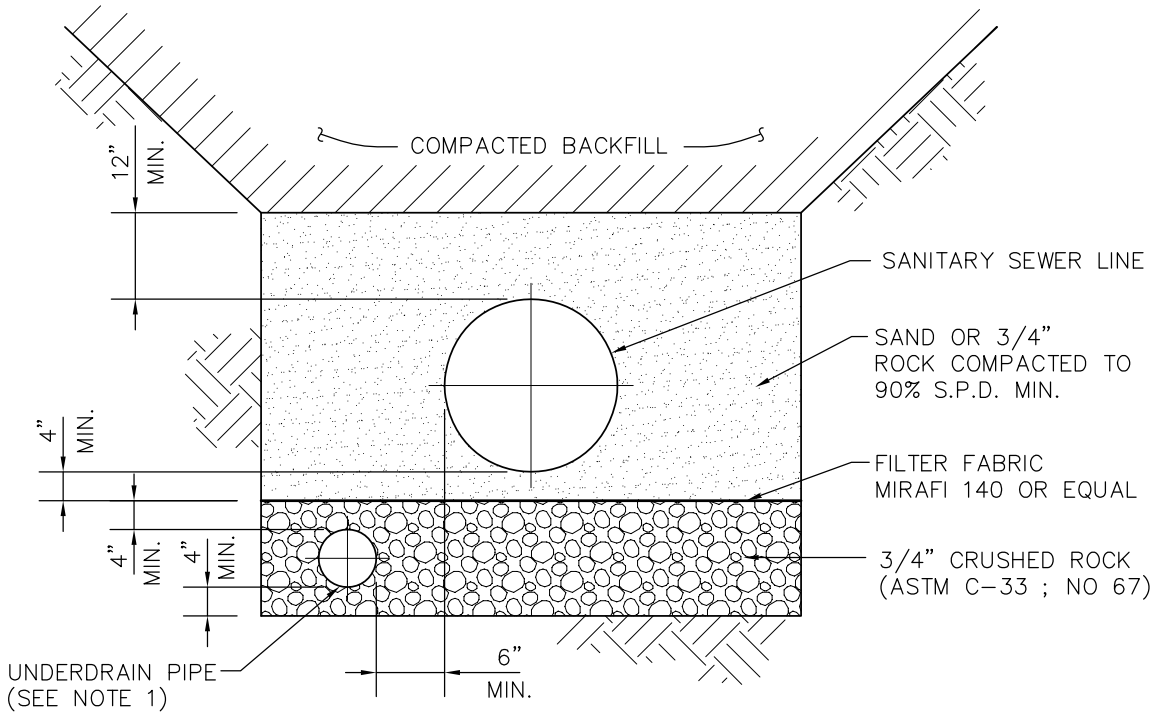
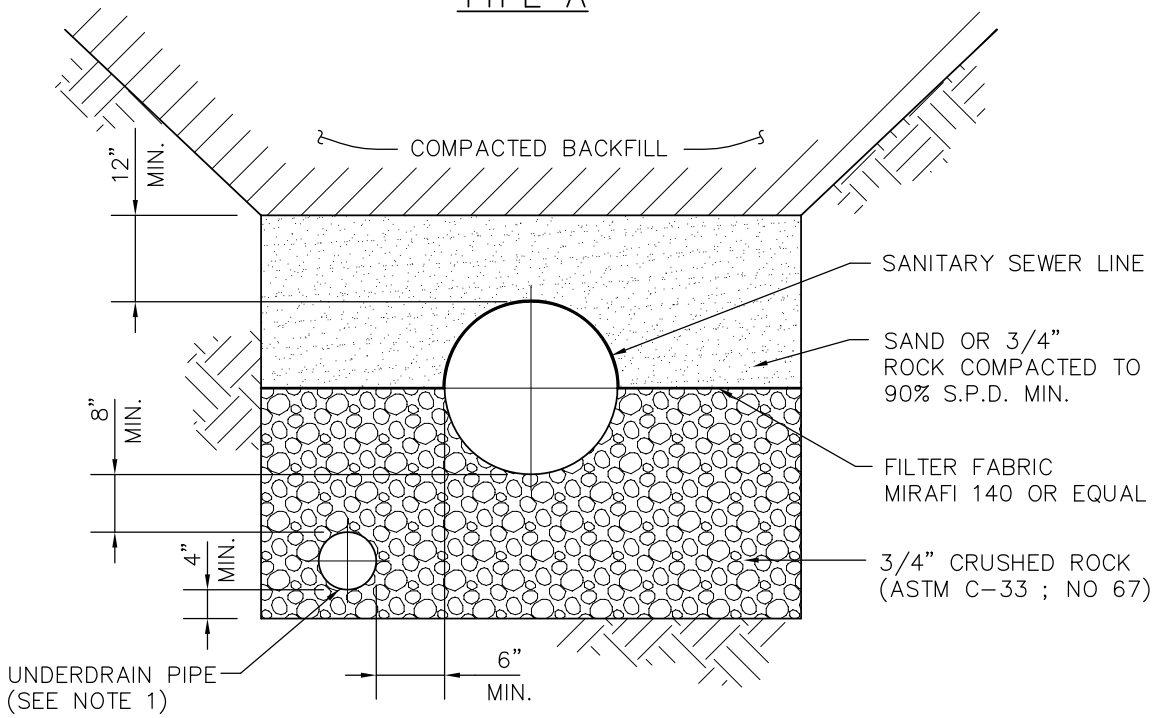


TYPE A



TYPE B

NOTES:

1. UNDERDRAIN SHALL BE THE SAME OR GREATER STRENGTH THAN SEWER LINE.
2. OWNERSHIP, OPERATION, AND MAINTENANCE OF THE UNDERDRAIN SYSTEM IS NOT THE RESPONSIBILITY OF THE DISTRICT.
3. UNDERDRAINS TO BE ROUTED AROUND MANHOLE BASES AND DRAINED TO STORM SEWER.
4. MIN. PIPE COVER TO BE 5' BELOW FINAL STREET GRADE.

BEDDING FOR SANITARY SEWER LINES WITH UNDERDRAIN

Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

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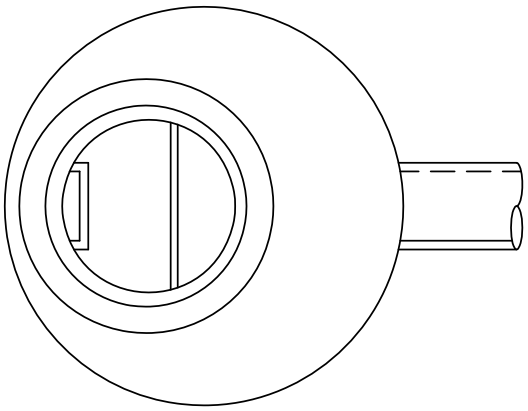

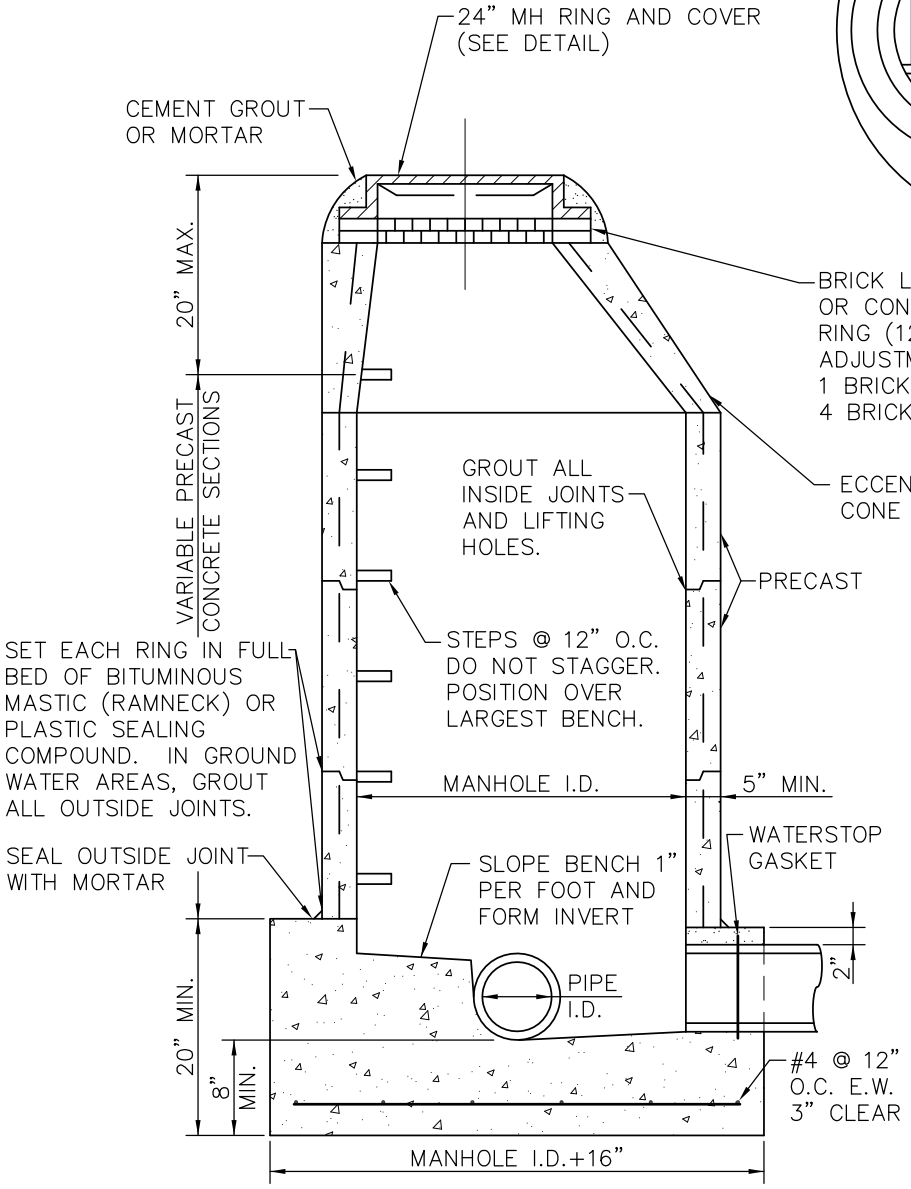

PIPE I.D.	MANHOLE I.D.	RING & COVER
18" & SMALLER	4'-0"▲	24"
21" TO 48"	5'-0"	30"
54"	6'-0"	30", 36" W/24"
60" & LARGER	SPECIAL DESIGN	INNER COVER

▲ WHENEVER MORE THAN A TWO WAY MANHOLE OF MAX. PIPE I.D. IS REQUIRED, THE MANHOLE SHOULD BE INCREASED TO LARGER DIA., EG. 18"x18"x18", REQUIRES 5'-0" I.D.

NOTES:

1. MANHOLE BARREL MIN. DIA. SHALL CONFORM TO TABLE BELOW.
2. SHAPING FOR SMOOTH MAN-HOLE INVERTS MUST BE DONE BY FORMING OR SHAPING BASE CONCRETE.
3. MANHOLE STEPS SHALL BE PER MANHOLE STEP DETAIL(S).
4. PRECAST CONCRETE SECTIONS SHALL CONFORM TO ASTM C-478.
5. BLOCK-OUTS, WHEN APPROVED, SHALL EXTEND A MAX. OF 6" PAST MANHOLE O.D. AND BE SATISFACTORILY PLUGGED AND SEALED.
6. CONCRETE MANHOLES MAY BE POURED IN PLACE ONLY WITH PRIOR APPROVAL.
7. ALL MORTAR GROUT SHALL BE MIXED WITH TYPE II CEMENT.
8. BENCH MUST HAVE A BRUSHED, NON-SKID SURFACE.
9. OUTFALL AND DROP MANHOLES SHALL BE LINED WITH INTERIOR CORROSION-RESISTANT COATING PER ENGINEERING STANDARDS.
10. INTERMEDIATE PLATFORMS ARE REQUIRED ON ALL MANHOLES INSTALLED AT DEPTHS EQUAL TO OR GREATER THAN 20-FEET.

PRECAST MANHOLE

Castle Pines North METROPOLITAN DISTRICT

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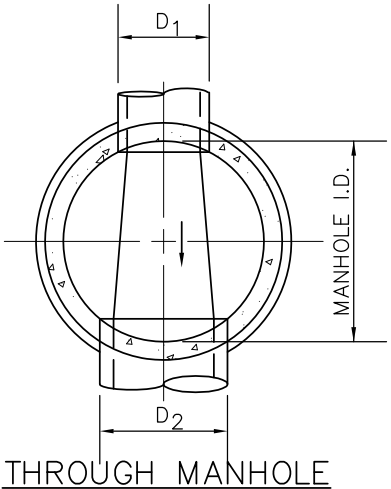
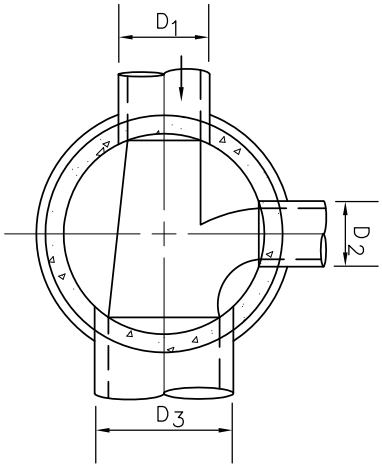
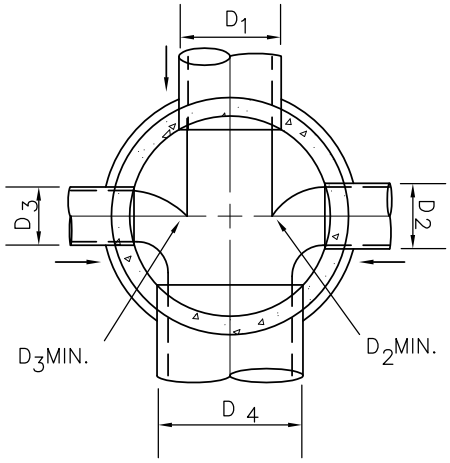


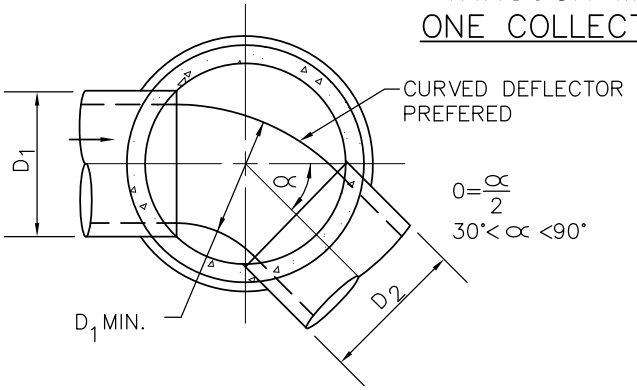
THROUGH MANHOLE



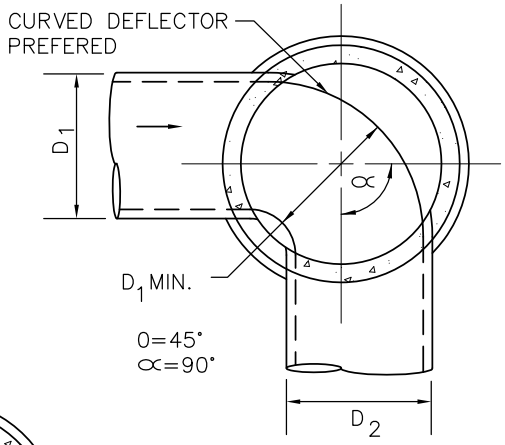
THROUGH MANHOLE
ONE COLLECTION LINE



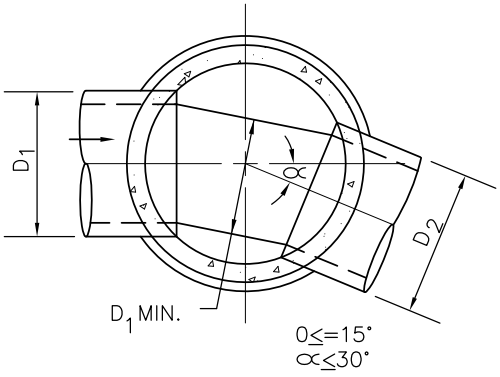
THROUGH MANHOLE
TWO COLLECTION LINES



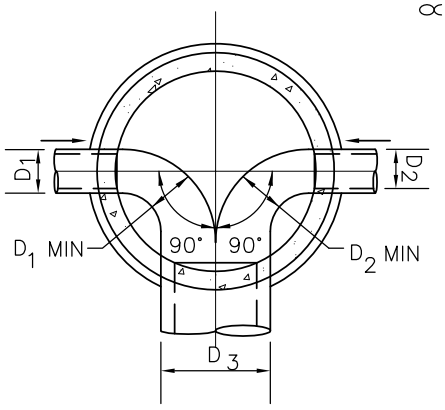
INTERMEDIATE ANGLE



SHARP ANGLE



INTERMEDIATE ANGLE



OPPOSED LATERALS

CURVED DEFLECTOR "POINTS" SHALL EXTEND COMPLETELY ACROSS THE OPPOSED LATERALS AS SHOWN.

CURVED DEFLECTOR "POINTS" SHALL EXTEND ACROSS THE CENTERLINE OF THE OPPOSING PIPES AS SHOWN.

NOTES:

1. Pipe invert elevation and drop through manholes shall be in conformance with the reviewed and signed Construction Plans. The intention is to promote smooth, non-turbulent flow through the manholes by keeping the larger lines lower in the manhole and bringing the smaller lines in slightly higher.
2. Maximum inside drop through any manhole shall be 18 inches.
3. Minimum drop through any manhole shall be 0.2 ft.
4. All invert deflectors shall be curved in shape to provide smooth flow transitions as shown in this detail.
5. Minimum angle between the centerline of any incoming pipe and the center of the outgoing pipe shall be 90 degrees.

MANHOLE BASE AND DEFLECTOR

Castle Pines North METROPOLITAN DISTRICT

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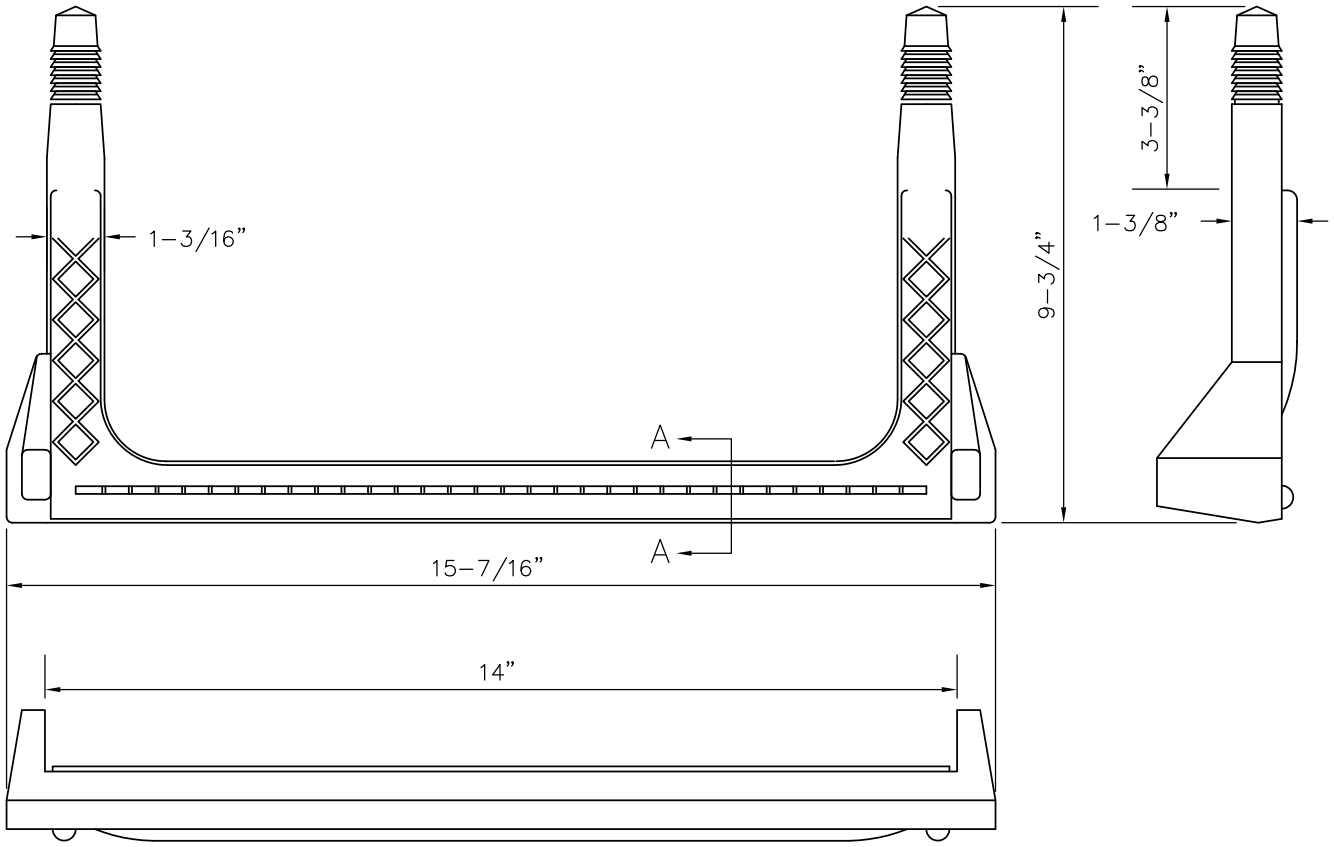
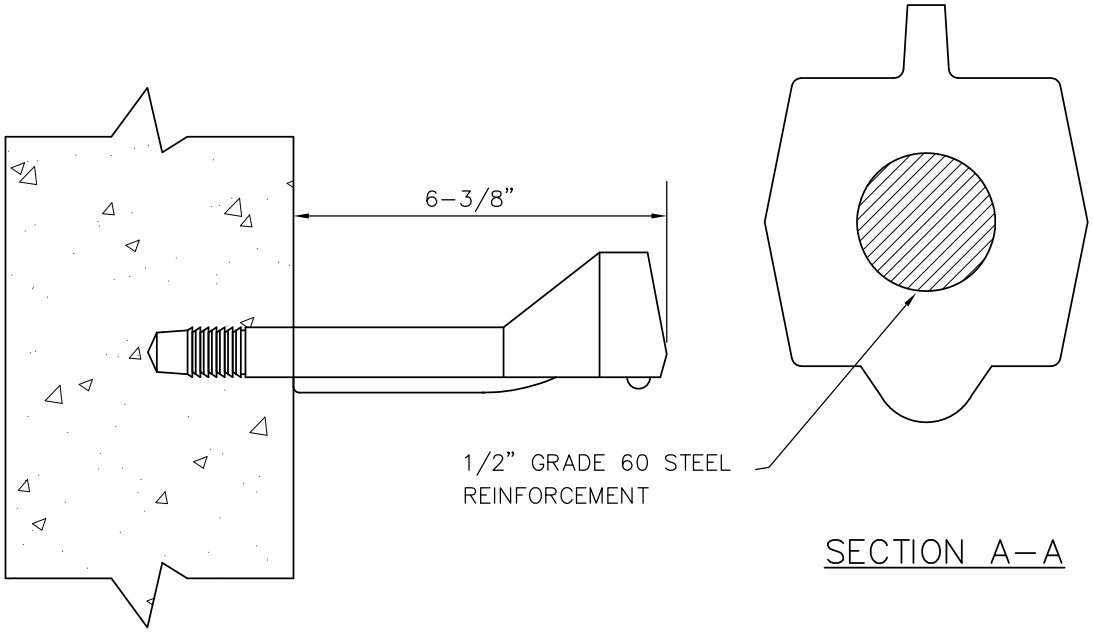


COPOLYMER POLYPROPYLENE PLASTIC



SECTION A–A

PLASTIC MANHOLE STEP

Castle Pines North
METROPOLITAN DISTRICT

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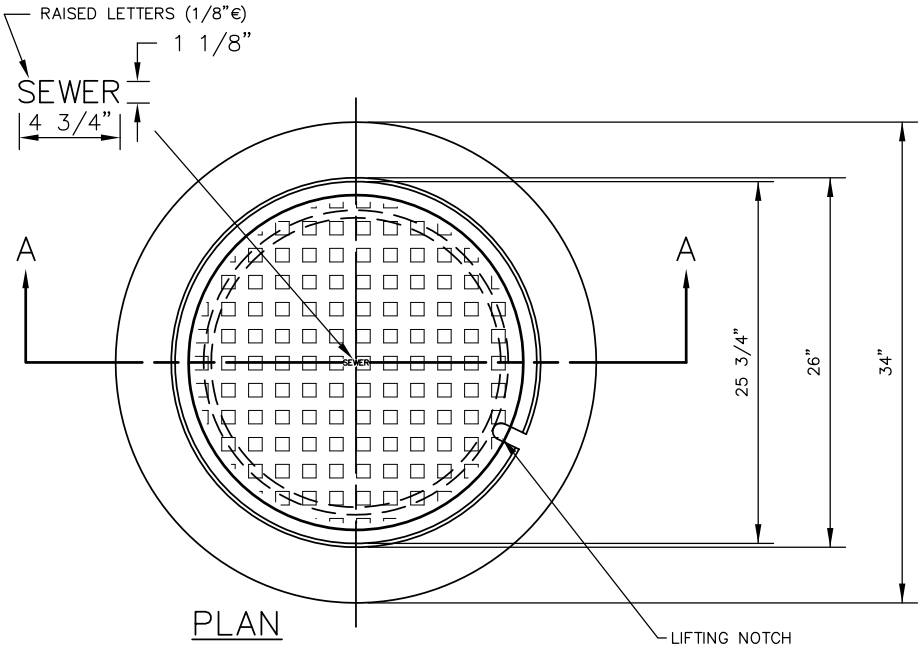
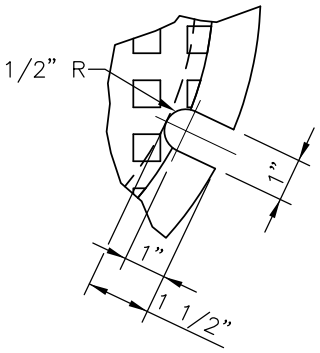
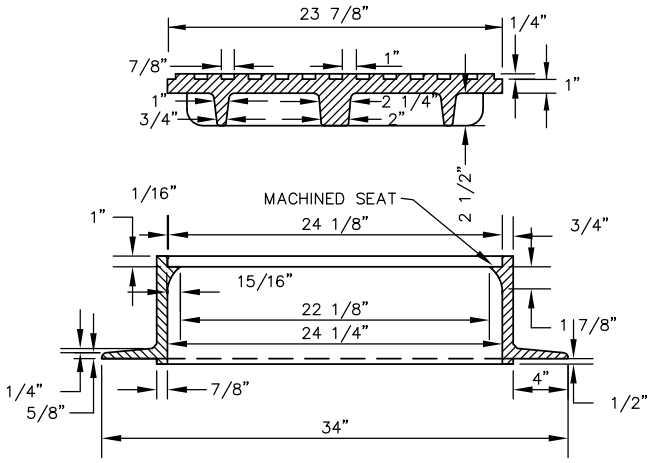


PLAN



LIFTING NOTCH



SECTION A–A

NOTE:

1. CASTING SPECIFICATIONS: ASTM A–48 WITH A MINIMUM TENSILE STRENGTH OF 25 KSI (CLASS 25)
2. ALL CASTINGS TO BE DIPPED IN ASPHALT BASE PAINT (OR APPROVED EQUAL)
3. A 30–INCH RING & COVER MAY BE REQUIRED ON MANHOLES 5' DIA. AND LARGER.
4. CASTINGS SHALL BE AS SPECIFIED BELOW OR EQUAL:

MANUFACTURES	CAT. #
NEENAH	R–1706
CASTINGS, INC.	MH–400–24 C.I.
HUTCHINSON FDRY. & STL. INC.	MH–400

24" MANHOLE RING AND COVER

Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

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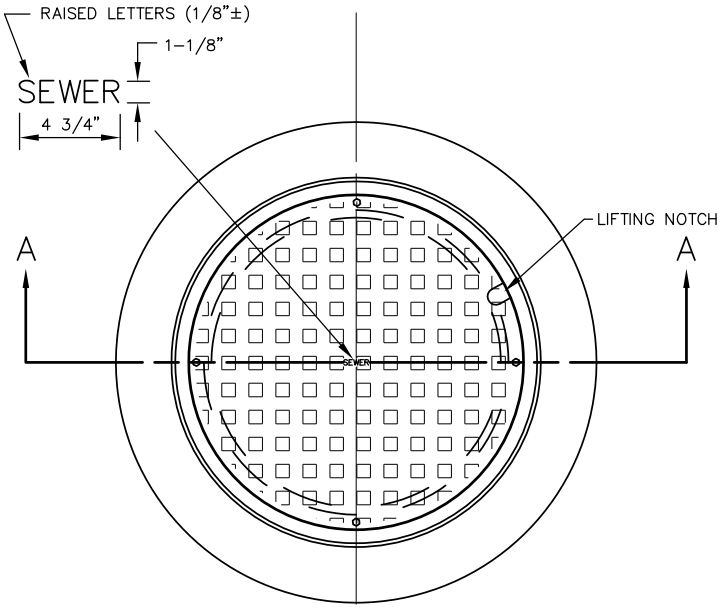
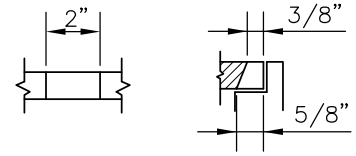
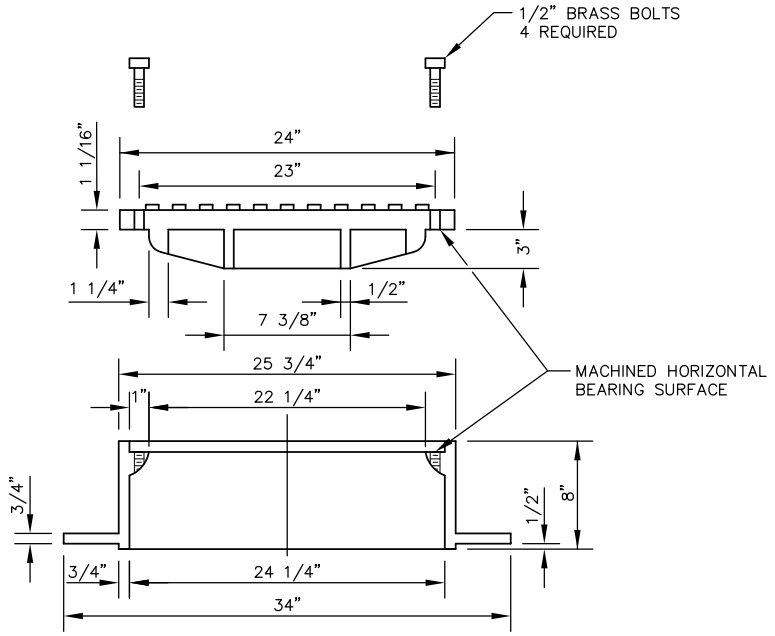


PLAN



FRONT VIEW SIDE VIEW

LIFTING NOTCH



SECTION A–A

NOTES:

1. CASTING SPECIFICATIONS: ASTM A–48 WITH A MINIMUM TENSILE STRENGTH OF 25 KSI (CLASS 25)

2. CASTINGS SHALL BE AS SPECIFIED BELOW OR EQUAL: (CAST IRON ONLY)

MANUFACTURES	CAT. #
J MARK CORP.	J–1161
DEETER	1258–B
NEENAH	R–1925

3. COVER SHALL HAVE SELF–CENTERING BOLT HOLES.

24" MANHOLE RING AND BOLT DOWN COVER

Castle Pines North METROPOLITAN DISTRICT

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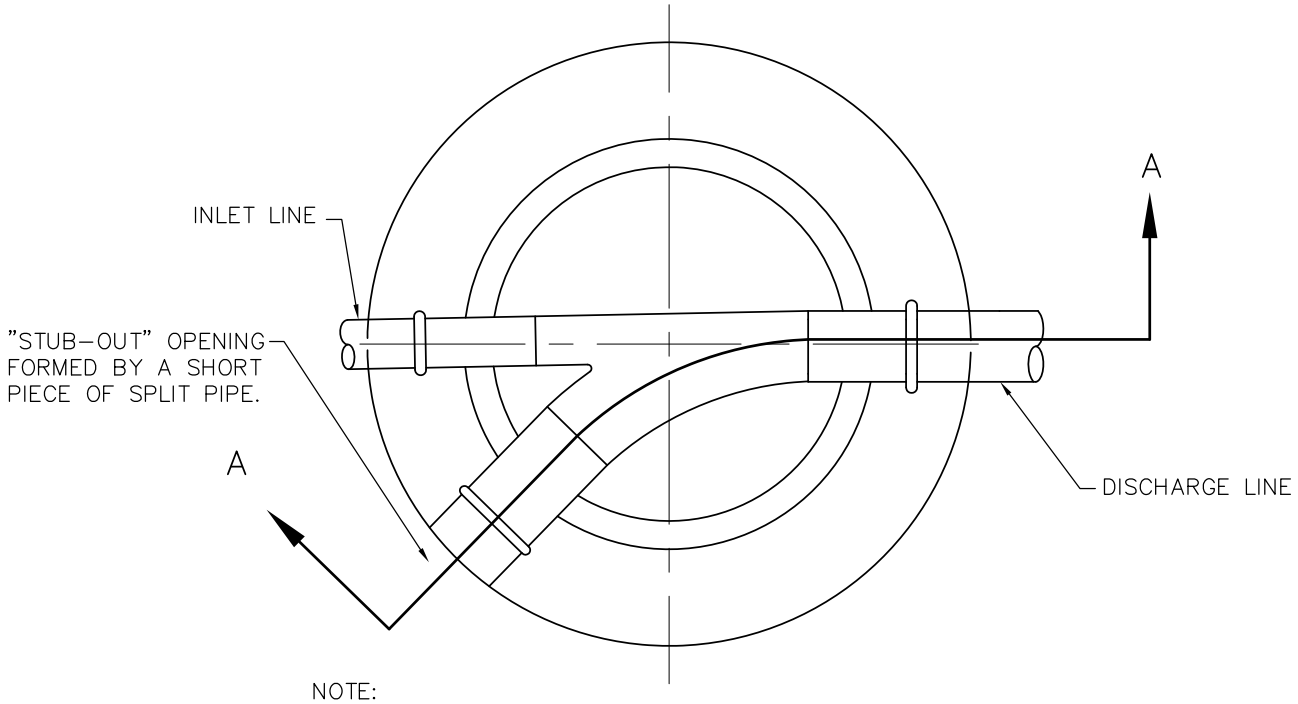
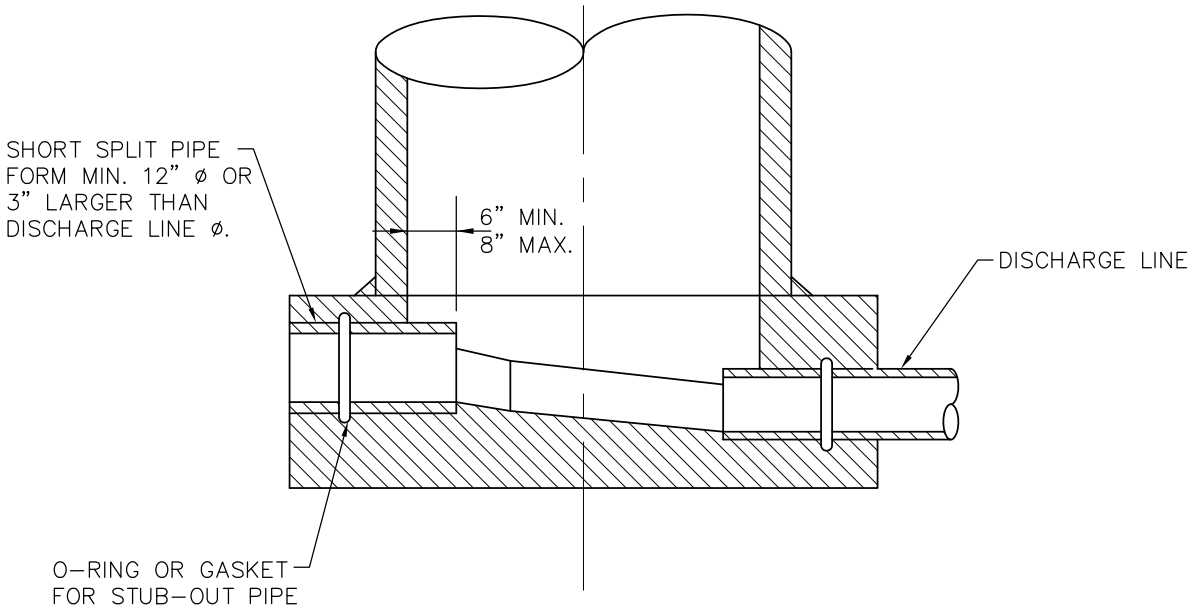


NOTE:
"STUB-OUT" OPENING IN BASE SHALL BE FORMED WITH A SHORT PIECE OF "SPLIT PIPE" AND BENCH FORMED ACCORDINGLY. THE PIPE SHALL BE A MINIMUM OF 12" IN DIA. OR 3" LARGER THAN THE DISCHARGE LINE SIZE. AN "O" RING GASKET SHALL BE USED ON THE LINE TO FORM A GASKET "KEY" FOR USE WHEN THE FUTURE PIPE IS CONSTRUCTED. AFTER THE CONCRETE HAS SET THE "SPLIT PIPE" SHALL BE BROKEN OUT AND THE HOLE CLOSED WITH BRICK AND MORTAR.



SECTION A-A

STUB-OUT MANHOLE

Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

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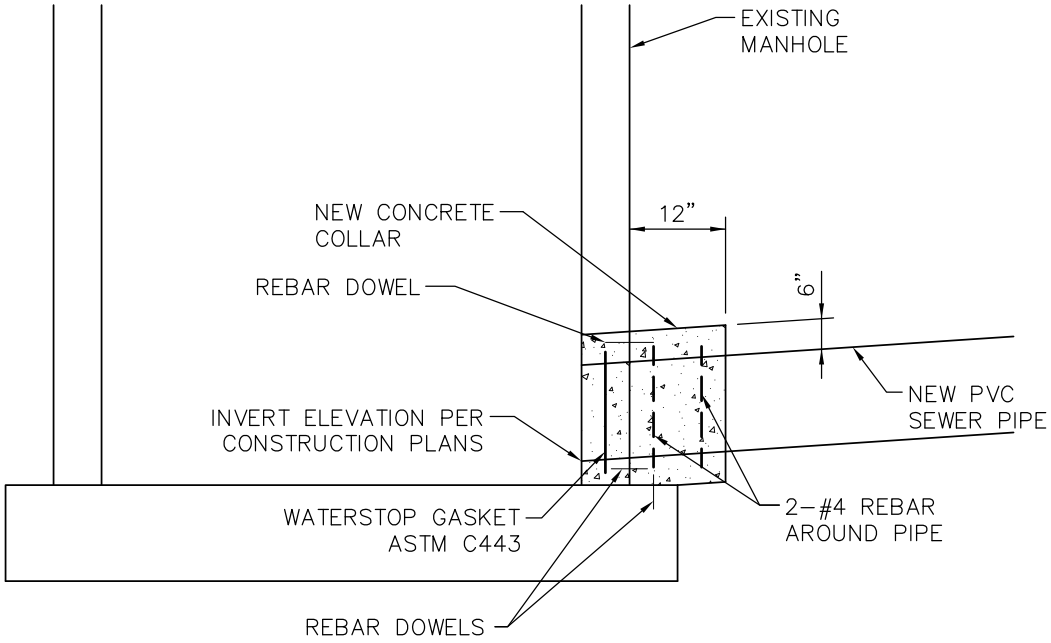

NOTES:

1. USE CONCRETE BONDING AGENT BETWEEN NEW CONCRETE AND THE EXISTING PRECAST CONCRETE.
2. CORE DIAMETER IN EXIST. MH TO BE ONE PIPE–SIZE LARGER THAN PROPOSED TIE–IN PIPE.
3. RESHAPE INVERTS & BENCHES USING CONCRETE TO ACHIEVE PROPER FLOW THROUGH MANHOLE.

CONNECTION TO EXISTING MANHOLE

Castle Pines North METROPOLITAN DISTRICT

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Engineers & Scientists

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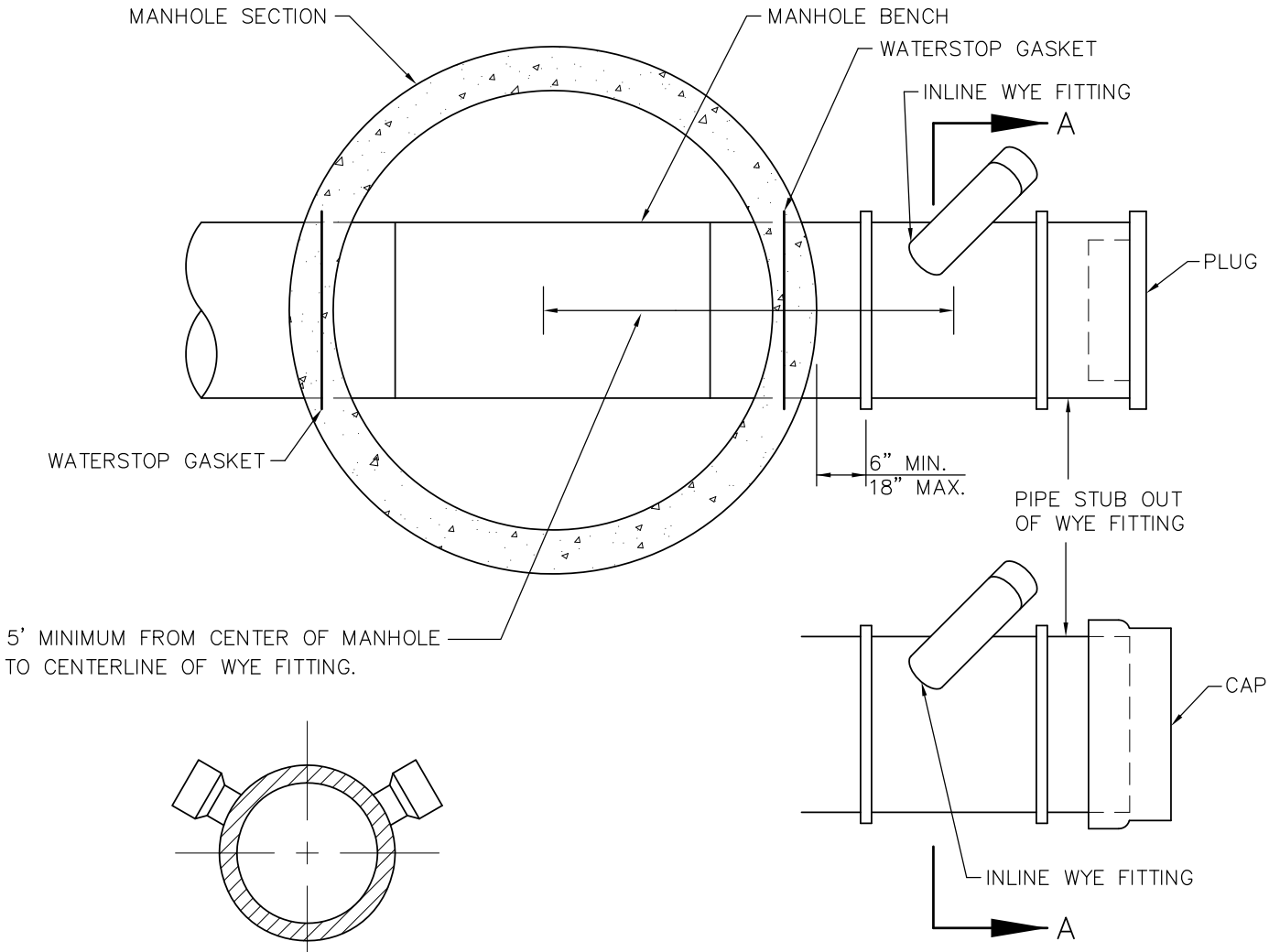

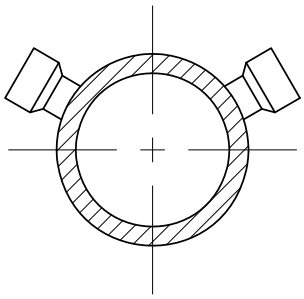

SECTION A–A

NOTE:
TAPS IN STAGGERED
CONFIGURATION AT
10 O'CLOCK OR
2 O'CLOCK POSITION.

NOTES:

1. ONLY ONE SERVICE CONNECTION IS ALLOWED PER MANHOLE.
2. USE IN CONJUNCTION WITH THE STANDARD MANHOLE DETAIL.
3. SLOPE OUT OF MANHOLE TO WYE FITTING IS TO BE AT LEAST 0.5%

SERVICE CONNECTION TO DEAD END MANHOLE

Castle Pines North METROPOLITAN DISTRICT

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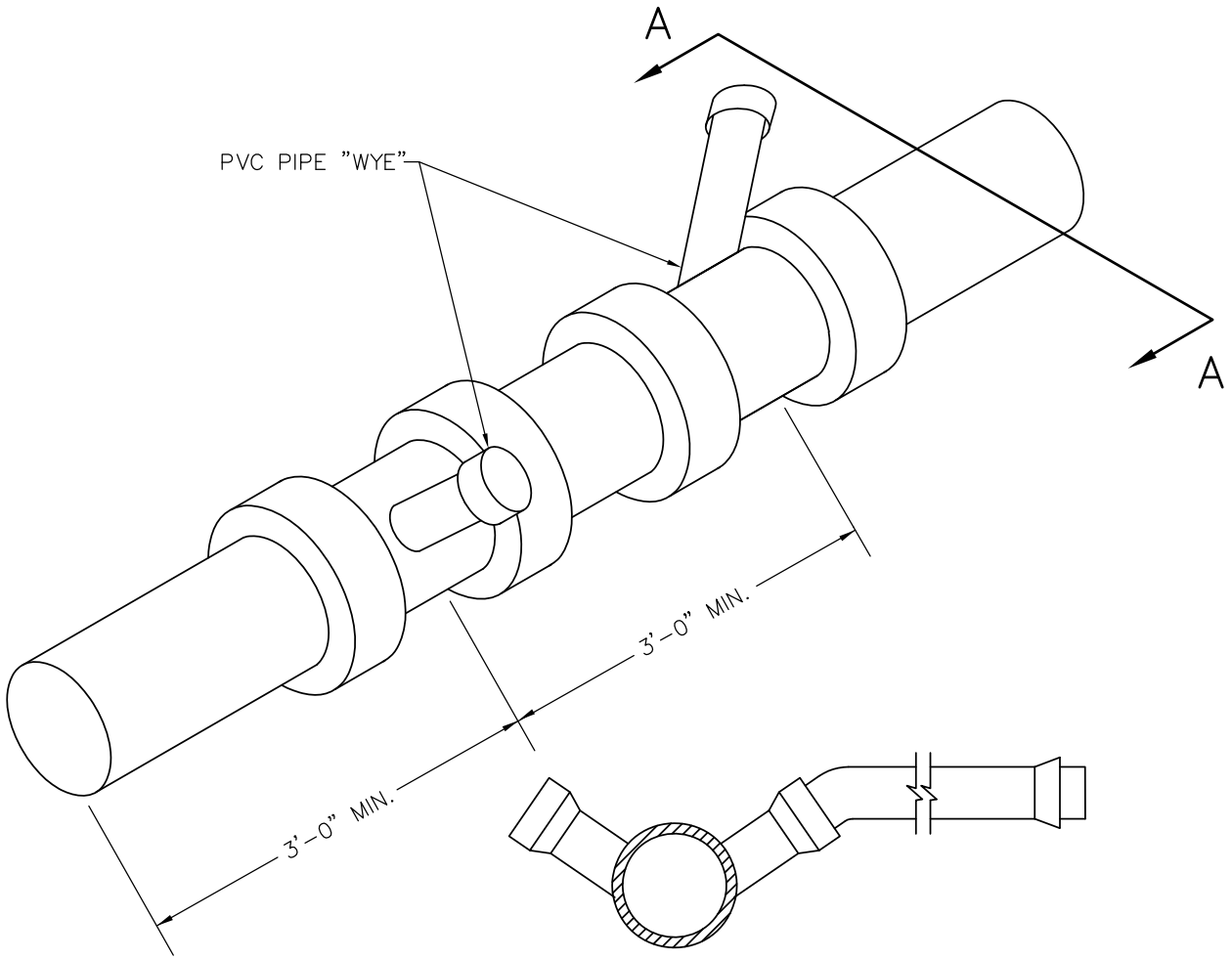

SECTION A–A

NOTE
TAPS IN STAGGERED CONFIGURATION AT
10 O'CLOCK OR
2 O'CLOCK POSITION

NOTES:

1. SANITARY SEWER SERVICE TAPS SHALL BE LOCATED ON THE MAIN AT THE 2 O'CLOCK OR 10 O'CLOCK POSITION.
2. THE MINIMUM DISTANCE BETWEEN ANY TWO CONSECUTIVE FITTINGS SHALL BE 3 FEET, MEASURED BETWEEN FITTING CENTERLINES.
3. SANITARY SEWER SERVICE TAPS SHALL NOT BE MADE WITHIN 3 FEET OF A PIPE JOINT, OR 5 FEET FROM EDGE OF MANHOLE BASE.
4. A MAXIMUM OF FOUR SERVICE TAPS ARE ALLOWED PER 20 FOOT LENGTH OF PIPE.
5. ALL SANITARY SEWER TAPS SHALL USE "WYE" STYLE FITTINGS. TEES ARE NOT ALLOWED.
6. SERVICE CONNECTIONS TO MANHOLES SHALL BE PERFORMED IN ACCORDANCE WITH THE "SERVICE CONNECTION TO DEAD–END MANHOLE" CONSTRUCTION DETAIL.

SERVICE CONNECTION TO NEW CONSTRUCTION

Castle Pines North METROPOLITAN DISTRICT

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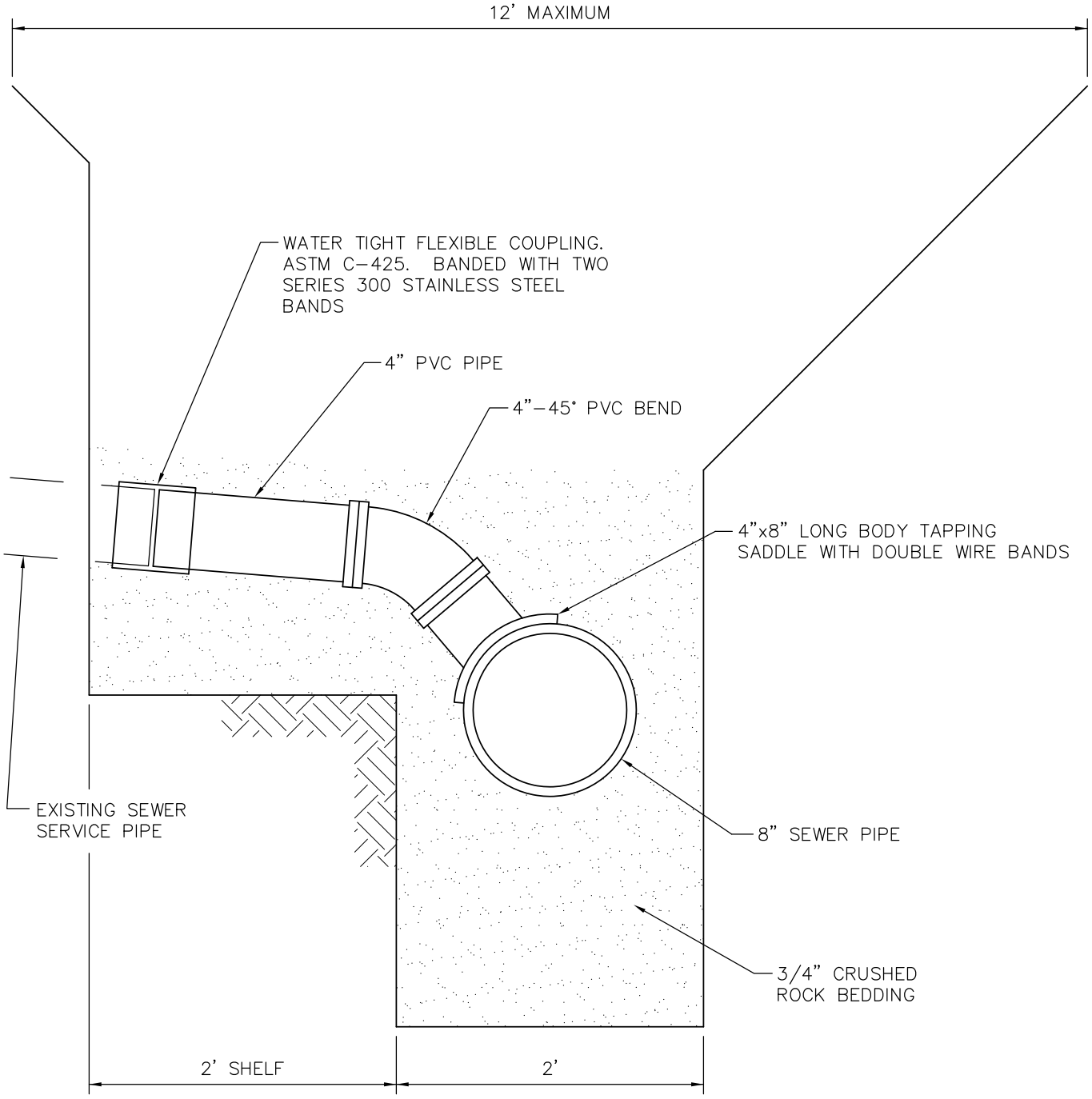

NOTE:
MAXIMUM TRENCH WIDTH AT SERVICE CONNECTIONS IS 12 FEET.

CONNECT TO EXISTING SANITARY SEWER

Castle Pines North METROPOLITAN DISTRICT

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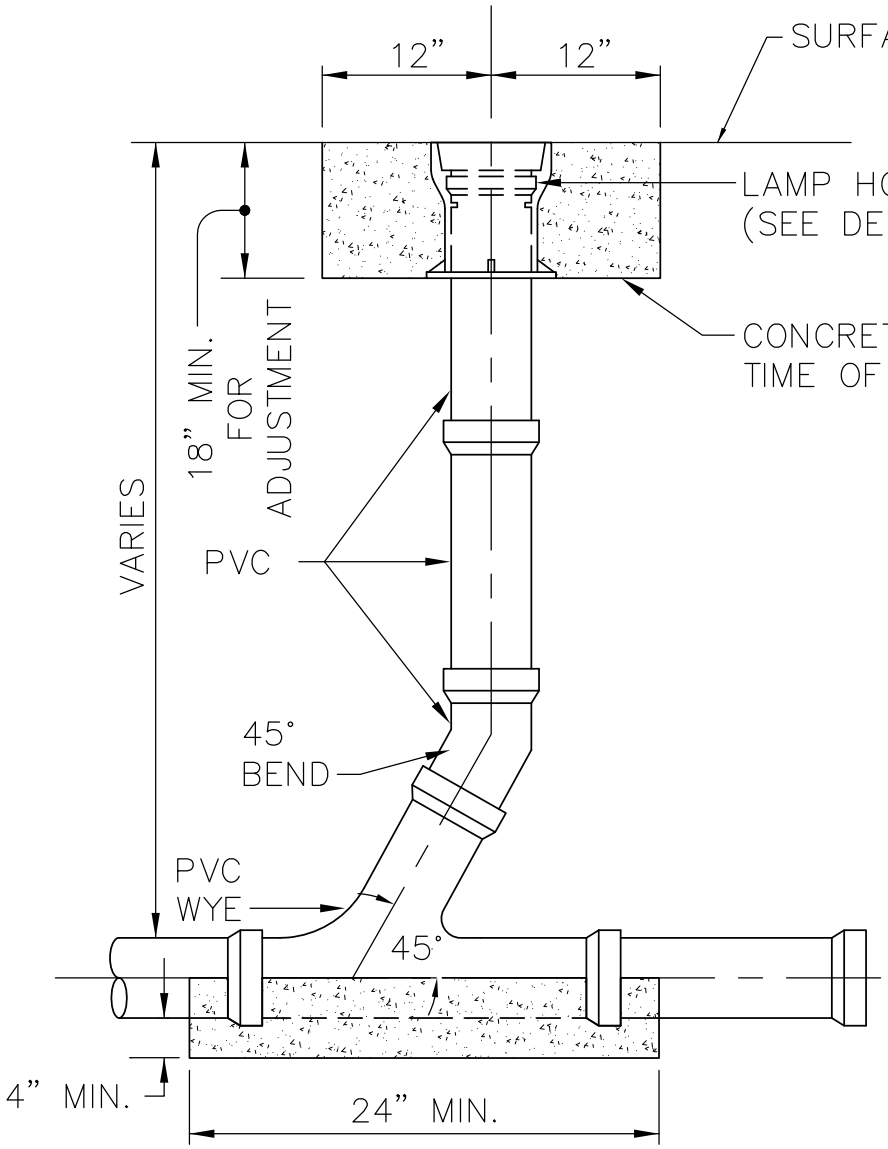
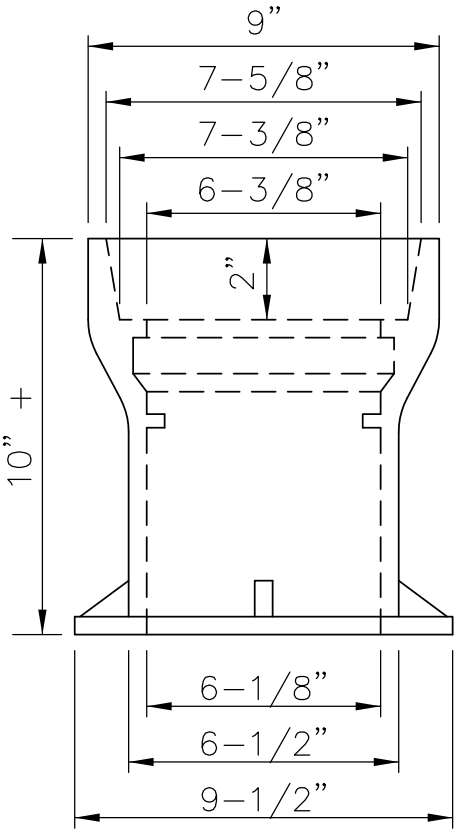


ELEVATION VIEW



COVER DETAIL

NOTES:

1.) COVER SHALL BE MARKED "SEWER"

2.) TYLER SERIES 6855
SLIP TYPE TOP SECTION D & L SUPPLY
SERIES M8056 OR EQUAL.

I.D. = 6-1/8"

IN-LINE CLEANOUT DETAIL (4")

N.T.S.

IN-LINE SANITARY SEWER
CLEANOUT (4")

Castle Pines North
METROPOLITAN DISTRICT

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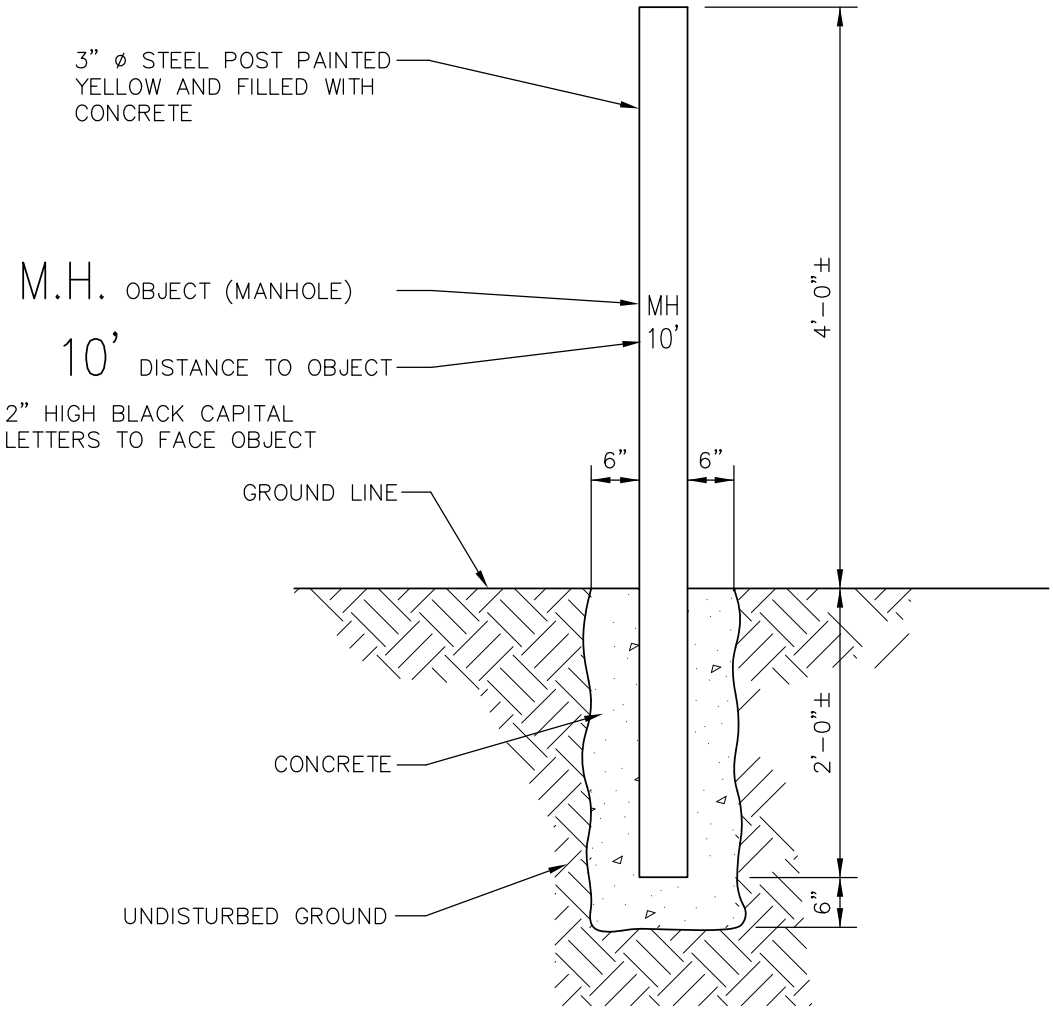

STEEL MARKER POST

Castle Pines North METROPOLITAN DISTRICT

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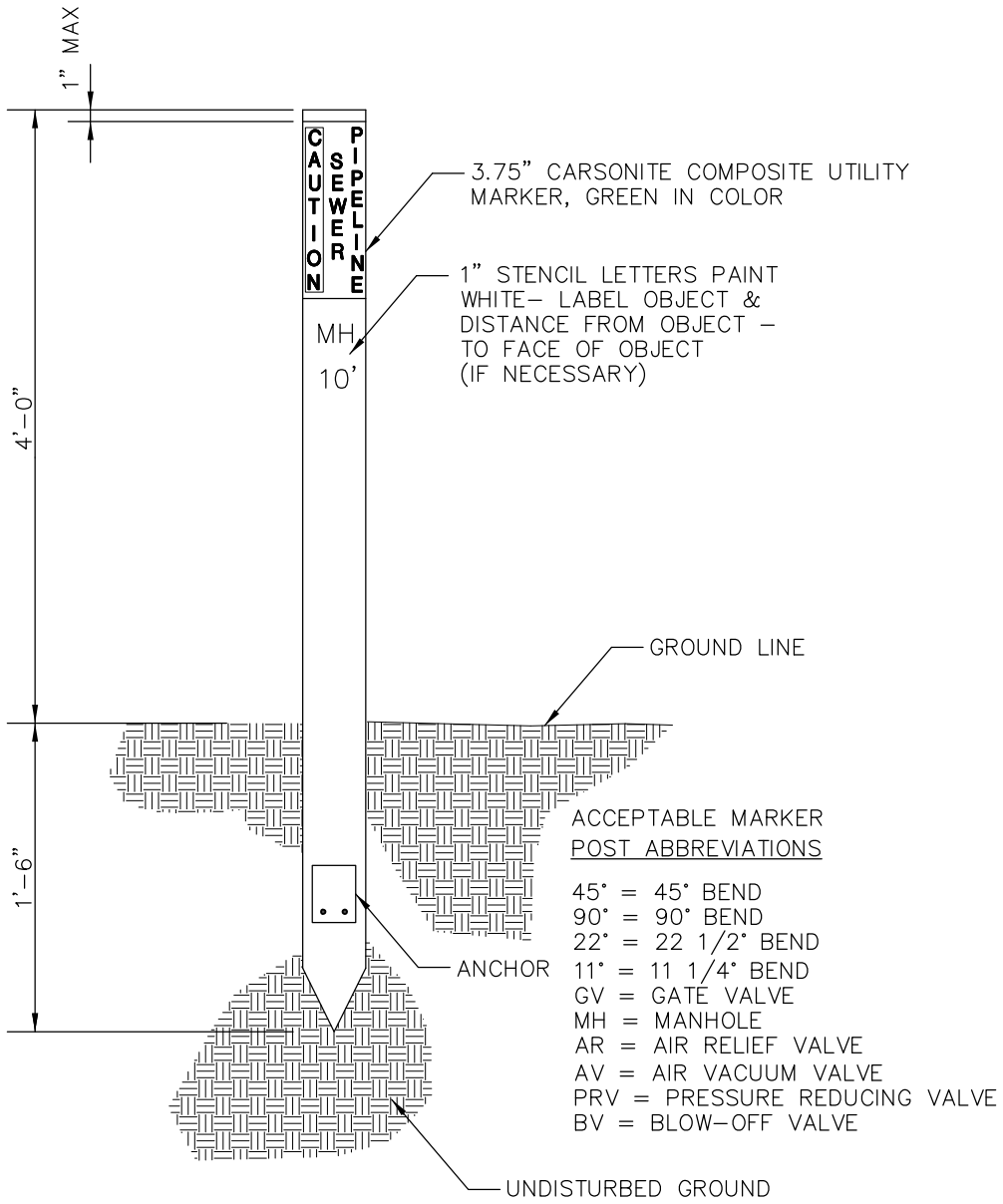

*CARSONITE MARKER POST TO BE USED IN PLACE OF STEEL MARKER POST ONLY WITH PRIOR APPROVAL BY THE DISTRICT.

CARSONITE MARKER POST

Castle Pines North METROPOLITAN DISTRICT

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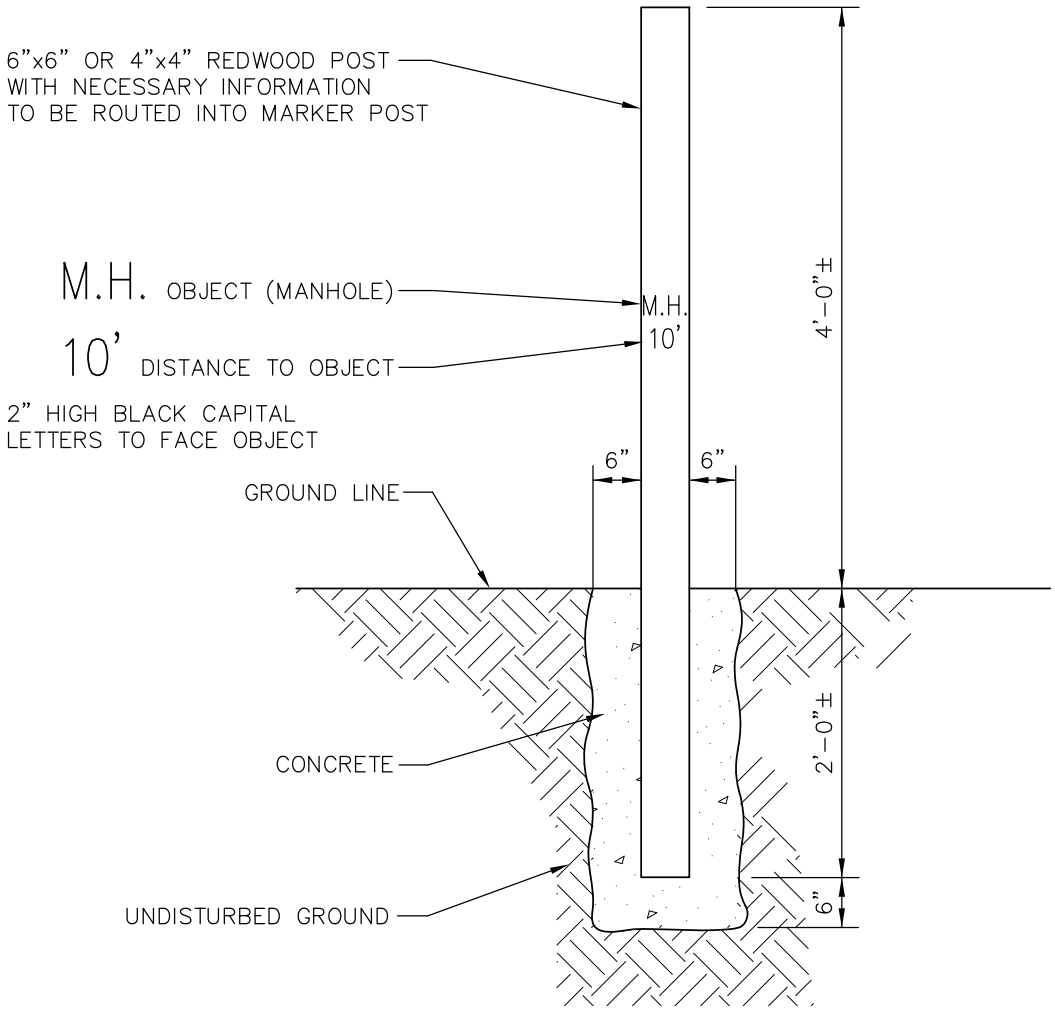

NOTE: REDWOOD MARKER POST TO BE USED IN PLACE OF STEEL MARKER POST ONLY WITH PRIOR APPROVAL BY THE DISTRICT.

REDWOOD MARKER POST

Castle Pines North METROPOLITAN DISTRICT

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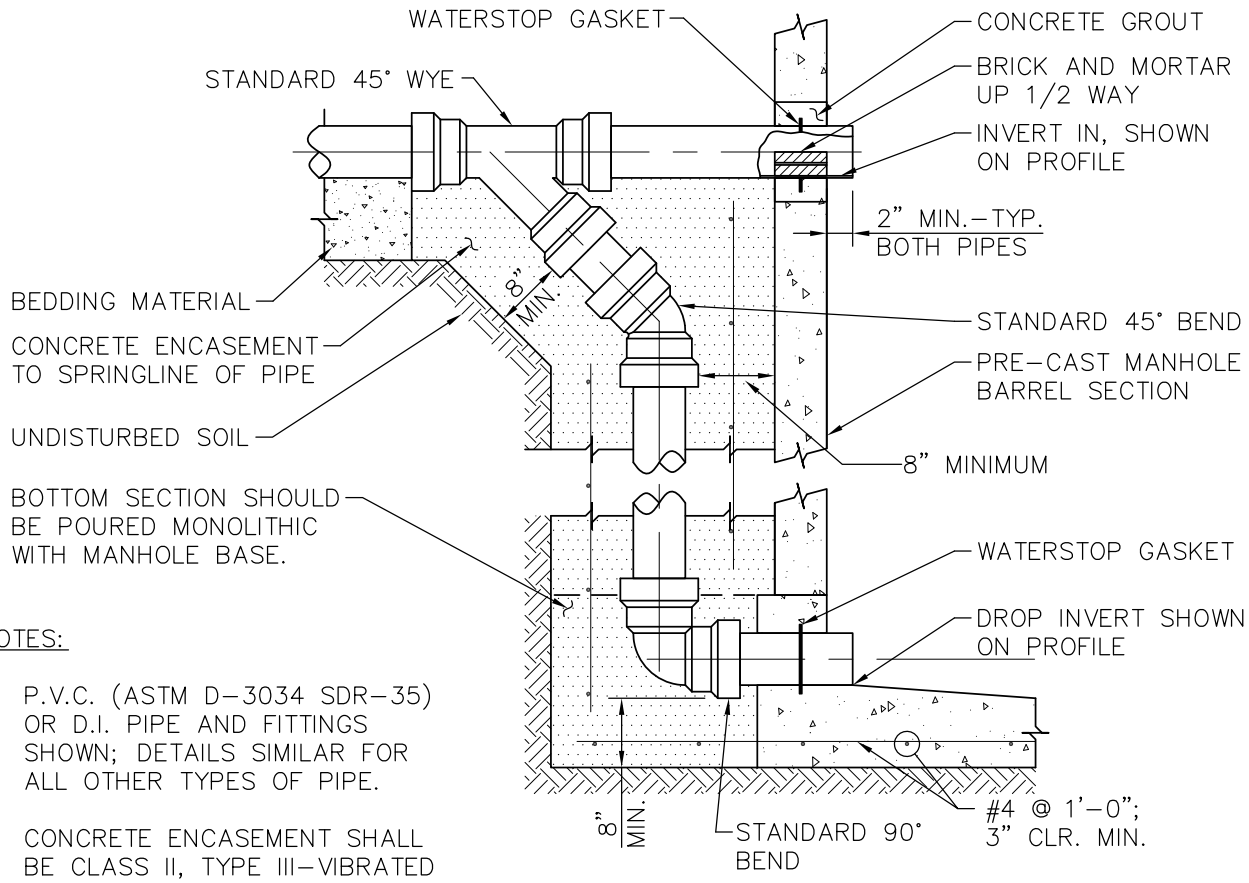
DRAWING NO.: CPN-17S DATE: 8/13 PAGE:



NOTES:

1. P.V.C. (ASTM D–3034 SDR–35) OR D.I. PIPE AND FITTINGS SHOWN; DETAILS SIMILAR FOR ALL OTHER TYPES OF PIPE.
2. CONCRETE ENCASEMENT SHALL BE CLASS II, TYPE III–VIBRATED AND POURED MONOLITHIC WITH MANHOLE BASE MIN. 8" THICK ALL AROUND DROP.
3. DIAMETER OF DROP PIPE SHALL NOT BE LESS THAN THE LINE DIAMETER.
4. ANY DROP OVER 4'–0" REQUIRES VERTICAL AND HORIZONTAL RE–INFORCEMENT (#4@ 1'–6" O.C.–3" CLEAR) IN ADDITION TO THE REINFORCEMENT SHOWN IN THE MANHOLE BASE.
5. MAXIMUM ALLOWABLE DROP SHALL BE SUBJECT TO THE APPROVAL OF THE DISTRICT ENGINEER.
6. BOTH PIPE INVERTS SHALL BE AS SPECIFIED ON PLAN AND PROFILE DESIGN.
7. ALL DROP MANHOLES SHALL BE LINED WITH STRONG–SEAL OR APPROVEED EQUAL PER MANUFACTURER'S SPECIFICATIONS.

OUTSIDE DROP STRUCTURE FOR SEWER 15" & SMALLER

Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
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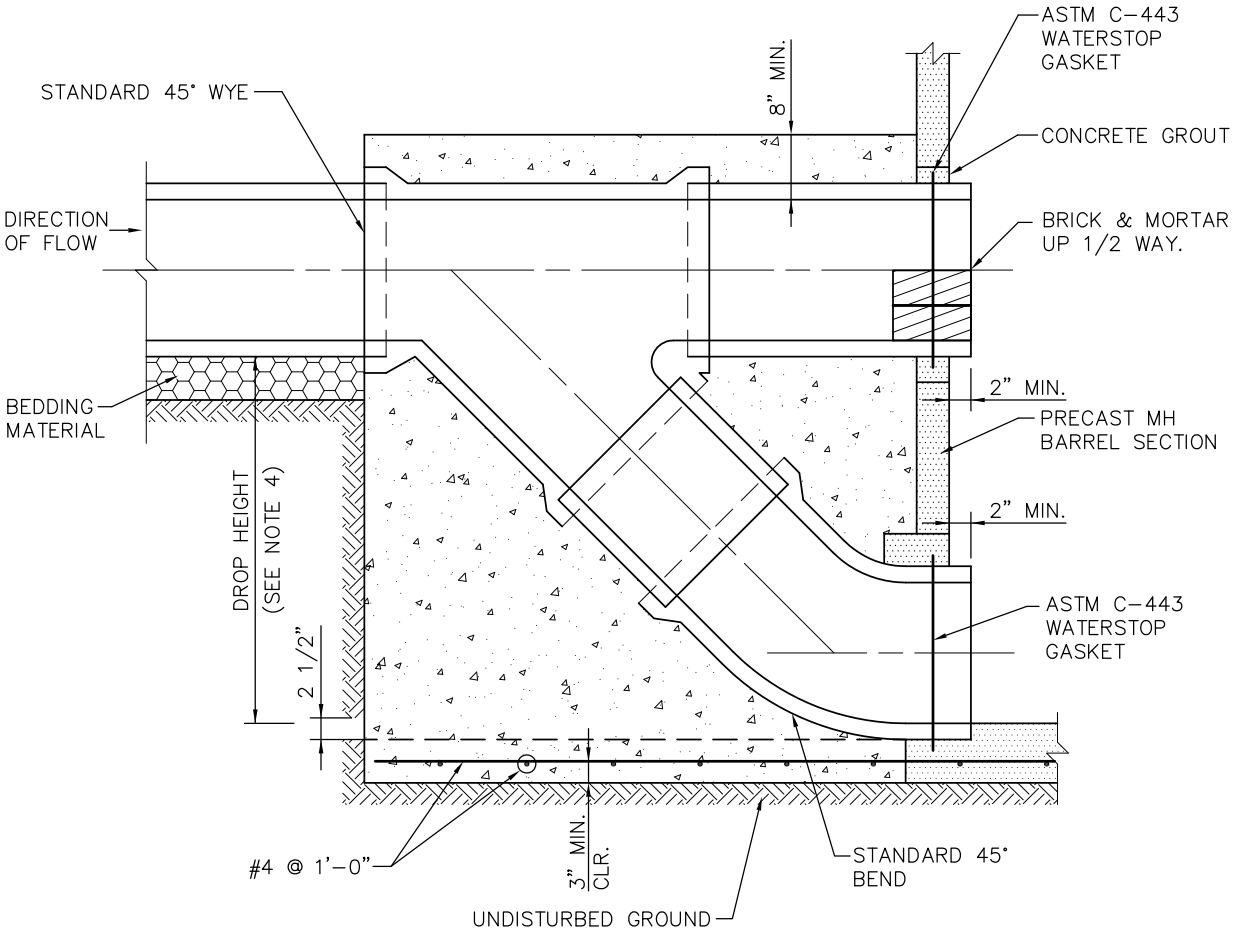

NOTES:

1. P.V.C. (ASTM F-679 SDR-35) OR D.I. PIPE AND FITTINGS IS SHOWN; DETAILS SIMILAR FOR OTHER TYPES OF PIPE.
2. CONCRETE ENCASEMENT SHALL USE TYPE II CEMENT; VIBRATED AND POURED MONOLITHIC WITH MANHOLE BASE. MIN. 8" THICK ALL AROUND PIPE.
4. MAXIMUM ALLOWABLE DROP SHALL BE SUBJECT TO THE REVIEW OF THE DISTRICT.
5. DIAMETER OF DROP PIPE SHALL NOT BE LESS THAN THE LINE DIAMETER.
6. ANY DROP OVER 3'-0" REQUIRES VERTICAL AND HORIZONTAL REINFORCEMENT (#4 @ 1'-6" O.C.-3" CLEAR) IN ADDITION TO THE REINFORCEMENT SHOWN.
7. BOTH PIPE INVERTS SHALL BE AS SPECIFIED ON PLAN AND PROFILE DESIGN.
8. ALL DROP MANHOLES SHALL BE LINED WITH STRONG-SEAL OR APPROVEED EQUAL PER MANUFACTURER'S SPECIFICATIONS.

OUTSIDE DROP STRUCTURE FOR SEWER 18" OR LARGER

Castle Pines North METROPOLITAN DISTRICT

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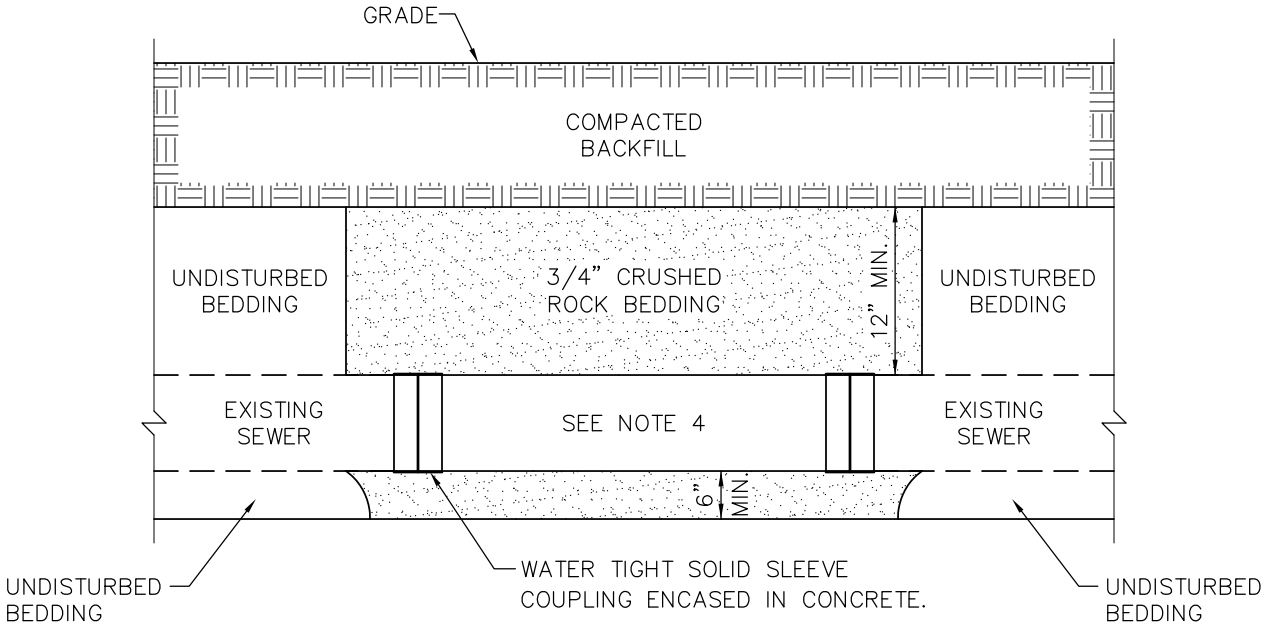
DRAWING NO.: CPN-19S DATE: 8/13 PAGE:



NOTES:

1. WHEN SANITARY SEWER LINES ARE DAMAGED, THE DISTRICT SHALL BE NOTIFIED IMMEDIATELY BY THE CONTRACTOR.
2. THE CONTRACTOR SHALL PROVIDE BYPASS PUMPING UNTIL THE REPAIR IS CONSTRUCTED, REVIEWED, AND APPROVED BY THE DISTRICT.
3. SANITARY SEWER LINE REPAIRS SHALL NOT BE BACKFILLED UNTIL THEY ARE REVIEWED BY THE DISTRICT.
4. THE MAIN REPAIR SHALL USE PVC PIPE OF A CLASS AT LEAST EQUAL TO THE EXISTING PIPE, BUT IN NO CASE LESS THAN THE FOLLOWING MINIMUM CLASS. FOR LINES 15–INCHES IN DIAMETER OR LESS, ASTM D3034 SDR35, FOR LINES 18–INCHES IN DIAMETER OR LARGER, ASTM F679. THE DISTRICT MAY REQUIRE OTHER MATERIALS AND REPAIR TECHNIQUES ON A CASE BY CASE BASIS. THE NEW PIPE SHALL BE CONNECTED TO THE EXISTING MAIN USING WATER TIGHT SOLID SLEEVE COUPLINGS (RIGID). EACH SOLID SLEEVE SHALL BE ENCASED IN CONCRETE.

PIPE REPAIR

Castle Pines North METROPOLITAN DISTRICT

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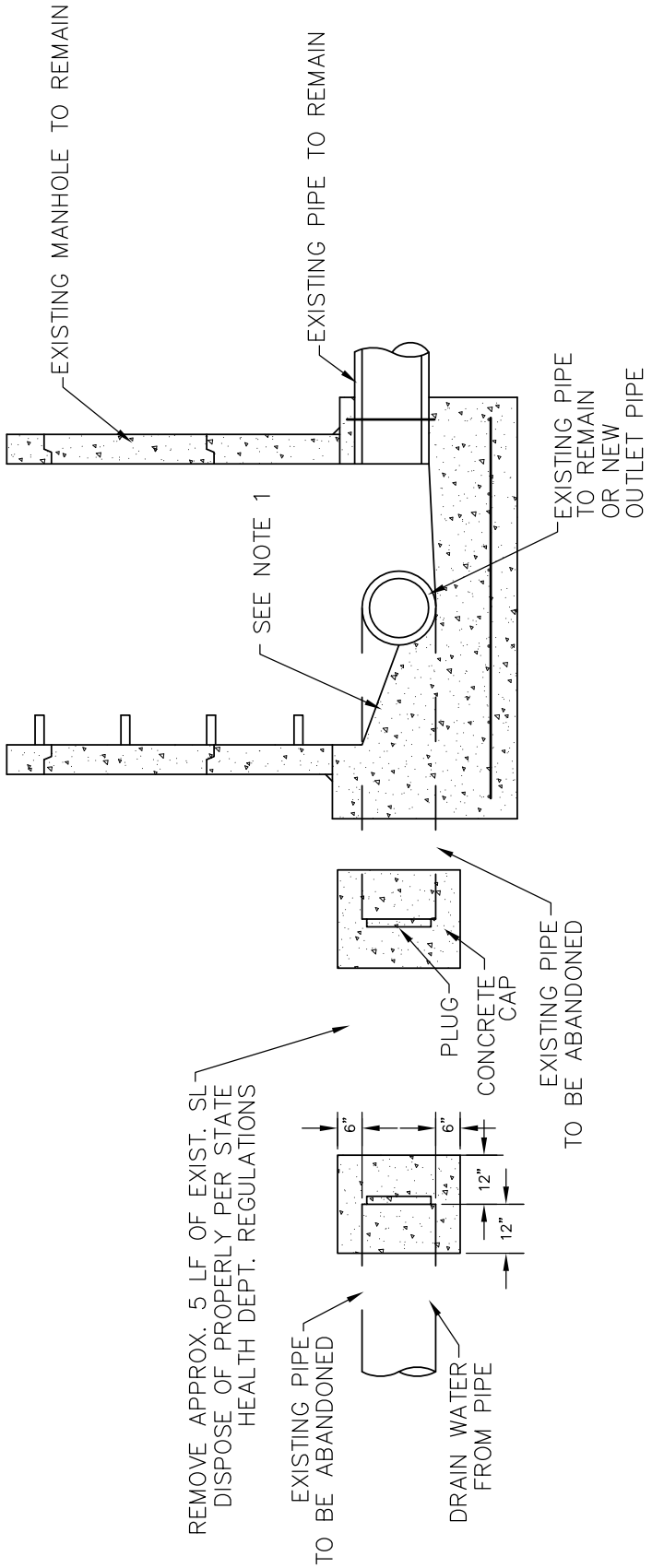
DRAWING NO.: CPN–20S DATE: 8/13 PAGE:



NOTES:

1. RESHAPE BENCH & INVERT USING CONCRETE. PLUG INVERT TO BE ABANDONED WITH CONCRETE.

PIPE ABANDONMENT

Castle Pines North METROPOLITAN DISTRICT

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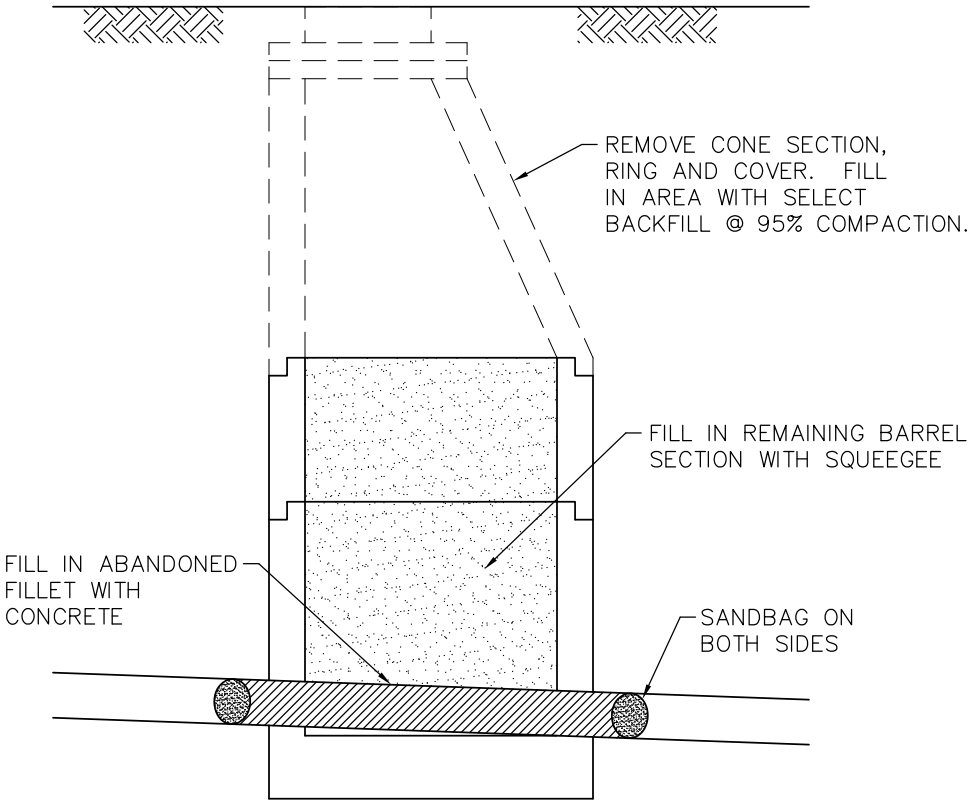
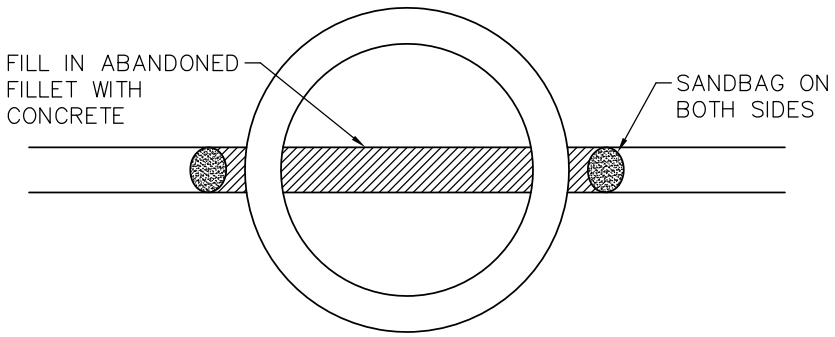


PROFILE



MANHOLE ABANDONMENT

Castle Pines North METROPOLITAN DISTRICT

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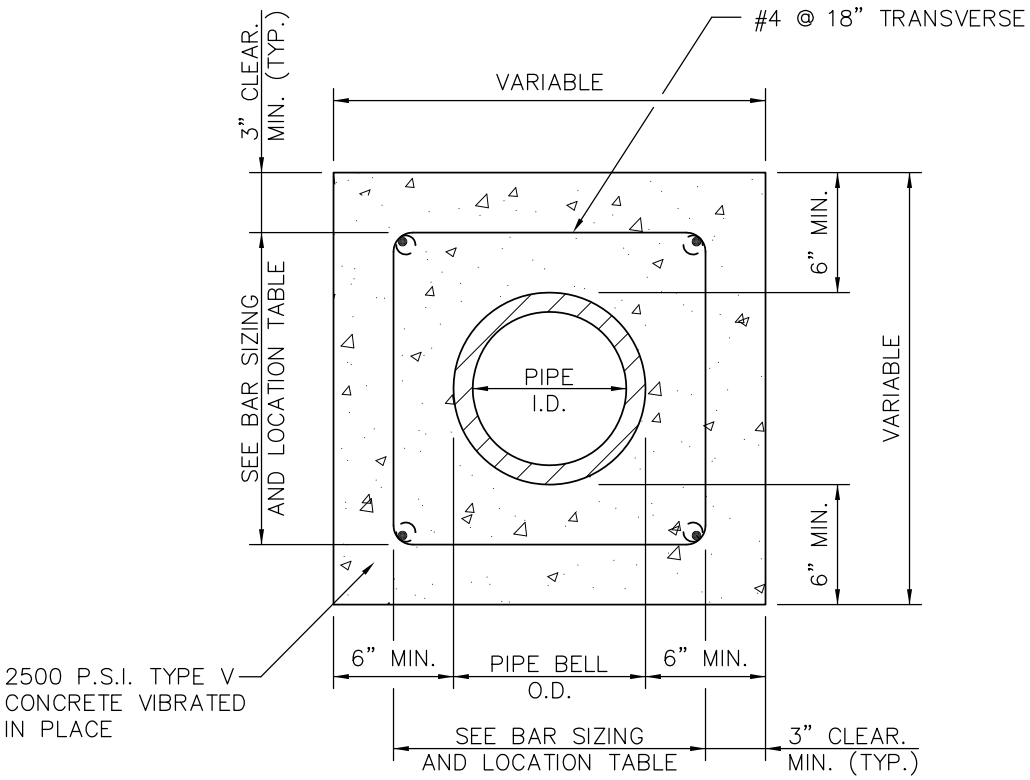

REINFORCEMENT STEEL

PIPE I.D.	LONGITUDINAL BARS – LOCATION		
6 IN.	4–NO. 4 BARS	1 EACH	CORNER
8 IN.	4–NO. 4 BARS	1 EACH	CORNER
10 IN.	8–NO. 4 BARS	3 EACH	SIDE
12 IN.	8–NO. 4 BARS	3 EACH	SIDE
15 IN.	8–NO. 4 BARS	3 EACH	SIDE
18 IN.	8–NO. 4 BARS	3 EACH	SIDE
21 IN.	12–NO. 4 BARS	4 EACH	SIDE
24 IN.	12–NO. 4 BARS	4 EACH	SIDE
27 IN.	12–NO. 4 BARS	4 EACH	SIDE
30 IN.	12–NO. 4 BARS	4 EACH	SIDE
33 IN.	12–NO. 4 BARS	4 EACH	SIDE
36 IN.	16–NO. 4 BARS	5 EACH	SIDE

NOTE:

THE DISTRICT SHALL REVIEW THIS DETAIL FOR USE ON A CASE BY CASE BASIS. SPECIAL ENCASEMENTS MAY BE REQUIRED AT CREEK CROSSINGS AND CONDUIT CROSSINGS.

CONCRETE ENCASEMENT

Castle Pines North METROPOLITAN DISTRICT

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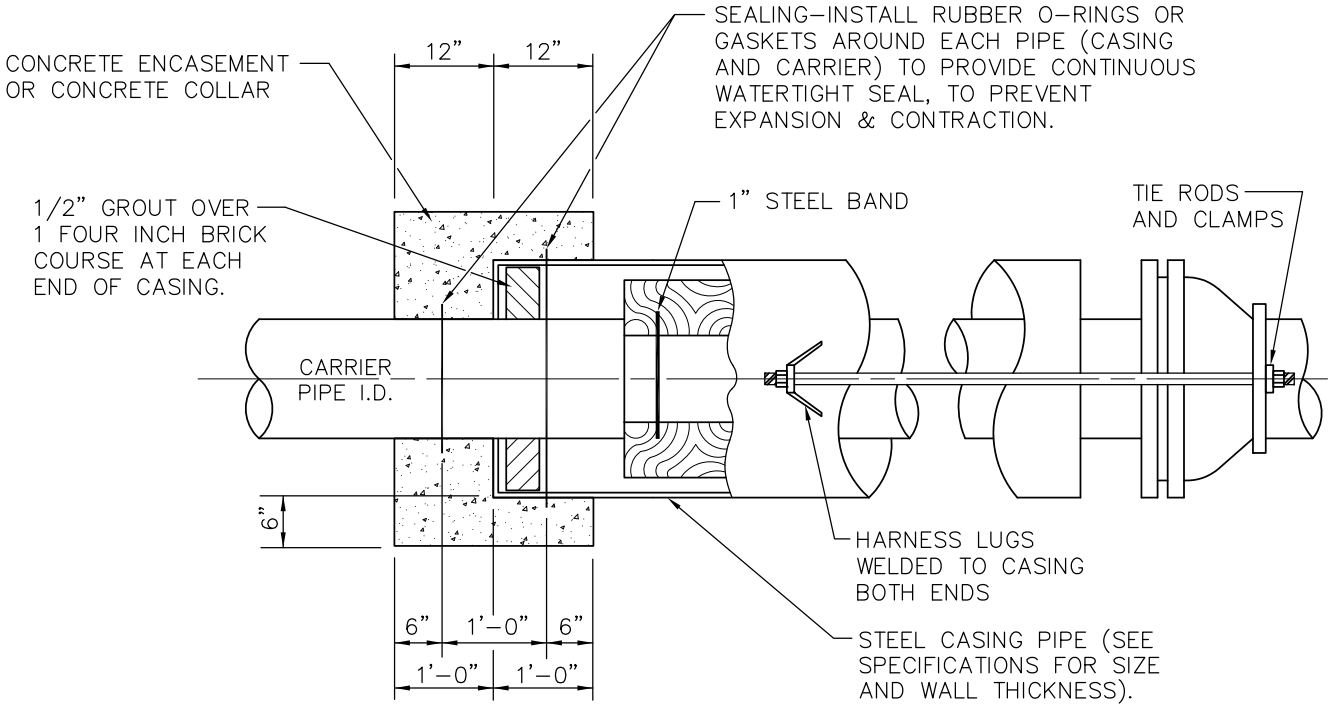
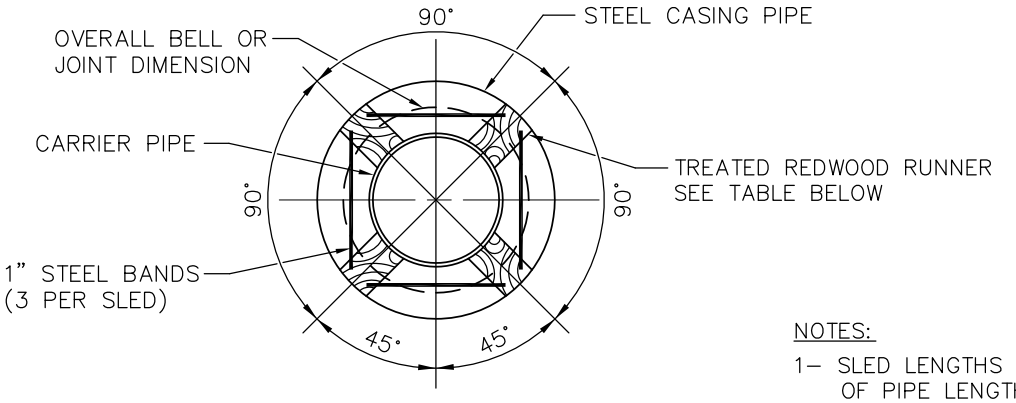


SLED DETAIL



NOTE:
NEOPRENE OR PVC RUNNERS MAY BE USED AS AN ALTERNATIVE TO TREATED REDWOOD.

NOTES:

1– SLED LENGTHS TO BE 75% OF PIPE LENGTHS.

2– HARNESS LUGS TO BE INSULATED FROM D.I. PIPE

3– ENTIRE LENGTH OF CARRIER PIPE TO BE RESTRAINED AT THE DISTRICT'S REQUEST.

4– CONTRACTOR TO RESTRAIN CARRIER PIPE TO CASING PIPE AT THE DISTRICT'S REQUEST.

PIPE CASING DETAIL

PIPE DIA.	CASING PIPE		RUNNER SIZE
	MIN. O.D.	MIN. WALL THICKNESS	
8"	18"	0.375"	4" x 4"
10"	20"	0.375"	4" x 4"
12"	22"	0.375"	4" x 4"
15"–21"	28"	0.406"	4" x 4"
24"–30"	32"	0.469"	4" x 6"

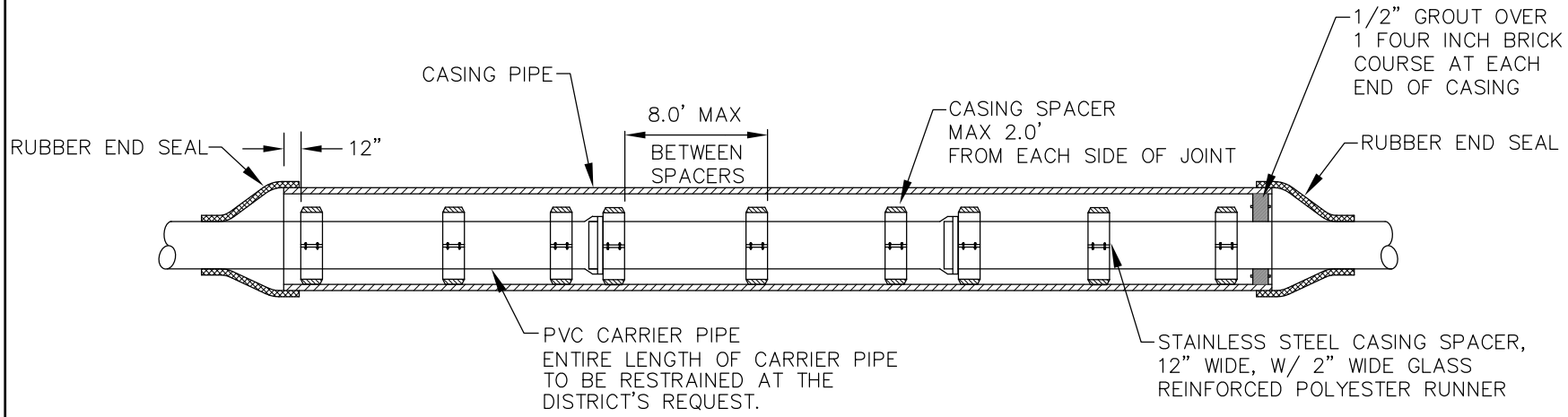
PIPE CASING AND SLED REDWOOD RUNNERS

Castle Pines North METROPOLITAN DISTRICT

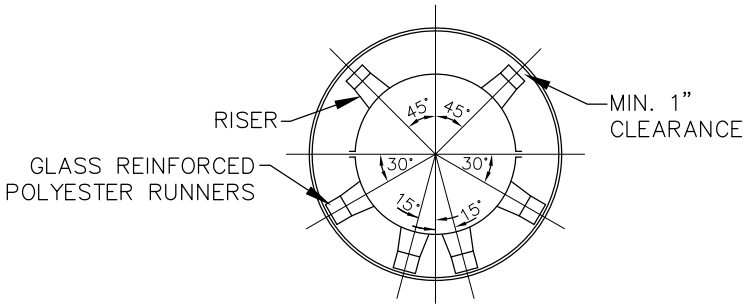
Kennedy/Jenks Consultants
Engineers & Scientists

DRAWING NO.: CPN–24S DATE: 8/13 PAGE:

PIPE CASING AND SLED GLASS REINFORCED POLYESTER RUNNERS



NOTE:
CONTRACTOR TO RESTRAIN CARRIER PIPE TO CASING PIPE AT THE DISTRICT'S REQUEST.



SIZES 14" THROUGH 36"

RUNNER CONFIGURATION

PIPE CASING DETAIL

PIPE DIA.	CASING PIPE		RUNNER SIZE
	MIN. O.D.	MIN. WALL THICKNESS	
8"	18"	0.375"	4" x 4"
10"	20"	0.375"	4" x 4"
12"	22"	0.375"	4" x 4"
15"–21"	28"	0.406"	4" x 4"
24"–30"	32"	0.469"	4" x 6"

DRAWING NO.: CPN–25S DATE: 8/13 PAGE:

Castle Pines North
METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
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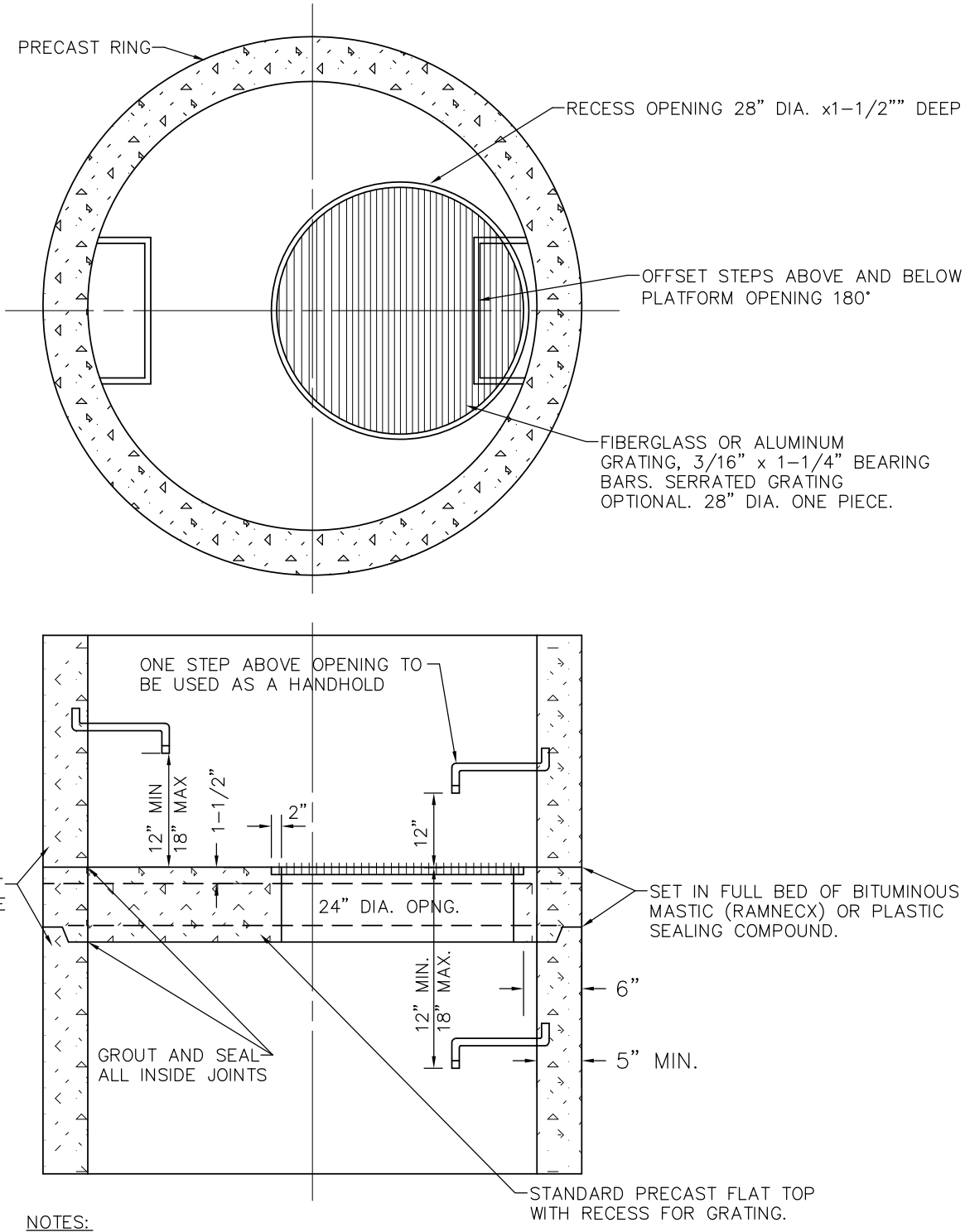


NOTES:

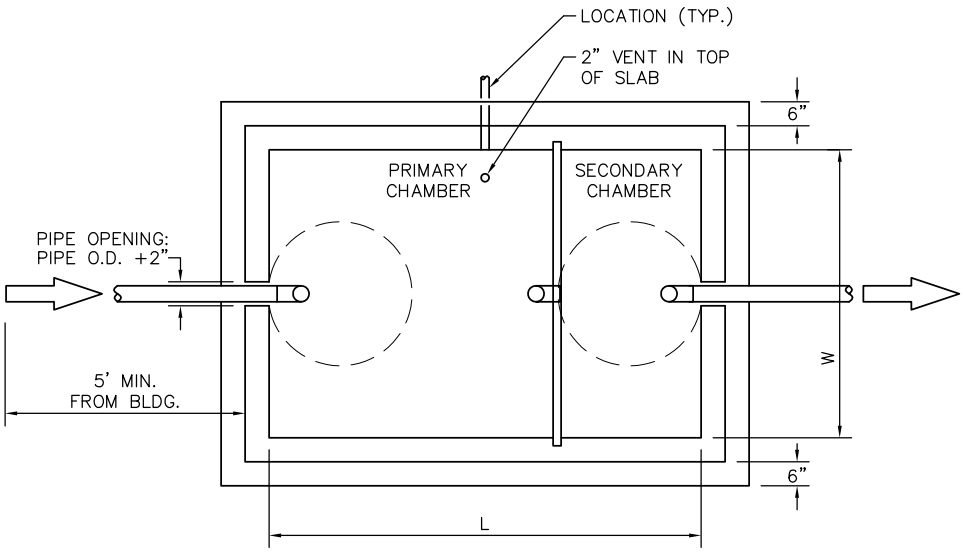
1. REQUIRED IN MANHOLES WHERE DEPTH MEASURED FROM RING AND COVER TO THE INVERT IS 20 FEET OR GREATER.
2. VERTICALLY CENTER FLATTOP PLATFORM BETWEEN RING AND COVER AND MANHOLE INVERT.

INTERMEDIATE PLATFORM

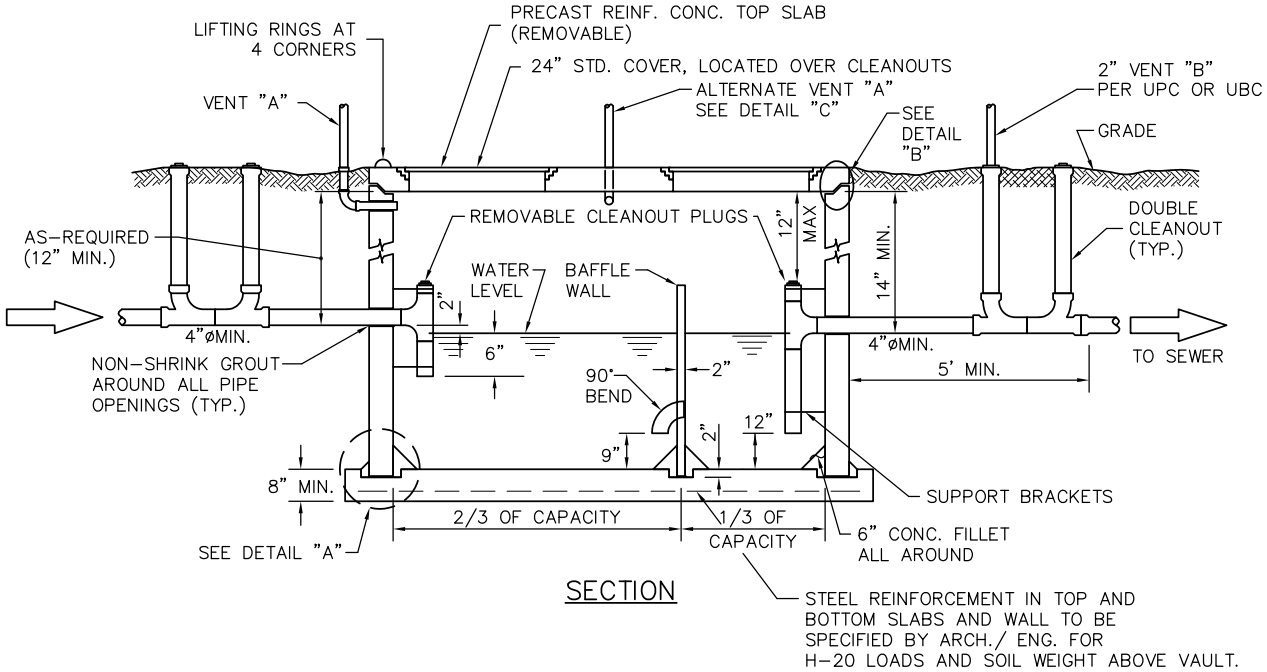
Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

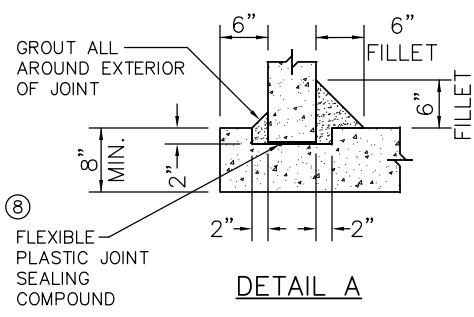
DRAWING NO.: CPN-26S DATE: 6/14 PAGE:



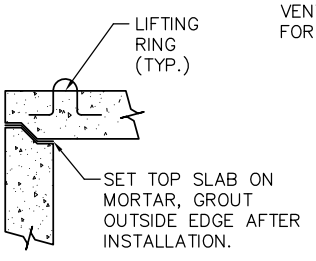
PLAN



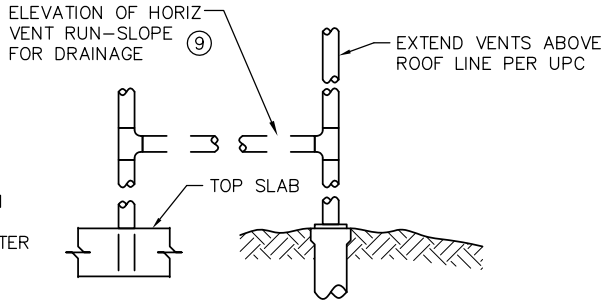
SECTION



DETAIL A



DETAIL B



DETAIL C

COMMERCIAL GREASE INTERCEPTOR
SHEET 1 OF 2

Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

DRAWING NO.: CPN-27S-1.1 DATE: 4/14 PAGE: 1/2

GENERAL NOTES:

1. THESE STANDARD DETAILS SHALL ONLY BE CONSTRUED TO SHOW CONCEPTUAL AND STANDARD DIMENSIONAL REQUIREMENTS FOR GREASE INTERCEPTOR AND SHALL NOT BE USED FOR CONSTRUCTION. THE ARCHITECT/ENGINEER SHALL FURNISH STRUCTURAL DESIGN CRITERIA, HYDRAULIC LOADING, VOLUME & RETENTION TIME REQUIREMENTS AND DETAILED CONSTRUCTION DRAWINGS, INCLUDING SITE PLAN FOR APPROVAL PRIOR TO CONSTRUCTION.

2. SECONDARY TANK HAS VOLUME EQUAL TO 1/3 OF TOTAL CAPACITY.

3. ALL PIPE AND FITTINGS TO BE SCHEDULE 40 PVC EXCEPT WHERE NOTED OTHERWISE AND SHALL BE 4" MINIMUM DIAMETER.

4. WELLS, BOTTOM AND TOP SLAB TO BE REINFORCED THROUGHOUT. ADDITIONAL DIAGONAL REINFORCING TOP AND BOTTOM IS REQUIRED AROUND ACCESS OPENINGS. ALL REBAR SHALL HAVE A 3" MINIMUM COVER TO FACE OF CONCRETE.

5. THICKNESS OF WALLS, BOTTOM AND TOP SLAB TO BE DETERMINED FROM STRUCTURAL LOADING REQUIREMENTS BY ARCHITECT/ENGINEER. CAST-IN- PLACE BOTTOM SLAB SHALL NOT BE LESS THAN 8" THICK.

6. INLET AND OUTLET PIPE SIZES SHALL BE DETERMINED BY ARCHITECT/ENGINEER BUT SHALL NOT BE LESS THAN 4" DIAMETER (OUTLET PIPE INVERT TO BE 2" LOWER THAN INLET).

7. REINFORCED CONCRETE BOTTOM SLAB SHOWN. (MAY BE INTEGRALLY CAST WITH PRE-CAST WALL SECTIONS AT CONTRACTOR'S OPTION).

8. ALL JOINTS IN PRE-CAST SECTIONS TO BE SEALED WITH FLEXIBLE PLASTIC JOINT SEALING COMPOUND TO FED. SPEC. S-SS-C0210 (EXCEPT TOP SLAB).

9. VENT PIPE MATERIALS AND LOCATION SHALL BE IN ACCORDANCE WITH THE PLUMBING CODE.

10. ROUND OR CIRCULAR GREASE INTERCEPTOR WILL REQUIRE SPECIAL DESIGN AND APPROVAL.

11. PRE-CAST CONCRETE SHAPES ARE SHOWN: CAST-IN-PLACE CONCRETE STRUCTURE IS OPTIONAL.

12. PRE-CAST REINFORCED CONCRETE SECTIONS SHALL BE IN ACCCORDANCE WITH ASTM-C-478.

13. DESIGN CRITERIA: (MINIMUM)

UNIT WEIGHT OF "SOIL"	120 PCF
EQUIVALENT FLUID PRESSURE	30 PCF
LIVELOADS (IF APPLICABLE)	AASHTO H=20
CONCRETE STRENGTH (F'c)(TYPE II CEMENT)	4000 PSI

TOP SLAB MAY BE ONE PIECE OF MULTIPLE SEGMENT CONSTRUCTION AT CONTRACTOR'S OPTION.

14. SUPPORT BRACKETS AND CLEAN-OUT PLUGS SHALL BE BRASS

15. OTHER VARIOUS COMBINATIONS OF TANK DIMENSIONS MAY BE SUBMITTED FOR APPROVAL, PROVIDED THAT ANY ALTERNATE DESIGN SHALL HAVE THE SAME BASIC PROPORTIONAL DIMENSIONS, COMPARABLE VOLUMES AND FUNCTIONAL CAPABILITIES AS THESE STANDARD DETAILS.

16. DRAWINGS ARE NOT TO SCALE.

17. DEPENDING ON THE SEWAGE LOADING TYPE, A SAMPLING STATION OR MANHOLE MAY BE REQUIRED. DISTRICT TO DETERMINE UPON REVIEW.

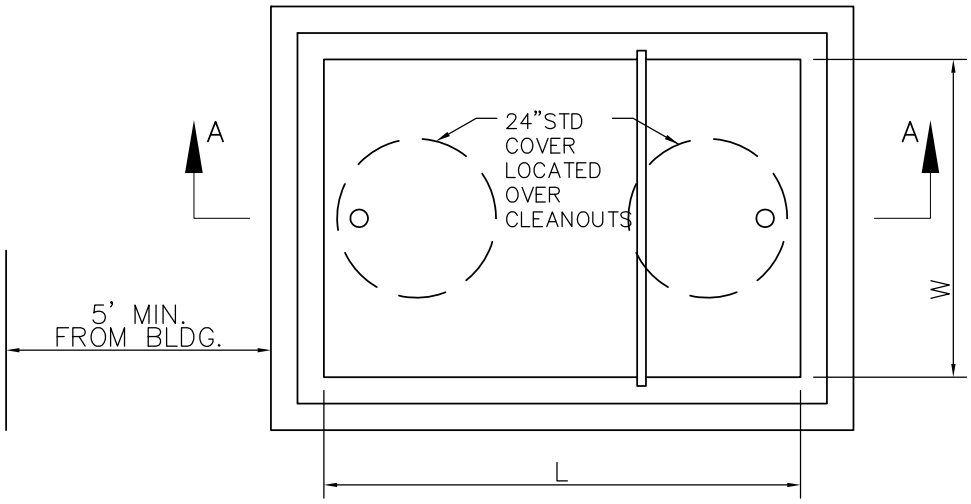
⇨ 18. MINIMUM CAPACITY SHALL BE 750 GALLONS UNLESS OTHERWISE APPROVED BY THE DISTRICT.

COMMERCIAL GREASE INTERCEPTOR
SHEET 2 OF 2

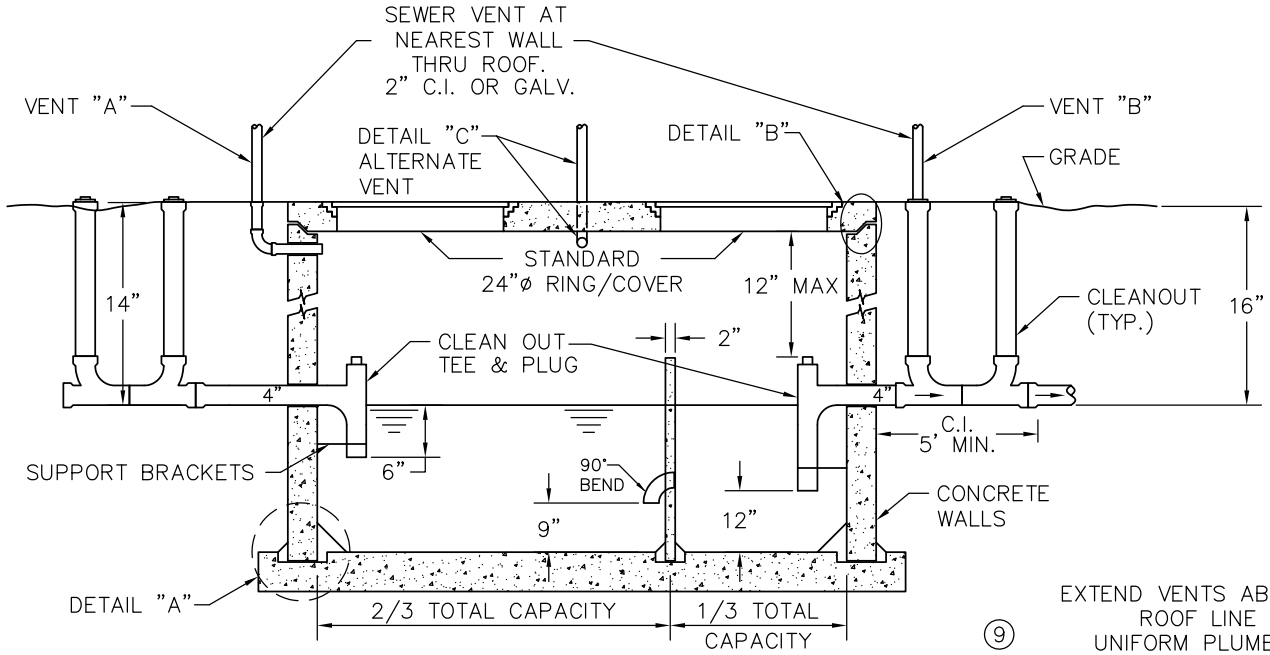
Castle Pines North
METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

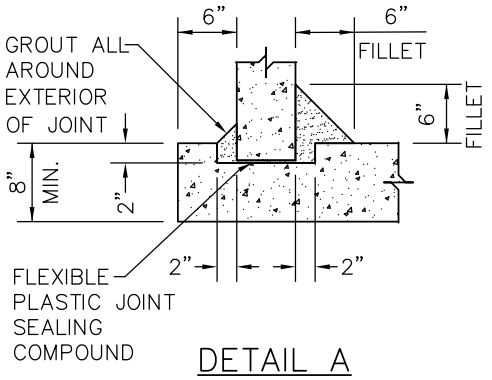
DRAWING NO.: CPN-27S-1.2 DATE: 4/14 PAGE: 2/2



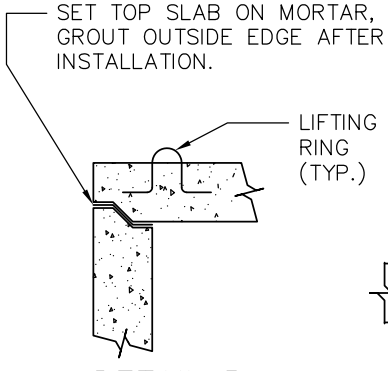
PLAN



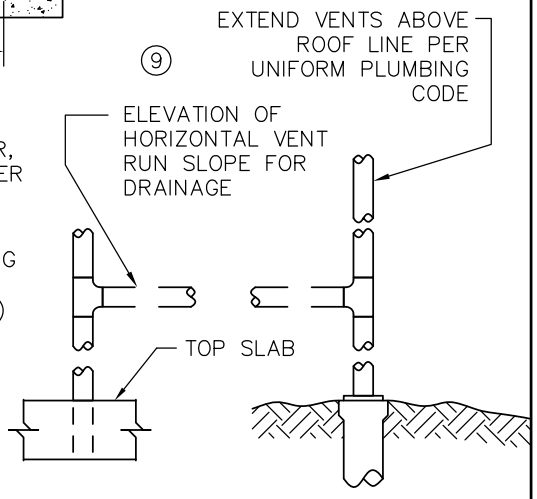
SECTION "A–A"



DETAIL A



DETAIL B



DETAIL C

COMMERCIAL SAND & OIL INTERCEPTOR
SHEET 1 OF 2

Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

DRAWING NO.: CPN–28S–1.1 DATE: 4/14 PAGE: 1/2

GENERAL NOTES:

1. THESE STANDARD DETAILS SHALL ONLY BE CONSTRUED TO SHOW CONCEPTUAL AND STANDARD DIMENSIONAL REQUIREMENTS FOR SAND & OIL INTERCEPTOR AND SHALL NOT BE USED FOR CONSTRUCTION. THE ARCHITECT/ENGINEER SHALL FURNISH STRUCTURAL DESIGN CRITERIA, HYDRAULIC LOADING, VOLUME & RETENTION TIME REQUIREMENTS AND DETAILED CONSTRUCTION DRAWINGS, INCLUDING SITE PLAN FOR APPROVAL PRIOR TO CONSTRUCTION.

2. SECONDARY TANK HAS VOLUME EQUAL TO 1/3 OF TOTAL CAPACITY.

3. ALL PIPE AND FITTINGS TO BE SCHEDULE 40 PVC EXCEPT WHERE NOTED OTHERWISE AND SHALL BE 4" MINIMUM DIAMETER.

4. WELLS, BOTTOM AND TOP SLAB TO BE REINFORCED THROUGHOUT. ADDITIONAL DIAGONAL REINFORCING TOP AND BOTTOM IS REQUIRED AROUND ACCESS OPENINGS. ALL REBAR SHALL HAVE A 3" MINIMUM COVER TO FACE OF CONCRETE.

5. THICKNESS OF WALLS, BOTTOM AND TOP SLAB TO BE DETERMINED FROM STRUCTURAL LOADING REQUIREMENTS BY ARCHITECT/ENGINEER. CAST-IN- PLACE BOTTOM SLAB SHALL NOT BE LESS THAN 8" THICK.

6. INLET AND OUTLET PIPE SIZES SHALL BE DETERMINED BY ARCHITECT/ENGINEER BUT SHALL NOT BE LESS THAN 4" DIAMETER (OUTLET PIPE INVERT TO BE 2" LOWER THAN INLET).

7. REINFORCED CONCRETE BOTTOM SLAB SHOWN. (MAY BE INTEGRALLY CAST WITH PRE-CAST WALL SECTIONS AT CONTRACTOR'S OPTION).

8. ALL JOINTS IN PRE-CAST SECTIONS TO BE SEALED WITH FLEXIBLE PLASTIC JOINT SEALING COMPOUND TO FED. SPEC. S-SS-C0210 (EXCEPT TOP SLAB).

9. VENT PIPE MATERIALS AND LOCATION SHALL BE IN ACCORDANCE WITH THE PLUMBING CODE.

10. ROUND OR CIRCULAR GREASE INTERCEPTOR WILL REQUIRE SPECIAL DESIGN AND APPROVAL.

11. PRE-CAST CONCRETE SHAPES ARE SHOWN: CAST-IN-PLACE CONCRETE STRUCTURE IS OPTIONAL.

12. PRE-CAST REINFORCED CONCRETE SECTIONS SHALL BE IN ACCCORDANCE WITH ASTM-C-478.

13. DESIGN CRITERIA: (MINIMUM)

UNIT WEIGHT OF "SOIL"	120 PCF
EQUIVALENT FLUID PRESSURE	30 PCF
LIVELOADS (IF APPLICABLE)	AASHTO H=20
CONCRETE STRENGTH (F'c)(TYPE II CEMENT)	4000 PSI

TOP SLAB MAY BE ONE PIECE OF MULTIPLE SEGMENT CONSTRUCTION AT CONTRACTOR'S OPTION.

14. SUPPORT BRACKETS AND CLEAN-OUT PLUGS SHALL BE BRASS

15. OTHER VARIOUS COMBINATIONS OF TANK DIMENSIONS MAY BE SUBMITTED FOR APPROVAL, PROVIDED THAT ANY ALTERNATE DESIGN SHALL HAVE THE SAME BASIC PROPORTIONAL DIMENSIONS, COMPARABLE VOLUMES AND FUNCTIONAL CAPABILITIES AS THESE STANDARD DETAILS.

16. DRAWINGS ARE NOT TO SCALE.

17. DEPENDING ON THE SEWAGE LOADING TYPE, A SAMPLING STATION OR MANHOLE MAY BE REQUIRED. DISTRICT TO DETERMINE UPON REVIEW.

18. VENT "A" MAY RISE A MINIMUM OF 42" ABOVE FIXTURE FLOOD LINE AND MAY COMBINE WITH VENT "B" ABOVE THE 42" LINE TO FORM A SINGLE VENT THROUGH THE ROOF.

19. PLUMBING PER CITY/COUNTY STANDARDS.

⇨ 20. MINIMUM CAPACITY SHALL BE 500 GALLONS UNLESS OTHERWISE APPROVED BY THE DISTRICT.

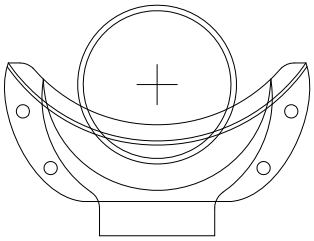
COMMERCIAL SAND & OIL INTERCEPTOR
SHEET 2 OF 2

Castle Pines North
METROPOLITAN DISTRICT

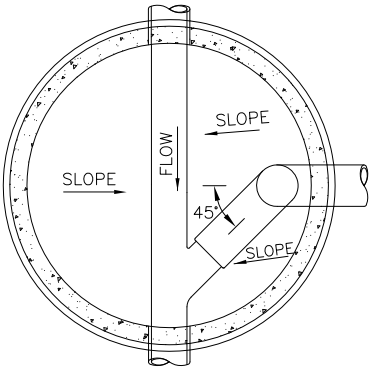
Kennedy/Jenks Consultants
Engineers & Scientists

DRAWING NO.: CPN-28S-1.2 DATE: 4/14 PAGE: 2/2

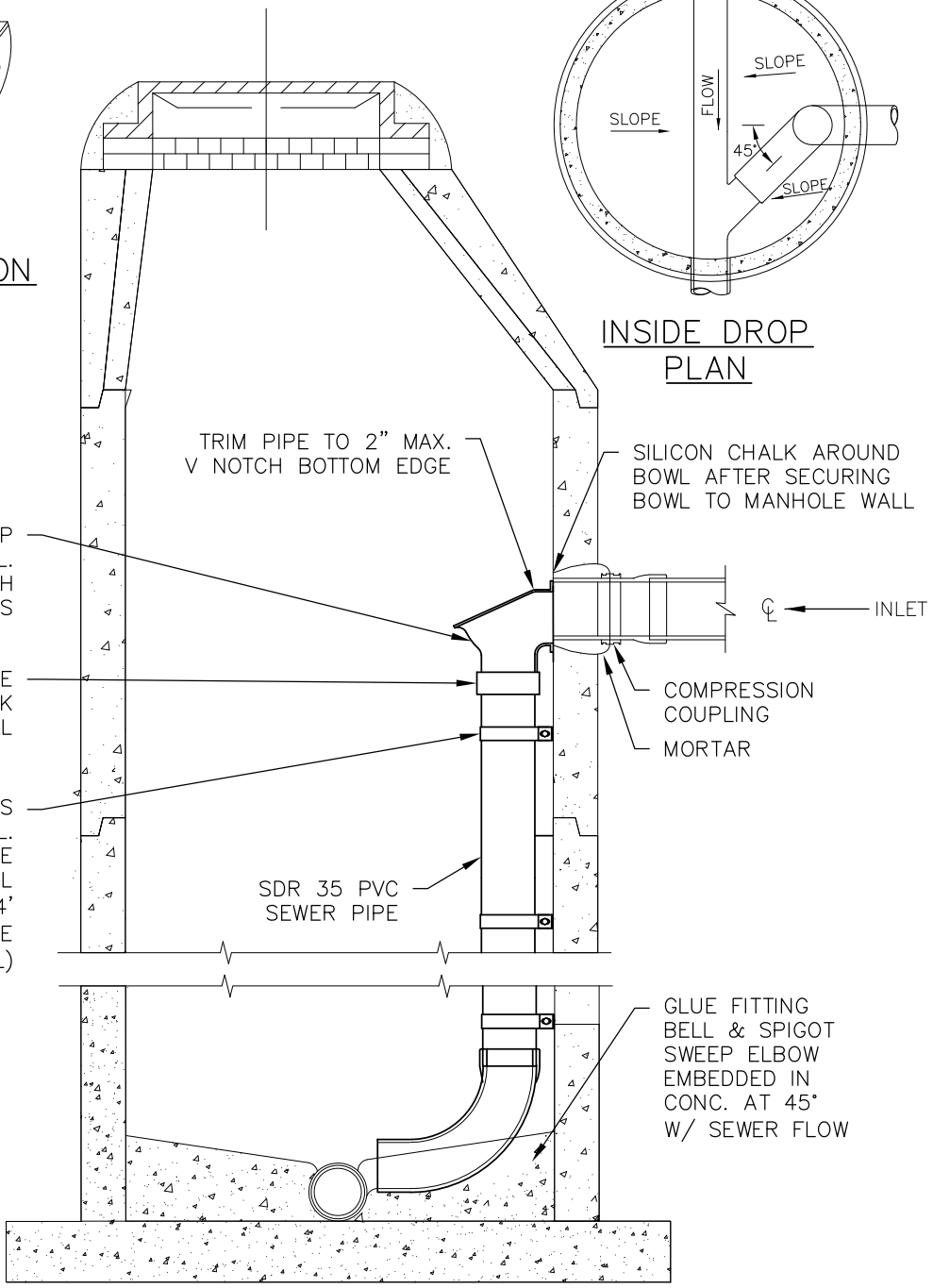
NOT USED



DROP BOWL
MOUNTING POSITION



INSIDE DROP
PLAN



INSIDE DROP – SECTION

NOTES:

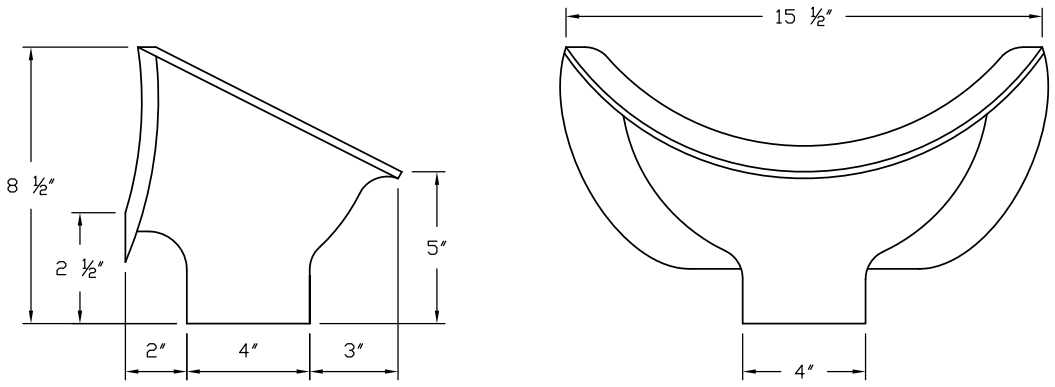
1. CONTRACTOR IS REQUIRED TO SUBMIT SHOP DRAWINGS FOR ALL INSIDE DROP PIPE AND FITTINGS.
2. ALL MORTAR GROUT SHALL BE MIXED WITH TYPE II CEMENT.
3. ALL INSIDE DROP CONNECTIONS FOR SERVICES AND COLLECTOR SEWERS SHALL USE THE DROP BOWL AS PRODUCED BY: RELINER–DURAN, INC. OR EQUAL.
4. SECURE DROP PIPE TO MANHOLE WALL WITH RELINER–DURAN, INC. STAINLESS STEEL ADJUSTABLE CLAMPING BRACKETS OR EQUAL.
5. SEE CPN–31S FOR INSIDE MANHOLE DROP BOWL AND CPN–32S FOR INSIDE MANHOLE DROP CONNECTION BRACKET.

INSIDE MANHOLE DROP CONNECTIONS

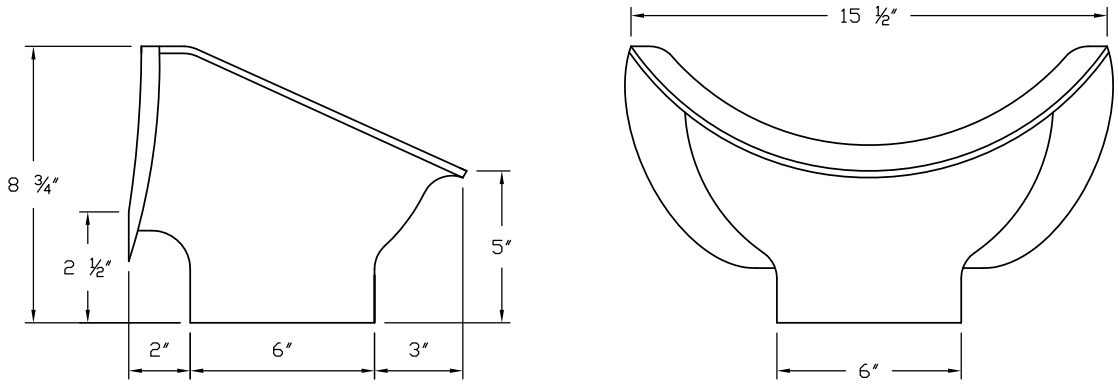
Castle Pines North
METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

DRAWING NO.: CPN–30S DATE: 12/15 PAGE:



"A–4" DROP BOWL



"A–6" DROP BOWL

SPECIFICATIONS:

THE RELINER DURAN, INC. "A–4" BOWL WILL SERVICE UP THROUGH FULL 6" INLETS. THE "A–6" BOWL WILL SERVICE UP THROUGH FULL 8" INLET AND CAN BE USED FOR 10" AND 12" INLET MODERATE FLOWS. ALL SIZES ARE FOR RETROFIT OR NEW CONSTRUCTION. FABRICATED IN MARINE GRADE FIBERGLASS AND FINISHED IN BRIGHT WHITE GEL COAT.

INSIDE MANHOLE DROP BOWL

Castle Pines North METROPOLITAN DISTRICT

Kennedy/Jenks Consultants
Engineers & Scientists

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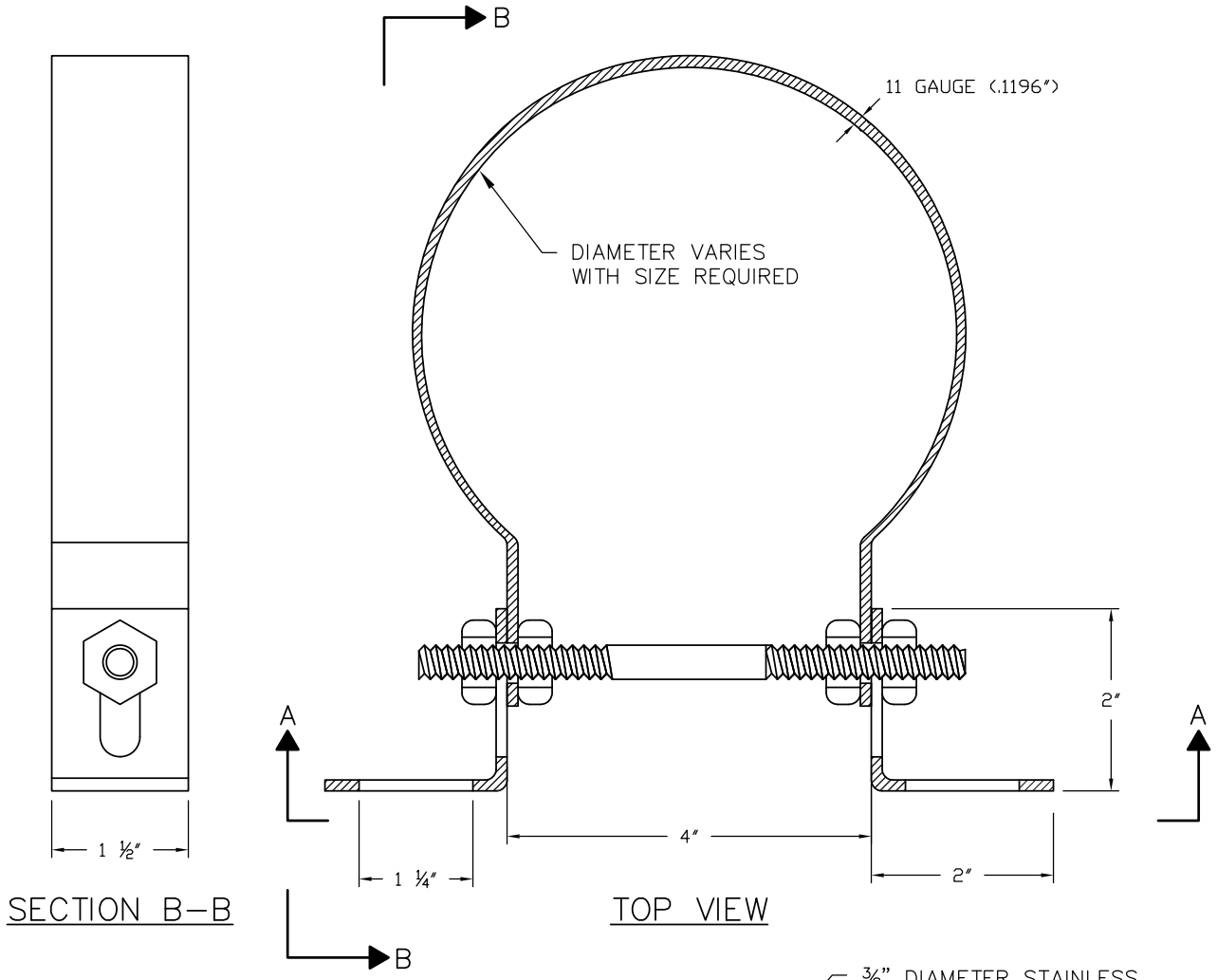

SECTION B–B

TOP VIEW

SECTION A–A

SPECIFICATIONS:

1) CLAMPS AND BRACKETS ARE TYPE 304 STAINLESS STEEL, 11 GAUGE (.1196").
2) ⅜" ø PINCH BOLTS AND NUTS ARE TYPE 18–8 STAINLESS STEEL.

INSIDE MANHOLE DROP CONNECTION BRACKET

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