



DOMINION
WATER AND SANITATION DISTRICT
STANDARDS AND SPECIFICATIONS FOR
POTABLE WATER AND SANITARY SEWER

DOMINION WATER AND SANITATION DISTRICT
9250 E. Costilla Ave. Suite 400
Greenwood Village, CO 80112

April 2026

REVISIONS

1. March 2015.....Adoption of Standards by Board, Published for Use
2. May 22, 2015 (Major Revisions, not published).....General Updates
3. August 14, 2015 (Minor Revisions, not published).....Update to Underdrain Standard Details
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6. November 2017.....Adoption of Chapter 8 and General Updates
7. November 2018.....Updates to Underdrain Cleanout, Irrigation Meter Vault and Pipe Bedding
8. February 2020.....Adoption of Chapter 9 and General Updates
9. November 2025.....General Updates
10. April 2026.....General Updates

TABLE OF CONTENTS

Chapter 1.....	General Requirements
Chapter 2.....	Design Review
Chapter 3.....	Construction Requirements and Acceptance Procedures
Chapter 4.....	Water Distribution System Specifications
Chapter 5.....	Sanitary Sewer Collection System Specifications
Chapter 6.....	Standard Drawing Details and Notes

CHAPTER 1
GENERAL REQUIREMENTS

TABLE OF CONTENTS

	PAGE
1.01 AUTHORITY	1
1.02 EFFECTIVE DATE OF STANDARDS.....	1
1.03 REVISIONS, AMENDMENTS OR ADDITIONS	1
1.04 DWSD CONTROL.....	1
1.05 DEFINITIONS	2
A. Approved Documents	2
B. Board.....	2
C. CAB	2
D. Commercial Development	2
E. Contractor.....	2
F. Customer	2
G. District/DWSD.....	2
H. DWSD Engineer	2
I. DWSD Representative.....	2
J. Engineer of Record	2
K. Fire Marshal	2
L. General Manager.....	3
M. Open Space	3
N. Paving.....	3
O. Project	3
P. Residential Development	3
Q. Operations Manager.....	3
1.06 ABBREVIATIONS	3

CHAPTER 1

GENERAL REQUIREMENTS

1.01 AUTHORITY

These Standards for Potable Water and Sanitary Sewer (Standards) are promulgated by the General Manager of Dominion Water & Sanitation District (DWSD) in accordance with the authority granted by the DWSD Board of Directors (Board).

The General Manager hereby delegates to the DWSD Engineer the administration of these Standards including interpretation, enforcement, revisions, waiver and variance.

1.02 EFFECTIVE DATE OF STANDARDS

These Standards shall be effective from the date they have been approved by the Board. The date shall be noted on the title sheet of the Standards. Upon approval by the Board, the Standards shall supersede all previous editions, except in the case of an ongoing construction contract that has received a Notice to Proceed from DWSD. In the case that an ongoing construction contract was started, and is based on a previous version of the Standards, that Project shall be allowed to continue with the previous version as the required Standards for that Project. It shall be the responsibility of the holders of the Standards to determine that the set in their possession is the current edition.

1.03 REVISIONS, AMENDMENTS OR ADDITIONS

These Standards may be revised, amended or added to from time to time, and such revisions, additions or amendments shall be binding and in full force and effect as of the date of their adoption, with the exception noted in Chapter 1, Paragraph 1.02.

1.04 DWSD CONTROL

The construction of any facility connected to, or to become connected to, DWSD's facilities shall conform to the criteria set forth in the most current edition of the Standards and applicable Federal, State, and Local codes and ordinances and plumbing codes enacted and enforced by Douglas County and Fire Rescue Authority (South Metro).

DWSD and its Representatives shall have access to all facilities at all times to all areas on the premises for the purpose of inspection and/or sampling.

Any interpretation or clarification of the Standards shall be made by the DWSD Engineer, whose decision shall be final. No action, direct or indirect, of or by any person in making any connection, disconnection, repair or otherwise doing work with respect to any water, and sewer facility served by DWSD in violation of these Standards shall continue after discovery.

1.05 DEFINITIONS

A. Approved Documents:

Construction documents, including plans and specifications prepared by the Customer's Professional Engineer and approved by the DWSD Engineer.

B. Board:

The Board of Directors of DWSD.

C. CAB:

Sterling Ranch Community Authority Board

D. Commercial Development:

Multi-family dwelling units and other development including offices, schools, and restaurants, except residential development.

E. Contractor:

Any person, firm corporation, association or agency constructing facilities which are to be connected to DWSD's facilities.

F. Customer:

Any person, firm, corporation, association or agency who is authorized, or who desires, to obtain water and sewer services from DWSD.

G. District/DWSD:

Either term can be used to refer to Dominion Water & Sanitation District, their Successors or Assigns.

H. DWSD Engineer:

The person designated to act as DWSD Engineer for Dominion Water & Sanitation District. The DWSD Engineer oversees plan reviews, site inspections, and administers the Standards.

I. DWSD Representative:

A person designated by the DWSD Engineer to conduct plan review, site inspection and other duties with respect to any Project.

J. Engineer of Record:

Licensed professional engineer who is in "responsible charge" of a project and whose seal and signature appear on the final construction documents.

K. Fire Marshal:

The person designated by South Metro for the jurisdiction in which the system construction occurs. The Fire Marshal shall have sole authority over fire protection matters.

L. General Manager:

The person designated to act as General Manager for DWSD. The General Manager administers and supervises the affairs of operations and maintenance of facilities of DWSD.

M. Open Space:

Any area not intended to receive future development.

N. Paving:

Concrete or asphalt pavement.

O. Project:

A facility or portion thereof which is to be connected to the DWSD's facilities.

P. Residential Development:

Single family dwelling units.

Q. Operations Manager:

The person who oversees the operations of DWSD.

1.06 ABBREVIATIONS

All mention or reference to documents or specifications shall be the latest edition or revision thereof. The following abbreviations are commonly used in these specifications:

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction, Inc.
ANSI	American National Standard Institute, Inc.
ASA	American Standards Association
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWWA	American Water Works Association
CDPHE	Colorado Department of Public Health and Environment
ISO	Insurance Services Office
NACE	National Association of Corrosion Engineers
NEC	National Electric Code
NSF	International Standard/American National Standard
OSHA	Occupational Safety and Health Administration
SSPC	Society for Protective Coatings
UL	Underwriters Laboratory
UPC	Uniform Plumbing Code
UNI	Uni-Bell Association
WRA	Water Reducing Agent
WRF	Water Reclamation Facility

CHAPTER 2

DESIGN REVIEW

TABLE OF CONTENTS

	PAGE
2.01 DESIGN REVIEW PROCESS.....	1
2.02 PREPARATION OF CONSTRUCTION DOCUMENTS.....	1
2.03 CONSTRUCTION DOCUMENTS.....	2
A. Title Sheet.....	2
B. Overall Utility Plan.....	3
C. Plan and Profile Sheets.....	3
D. Details Sheets.....	4
2.04 EASEMENTS.....	5
A. Easements (Residential Development).....	5
B. Easements/Plan Approval (Commercial Development).....	5
2.05 PLAN APPROVAL.....	6
2.06 VARIANCES.....	6
2.07 FEES.....	6
2.08 FORMS.....	6
A. DWSD New Water Connection Request Form.....	8
B. DWSD New Sanitary Sewer Connection Request Form.....	9

CHAPTER 2

DESIGN REVIEW

2.01 DESIGN REVIEW PROCESS

Design Review is a step in the Development Review process, outlined in Section 6.11 of the DWSD Rules and Regulations, and is required for Retail Facilities and for DWSD Wholesale Facilities.

For customers: See Section 6.10 of DWSD Rules and Regulations for water and sanitary service application procedures. Upon DWSD approval of the Application for Service, the customer may enter the development review process. Once all requirements outlined in Section 6.11 have been met, DWSD will issue a written Authorization to Construct.

Commercial customers shall undergo review of any pretreatment requirements. For DWSD pretreatment standards refer to Appendix E. DWSD performs plan reviews for sand/oil and grease interceptors in compliance with SPR standards but may defer to SPR for additional review prior to construction under their pretreatment program.

South Platte Renew can be reached at the following email:

SPRPretreatment@englewoodco.gov

2.02 PREPARATION OF CONSTRUCTION DOCUMENTS

Construction Documents submitted to DWSD for review, comment, and approval of a system extension or modification shall be prepared by or under the direct supervision of a Professional Engineer (P.E.) registered by the State of Colorado. Plans and specifications shall bear the P.E.'s seal. Electronic copies of the plans and other submittal documents, in PDF format, shall be submitted either via download link or USB compatible storage device for review. DWSD reserves the right to require hard copies of the documents at the specific request of the DWSD Engineer.

The Customer and the P.E. shall be responsible for the adequacy of the plans and specifications. Any failure or unsatisfactory performance of the system shall not be a cause for action against DWSD. Costs to revise the plans and inspections following rejected plans will be borne by the Customer.

Any review performed by DWSD is solely for the purpose of DWSD and DWSD assumes no liability or responsibility as a result of having performed any such review, for having failed to perform any such review or for having collected a fee therefore.

2.03 CONSTRUCTION DOCUMENTS

The Construction Documents shall consist of plans and specifications submitted and shall be in strict compliance with the Standards contained herein and shall meet any special conditions that may be reasonably required by DWSD. No work shall commence on any facilities until the DWSD Engineer issues a written Authorization to Construct. (see Section 6.11 of Rules and Regulations)

The approval is only valid for one year. If construction has not begun within one year, the Construction Documents must be resubmitted, and in case of any change of ownership, the Construction must be resubmitted to DWSD for approval. (see Section 6.13 of Rules and Regulations)

Each and every deviation from the Standards shall be considered a variance and each request shall be in writing and submitted to DWSD with the Construction Documents for approval.

Addenda and modifications to the plans and specifications take precedence over the original Construction Documents. In the plans, calculated dimensions shall take precedence over scaled dimensions and noted material over graphic indication.

Construction shall be completed in full compliance with the Approved Documents. Any revisions or modifications shall be made ONLY after written approval of the DWSD Engineer.

Revisions affecting fire protection service shall be approved by the Fire Marshal and Douglas County. Construction Documents shall be submitted electronically to the District Engineer consisting of the following sheets:

- Title Sheet
- Overall Utility Plan
- Plan and Profile Sheets
- Detail Sheet(s)

The following minimum standards shall apply as follows:

A. Title Sheet

The title shall contain:

1. Name of Project.
2. Location Map of Project
3. Name and Address of Customer
4. Name and Address of Engineer
5. Subdivision Name and Filing Number.
6. Signature lines for DWSD Engineer, Fire Marshal, Douglas County and any

other governmental entity as required.

7. Professional Engineer's Seal and Signature.

B. Overall Utility Plan

The Overall Utility Plan shall contain:

1. Location, horizontal alignment and dimensions of existing and proposed streets, easements and right-of-way.
2. Street names, or letters if names have not been assigned.
3. Lots to be served (with lot and block numbers).
4. Existing or proposed water mains, sewer mains, water service lines, non-potable water mains, sewer service lines, valves, fire hydrants, fittings, manholes, vaults, inlets, underdrains, cleanouts and other appurtenances.
5. Existing or proposed storm sewers, sanitary sewer force mains, and other wet utilities whether owned by DWSD or not.
6. Gas, electric, cable, fiber optic, and telephone lines shall be shown within the easement or limits of construction of the Project.
7. Scale shall be a commonly used scale from 1"=20' to 1"=100'.
8. North Arrow

C. Plan and Profile Sheets

Plan and Profile Sheets shall contain:

Plan view shall include a topographic survey to identify contour elevations and all visible surface features (drainage courses, roads, sidewalks, curbs, gutters, slope lines, traffic signs and lights, fencing, gates, trees, landscaping, etc.). All horizontal and vertical datum is required to be on the DWSD Coordinate System Project Benchmark: NGA point "A 307" elevation of 5540.05' (NAVD88) and shall be noted on the drawings. Legend for survey shall be provided in accordance with the Standard Legend in Chapter 7.

1. Centerline profile and horizontal alignment of filings, streets, right-of-ways, and easements, both existing and proposed. Profile view shall include the vertical ground profile at centerline of each road, drainage ditch, and other significant grade breaks.
2. Existing and proposed curb, gutter, sidewalk, and other roadway features and

parking lots.

3. Lot and block number of lots to be served. Property lines shall be shown.
4. A service line table shall be provided for each drawing sheet indicating the service lines included on that particular sheet. Information to be included in the table is address/lot number, type of service, size and material, station or northing & easting and vertical elevation of sanitary stub inverts, top of sanitary bend (riser) and curb stop location.
5. Existing and proposed water, sanitary sewer, underdrain, and non-potable facilities. Water, sanitary sewer, underdrains and non-potable water shall be shown in both plan and profile views.
6. Water, sanitary sewer, underdrain, and non-potable lines shall be stationed. Curvilinear pipes shall also be stationed and have radius and bearings noted.
7. Dimensions from property line, flow-line or centerline for all proposed water, sanitary sewer, underdrain and non-potable facilities. Dimensions between utilities, including storm sewers, shall be required to document horizontal separation.
8. Pipe diameters, lengths, depths, slopes, elevations, and inverts.
9. Valves, fire hydrants, manholes, fittings, service lines, blowoff, and segments of restrained pipe shall be stationed. Service lines may follow a standard layout if shown on the detail sheets. Manholes shall be provided centerline elevations for pipe entering and leaving the manhole as well as the elevation of the rim. Other structures shall be provided with elevations of the pipes entering or below the structure and the elevation of the rim or access cover. Buried valves shall have centerline elevation noted.
10. Visible and buried utilities including storm sewer, gas, electric, cable, fiber optic, and telephone. The point of crossing shall be noted on the profile view. The "top of pipe" elevation shall be noted at the point of crossing where known.
11. North arrow, scale, benchmarks, profile elevations, pipeline stationing.
12. Scale for horizontal shall be 1"=20' or 1"=40', and for vertical 1"=5' or 1"=10'.

D. Detail Sheets

Detail sheet(s) shall contain details specific to the Project. Standard Details that are part of the Standards can be included as well, though no edits to the details shall be made without

approval from DWSD.

2.04 EASEMENTS

A. Easements (Residential Development)

Water, sanitary sewer and underdrain facilities, which are to be granted to DWSD, shall be located within a dedicated right-of-way or easement.

Easements shall be dedicated on the plat or granted to DWSD on the DWSD's Grant of Easement form. Necessary easements shall be executed and recorded prior to the start of construction. The start of the two-year warranty period is dependent on the requirements in Chapter 3, Paragraph 3.12 of these Standards.

No structure or building, fencing, streetlight, power pole, utility pole, yard light, mailbox or sign, whether temporary or permanent or any landscaping features, plants, trees or shrubs that exceed 48 inches in height at maturity and the root system will not interfere with or damage DWSD's facilities. No other utility lines or facilities shall be located within 6 feet of any DWSD facility.

In the event that any of the above items are placed in DWSD's easements without written permission of the DWSD Engineer, they shall be removed at the expense of the Customer.

The minimum width of an easement for a single utility line shall be 15 feet. If two or more utilities are to be located within the same easement, the minimum width shall be:

- Two utility lines – 30 feet
- Three utility lines – 40 feet
- Four utility lines – 50 feet

Utilities shall be generally centered in the easement unless otherwise approved by DWSD.

B. Easements/Plan Approval (Commercial Development)

The approval of utilities plans for commercial development within DWSD where DWSD will own and maintain the water and sanitary sewer facilities is contingent on the acceptance of the appropriate easements. Easements are required to be granted to the DWSD for the purpose of maintaining the utilities once they have been granted final acceptance by DWSD. Easements shall be dedicated on the plat or granted to DWSD on DWSD's Grant of Easement form. If the easements are being dedicated on the plat, a copy needs to be submitted with the drawings at the time of initial submittal for review. Easements granted by separate document will require the following:

1. Meets and Bounds legal description

2. Exhibit showing the limits of the easements
3. Title policy for the property

The legal description, exhibit, title policy and executed easement forms shall be submitted for approval to DWSD prior to the issuance of a written Authorization to Construct.

2.05 PLAN APPROVAL

The DWSD Engineer will not approve any Construction Drawings until the Fire Marshal has approved, in writing, the number, location and spacing of fire hydrants.

Upon notice of plan approval, the Customer shall submit electronic copy of stamped and signed Construction Drawings to the DWSD Engineer for signatures. The signed Construction Documents will be considered the Approved Documents.

2.06 VARIANCES

Request for a variance from the requirements of these Standards shall be submitted in writing to the DWSD Engineer. Each variance request shall include a detailed description of the proposed variance together with the Customer's Professional Engineers' analysis of the impact of the variance. The decision of the DWSD Engineer to grant or deny any variance will be final.

Each variance request shall include a detailed description of each location of the variance. For example, a variance to the horizontal separation requirements will not be granted for the entire project. The request must include a description of each location that violates the Standards and requires a variance.

Variations will be granted on a per project basis and are not to be interpreted as a permanent change to the Standards.

2.07 FEES

DWSD may collect a fee to offset the costs of plan review, inspection and administration. Fees shall be in accordance with the Rules and Regulations of DWSD and CAB, which are amended from time to time. Fees apply to new construction projects, and modifications to existing facilities and services, including the interior plumbing of non-residential properties.

2.08 FORMS

During the Service Application as outlined in Section 6.10 of the DWSD Rules and Regulations, any new connections to the DWSD water distribution system or sanitary sewer system shall be verified in the master hydraulic model. The Customer shall submit

the following applicable form(s) to DWSD and are responsible for accommodating any design changes recommended by the model output.



DWSD NEW WATER CONNECTION REQUEST FORM (EXAMPLE)

Request form from DWSD Engineer

Date: XX/XX/XXXX

Name:	Land Use:
Point of Contact:	Parcel Number:
Phone/Email:	Expected Water Use
New Connection Location:	(average demand):

The purpose of this form is to provide information pertinent to *Customer* for a new connection to the Dominion Water and Sanitation District (DWSD) water distribution system. The information provided in this form was taken from the Water Master Plan hydraulic model prepared by DWSD Representative. The results provided in this form are subject to change upon future updates to the model.

The connection node modeled for the tie-in point is shown in **Figure 1** below:

Insert snip from model where connection node for new connection here

Figure 1. Model Location for New Connection Point

The following are results from the model for *Customer* use intended to inform the design of the new water connection.

Static Pressure Range: _____ psi – _____ psi

Elevation: _____ feet

Demand Scenario: _____

Fire Flow Results: _____



DWSD NEW SANITARY SEWER CONNECTION REQUEST FORM (EXAMPLE)

Request form from DWSD Engineer

Date: XX/XX/XXXX

Name:	Land Use:
Point of Contact:	Parcel Number:
Phone/Email:	Expected Sewer Discharge (average daily flow):
New Connection Location:	

The purpose of this form is to provide information pertinent to *Customer* for a new connection to the Dominion Water and Sanitation District (DWSD) collections system. The information provided in this form was taken from the Wastewater Master Plan collection system model prepared by DWSD Representative. The results provided in this form are subject to change upon future updates to the model.

The connection node modeled for the tie-in point is shown in **Figure 1** below:

Insert snip from model where connection node for new connection here

Figure 1. Model Location for New Connection Point

The following are results from the model for *Customer* use intended to inform the design of the new sanitary sewer connection.

Sewer Main Capacity: _____ % full

Sewer Main Velocity: _____ ft/s

Invert Elevation: _____ ft

Receiving Lift Station: _____

CHAPTER 3

CONSTRUCTION REQUIREMENTS AND ACCEPTANCE PROCEDURES

TABLE OF CONTENTS

	PAGE
3.01 GENERAL.....	1
3.02 CONSTRUCTION PROCEDURES.....	1
3.03 INSPECTION PROCEDURE.....	2
3.04 CONSTRUCTION SUBMITTALS.....	3
3.05 SURVEYING.....	4
3.06 STANDARD LEGEND.....	4
3.07 TRAFFIC CONTROL.....	5
3.08 SERVICE INTERRUPTION.....	5
3.09 CONNECTIONS TO EXISTING MAINS.....	6
3.10 EXISTING UTILITIES AND STRUCTURES.....	6
3.11 SAFETY.....	7
3.12 ACCEPTANCE OF FACILITIES.....	7
A. Tests and Inspections.....	7
B. Acceptance Inspections.....	8
C. Record Drawings and Easements.....	8

CHAPTER 3

CONSTRUCTION REQUIREMENTS AND ACCEPTANCE PROCEDURES

3.01 GENERAL

This section applies to water and wastewater facilities that will connect to DWSD Wholesale Facilities, whether owned and operated by DWSD or a Customer. Utility systems connecting to DWSD Wholesale Facilities shall be constructed in accordance with these Standards and the Approved Documents. More detailed requirements for the construction of DWSD Wholesale Facilities will be found in the contract documents issued by DWSD.

3.02 CONSTRUCTION PROCEDURES

Following the issuance of Authority to Construct, the Customer may proceed with construction. In addition to construction requirements contained in other portions of these Standards:

A preconstruction conference shall be held prior to the commencement of work with the General Manager, DWSD Engineer, DWSD's other Representatives, Contractor who is to perform the work, and the Customer's Professional Engineer.

The DWSD Engineer shall be notified a minimum of 48 hours prior to the commencement of work. This notice shall be given for new projects and for projects that have been inactive for more than one week.

Inspections for "ongoing" work may be scheduled with 24-hour notice.

Development phasing of any project shall be shown on the initial Construction Document submittal and made a part of the application procedure. Construction shall be accurately surveyed and staked in accordance with the Approved Documents.

Adequate provisions for notification of a service outage must be given by the Customer prior to the actual isolation of the system by DWSD. Outages shall be kept to a minimum. Outages shall be coordinated a minimum of two weeks in advance.

DWSD shall be notified whenever it becomes necessary to open or close a valve on the existing water system. Only DWSD personnel are authorized to operate valves owned or operated by DWSD. The Customer may operate DWSD owned/operated valves under the direct supervision of DWSD or in a life safety emergency.

3.03 INSPECTION PROCEDURE

DWSD shall have a right to inspect at all times, facilities connected to, or to become connected to DWSD's facilities. Authorized employees and representatives of the DWSD shall be allowed free access at reasonable hours to any building or premises receiving water or sanitary sewer, service to ensure compliance with these Standards.

Inspection performed by DWSD is solely for the purposes of DWSD and DWSD assumes no liability or responsibility as a result of having performed such inspection, for having failed to perform such inspection or for having collected a fee therefore. Such inspection shall not be deemed to be an approval of the size, slope, alignment, materials used in construction, the method used in excavating, the placing of pipe, jointing, testing, backfilling or any other aspect of the facility inspected.

Personnel authorized by DWSD will inspect construction of utilities.

Inspection shall not relieve the Customer from any obligation to perform the work strictly in accordance with the Standards and the Approved Documents. Any work, which is not in accordance with the Standards and the Approved Documents, shall be removed and corrected at the Customer's sole expense.

Approval by DWSD shall in no manner relieve the Customer from responsibility for errors or omissions in the plans. Errors shall be corrected by Customer at no expense to DWSD.

Whenever a conflict occurs in the Standards or between the Standards and Approved Documents, the DWSD Engineer shall make the final interpretation.

Materials used shall be subject to the inspection and approval of DWSD at all times. DWSD has the right to perform testing deemed necessary to ensure compliance of the material with these Standards. Failure to condemn or reject inferior materials or work shall not be construed as acceptance.

DWSD shall have the authority to reject defective or inferior materials or defective workmanship and to suspend work until such time that the Customer has replaced the materials or corrected the defective work.

Whenever defective materials or work are rejected, the Customer shall promptly remove the defective materials and replace defective work to the satisfaction of DWSD. In the event the Customer fails to remove rejected materials within a reasonable length of time, DWSD may arrange for such removal at the expense of the Customer.

Except in cases of emergency, maintenance or protection of work already done, no work shall be allowed between the hours of 6 p.m. and 7 a.m. nor on Saturday, Sunday or legal holidays unless approved by DWSD. When inspectors are required to work overtime, it shall be at the Customer's expense. Requests for overtime shall be made to DWSD at least 48 hours in advance. Payment for such overtime work shall be made by check to DWSD.

3.04 CONSTRUCTION SUBMITTALS

Shop drawings and engineering data (submittals) covering equipment and fabricated components and building materials which will become a permanent part of the Project shall be submitted to DWSD for review, as required. Contractor shall provide DWSD with a full list of submittals for the Project prior to construction. DWSD shall indicate which submittals require DWSD review. Submittals shall verify compliance with the Standards, and Approved Documents shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and the operation of component materials and devices; the external connections, anchorages, and supports required; the performance characteristics; and dimensions needed for installation and correlation with other materials and equipment.

Submittals, regardless of origin, shall be approved by Contractor and clearly identified with the name of the Project, Contractor's name, and references to applicable Standards paragraphs, Project specifications and Approved Documents. Each copy of submittals, regardless of origin, shall be stamped or affixed with an approval statement of Contractor. Submittals shall be reviewed and approved by the P.E. prior to being submitted to DWSD. The submittal shall bear their stamp of approval. Each submittal shall indicate the intended use of the item. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on drawings and other descriptive data.

Submittals shall be delivered electronically to DWSD in PDF format and with a hard copy if requested. DWSD's review of submittals covers only general conformity to the Standards and Approved Documents, external connections, and dimensions that affect the layout; it does not indicate thorough review of dimensions, quantities, and details of the material, equipment, device, or item covered. DWSD's review shall not relieve Contractor of sole responsibility for errors, omissions, or deviations in the drawings and data, nor of Contractor's sole responsibility for compliance with the Approved Documents. DWSD shall review and return comments within 21 days.

Adequate operation and maintenance information shall be supplied for equipment that will be operated and maintained by DWSD. The Contractor shall provide a Project specific operation and maintenance manual for each type of equipment installed. Unless otherwise agreed by DWSD, the operation and maintenance manual for each type of equipment shall only be submitted for review following review of shop drawings and engineering data pertaining to that equipment.

Operation and maintenance manuals shall include the following minimum information:

- a. Equipment function, normal operating characteristics, and limiting conditions.
- b. Assembly, installation, alignment, adjustment, and checking instructions.
- c. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.
- d. Lubrication and maintenance instructions.

- e. Guide to troubleshooting.
- f. Parts lists and predicted life of parts subject to wear.
- g. Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.
- h. Test data and performance curves, where applicable

3.05 SURVEYING

Line and grade for water, sewer, underdrain and non-potable water lines shall be established by a Professional Land Surveyor (Surveyor) licensed to practice in the State of Colorado.

Correct alignment and elevation of the utilities as shown on the Approved Documents is the responsibility of the Customer. Approval of the staked alignment and elevations by DWSD does not relieve the Customer in any manner from the responsibility for field errors. No pipe shall be installed without line and grade stakes set by the Surveyor and approved by DWSD.

Exception: If a main is to be extended in an existing street and if the Customer's P.E. who prepared the plans can show that the finish grade of the street is to remain unchanged, no grade stakes need be set.

Hubs and stakes shall be set on an offset line to mark the location of the center line of the main. Center line hubs and stakes may be used in addition to the offset hubs and stakes; however, they may not be set instead of the offset hubs and stakes.

Valves, crosses, tees, bends, fittings, fire hydrants, services, manholes, etc.. shall be staked for line and grade. Points of curvature and points of tangency of curves, as well as points on the curve, shall be staked for line and grade.

3.06 STANDARD LEGEND

	Surfaced Street		Existing Contour
	Surfaced Street with curb		Proposed Contours
	Non-surfaced Street		Bank or Slope Lines
	Concrete Sidewalk		Test Hole
	Manhole		Concrete Encasement
	Drainage course or flow path		Concrete Thrust Block
	Water or Gas Valve		Drain or Culvert

	Water or Gas Meter		Tunnel Casing
	Telephone or Power Pole	SMALLER THAN 24"	Existing Utility
	Fire Hydrant	24" AND LARGER	Existing Utility
	Sign	SMALLER THAN 24"	Proposed Utility
	Street Light	24" AND LARGER	Proposed Utility
	Fence		Non-Connecting Piping

3.07 TRAFFIC CONTROL

Traffic control shall be in accordance with the requirements of the Douglas County Public Works, Colorado Department of Highways and the law enforcement agency (i.e.: Douglas County Sheriff, Colorado State Patrol) whose jurisdiction applies or other governing entity.

The Customer shall be responsible for the provision of a safe travel way on dedicated roadways on and adjacent to the job site. The Customer shall provide for proper traffic control warning devices around excavations, embankments and obstructions and shall provide maintenance of said devices.

The Customer shall not close any street or portion of a street without receiving an approved traffic control plan from the agencies that have jurisdiction. It is the Customer's responsibility to notify Douglas County, DWSD, the Douglas County Sheriff and South Metro a minimum of 24 hours prior to closing any street and immediately after opening of any street.

3.08 SERVICE INTERRUPTION

In the event that existing water, sanitary sewer, underdrain, or non-potable water service will be interrupted as a result of construction, the Contractor shall be responsible for written notification of affected customers at least two weeks in advance of the work. Verbal notification shall be made again the day prior to the service interruption. Service interruptions for schools, medical clinics and various commercial businesses shall be conducted at times specified by DWSD. If outages for more than four hours are necessary, they must be conducted at times to cause the least inconvenience to other customers. Under all circumstances, work shall be continuous until all customers are back in service. If, in the process of installing a connection, there exists a facility that cannot be out of water, as designated by DWSD, such as a hospital, appropriate temporary means shall be taken to provide and convey water. DWSD, Douglas County and South Metro shall approve such measures prior to their construction.

3.09 CONNECTIONS TO EXISTING MAINS

No connection shall be made to an existing main until all inspections have been performed and accepted by DWSD. Where connections are made between new and existing lines, each connection shall be made as indicated in Approved Documents. Customer shall submit a new connection form prior to final Approved Documents, refer to Chapter 2. If field conditions make the detailed connection impossible, then an alternative method may be used with the approval of DWSD.

The location of existing stub-outs shown in DWSD's records is based on the best available information and may not be exact. The Customer shall be responsible for determining the exact location and elevation of any stub-out and adjusting the design or construction of the new facilities as necessary.

The Customer shall notify DWSD a minimum of two weeks in advance of connection to an existing line or interruption service to an existing line.

The Customer is responsible for any de-watering necessary which shall be done without damage to property and as detailed in Chapter 4, Paragraph 4.03-A.6.

Special care shall be taken to prevent contamination when draining, cutting into, or making connections to existing pipes. No trench water, mud, or dirt shall be permitted to enter the lines as detailed in Chapter 4, Paragraph 4.03-D.1.

For sanitary systems: At the beginning of a construction project, the Customer shall install a watertight plug in the connection manhole, the first manhole upstream, or another location acceptable to DWSD in order to prevent any inflow to enter the existing sewer system. The Contractor, in the presence of DWSD, shall remove this plug. Related costs shall be borne by the Customer.

For connection to potable water system: No connection will be made to DWSD Wholesale Water Facilities before inspections and disinfection testing have been completed and accepted by DWSD.

3.10 EXISTING UTILITIES AND STRUCTURES

It shall be the responsibility of the Customer to investigate and verify the existence and location and elevations of existing utilities.

The Customer shall be solely responsible for the protection of existing structures or utilities including pipes, cables, fences or similar items. Existing structures or utilities disturbed by construction are to be restored to their original location and condition unless otherwise noted on the Approved Documents. Permission for adjustment of existing structures, utilities or other items shall be obtained from the appropriate owners or agencies in written form with items clearly identified.

3.11 SAFETY

The Customer shall be responsible for initiating, maintaining and supervising safety programs in connection with the work. It shall be the responsibility of the Customer to provide safety measures for DWSD in order for DWSD to perform the required inspections.

The Customer shall comply with applicable laws, ordinances, rules, regulations and orders of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss, and shall provide and maintain necessary safeguards for the protection of property and utilities. Damage, injury or loss to any property caused, directly or indirectly, in whole or in part, by the Customer, or anyone directly or indirectly employed by the Customer or anyone for whose acts the Customer may be liable, shall be remedied by the Customer.

3.12 ACCEPTANCE OF FACILITIES

Prior to connection to the DWSD system, DWSD will inspect and accept the work.

A. Tests and Inspections

The Contractor shall perform tests and inspections for water and sewer installations as described in the individual Chapters and in the presence of DWSD, as required. Electronic copies of the test reports shall be provided to DWSD. The Contractor shall notify DWSD a minimum of 48 hours prior to any inspections required by DWSD. The following list of the tests and inspections are required and shall be performed as specified in other portions of these Standards:

- Water Installations:
 - Hydrostatic Test
 - Disinfection
 - Fire Hydrant Leak Test
 - Cathodic Protection System Test
 - Tracer Wire Test
- Sewer Installations:
 - Alignment and Deflection Tests (Mandrel for straight sections only)
 - TV Inspection with location and the distance from the starting manhole of each tap called out and provide CD or DVD to DWSD (straight and curvilinear sections)
 - Leakage Tests (Low Pressure Air Test, ASTM F1417)
 - Exfiltration and Infiltration (if applicable)
 - Vacuum Test of Manholes (ASTM C1244)
 - Tracer Wire Test
- Other Items:
 - Compaction of Bedding, Backfill and Subgrade
 - Any required materials testing.

B. Acceptance Inspection

After installation and testing of water and sanitary sewer lines is completed, and DWSD has accepted the tests, an Acceptance Inspection shall take place. DWSD and Contractor shall inspect for approval the following items:

- Valve box alignment and accessibility
- Manhole ring alignment and vertical adjustment
- Main line, blowoff assembly and fire hydrant location and operation
- Proper operation of all valves, including air/vac valves
- Proper operation of all meters

Discrepancies and punchlist items shall be noted on a punch list which shall be submitted to the Contractor for correction prior to connection to the existing system.

C. Record Drawings and Easements

The Contractor shall maintain a working set of Construction Record Drawings at the site. The Construction Record Drawings shall be continuously kept up to date and available to DWSD upon request and shall be submitted at the conclusion of the Project. The Construction Record Drawings shall include the following information, at a minimum:

- Surface features including manholes, valve boxes, cleanouts and fire hydrants. Buried valves shall have top of nut elevation recorded.
- Vertical waterline design information (in station/elevation format) specifically called out in the profile view of the plans, including but not limited to: tees, bends, deflections, and casings.
- Curvilinear pipes, if allowed by special variance, shall have centerline and elevation noted at each PC, Mid-Point & PT.
- Manholes shall be provided with elevations for pipe inverts entering and leaving the manhole as well as the elevation of the rim. Other structures shall be provided with elevations of the pipes entering or below the structure and the elevation of the rim or access cover.
- Changes or addenda to the construction documents.

The Contractor shall furnish an electronic survey file at the completion of the Project. Electronic drawing files shall be provided as an AutoCAD file (.dwg) and ESRI Shape file (.shp). AutoCAD data shall be modified to state plane coordinates for export. Horizontal and vertical datum is required to be on the DWSD Coordinate System Project Benchmark: NGA point "A 307" elevation of 5540.05' (NAVD88). The electronic survey shall include the following, at a minimum:

- Information required in the Construction Record Drawings as specified herein.
- Plat Topographic survey to identify contour elevations and visible surface features (drainage courses, roads, sidewalks, curbs, gutters, slope lines, traffic signs and

lights, fencing, gates, trees, landscaping, etc.). Survey shall be completed following the restoration and shall extend to 30 feet on each side of the pipeline. Contours shall be at one foot intervals.

- Vertical ground profile at centerline of each road, drainage ditch, and other significant grade breaks.
- Stream bed and water surface elevations at the crossing of any waterways.
- Existing right-of-way and easements and new permanent easements or temporary construction easements within 30 feet of each side of the pipeline.

Following the completion of the Project, the following items shall be submitted to DWSD:

- Completed Construction Record Drawings
- A complete electronic survey that shows surface features, utilities, roadways, and the new system. The survey shall be delivered to DWSD in electronic format on a USB compatible storage device or transferred electronically.
- Approved submittals.
- Easements for water and sanitary sewer lines which were not dedicated to the plat.
- Grant and Acceptance of Utilities Agreement.

CHAPTER 4

WATER DISTRIBUTION SYSTEM SPECIFICATIONS

TABLE OF CONTENTS

	PAGE	
4.01	WATER MAIN DESIGN	
	A. Flow Design Criteria	1
	B. Hydraulic Design	2
	C. Location and Alignment.....	3
	D. Pipe Class	8
	E. Depth.....	9
	F. Groundwater Barriers	9
	G. Valves.....	9
	H. Fire Hydrants	12
	I. Fire Sprinkler Lines.....	13
	J. Pressure Regulating Stations.....	13
	K. Air and Vacuum Valves	13
	L. Blowoff Assemblies.....	14
	M. Rods, Clamps and Restraining Devices.....	14
	N. Thrust Blocks.....	14
	O. Wet Taps.....	14
	P. Corrosion Protection	15
	Q. Limits of Accuracy (Allowable Error).....	15
	R. Water Quality Sampling Stations	15
4.02	WATER MAIN MATERIALS	
	A. Ductile Iron Pipe	16
	B. Polyvinyl Chloride Pipe - PVC.....	17
	C. Tapping Requirements	17
	D. Water Main Fittings.....	18
	E. Valves.....	18
	F. Fire Hydrants	20
	G. Valve Boxes.....	21
	H. Combination Air Relief-Vacuum Breaker Assemblies	21
	I. Tapping Sleeves and Saddles	22
	J. Rods and Clamps	22
	K. Pipe Restraint.....	22
	L. Thrust Blocks.....	23
	M. Bedding Material	24
	N. Pre-Cast Concrete Vaults and Manholes	25

CHAPTER 4

WATER DISTRIBUTION SYSTEM SPECIFICATIONS

TABLE OF CONTENTS

	PAGE	
4.02	WATER MAIN MATERIALS (Continued)	
	O. Concrete	25
	P. Concrete Reinforcement	26
	Q. Manhole Rings and Covers.....	26
	R. Flexible Plastic Joint Sealing Compound.....	27
	S. Pipe Encasement.....	27
	T. Groundwater Barriers.....	28
	U. Coal Tar Epoxy Damp-proofing for Buried Vaults or Manholes.....	28
	V. Filter Fabric	28
	W. Tracer Wire.....	29
	X. Marking Tape.....	29
	Y. Corrosion Protection for Pipelines	30
4.03	WATER MAIN INSTALLATION	
	A. Excavation.....	32
	B. Pipe Foundations and Bedding	33
	C. Trench Backfilling and Compaction	34
	D. Installation of Water Main.....	35
	E. Installation of Tracer Wire.....	37
	F. Installation of Valves and Valve Boxes.....	37
	G. Installation of Fittings.....	38
	H. Installation of Tapping Sleeves (“Wet Tap”).....	38
	I. Installation of Fire Hydrants	39
	J. Installation of Blowoff Assemblies.....	39
	K. Installation of Thrust Blocks.....	40
	L. Protection of Water Lines near Sanitary and Storm Sewer Facilities.....	41
	M. Abandonment of Utilities	41
	N. Hydrostatic Testing of Water Mains.....	41
	O. Disinfection of Water Mains.....	43
	P. Installation of Corrosion Protection for Pipelines.....	48
4.04	WATER SERVICE LINE DESIGN	
	A. Flow Design Criteria	54
	B. Hydraulic Design	54
	C. Sizing.....	54
	D. Location and Alignment.....	55
	E. Depth.....	55
	F. Service Taps.....	56
	G. Materials.....	56
	H. Valves.....	56
	I. Pressure Reducing Valves (PRV)	56

CHAPTER 4

WATER DISTRIBUTION SYSTEM SPECIFICATIONS

TABLE OF CONTENTS

	PAGE
4.05	WATER SERVICE MATERIALS
A.	“K” Copper Pipe57
B.	Ductile Iron Pipe57
C.	Polyvinyl Chloride Pipe - PVC57
D.	Bedding Material57
E.	Water Service Fittings57
F.	Valves.....57
G.	Corporation Stops58
H.	Tapping Saddles.....58
I.	Copper Setters.....58
J.	Curb Boxes58
K.	Bell Restraints.....58
4.06	WATER SERVICE INSTALLATION
A.	Excavation60
B.	Pipe Foundation and Bedding.....60
C.	Trench Backfilling and Compaction60
D.	Installation of Water Service Lines60
E.	Installation of Polyethylene Wrapping.....61
F.	Installation of Valves and Valve Boxes.....61
G.	Installation of Fittings.....61
H.	Installation of Gate Valves with Drains.....62
I.	Installation of Service Taps.....62
J.	Abandonment of Water Service Lines.....63

CHAPTER 4

WATER DISTRIBUTION SYSTEM SPECIFICATIONS

TABLE OF CONTENTS

	PAGE
4.07 CROSS CONNECTION CONTROL CRITERIA	
A. General	64
B. Types of Cross-Connection Control Devices	65
C. Application of Devices	66
D. Water Conservation Devices	67

CHAPTER 4

WATER DISTRIBUTION SYSTEM SPECIFICATIONS

4.01 WATER MAIN DESIGN

Water distribution mains are generally defined as pipes sized 4 inches or more that serve multiple Customers. Water transmission lines are generally defined as pipes sized 16 inches or greater that have no direct connections for Customers. These pipe sizes are not absolute. It is possible to have an 18-inch water distribution main with service taps for Customers. This Chapter specifies the criteria for water distribution mains, but transmission mains should also follow these general requirements. Transmission mains must undergo special review and approval from the District and may be subject to more stringent requirements.

When water distribution main specifications and details reference Denver Water Complete Engineering Standards and Capital Projects Construction Standards, the requirements listed in the most recent version of those Standards and Details shall apply. In the event of a conflict between the Denver Water Standards and these Standards, the District Engineer shall make the final interpretation.

A. Flow Design Criteria

Water system design shall be based on the hydraulic capacity of the system using the following criteria.

1. Domestic Demand Criteria

The domestic demand criteria are set forth in Table 4-1.

The criteria in Table 4-1 are suggested planning criteria, and at the discretion of the District Engineer, different unit flow factors may be required.

The demand for Commercial/Industrial developments shall be based on the gross acreage of the development including roadways.

2. Irrigation Demand Criteria

Most irrigation demands are included in Table 4-1 however, an additional component for irrigation demand shall be included in systems where irrigation taps 2-inch diameter or larger are proposed. The actual flow calculated by the Customer's landscape architect shall be utilized for estimation purposes only. However, if the system has yet to be designed, a Unit Flow Factor of 2500 gpad and a Peaking Factor of 3.5 shall be used.

All irrigation demands for single family homes shall be designed using potable water in accordance with Chapter 4.

3. Fire Flow Criteria

Fire flow requirements shall be determined in accordance with the recommendations contained in the most recent "Guide for Determination of Required Fire Flow" as published by the Insurance Services Office (I.S.O.) Municipal Survey Service of Appendix B of International Fire Code. The Customer's Professional Engineer shall determine the Needed Fire Flow (NFF) based on the parameters of the proposed development; however, the flow rates in Table 4-2 may be used as a general guideline.

Developments which consist of a combination of building types shall calculate the needed fire flow based on the highest flow requirement within the system.

B. Hydraulic Design

1. Analysis Criteria

Water distribution systems shall be analyzed for pressure, velocities, head loss and surge allowance using a pipe network analysis method such as Hardy Cross. Surge allowance shall be calculated by using the guidelines set forth in AWWA C-900 Appendix A or Uni-Bell Handbook for the design and construction of PVC pipe, whichever is more restrictive.

The distribution system shall be sized to meet the following criteria:

Average Day Demand

Minimum Pressure:	40psi
Maximum Pressure (including surge):	150 psi
Maximum Velocity:	5 ft/sec.
Maximum Head Loss:	1 ft/100ft.

Maximum Day Demand + Needed Fire Flow

Minimum Pressure:	20 psi
Maximum Pressure (including surge):	150 psi
Maximum Velocity:	10 ft/sec.
Maximum Head Loss:	5 ft/100 ft

Demand points for the Needed Fire Flow shall be determined from adjacent fire hydrants as outlined in Table 4-2. All fire hydrants shall meet the minimum criteria as noted above.

If the maximum pressure is exceeded, the pipe class shall be increased or a PRV shall be installed to step the pressure in that zone down to an acceptable level. If pressures of greater than 120 psi must be used in order to properly meet the demands, a higher-pressure class of pipe will be required as outlined in Chapter 4, Paragraph 4.01-D.

2. Water Line Looping

Water lines shall be looped so that no more than one fire hydrant is out of service at any time when any repair of the water line or an interruption of service occurs. No more than one fire hydrant or fire sprinkler system shall be installed on a single line that is not looped.

In the event that the looping is to be constructed as part of future phases, it shall be included as part of the pipe network analysis. Upsizing, at customer's cost, of distribution lines shall be required when the hydraulic analysis indicates that upsizing is needed for current or future phases to meet the hydraulic criteria for all construction phases.

C. Location and Alignment

1. Streets

Water mains shall be located within dedicated rights of way along an alignment that generally follows the roadway 6 feet inside of the flowline. On streets running north and south, the water line shall be placed on the east side of the street. On streets running east and west, the water line shall be placed on the north side of the street. On roadways which meander in each direction, the water line shall not zig-zag across the street.

2. Easements

When water mains cannot be located within dedicated right-of-way, they shall be located within a dedicated easement at least 15 feet wide as required in Chapter 2, Paragraph 2.05. Within residential developments, the easement shall be located within an open space tract. Under exceptional circumstances, the District Engineer may allow the easement to be located between two residential lots; however, the easement shall be at least 20 feet wide. In some instances, additional width may be required in accordance with Chapter 2, Paragraph 2.05.

The water main shall be placed no more than 2 feet from the centerline of the easement with a minimum depth of cover of 6 feet when located in an easement. Horizontal deflections or curvilinear alignments in water mains located in easements are not permitted. Valves may be located in dedicated "open space" or "common" areas, but not between residential lots.

Grading within the District easement is permissible; however, the side slope may not exceed a 6:1. The grade along the length of the easement may not exceed 5 percent unless otherwise approved by the District Engineer. Vehicle access must be maintained at all times.

When a water main crosses an existing or future open space drainageway, the line shall cross perpendicular to the drainageway or as close to perpendicular as feasible. If the slope of the drainageway downstream from the crossing exceeds a grade of 0.5 percent within 200 feet of the crossing, a cutoff wall located 10 feet to 15 feet downstream from the crossing shall be required. The cutoff wall shall continue to a minimum depth of 2 feet below the water line. A minimum 6-foot wide footing is required at the bottom of the cut off wall. The water line shall be concrete encased as required in the Standard Details. Concrete Encasement for the width of the drainageway plus 5 feet on each side.

3. Alignment with other Utilities

Water lines shall be designed to adhere to the minimum alignment requirements as stated herein. Variances may be granted by DWSD to decrease separation within local roadways where insufficient room is available. Variance requests shall be submitted as required in Chapter 2, Paragraph 2.07. Variances will not be allowed in easements or open spaces. Variances will be reviewed and approved on a limited basis, and will not be considered when adjusting the locations of the planned installation can be easily accomplished.

Vertical Utility Separation – for all utilities:

A minimum of 18 inches of vertical separation is required for parallel lines and when crossing any other utility. All effort shall be made to lay out the system to meet these minimum requirements. Generally, water lines shall be a minimum of 18 inches above non-potable water lines, which shall be a minimum of 18 inches above storm sewers, which shall be a minimum of 18 inches above sanitary sewers. Dry utilities, such as gas and electrical should be generally located above wet utilizes, such as water. Utility crossings shall follow the Standard Details and other applicable standards depending on the situation outlined in the detail.

Where water lines cross sanitary sewer lines, they shall be installed above sewers and laid to provide a vertical clear distance of at least 18 inches between the bottom of the water line and top of the sanitary sewer line. When a new water line crosses an existing sanitary sewer at a point less than 18 inches above the sanitary sewer, the District Engineer shall be notified and adjustments shall be made. Where a minimum separation of 18 inches and minimum cover of 5 feet cannot be maintained, it must go through the variance process. The sanitary sewer line shall be encased at the crossing.

Horizontal Utility Separation – for all utilities:

Potable water lines shall be designed so that 10 feet of horizontal separation, measured from outside edge of pipe to outside edge of

pipe, shall be maintained from sanitary sewer, non-potable water, and storm sewer lines. Sanitary sewer lines shall be designed so that 10 feet of horizontal separation, measured from outside edge of pipe to outside edge of pipe, shall be maintained from potable water, non-potable water, and storm sewer lines.

Separation from dry utilities shall be based on the requirements of the owning agency of the dry utility and to allow enough space for safe construction and future maintenance of both lines.

When horizontal separation of 10 feet is not possible, one of the following special construction measures shall be incorporated into the design in order for the District to approve the requested variance. All utilities shall be laid in a separate trench, regardless of which option is used. Note that the separation distance between potable and non-potable water lines may be reduced to no closer than 6 feet, measured outside of pipe to outside of pipe, without requiring special construction measures. However, a variance request is still necessary. All efforts shall be made to maintain the 10-foot minimum separation requirement. Special construction measures for when less than 10 feet of separation is proposed shall be:

- a. Sanitary sewer or storm sewer lines that do not meet the separation requirements to potable water lines shall be constructed of C900 water pipe grade PVC pipe, having a minimum pressure rating of 150 psi. All other Standards for water line materials and construction shall apply. The completed section of sewer (storm or sanitary) shall be pressure tested to 150 psi to ensure there are no leaks. The pipe shall be continuously marked by means of wrapping utility marking tape indicating the line's service (sanitary or storm). The C900 material shall be transitioned to and from at manholes only, no partial reaches are allowed, and shall continue for the entire length of the pipe that does not meet the separation distance.

Or,

- b. Potable water, sanitary sewer, or storm sewer lines that do not meet the separation requirements to other utilities shall be installed in a casing pipe or flow fill for the entire length of the pipe that does not meet separation distance. Casing pipe design shall be submitted for review along with the variance. The flow fill shall meet the Colorado Department of Transportation Structural Backfill (flow fill) Standards and have a minimum strength of 50 psi after 28 days. The mix design shall be submitted for review along with the variance. The flow fill shall

replace the pipe bedding and extend a minimum of 6 inches on all sides of the pipe. Either utility may be cased or flow filled for the entire length that does not meet the separation distance.

Or,

- c. In instances where the potable water lines are above sanitary sewer or storm sewer line a variance may be submitted to reduce the horizontal separation and potentially eliminate casing pipe or flow fill if the minimum vertical separation of 18 inches is met.

This reduction in separation will only be considered after all reasonable efforts have been made to maintain the 10-foot minimum separation.

The following tables can be used as a quick reference for the horizontal separation requirements.

	Horizontal Separation Requirements (feet) to Other Wet Utility [Measured Edge to Edge]			Variance Required if Horizontal Separation is not met?
Utility Type	Potable Water	Sanitary Sewer	Storm Sewer	
Potable Water	-	10	10	Yes
Sanitary Sewer	10	-	10	Yes
Storm Sewer	10 ¹	10 ¹	-	Yes
	Special Construction Required if Horizontal Separation is 6-10 feet			
Utility Type	Potable Water	Sanitary Sewer	Storm Sewer	
Potable Water	-	b	b	
Sanitary Sewer	a, b	-	a, b	
Storm Sewer	a, b ³	a, b ³	-	
	Special Construction Required if Horizontal Separation is less than 6 feet			
Utility Type	Potable Water	Sanitary Sewer	Storm Sewer	
Potable Water	-	b	b	
Sanitary Sewer	a, b	-	a, b	
Storm Sewer	a, b ³	a, b ³	-	

*1 - Storm sewer design and construction is governed by Douglas County. Horizontal separation of 10 feet is required by Douglas County Standards. All variances must be approved by Douglas County for the storm sewer, and by the District for the other utility.

*2 - A variance is required to be reviewed and approved by the District if the separation is less than 10 feet. However, special construction measures are not required if the separation is between 6 and 10 feet.

*3 - Special construction for storm sewers for less than 10 feet of horizontal separation are suggested methods that will be acceptable to the District. If these methods affect the storm sewer installation, they must be approved by Douglas County.

4. Curvilinear Water Mains

Curvilinear alignments for potable water mains will only be considered by special variance submitted to DWSD for approval where the design using only straight pipe must be shown to be highly impractical. If approved, the curvilinear alignment will be permitted only in accordance with the criteria outlined in Tables 4-3, 4-4 and 4-5. Curvilinear alignments for sewer are to be designed as specified in Chapter 5. Curves shall be designed using "standard length" pipe (13, 18 or 20 feet). The field cutting of pipe to achieve a smaller radius shall not be permitted. Curvilinear alignments shall follow the same location criteria set forth in Chapter 4, Paragraph 4.01- C.1.

Water mains shall follow horizontally straight alignments between connections whenever possible. In the event that such an alignment results in a substantial increase in the number of fittings, curvilinear alignments may be permitted by variance. Curvilinear water mains shall parallel the street centerline minimum curvature as outlined in Tables 4-3, 4-4 and 4-5.

The curvature of the potable water mains shall be achieved by a uniform deflection of the pipe joints. Deflecting of the pipe barrels is not permitted. Curvilinear mains may either be a continuous curve from fitting to fitting or manhole to manhole or a single transition from "tangent to curve" or "curve to tangent". Complex curves or segmented "tangent to curve to tangent" alignments are not permitted. All curvilinear sections of pipe shall be fully restrained in accordance with Chapter 4, Paragraph 4.01-M.

Curvilinear Pipes will only be allowed for 12-inch pipe and smaller. Deflection design and layout shall follow Pipe Manufacturer standards for pipe specified. Deflections shall be at joints only and may require the use of a high deflection coupling when manufacturer's recommended deflection will be exceeded. If high deflection couplings are utilized, they shall be submitted for review and approval. High

deflection couplings shall only be used if they are compatible with the pipe materials. Otherwise, fittings shall be used to create deflection points for water mains. For both types of installation (deflection of standard joints and the use of high deflection couplings) the designed deflection shall be no greater than 80% of the manufacturer's allowable deflection (i.e. 4-degrees where 5-degrees allowed by manufacturer). It is common for standard joints to allow up to 1-degree of deflection and high deflection couplings to allow up to 5-degrees of deflection. All joints within a single radius shall be either standard or high deflection couplings, they shall not be mixed.

Plan drawings shall include a labeled radius of curvature for all locations requiring a curve in the alignment.

D. Pipe Class

All materials for the water distribution mains shall be in accordance with Chapter 4, Paragraph 4.02 of these specifications.

1. Selection of Pipe Classes

Water mains shall be standard diameters of: 4-inch, 6-inch, 8-inch, 10-inch, 12-inch, 16-inch, 18-inch, 20-inch, and 24-inch.

- a. Ductile iron pipe may be used in all pressure zones. Ductile iron pipe shall be Pressure Class 250, minimum.
- b. PVC pipe C900 Pressure Class/Pressure-Rated for 150 psi may be used in all pressure zones with a combined operating pressure and surge pressure of less than 150 psi.
- c. PVC pipe C900 Pressure Class/Pressure-Rated for 200 may be used in all pressure zones with a combined operating pressure and surge pressure of less than 200 psi. This will only be acceptable following a variance review.
- d. Water lines in side lots or tracts shall be a minimum of PVC pipe C900 Pressure Class/Pressure-Rated for 200 or Pressure Class 250 DIP.
- e. Water line depressions shall be a minimum PVC pipe C900 Pressure Class/Pressure-Rated for 200 or Pressure Class 250 DIP.
- f. Fire hydrant leads shall be Pressure Class 250 DIP minimum.
- g. Fire suppression lines shall be Pressure Class 250 DIP minimum.

- h. All taps larger than 2-inches and all laterals shall be made using tee fittings. All service taps shall be made by direct tapping or with tapping saddles. If DIP is intended to be direct tapped for 3/4-inch service, the pipe class shall be increased to Special Thickness Class 52 to ensure three thread engagements for the tap. If the service line is larger than 3/4-inch, refer to AWWA C151 Table A.1 to determine necessary pipe thickness for three thread engagement. PVC pipe shall be direct tapped only for C900 pipe in pressure classes greater than 150 for taps 1 inch and smaller. Taps from 1 to 2-inches in size on PVC pipe shall be made with tapping saddles. Taps on PVC pipe 4-inch and smaller and 16-inch and larger shall be made with tapping saddles. C900 pipe shall not be direct tapped. All services for C900 pipe shall be tapping saddles as outlined in Chapter 4, Paragraph 4.02-I.

E. Depth

All water mains shall be designed so that a minimum of 5 feet of cover shall exist over the top of pipe after final grade has been established. Where the water line is constructed in an easement between lots, the minimum depth shall be 6 feet from final grade to top of pipe. The maximum depth of a water main shall not exceed 10 feet to top of pipe after final grade has been established unless a variance request is approved.

F. Groundwater Barriers

Continuity of embedment material shall be interrupted by low permeability groundwater barriers to impede passage of water through the embedment. Groundwater barriers shall be soil plugs of 3 feet in length, extending the full depth and width of granular material unless otherwise indicated on the drawings. Groundwater barriers shall be placed at designed locations and indicated on the drawings. The locations may be adjusted based upon the field conditions encountered. Any change from the locations indicated on the drawings shall be approved by DWSD and shall be recorded on the record drawings. Groundwater barriers for water lines shall be used where the trench is below the groundwater elevation, where a pipe crosses a pond or embankment and concrete encasement is not used, or any other area where the flow of groundwater in the trench is possible and must be prevented. When used for water lines, groundwater barriers shall be spaced not more than 400 feet apart unless otherwise indicated on the drawings. Materials shall be as specified in Chapter 4, Paragraph 4.02-T.

G. Valves

1. Placement Criteria

Valves shall be placed in the distribution system in accordance with the criteria below. These criteria shall be the minimum requirement and additional valves may be required where the District determines they are necessary.

Valves shall be placed in the distribution system such that:

- a. All tees and crosses 8" or larger have an isolation valve in all directions.
- b. No more than 20 dwelling units will be out of service as a result of a single main break.
- c. No more than one fire hydrant or fire suppression system will be out of service as a result of a single main break. Adjacent fire hydrants or fire suppression system shall not be affected.
- d. A fire service and a domestic service that serve the same unit can be independently isolated at the main, without disrupting supply to the other service line.
- e. No more than three valves shall be necessary to isolate a single main break.
- f. The maximum spacing between valves on a single line shall not exceed 500 feet for mains in residential or commercial zones. 16-inch and larger mains may have greater spacing's, up to 800 feet, if no laterals or taps are present and the District approves
- g. Any connection to the transmission system shall have a means of isolation directly adjacent to the transmission line. If a connection results in an adjacent service and fire hydrant being out of service as a result of a transmission main break, an additional valve will be required on the transmission main.
- h. Any future extensions of distribution mains may be accomplished without interruption of service.
- i. When a water line is placed through a side lot easement or tract for the purpose of looping or connecting to an infrastructure water line, isolation valves shall be placed at the points of connection. No water services shall be permitted on this portion of the water line.
- j. Valves may not be moved from the location shown on the Approved Documents without District approval.

2. Location and Alignment

Valve locations shall be determined in accordance with the following:

- a. At intersections, valves shall be located at the extension of the first property line.
- b. In the middle of blocks, valves shall be located along the projection of a property line, and adjacent to a fire hydrant.

- c. Valves shall be located within paved areas at a minimum of 1-foot from the lip of the curb and gutter or the edge of pan on the street side.
- d. Valves in landscaped or open space areas shall have an 18-inch square, 6-inch thick, reinforced concrete collar poured around the box.
- e. When a water line is placed through a side lot easement or tract for the purpose of looping or connecting to an infrastructure water line, isolation valves shall be placed at the connection in the street and on the connection to the infrastructure line. No water services shall be permitted on this portion of the water line.
Exceptions to the above criteria may be permitted for wet taps or in areas where a valve would be deeper than 10 feet.

3. Resilient Wedge Gate Valves

Resilient wedge gate valves shall be installed on water mains 12-inch in diameter and smaller. Resilient wedge gate valves shall be line size, or one nominal size smaller with reducers on each side. Resilient wedge gate valves shall be no smaller than 4-inches. Resilient wedge gate valves shall comply with all provisions of Chapter 4, Paragraph 4.02-E.1.

4. Butterfly Valves

Butterfly valves shall be installed on water mains 16-inch in diameter and larger. Butterfly valves shall be line size for all locations. Butterfly valves shall comply with all provisions of Chapter 4, Paragraph 4.02-E.3.

5. Pressure Regulating Valves

The function of the pressure regulating valve is to reduce an upstream high pressure to a pre-adjusted lower downstream pressure to vary the rates of flow without causing shock or water hammer on the system. Pressure regulating valves shall comply with all provisions of Chapter 4, Paragraph 4.02-E.4.

6. Operators

All buried valves shall have a standard AWWA 2-inch square operating nut. Buried valves shall have a position indicator in the valve box that is calibrated to the valve size and number of turns to open/close. Valves located in vaults shall have a hand-wheel operator. All valve operators shall open the valves by means of clockwise rotation (OPEN RIGHT) of the nut or hand-wheel. Blow off assemblies shall have a 2-inch brass nut attached with a brass cotter pin.

7. Zone Valves and other Critical Valves

Zone valves shall be provided in transition locations between filing zones, pressure zones or as dictated by DWSD. Zone valves shall have actuators located within a manhole as shown on Standard Details.

H. Fire Hydrants

The Fire Marshall shall approve the number, location and spacing of fire hydrants. The Fire Marshall will determine the required fire flows and locate the appropriate number of fire hydrants on the water main construction plans. The Fire Marshall shall have a signature block on the cover of the Approved Documents to confirm that they have been reviewed and approved.

Fire hydrants shall be located on the same side of the street as the water main. At intersections, fire hydrants will be located on the northeast corner. If hydrants are to be installed at locations other than street intersections, they shall be located along the projection of a property line.

The actual number and spacing of hydrants will depend on access road/parking lot configurations and the degree of hazard which the new development presents, i.e., sprinkled buildings require fewer hydrants, but flammable liquid storage areas require more hydrants. Hydrants shall be no more than 500 feet apart in single-family residential areas, 400 feet apart in multi-family developments, and 300 feet apart in commercial or industrial areas.

Fire hydrants shall be at least 5 feet from the edge of any driveway. In the event that fire hydrants are located within parking lots or alleys without curbs, vertical steel bollard (minimum 4-inch diameter) barriers shall be placed around the fire hydrants. Fire hydrants located behind curbs and sidewalks shall be placed 36-inches behind the back of curb or sidewalk to the center of the hydrant. The maximum allowable distance between tracer wire test boxes shall not exceed 500 feet.

Fire hydrant branch lines shall be set at right angles to street mains. The branch line from the main to the fire hydrant may not exceed 50 feet unless otherwise approved by the District Engineer. Lines that exceed 50 feet in length may need to be upsized to the next normal pipe size and reduced adjacent to the isolation valve of the fire hydrant assembly. The hydrant shall be set at the end of the branch line and shall face the branch line. No horizontal or vertical bends shall be used in installing fire hydrant branch lines without approval from the District Engineer. Under no circumstances shall any size or manner of tap be made on a fire hydrant branch line.

Each hydrant shall be connected to the main with a minimum of a 6-inch branch of ductile iron pipe controlled by an independent gate valve and restrained to the tee on the main. Taping saddles will not be permitted. The branch line and hydrant shoe shall be rodded to the main line tee and fire hydrant shall be thrust blocked. The entire hydrant shall be wrapped in plastic, including any extension installed on the hydrant to

raise it to final grade. All hydrants shall operate in an open right position (clockwise) only.

All hydrants connected to the mains of the District are provided for the primary purpose of furnishing water for fire suppression and shall be opened and used only by persons authorized to do so by the District.

Any other use of fire hydrants shall be allowed by permit issued by the District and shall require the use of a hydrant meter and regulating valve for the monitoring of water use. Authorized personnel shall make the connection and disconnection only. Rates to be charged for water extracted from each hydrant shall be in accordance with the current fee schedule. Should the Retail Districts allow other uses for fire hydrants, they shall be metered.

Use of hydrant water shall cease for the duration of any fire within the District, or for any other reason upon notice by the District. The Customer is responsible to pay for any damage to the hydrant, hydrant meter, or other District property.

I. Fire Sprinkler Lines

Fire sprinkler lines shall be installed using ductile iron pipe at right angles to distribution mains and shall run in as straight a line as possible from the main to the property line and from the property line to the proposed structure. Provide the ability to isolate the fire sprinkler line and backflow preventor. Horizontal and vertical bends must be approved by the District and shall only be permitted where interference prohibits a straight-line installation.

All fire sprinkler lines shall be 100 percent restrained from the main to the proposed structure by means of restrained joint pipe, restraining rods, or other devices approved by the District. No taps are permitted on fire sprinkler lines.

Post indicator valves are permissible; however, the District does not require them. A post indicator valve may be installed on the fire sprinkler line provided it is designed to operate in an open right position (clockwise) only.

J. Pressure Regulating Stations

Pressure regulating valve (PRV) stations are used to control pressures between distribution zones. When main extension plans are submitted for review, the need for a pressure regulating valve station shall be determined based on existing pressure zones and the impact on the proposed development. Pressure reducing and regulating valves shall be of a type capable of maintaining pre-adjusted downstream pressures with varying rates of flow and upstream pressure without causing water hammer. Pressure reducing and regulating valves shall be installed in concrete vaults in accordance with the Standard Details.

K. Air and Vacuum Valves

Combination air and vacuum release valves shall be installed at each high point on all

water mains 16-inch diameter and larger. Combination air and vacuum release valves shall be installed at each high point on all water mains 12-inch and smaller if there is not a fire hydrant at the high point or if there are no service lines along the main. Air and vacuum release valves shall be installed in precast concrete manholes or vaults fitted with air vents in accordance with the Standard Details.

L. Blowoff Assemblies

All water mains, which are not looped, shall have a blowoff assembly installed at the end of the main. Water mains located in cul-de-sacs that are designed as dead-end lines shall have a 2-inch assembly installed on the end plug in accordance with the Standard Details. Water mains which are part of phased construction and are, in effect, dead end lines until future looping shall have a 2-inch assembly installed on the main or on the end plug in accordance with the Standard Details.

In instances where the water mains are stubbed out for future phasing, the in-line valve shall be restrained from the tee to the valve, and pipe placed past the in-line valve to prevent the valve from blowing off when the main is extended in the future. Length of pipe required past the valve shall be based on the restrained length required in the Standard Details.

M. Rods, Clamps and Restraining Devices

All bends, tees, plugs, reducers, valves, fire hydrants, and fire suppression systems shall be fully restrained in accordance with the Standard Details. All pipe joints on each side of a bend, tee, plug, or valve shall also be restrained within the lengths shown in the Standard Details. Rods and clamps shall be used on ductile iron and PVC pipe systems. Where mechanical joint pipe is used, rods may be bolted through the joint bolt holes in accordance with the Standard Details. All clamps shall be covered with an epoxy coating as specified. In all cases where reducers with a reduction ratio equal to or greater than 2 to 1 are used, special rodding and clamping procedures shall be required.

N. Thrust Blocks

Concrete thrust blocks shall be installed at all bends, tees, plugs, fire hydrants, and fire suppression systems in accordance with the Standard Details. Pipe and fittings shall be separated from concrete by 8-mil polyethylene bond breaker. Size of thrust block, type of concrete, and dimensions shall be in accordance with the Standard Details.

O. Wet Taps

When a connection is required on an existing distribution or transmission main, the District may require a wet tap. This determination is based on the effect any connection may have on the interruption of service to customers, the effect on the transmission system, or the time restrictions involved with working in an existing street.

The minimum size wet tap is 4-inch diameter and, generally, the maximum size wet

tap is 12-inch diameter. The maximum size of the wet tap shall be limited to 75% of the nominal diameter of the distribution or transmission main (i.e.: maximum diameter wet tap on 16-inch main is 12-inch). Wet taps shall not be permitted within 48-inch of a bell or coupling. Wet taps shall only use a flanged resilient wedge gate valve for tapping.

P. Corrosion Protection

1. Cathodic protection shall be designed for all sections of DIP in accordance with NACE International SP0169 and AWWA M41. Drawings shall indicate the location of each anode, underground reference electrode, buried insulated flange, and field test station complete with a description of piping connected are indicated. Drawings with sufficient information that each underground galvanic anode and underground reference electrode can be exactly excavated or replaced.

If borings and geotechnical results indicate non-corrosive soils a request for omission of the cathodic protection system may be submitted to DWSD for approval.

Operations and maintenance manual for the cathodic protection system shall be provided.

2. Wax tape shall be provided in accordance with AWWA C217 for all buried metallic hardware on pipe fittings, valves and restraints.
3. Polyethylene encasement shall be provided for all DIP, valves, and fittings in accordance with AWWA C105.

Q. Limits of Accuracy (Allowable Error)

A limit of accuracy refers to the horizontal and vertical deviation permissible during the laying of water mains. The allowable error shall be a maximum of plus or minus 0.3 feet in a vertical direction, but no deviation will be allowed which results in less than 5 feet of cover. The allowable horizontal error shall be a maximum of plus or minus 0.3 feet. Any line that does not meet the criteria shall be removed and re-installed.

R. Water Quality Sampling Stations

Water quality sampling stations are used by DWSD for distribution system water quality testing throughout the system. The Contractor shall coordinate location and quantity with DWSD during plan approval. They are not intended to be placed on dead-end lines, but in easily accessible sites that are minimally disruptive to the public. Refer to the Standard Details.

4.02 WATER MAIN MATERIALS

All pipe materials used in the construction of the water system shall conform to the requirements specified herein. Any material proposed as an equal must be approved by the District in writing prior to construction. All materials furnished shall be new and undamaged. All installations shall be constructed in accordance with these specifications. All necessary pipes, joints and appurtenances shall be furnished and installed whether shown on approved construction drawings or not. All installations shall be completed as fully operable.

When materials reference Denver Water Complete Engineering Standards, the requirements listed in the most recent version of those Standards shall apply. In the event of a conflict between the Denver Water Standards and these Standards, the District Engineer shall make the final interpretation.

A. Ductile Iron Pipe

1. Manufacture

Ductile iron pipe shall be manufactured in strict accordance with AWWA Standard Specification C151.

2. Size of Pipe

This specification shall cover all sizes of ductile iron pipe 24 inches in diameter and smaller.

3. Joint Type

All ductile iron pipe joints shall be push on joint single gasket or mechanical joint single gasket. The rubber gasket shall conform to the requirements of AWWA C-111.

4. Pressure Class

Pipe furnished shall be Pressure Class 250 for all sizes 4 inches in diameter and larger. Where pipe will be direct tapped without the use of tapping saddles, pipe shall be Special Thickness Class 52 minimum. The preceding classes are minimums and higher classes may be required. In cases of smaller pipe with larger taps, all pipe thickness shall be verified with Table AWWA C151 A.1 and shall have at least 3 thread engagement for specific pipe thickness classifications.

5. Laying Length

Pipe furnished shall have a normal laying length of 18 feet or 20 feet. Random lengths are not acceptable.

6. Cement Mortar Lining

All pipe furnished shall have standard thickness cement mortar lining with seal coat in accordance with AWWA C-104.

7. Exterior Coating

All pipe furnished shall have an exterior asphaltic coating in accordance with Manufacturer's standards.

B. Polyvinyl Chloride Pipe - PVC

1. Manufacture

All polyvinyl chloride pipes shall be manufactured in strict accordance with AWWA Standard C900 or C 905.

2. Size of Pipe

This specification shall cover all sizes of PVC pipe 16-inch and smaller. All pipe 18-inch diameter and larger shall be ductile iron unless otherwise approved by the District.

3. Joint Type

Joints shall use a standard elastomeric gasket push-on type joint.

4. Thickness Class

Pipe furnished under this specification shall be Pressure Class 150 or greater.

5. Laying Lengths

Pipe shall have a normal laying length of 13, 18 or 20 feet. Random lengths are not acceptable.

C. Tapping Requirements

See Table 4-6. PVC pipe shall be direct tapped only for C900 pipe in pressure classes greater than 150 for taps 1 inch and smaller. Taps from 1 to 2 inches in size on PVC pipe shall be made with tapping saddles. Taps on PVC pipe 4-inch and smaller and 16-inch and larger shall be made with tapping saddles. C900 pipe shall not be direct tapped. All services for C900 pipe shall be tapping saddles as outlined in Chapter 4, Paragraph 4.02-I.

D. Water Main Fittings

1. Mechanical joint restraints shall be in accordance with Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. Fittings shall be ductile iron mechanical joint, Class 350 minimum for pipe diameters 24-inches and smaller and Class 250 minimum for pipe diameters larger than 24-inches. Class 250 fittings shall conform to AWWA C-110 and C-111. Class 350 fittings shall conform to AWWA C-111 and C-153. Push on joints may be used as long as they are fully restrained in accordance with these specifications. All fittings shall have applied fusion bonded epoxy coating and lining with a minimum thickness of 8 to 12 mils as per AWWA C116-15, and wrapped with polyethylene per AWWA C105. When in contact with treated or potable water, certify lining material as being in compliance with NSF 61. All rods, bolts and nuts shall be fabricated in accordance with ASTM A193, Grade B7, from a low alloy, high strength steel or shall be stainless steel in accordance with Denver Water's Complete Engineering Standards. Rods, bolts, and nuts shall be coated with wax tape.

Alternative protective coating systems for buried pipe fittings maybe considered on a case-by-case basis if a DWSD approved Cathodic Protection System Study recommends a system that offers equivalent protection.

2. All bends shall be restrained in accordance with Denver Water's Complete Engineering Standards.
3. Solid sleeve fittings shall be restrained in accordance with Denver Water's Complete Engineering Standards.

E. Valves

1. Resilient Wedge Gate Valves

All gate valves shall be resilient seated, epoxy coated, cast iron body, with a non-rising stem. Resilient seated gate valves shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. Valve stems shall be sealed with two "O" rings, each of which shall be designed as to allow replacement under full line pressure when the valve is in the full open position.

Gate valves may have flanged or mechanical joint ends. Flanges shall be sized and drilled in accordance with ANSIB16.1 Class 125 or mechanical joint ends rated for 250 psi, minimum, in conformance with AWWA-C111. Flanges shall be machined to a flat face with a finish of 250 microinches, AARH maximum or machined to a flat surface with a serrated finish in accordance with AWWA C-207. Mechanical joints ends shall be compliant with AWWA C-111. Tee head bolts and hexagon nuts shall be fabricated from high-strength low alloy steel.

All gate valves shall have the year of manufacture cast as part of the valve body. Any valve that is more than two (2) calendar years old shall not be installed unless approved in writing by the District.

Ferrous surfaces, except machined or bearing surfaces or flange faces, shall be prepared for coating in accordance with SSPC SP10. These surfaces shall then be coated with a two-part thermosetting polyamide epoxy in two or more uniform coats or with fusion-bonded epoxy to a minimum DFT of 10 mils. Epoxy coating shall be in accordance with AWWA C550.

2. Tapping Valves

Tapping valves shall be resilient wedge gate valves with centering ring on flanged face of valve, for proper alignment. Tapping valves shall conform to Chapter 4, Paragraph 4.02-E.

3. Butterfly Valves

All butterfly valves shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. All butterfly valves shall have a working pressure equal to or greater than the pipe classification where it is located. In no case shall the valve be rated for less than 150 psi working pressure.

The actuator shall be capable of withstanding an overload input torque of 300 foot-pounds at full open or closed position without damage to the valve or valve actuator. Torque limiting devices shall be provided with all butterfly valve actuators. All gearing shall be totally enclosed and sealed from ground water. Geared actuators shall be provided on all valves larger than 8-inches, the actuator shall be designed to resist submergence in water to 25 feet head pressure. The maximum input torque required to fully open or close the valve for Class 150B conditions shall not exceed 150 foot-pounds when applied to the operating nut.

All buried butterfly valves shall have mechanical joint ends in conformance with AWWA C-111. Tee-head bolts and hexagon nuts shall be fabricated from high-strength low alloy steel in accordance with Denver Water's Complete Engineering Standards. Flanged ends may be approved by the District if necessary. When specified, butterfly valves shall have flanged ends sized and drilled in accordance

with ANSI-B16.1 Class 125. Flanges shall be machined to a flat face with a finish of 250 micro-inches, AARH maximum or machined to a flat surface with a serrated finish in accordance with AWWA-C-207.

4. Pressure Reducing and Regulating Valve

Pressure regulating valves shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. Components shall be suitable for exposure to chlorinated water.

Material for valve body shall be cast-iron. Flanges and covers shall conform to ASTM Standard Designation A48 Class 35. Bronze castings or parts for internal trim shall conform to ASTM Standard B61 and B62. The valve shall be fully bronze mounted and all packing shall have rubber seals to provide tight closure and prevent metal to metal friction.

The pressure reducing valve shall be hydraulically operated with a free-floating guided piston having a seat diameter equal to the size of the valve. An indicator rod shall be furnished as an integral part of the valve to show the position of the piston within the valve body. The valve shall be provided with a check feature to prevent backflow.

All pressure reducing and regulating valves shall be installed in concrete vaults, as per Chapter 4, Paragraph 4.02-N, and as shown in the Standard Details.

All pressure reducing and regulating valves shall be certified by the manufacturer that the assembly has been inspected and all of the specified tests have been performed. A copy of the certification shall be sent to the District upon request.

5. Swing Check Valves

Swing check valves shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions.

All check valves shall be installed in vaults in a horizontal position with exterior lever and adjustable spring operation. See Chapter 4, Paragraph 4.02-N.

The operating pressure shall be 175 psi or equal to the operating pressure of the pipe.

F. Fire Hydrants

Fire hydrants shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. Hydrants shall have an underground 6-inch connection, two 2½-inch hose connections and one 4.5-inch pumper connection. Threads on the pumper and hose connections shall conform to the requirements of the "National Standard Screw Threads for Fire Hose Couplings and Fittings," published by the Insurance Services Office. Fire hydrants shall be cast iron

with bronze seat mountings and shall have a traffic breakaway feature incorporated into the barrel and operating shaft at the finished grade elevation. The operator nut shall be National Standard pentagon shape and measure 1-1/2 inches from point to opposite flat. The fire hydrant assembly shall include the hydrant, an auxiliary 6-inch gate valve and a 6-inch diameter lateral pipe.

G. Valve Boxes

Valve boxes shall be the three-piece adjustable screw type 6-inch in diameter and conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. All extensions to a valve box shall be coal tar coated, and wrapped in 8-mil polyethylene plastic (see Chapter 4, Paragraph 4.02-U) Valve box covers shall be marked with lettering that indicates the type of utility, "WATER" and "SEWER." All valve boxes shall have a lip or flange extending into the valve box shaft. No slip-type boxes will be allowed. The valve box shall be of a design which will not transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve with the box cover 1/4- inch below the surface of the pavement.

The manufacturer shall furnish a sworn statement that the inspection and all specified tests have been completed and that results comply with the requirements of these Standards. A copy of the Certification shall be provided to Dominion Water and Sanitation.

Valve boxes shall be provided as described herein and Paragraph 4.03-F and as shown in the Standard Details.

H. Combination Air Relief-Vacuum Breaker Assemblies

1. Air Release Valves

Air and vacuum release valves shall have cast-iron bodies, stainless-steel float and working parts and shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. Except as modified or supplemented herein, all valves furnished under this section shall conform to the applicable performance requirements of AWWA C512 and NSF 61. All pipe and fittings used in the relief valve system shall be copper and/or brass and connections shall be threaded. See the Standard Details. Components shall be suitable for exposure to chlorinated water.

The manufacturer shall furnish a sworn statement that the inspection and all specified tests have been completed and that results comply with the requirements of these Standards. A copy of the Certification, including compliance with NSF/ANSI 61, shall be provided to Dominion Water and Sanitation.

2. Vault

The vault shall be a 60-inch diameter precast concrete manhole with 24-inch manhole grade rings, frame and cover. Grade beams shall be precast concrete with dimensions of 12-inches by 6-inches by 8 feet long. See Standard Details.

3. Vent Piping

Vent piping below ground shall be 6-inch nominal diameter, PVC pipe, Schedule 40. Above ground piping shall have an exterior with a black anodized finish, and be sized per Standard Details.

I. Tapping Sleeves and Saddles

1. Fabricated Carbon Steel and Stainless Steel Tapping Sleeves and Saddles

Tapping sleeves and saddles shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. Components shall be suitable for exposure to chlorinated water.

The manufacturer shall furnish a sworn statement that the inspection and all specified tests have been completed and that results comply with the requirements of these Standards. A copy of the Certification, including compliance with NSF/ANSI 61, shall be provided to Dominion Water and Sanitation.

J. Rods and Clamps

Harness rods shall be mild steel conforming to ASTM A-36 with hex nuts conforming to ASTM A-307, Grade A or B, Hexagon heavy series. The number and size of rods shall be as indicated in the Standard Details. All rods and clamps shall be covered with wax tape.

K. Pipe Restraint

Joint restraint devices shall be used at bends and fittings where joint restraint devices are specifically required. Joint restraint devices shall be required for the following installations:

1. Fire hydrants
2. Fireline connections
3. Domestic line connections 3-inches and larger
4. Vertical bends
5. Reducers
6. Vertical and horizontal offsets
7. Horizontal bends, line valves, plugs, and fittings
8. Bulkheads and plugs

9. Bored casings
10. When the bearing capacity of the soil is not sufficient to provide adequate restraint in the opinion of the district.
11. When the district identifies potential future development that may utilize or connect to the water main to be installed.

Horizontal and vertical offsets and reducers shall be restrained on each side of the fitting. For other fittings, the length of tied pipe shall be in accordance with the Standard Details.

Bends, fittings, tees, fire hydrant tees, and service taps 3-inches and larger, shall be restrained by using mechanically tied joints and thrust blocks. Thrust blocks shall be placed against undisturbed soil, have sufficient clearance from adjacent interference, and meet all other requirements as described in Chapter 4, Paragraph 4.02-L. Vertical bends on pipe sizes 12-inch and smaller are not required to have thrust blocks.

a. Ductile Iron Pipe

Mechanical joint restraint for ductile iron pipe shall conform to Denver Water's Complete Engineering Standards.

b. PVC Pipe

Mechanical joint restraint for PVC pipe shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions.

c. Bolt Through Restraint

Bolt through MJ restraints may be used in the jointing of two MJ fittings when a combination of two fittings is required and shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. Adaptors shall be manufactured of Ductile-iron conforming to ASTM A536-80.

d. Solid Sleeves

Two solid sleeves shall be used when making a connection to an existing water main to install a branch line either the same size or smaller.

L. Thrust Blocks

Concrete thrust blocks shall be installed at all tees, plugs, bends greater than 5°, fire hydrants or where designated on the plans in accordance with the Standard Details. Thrust blocks are not required for vertical bends of less than 45 degrees. Size of thrust block and dimensions shall be in accordance with Standard Details (usually twice the diameter of the pipe used). Thrust blocks shall be constructed of "Class B" concrete as defined in these specifications.

M. Bedding Material

Pipe bedding shall be defined as that portion of the pipe zone which extends from 6 inches below the bottom of the pipe to 6 inches above the top and along the sides of the pipe.

The Customer shall provide, upon request, certified test results of the bedding material confirming compliance with the following standards and a sample of the bedding material.

1. Pipe Bedding

Bedding for water and sewer mains constructed of PVC and DIP shall be in accordance with Denver Water Engineering Standards for Squeegee Sand. Bedding shall be placed in layers not more than 6-inches deep and shall be compacted around the pipe as specified.

2. Flowable Fill

Flowable Fill shall conform to the following mix proportions per cubic yard:

Cement	100 lb
Fly Ash	100 lb
Sand (SSD)	2760 lb
Water	386 lb
Air Entraining Agent	5 percent
Compressive strength at 28 days	75 psi minimum 120 psi maximum

The type of cement used shall be ASTM Type II, the class of fly ash in CLSM shall be Air entraining agent can be used to increase flowability. Flowable fill shall have a maximum 28-day compressive strength of 60 psi.

3. Granular Fill

Granular fill material for use as base for structures or stabilization of trench bottoms shall be crushed rock or pea gravel coarse aggregate in accordance with CDOT gradation No. 67 and per ASTM C33. Material shall be placed in layers not more than 6-inches deep and compacted as specified.

4. Job Excavated Materials

Job excavated material shall be free from debris, organic matter, and stones, placed in uniform layers not more than 8-inches thick, and compacted to 95% maximum density as determined by ASTM D698.

5. Graded Backfill

Graded Backfill shall replace job excavated material where the job excavated material is deemed unsuitable. Graded backfill shall be a gravel mixture with no clay lumps or organic material. It shall be uniformly graded from in size from 3/4-inch size to No. 200 sieve. The fraction passing the No. 4 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 5. Materials shall be compacted as outlined in the trench backfill section and shall be covered with 6-inches of topsoil where outside of roadways.

N. Precast Concrete Vaults and Manholes

Precast vaults and manholes shall conform to the size, shape, form, and details shown on the plans and shall conform to Denver Water's Complete Engineering Standards.

O. Concrete

Class A concrete shall be used for all cast-in-place and precast concrete structures. The concrete shall have a maximum allowable water/cement (w/c) ratio of 0.50 by weight. The w/c ratio may be increased to 0.56 by weight by the addition of an approved water reducing agent (WRA) conforming to ASTM Designation C-494 - Type A. The WRA, in suitably diluted form, may be added to water containing an air-entraining agent for the batch providing the materials are compatible with each other. If the two are incompatible, they shall be introduced separately.

The concrete shall have a minimum 28-day compressive strength of 3,000 psi for cast-in-place structures and a minimum 28-day compressive strength of 4,000 psi for precast structures.

Fine aggregates shall be between 34% and 38% by volume of the total aggregates.

Class B concrete shall be used for all thrust blocks, protective pads, and encasements. The Class B concrete shall have a maximum w/c ratio of 0.63 by weight. The w/c ratio may be increased to 0.70 by the addition of a WRA as specified above.

Class B concrete shall have a minimum 28-day compressive strength of 2,000 psi.

A minimum of 10 days prior to starting concrete work, the Customer shall submit to the District Engineer for approval samples of the various aggregates to be used in the final mix and the concrete mix proposed to be used. The source of each sample of aggregate shall be stated. After approval of the aggregates and concrete mix, neither the source of aggregate nor the mix of the concrete shall be changed without written approval of the District Engineer.

P. Concrete Reinforcement

All deformed reinforcing bars shall conform to ASTM Standard A-615, Grade 40 or 50, or ASTM Standard A-617, Grade 40 or 60. All welded steel wire fabric shall conform to ASTM Standard A-185 except that the weld shear strength requirement shall be extended to include a wire size differential up to and including six gauges.

Q. Manhole Rings and Covers

Manhole rings and covers shall be cast iron in accordance with ASTM A-48, Class 35 B. Twenty-four-inch diameter assemblies shall be the "Denver Heavy" style with a combined weight of not less than 400 pounds, or as approved by DWSD (approximate distribution: Frame - 235 lbs., Lid 165 lbs.). All bearing surfaces shall be machined to the tolerances shown on the construction drawings. Manhole lifting holes shall be manufactured with an elongated oval hole per Standard Details. Manhole lids with more than one lifting hole shall not be accepted. Rim elevation shall be 4 inches to 8 inches above grade in open space and shall be flush to 1/4 inch below grade of any finished surface.

Manhole rings, covers, and risers shall be heavy duty and designed, manufactured, and tested in accordance with AASHTO M306. HS-20 rated manhole rings and covers shall be provided.

The manufacturer shall furnish a sworn statement that the inspection and all specified tests have been completed and that results comply with the requirements of these Standards. A copy of the Certification shall be provided to Dominion Water and Sanitation. The report shall include material data that is traceable to the originating foundry, traceable test bars that match, the name of the manufacturer, and the date of the pour.

The horizontal seating and vertical facing surfaces common to the ring and cover shall be machine finished to ensure non-rocking and full bearing for the entire width and circumference of the bearing surface to permit interchangeability with castings of the same design. The vertical face common to the ring and cover shall be beveled.

Covers shall be labeled with the name or symbol of the manufacturer, country of origin, and date of manufacture to be located at the manufacturer's option. In addition, the cover shall contain the owner's name and the respective utility contained in the manhole "WATER," "SEWER," "UNDERDRAIN", "NON-POTABLE WATER" all in 3-inch high lettering that is centered and recessed on the exposed face.

R. Manhole Flexible Plastic Joint Sealing Compound

Preforming flexible plastic joint sealing compound shall meet Federal Specification SS-S00210 and AASHTO M198 75 1, Type B. The sealing compound shall show no visible deterioration when immersed separately in a solution of acid, alkali and saturated hydrogen sulfide for a period of 30 days. The plastic gasket shall be "Ram-Nek" as manufactured by K.T. Snyder Company or an approved equal.

S. Pipe Encasement

All concrete encasements shall be reinforced in accordance with the applicable Standard Details. Concrete for encasement shall be "Class B" as defined in these specifications.

T. Groundwater Barriers

Groundwater barriers shall be placed as indicated on the drawings and specified herein.

The soil plugs shall be constructed from soil meeting ASTM D2487 classification GC, SC, CL, or ML and shall be compacted to 95 percent of maximum density at or near the optimum moisture content (ASTM D698). Alternatively, the barriers may be constructed of low strength concrete.

Where the pipeline crosses a paved area, a groundwater barrier shall be located outside but within 10 feet of the edge of the paved area on the side of the higher pipeline elevation at the crossing unless otherwise indicated on the drawings. Where the pipeline is within the paved area for lengths greater than 400 feet, the groundwater barrier shall extend from the trench bottom to 6-inches above the top of the pipe.

Where the pipeline crosses a pond or embankment, a continuous groundwater barrier for the full depth and width of the trench shall be provided under and along the pond and pond embankment and for a minimum distance of 25 feet beyond each end of the limits of the pond or pond embankment, unless otherwise directed by DWSD.

U. Coal Tar Epoxy Dampproofing for Buried Vaults or Manholes

All exterior surfaces for vaults or manholes shall be covered with dampproofing. The coal tar epoxy used for dampproofing the exterior of manholes shall have a final mil thickness of 20 mils, minimum, and shall be installed in at least two coats. Dampproofing shall be Tnemec “46H-413 Hi-Build Tneme-Tar”, Sherwin Williams “Hi-Mil Sher-Tar Epoxy”, or equal. Dampproofing shall be applied to all manholes and vaults in the shop prior to delivery at the site. Installation shall follow manufacturer’s recommendations.

All joints shall be sealed in accordance with Chapter 4, Paragraph 4.02-R.

V. Filter Fabric

Filter Fabric shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter Fabric shall be a non-woven fabric consisting of only continuous chains of polymeric filaments of yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the indicated properties:

<u>Property</u>	<u>Test Method</u>	<u>Unit</u>	<u>Minimum Average Roll Value*</u>
Fabric Weight	ASTM D 3776	oz/yd ²	5.7
Grab Strength	ASTM D4632	lb	155
Grab Elongation	ASTM D4632	percent	50
Mullen Burst Strength	ASTM D3786	psi	190
Apparent Opening Size	CW-02215	U.S. Standard Sieve Size	70

**Minimum average roll value in weakest principal direction.*

The fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust and debris.

W. Tracer Wire

Install minimum AWG 12 solid copper wire with 30-mil high density PE jacket complying with ASTM-D-1248. Tracer wire shall have a 30-volt rating. Tracer wire shall be Copperhead Industries “#12 CCS High Strength Soft Drawn 380#”, or approved equal. The splicing of tracer wire shall be in accordance with the manufacturer’s recommendations. The tracer wire shall be located in accordance with the Standard Drawings and shall not be installed deeper than 15 feet below grade. All tracer wire shall be tested following installation.

X. Marking Tape

Utility marking tape shall be installed 18 inches above the crown of the pipe in the trench. The marking tape shall be colored as indicated below and have black lettering which states the type of main located below (i.e. “water main located below”). Marking tape shall be polyethylene with a minimum width of 3 inches and a minimum thickness of 4 mils. Marking tape shall be Reef Industries “Terra Tape Standard” or approved equal.

Approved colors:

- Water Main – Blue
- Sewer Main – Green

Y. Corrosion Protection for Pipelines

1. Cathodic Protection

All DIP shall be cathodically protected by means of magnesium anodes, have bonded joints and corrosion monitoring test stations per NACE International SP0169 and SP0286.

The Contractor shall obtain the services of a NACE certified corrosion or cathodic protection specialist to review installation procedures and supervise the testing. The corrosion or cathodic protection specialist shall be acceptable to the District.

a. Packaged High Potential Magnesium Anodes

Each high potential magnesium anode shall be furnished as a packaged assembly with insulated lead wire, TW insulated, 12 AWG solid copper. The packaged assembly shall consist of a permeable cloth bag containing the anode and special compacted backfill. The anode shall be centered in the bag and completely surrounded by the backfill.

High potential magnesium anode alloy shall be Grade M1C, UNS alloy M15102, complying with ASTM B843.

High potential Magcorp magnesium anodes shall be as manufactured by Mesa Products, Inc.; Stuart Steel Protection Company; Farwest Corrosion Control Company; or acceptable equal.

b. Cathodic Protection Cable

All cable, sizes 12 AWG and larger, where specified herein or on the drawings to be cable Type CP, shall be stranded copper cathodic protection cable with low density high molecular weight polyethylene insulation

c. Flush Mounted Field Test Stations

Flush mounted field test stations shall consist of an ABS plastic vault, 18 inches long by 5 inches in diameter, complete with a terminal block and cast iron locking cover. All terminals in the test station shall be labeled for wire identification. The cover shall be painted yellow and cast with the inscription "CP TEST". Each terminal block shall be furnished with seven, nickel-plated marine brass terminals and two nickel-plated marine brass jumper strap as indicated on the drawings. Flush mounted field test stations shall be similar to "NM-7 Corrosion Control" terminal boxes, as manufactured by C.P. Test Services, Cott Manufacturing Co., or equal.

d. Underground Reference Electrodes

Underground reference electrodes shall be of the saturated, gelled, copper-

copper sulfate type, packaged in a special backfill and complete with 50 feet of 14 AWG stranded copper lead wire with high molecular weight polyethylene insulation. Underground reference electrodes shall be "Stealth SRE-007-CUY", as manufactured by Borin Manufacturing, Inc., or "Model UL-CUG" as manufactured by Electrochemical Devices, Inc.

2. Wax Tape

Wax tape material shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. The wax tape coating system is for coating buried hardware appurtenances associated with pipe, flanges, couplings, restraints, rods, clamps, and valves.

3. Polyethylene Wrapping

Polyethylene wrapping for encasement pipe shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions. The doubling of thinner material is not permitted. Polyethylene wrapping shall be installed around all ductile iron pipe, fittings, valves, fire hydrant barrels, rods, and clamps. Polyethylene encasement shall be clear (natural color).

Joint tape shall be PVC or polyethylene, self-sticking type, 10-mils thick. The manufacturer shall furnish a sworn statement that the inspection and all specified tests have been completed and that results comply with the requirements of these Standards. A copy of the Certification shall be provided to DWSD.

4.03 WATER MAIN INSTALLATION

A. Excavation

1. Limits of Excavation

Except with the written approval of the District Engineer, the maximum length of open trench shall be 600 feet, or the distance necessary to accommodate the amount of pipe installed in a single day, whichever is less. The distance is the collective length at any location, including open excavation, pipe laying and appurtenances and backfill not brought to finished grade. No trench shall be left open over night or at any time that construction operations are not ongoing. All utilities must be installed in a trench or otherwise flow filled.

2. Trench Width

Trenches shall be excavated so that a minimum clearance of 12-inches shall be maintained on each side of the pipe for proper placement and compaction of the bedding and backfill material. The maximum trench width, measured at the top of the pipe, shall be the outside diameter plus 24-inches on each side. The District may require installation of a higher class pipe for any trenches in excess of this width.

3. Tunneling and Boring

Tunneling or boring may be permitted when approved by the District Engineer and, Douglas County if boring is to occur within their right-of-way. If the earth in the tunnel sloughs off, the roof of the tunnel shall be broken down and the trench excavated as an open trench at the expense of the Contractor.

4. Trench Support

All excavations shall be properly sloped and supported as required by State and Federal Laws.

5. Grading and Stockpiling

Stockpiling and grading shall be controlled to prevent water from flowing into excavations. Obstruction of surface drainage shall be avoided and means shall be provided whereby storm water can flow uninterrupted into existing gutters, other surface drains or temporary drains. Excavated material shall not be placed or stockpiled closer than 2 feet from the top edge of the trench.

6. Dewatering

Ample devices shall be provided at all times to promptly remove and dispose of all water from any source entering the trench or structure excavation. Dewatering may be accomplished by the use of well points, sump pumps, rock or gravel drains placed below sub-grade foundations or subsurface pipe drains. Water shall be disposed of

in a suitable manner without damaging adjacent property or endangering public health or safety. The water shall not be drained into work completed or under construction. The dewatering operation shall continue until such time that, in the opinion of the District Engineer, it is safe to allow the water table to rise. Pipe trenches shall contain sufficient backfill to prevent pipe flotation.

7. Blasting

Blasting is not permitted.

B. Pipe Foundations and Bedding

1. Pipe Foundation

The trench bottom shall be excavated at least 6-inches below the invert of the pipe. Before the pipe is laid, the foundation shall be prepared by backfilling with bedding material conforming to these specifications. The bedding shall be thoroughly tamped to achieve a relative density of 70% (ASTM D2049).

Where rock is encountered during excavation, it shall be removed below the pipe and the trench backfilled with bedding material to provide a compacted foundation cushion with minimum thickness of 12-inches below the pipe bell.

Any ledge rock, boulders and large stones encountered shall be removed to provide a clearance of at least 12-inches below and on the side of the pipe and fittings.

If the bottom of the excavation is soft or unstable, and in the opinion of the Engineer of Record, cannot satisfactorily support the pipe or structure, additional excavation on the bottom and sides of the trench may be required. The excavation shall continue until in the opinion of the Engineer of Record, the foundation can be backfilled to provide an adequate foundation for the pipe or structure with Granular Fill as specified in Chapter 4, Paragraph 4.02-M. The Granular Fill shall be brought to the original elevation of the trench bottom, and the pipe bedding placed on top. If, in the opinion of the Engineer of Record, the finer bedding material will migrate into the Granular Fill, a layer of filter fabric shall be placed on top of the Granular Fill prior to bedding installation.

2. Pipe Bedding

Pipe shall be centered in the trench, adjusted to line and grade and the pipe bedding shall be placed so as not to disturb the alignment or grade. The bedding material shall be sliced under the haunches of the pipe to fill all voids. The slicing shall be performed when the bedding material is no higher than one-fourth of the pipe diameter.

The pipe shall be bedded as shown in the bedding Standard Detail. Each joint shall be recessed in bedding material in such a manner as to relieve the bell or coupling of all load and to insure continuous bearing along the pipe barrel upon the pipe

foundation.

The pipe bedding shall be placed from the pipe foundation to a point 6 inches above the top of pipe and compacted to the requirements set forth in these specifications. Backfilling shall be carried on simultaneously on each side of the pipe to assure proper protection and alignment of the pipe.

C. Trench Backfilling and Compaction

All trenches shall be backfilled after pipe, fittings, and appurtenances have been installed, inspected and approved by the Engineer of Record. Bedding and "pipe zone" backfill shall be installed in accordance with these specifications.

1. Procedure within the Pipe Zone

The bedding material within the pipe zone shall be compacted to a relative density of 70% (ASTM D2049). When backfilling within the pipe zone, special care shall be exercised to prevent settling or lateral movement of the pipe. To safeguard against movement of pipelines, backfill shall be placed in layers not exceeding 8-inches in thickness. Each layer shall be thoroughly compacted with hand-operated, power driven tampers.

2. Compaction above the Pipe Zone

The backfill material from the pipe zone to the proposed finished grade shall be compacted to a Standard Proctor density of 95% (ASTM D698) within 2 percent of optimum moisture content. In existing or proposed roadways all backfill material from the pipe zone to the road sub-grade shall be compacted in accordance with the requirements of the Douglas County Roadway Design and Construction Standards. Backfill to be compacted by heavy compaction equipment shall be placed in uniform horizontal lifts not exceeding 8 inches. Heavy compaction equipment shall not be used closer than 3 feet of any structure, nor closer than 3 feet to the top of the pipe. Before each lift is compacted, the material therein shall be brought within 1% above or 3% below the optimum moisture content for the specified compaction. Backfilling shall be done with material free of rubbish, frozen debris, oil cake, bituminous pavement, concrete, rock or other lump materials. Material of organic, spongy or otherwise improper nature shall not be used in backfilling and no material greater than 4-inches in any dimension shall be placed within 1 foot of any manhole or structure. All backfill material shall be subject to the approval of the District and Douglas County.

3. Compaction Tests

Compaction tests shall be taken at locations designated by the Engineer of Record and tested by an approved testing laboratory. All expenses involved in these tests shall be borne by the Customer. Copies of test results shall be provided to the District Engineer.

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. District acceptance of the lines will be contingent upon satisfactory compaction results. No testing of the pipeline shall be allowed until compaction meets Standard Specifications.

4. Final Clean up

After backfill and compaction has been completed, the surface shall be dressed smooth and graded to what the District Engineer deems a satisfactory condition.

D. Installation of Water Main

1. General

Pipe shall be installed to the lines and grades as shown on the approved plans to form a closed joint with the adjoining pipe and prevent sudden offsets of the line. Deflections of pipe joints shall be no more than 80 percent of the pipe manufacturer's deflection tolerances. The pipe and appurtenances shall be survey staked as required by the District and the interior of the water pipe shall be cleaned as the work progresses.

All pipe stored on site prior to installation shall be kept off the ground on footings to prevent stormwater from entering the pipe. At any time when pipe installation is not in progress, including work breaks, the noon hour, and overnight, the open end of the pipe shall be closed with a tight fitting cap or plug to prevent the entrance of dirt and debris into the pipe.

All water lines shall have a minimum of 5 feet and a maximum of 10 feet of cover from finished grade unless accepted through the variance process and shown on the Approved Documents.

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, work shall proceed only after the District approves the deviation through the variance process.

All pipe and fittings shall be carefully examined for cracks and other defects before installation. All lumps, blisters and excessive coating shall be removed from the bell or coupling and spigot ends of each pipe and the outside of the spigot end of each pipe. The outside of the spigot and the inside of the bell or coupling shall be wire brushed and wiped clean.

All pipe, fittings, valves and hydrants shall be carefully lowered into the trench to prevent damage to the water main materials, protective coatings, and linings. Under no circumstances shall water main materials be dropped or dumped into the trench.

2. Ductile Iron Pipe

Ductile iron pipe shall be delivered, handled and installed in accordance with AWWA C-600 and these specifications.

a. Push-on Joint Pipe

The inside of the bell or coupling and the outside of the spigot end shall be thoroughly cleaned to remove oil, grit, excess coating and other debris. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the bell socket, or the coupling end of the pipe. A thin film of gasket lubricant shall be applied to either the inside surface of the gasket or the outside of the spigot end of the pipe or both. Gasket lubricant shall be supplied and approved by the pipe manufacturer. Joint lubricant shall be non-toxic, water soluble, and certified to meet NSF/ANSI Standard 61. The spigot end of the pipe shall be placed into the bell or coupling end without touching the ground with the spigot end after cleaning. The joint shall then be completed by pushing the plain end to the bottom of the socket with a smooth steady motion. Stabbing of pipe shall not be permitted.

Pipe shall be marked with a depth mark to ensure that the spigot end is inserted to the full depth of the joint. Painting a depth mark at the appropriate location on the pipe shall mark field-cut pipe lengths. The spigot end shall be ground or filed to resemble the manufactured pipe end. Any damage or spalling of the cement mortar lining shall be repaired with a coal tar epoxy compound.

Deflecting push-on joint pipe to form a long radius curve shall not exceed the maximum limits shown in Table 4-3.

b. Mechanical Joint

The last 8 inches of the outside spigot and inside bell of mechanical joint pipe shall be thoroughly cleaned to remove oil, grease, grit, excess coating and other debris from the joint and painted with a soap solution made by dissolving 1/2 cup of liquid soap per 1 gallon of water. The cast iron gland shall be slipped on the spigot end of the pipe with the lip extension of the gland toward the socket, or bell end. The rubber gasket shall be painted with the soap solution and placed on the spigot end with the thick edge towards the gland.

The entire section of pipe shall be pushed forward to seat the spigot end in the bell. The gasket shall then be pressed into place within the bell. The gasket shall be seated evenly around the entire joint. The cast iron gland shall be moved along the pipe into position for bolting, all of the bolts inserted, and the nuts screwed hand tight. All nuts shall be tightened with a torque limiting wrench. The torque for various sizes of bolts shall be as recommended by the manufacturer.

Nuts spaced 180° apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland. Whenever it is desirable to deflect mechanical joint pipe in order to form a long radius curve, the amount of deflection shall not exceed the maximum limits shown in Chapter 4, Paragraph 4.01-C.4.

3. Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall be installed in accordance with AWWA Manual M-23, the manufacturer's recommendation, and these specifications. Pipe stored outside which will not be laid within 10 days shall be covered with an opaque material to prevent exposure to sunlight. Clear plastic sheets shall not be used. Both ends of the pipe shall be clear to allow for air circulation under the covering.

Immediately before joining two lengths of PVC pipe, the inside of the bell or coupling, the outside of the spigot and the elastomeric gasket shall be thoroughly cleaned. Lubrication of the joint and rubber gasket shall be done in accordance with the manufacturer's specifications.

Care shall be taken that only the correct elastomeric gasket, compatible with the annular groove of the bell, is used. Insertion of the elastomeric gasket in the annular groove of the bell or coupling must be in accordance with the manufacturer's recommendations. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint. The spigot and bell or coupling shall be aligned and pushed until the reference line on the spigot is flush with the end of the bell or coupling. Pushing shall be done in a smooth, steady motion.

E. Installation of Tracer Wire

The installation of all water and sewer lines shall require tracer wire. Tracer wire shall be taped to the top of the pipe at four-foot intervals and brought to the surface at the tracer wire valve box that is located immediately behind all fire hydrants.

F. Installation of Valves and Valve Boxes

Valves shall be handled in such a manner as to prevent any injury or damage. All joints shall be thoroughly cleaned before installation. Valves shall be located as specified on the construction drawings.

Valves shall be set and jointed to pipe in the manner previously specified for cleaning, laying and jointing of mechanical joints. Valves shall be set in such a manner that the valve stems are plumb. Valves shall be wrapped with polyethylene encasement material to protect the mechanical joint and valve body.

If requested by the District Engineer, valves shall be operated prior to installation to verify good operating condition.

When butterfly valves are installed on mains 16-inch diameter and larger, the valve operator shall be placed on the north side of mains running predominately east-west and on the east side of mains running predominately north-south.

A valve box shall be provided for every valve. The valve box shall not transmit shock or stress to the valve, and shall be centered and plumb over the wrench nut of the valve, with the box cover set to the elevation determined by the Customer's Professional Engineer. It shall be the responsibility of the Customer to ensure that valve boxes are plumb and set to the proper elevation.

Pressure regulating valves shall be installed in a horizontal position in an underground concrete manhole or concrete vault as applicable.

G. Installation of Fittings

All fittings shall be mechanical joint connections or fully restrained push on joints and installed in compliance with Chapter 4, Paragraph 4.03-K. Fittings shall be wrapped with a polyethylene encasement material in conformance with Chapter 4, Paragraph 4.03-P.3. All tees, valves, fittings and bends shall have restraint glands and thrust blocks in conformance with Chapter 4, Paragraph 4.03-K. Wax tape shall be applied to all hardware in accordance with Chapter 4, Paragraph 4.03-P.2.

H. Installation of Tapping Sleeves ("Wet Tap")

No connection shall be made to an existing main until all inspections have been performed and accepted by DWSD. Tapping sleeves shall be used where indicated on the construction drawings when a connection is required to an existing main that cannot be taken out of service. The tapping sleeve shall be manufactured for the specific outside diameter (O.D.) of the existing main and shall conform to Chapter 4, Paragraph 4.02-I. A tapping sleeve shall not be installed closer than 48 inches from a bell or coupling. The tapping sleeve and valve shall a slope of 0% from the main.

All excess debris, uneven coating or other material which may interfere with the sealing of the saddle shall be removed from the existing main prior to the bolting of the saddle. Once the saddle has been completely bolted and prior to the actual tapping operation, the saddle shall be air-tested with soap at the joints in order to check for leaks. If a leak cannot be stopped, regardless of the size of the leak, the tapping operation shall not be permitted.

Upon completion of the tap, the tapping sleeve and valve shall be wrapped in polyethylene in conformance with these Standard Specifications and a thrust block shall be poured behind the tapping sleeve. The entire excavation shall be backfilled in accordance with Chapter 4, Paragraph 4.03-B and 4.03-C, or as otherwise specified by the Douglas County Roadway Design and Construction Standards. All excavation, shoring, dewatering, traffic control and backfill shall be the responsibility of the Customer.

I. Installation of Fire Hydrants

All hydrants shall stand plumb and shall have the steamer nozzle facing the main at a right angle to the main. Fire hydrants located behind curbs and sidewalk shall be placed 36 inches behind the back of curb or sidewalk to the center of the hydrant.

Hydrants shall be set to finished grade such that the elevation of the center of the traffic flange is not more than 6 inches nor less than 4 inches finished grade or top of sidewalk. In the event that a hydrant must be raised to meet the Standard Details, an approved barrel extension kit supplied by the manufacturer shall be used. When the barrel is raised the breakaway coupling on the operating stem shall also be raised so that it matches the new elevation of the traffic flange. The maximum height of extension shall be 18 inches. In the event extensions are required in excess of the 18-inch limit, a new hydrant shall be installed which was manufactured for the required depth of bury.

Each hydrant shall be connected to the main with a 6-inch branch line of ductile iron pipe controlled by an independent 6-inch gate valve rodded to the tee on the main, a swivel adapter or a locked hydrant tee. The branch line shall be rodded and the entire assembly, including the hydrant, shall be restrained with eye bolts and wrapped with polyethylene. The hydrant shoe and main line tee shall be thrust blocked in accordance with these specifications. The weep holes on the hydrant shoe may not be plugged with the polyethylene or thrust block.

A drainage pit 3 feet in width and 3 feet deep shall be excavated below each hydrant and filled with 3/4-inch crushed rock. Crushed rock shall be used around the shoe of each hydrant and to a level 6 inches above the top of the pipe lateral.

Upon completion of installation, each hydrant shall be tested for leaks by closing all nozzle caps and turning the operating nut to full open. There shall be no leaks visible from the caps, traffic flange, bonnet, or surfacing from the weep holes upon completion of the leakage test, the operating nut shall be closed and a cap removed to allow the hydrant to drain. If the hydrant fails to drain properly, the hydrant shall be excavated to check the weep holes.

J. Installation of Blowoff Assemblies

Blowoff assemblies shall be installed to provide an outlet for flushing dead-end mains or for venting air during construction. All blowoffs shall be constructed of brass or copper. No galvanized or black iron materials are permitted.

1. Blowoffs shall be constructed of 2-inch copper and brass and shall conform to the Standard Details. A minimum separation of 2-feet is required between the operating valve and the standpipe. A slip-type cover shall be placed over the stand pipe immediately upon installation in order to prevent debris from entering the pipe. Rods and clamps shall be used to restrain a minimum of 40 feet of pipe.

2. Blowoff assembly valve boxes shall conform to Chapter 4, Paragraph 4.03-F.
3. Valves shall conform to Chapter 4, Paragraph 4.03-F.

K. Installation of Thrust Blocks

1. Installation

Thrust blocks shall be constructed at all bends and fittings which require support due to unbalanced line thrust. Outlets, bolts, nuts, clamps or other fittings shall not be blocked or made inaccessible. A bond breaker shall be placed between the pipe and the thrust block. If a large thrust block is to be poured, it shall be separated into sections by a suitable material. The sizes and shape of thrust blocks shall be in accordance with the Standard Details. Bearing surface areas are minimum areas to bear against the undisturbed trench wall. If, in the opinion of the Engineer of Record, the soil bearing capacity is not sufficient to provide adequate restraint based on minimum bearing areas shown on the Standard Details, then the minimum bearing area shall be increased to a size that will ensure adequate restraint. In every instance, the thrust block shall bear against undisturbed earth. When it is impossible, through over excavation or other cause, to pour a thrust block against undisturbed earth, harness rods shall be required to anchor the fittings to the main in accordance with the direction of the Engineer of Record.

Concrete for thrust blocks shall be Class "B" concrete as specified in Chapter 4, Paragraph 4.02-L and Paragraph 4.02-O. Before placing concrete, all equipment for mixing and transporting the concrete shall be clean. All debris, water or ice shall be removed from the excavation to be occupied by the concrete. Concrete shall not be placed on frozen sub-grade. If required, concrete shall be inspected by the District Engineer prior to backfill.

2. Form Work for Thrust Blocks

All forming for concrete thrust blocks and anchors will be done by bulkheading around the shape of the thrust block or anchor with wood, burlap, or reinforced paper sacks filled with sand or earth.

Sacks shall be of a size easily handled when full, and shall be left in place in the trench. Wood forms shall be removed before backfilling.

No horizontal struts or braces required for trench shoring shall remain in the concrete thrust blocks. Prior to placing concrete, the Engineer of Record shall inspect the forms.

When concrete is deposited against ground without the use of forms, the ground shall be thoroughly moistened, or other provisions made to prevent the ground from drawing water from the concrete.

3. Minimum Curing Time

Newly placed concrete shall be allowed to cure for a minimum of 24 hours.

4. Compaction of Fill over Thrust Blocks

Backfill may be placed over thrust blocks once the surface has set. However, no tamping or compacting shall be allowed above or around the thrust block for a minimum of 72 hours after placement.

L. Protection of Water Lines near Storm and Sanitary Sewer Facilities

In the event that a water main must cross a storm or sanitary sewer, the following criteria shall apply:

Refer to Chapter 4, Paragraph 4.01.C-3

M. Abandonment of Utilities

Utility pipes that are to be abandoned shall be filled with a flowable grout. Grout shall have flowing characteristics that will fill, with no space at the crown for the defined limits, the waterline to be abandoned. Mix shall be cement and sand type mixture with good flowing characteristics, a low-density cellular concrete, or a fly ash based mixture and shall set time shall be less than 24 hours. Minimum compressive strength after 28-days shall be 100 psi. Shrinkage shall not exceed 1 percent of the abandoned waterline diameter.

N. Hydrostatic Testing of Water Mains

1. General

No hydrostatic tests shall be made on any portion of the pipeline until all field placed concrete has had adequate curing time and all compaction test results have been submitted to and accepted by the District Engineer. All pressure and leakage tests shall be in accordance with AWWA C600 for ductile iron mains and AWWA Manual M-23 for PVC mains. The District Engineer shall be notified 24 hours in advance of any testing and all testing shall be performed in the presence of DWSD or DWSD approved personnel. No service taps shall be permitted until the main has passed the required hydrostatic and disinfection testing.

2. Standards

The specified test pressure shall be 1.5 times the operating pressure at the highest point along the test section or the working pressure rating of the pipe, whichever is greater. Under no circumstances shall the test pressure exceed twice the rated pressure of the valves or hydrants when the pressure boundary of the test section includes closed valves or hydrants.

The term "leakage", as used herein, refers to the total amount of water which must be introduced into the piping during the leakage test to maintain the test pressure.

No piping will be accepted if and while it exhibits a leakage rate in excess of that which is determined by using the formulas in either AWWA M-23 for PVC pipe or AWWA C600 for DIP pipe. All joints in piping shall be watertight and free from visible leaks during the leakage test. Each leak which is discovered shall be repaired by and at the expense of Contractor regardless of the amount that the total leakage may have been below the specified allowable leakage rate during the leakage test.

If the leakage test indicates a higher than allowable leakage rate, Contractor shall locate and repair leaking joints and other defective work to the extent necessary to reduce the leakage to an acceptable value.

3. Procedure

Each valved section of pipe shall be slowly filled with water and the specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the District.

Whenever the piping to be tested contains pipe of different diameters, the allowable leakage shall be calculated separately for each diameter and the corresponding length of piping. The resulting allowable leakage rates shall be added to obtain the total allowable leakage for the entire piping.

The pump, pipe connection, gauges and all other necessary equipment and personnel to complete the test shall be furnished by the Customer and shall be reviewed by the District prior to testing. Barrels and buckets shall not be acceptable to measure water loss. An assembly that includes a clean vessel shall be used. If the material is found to be inadequate, testing shall be postponed until acceptable materials are provided. All corporation cocks and taps to the main line and all connection piping and valves required to make the test, whether or not specified or shown on the construction drawings shall be installed at the expense of the Customer.

Before applying the specified test pressure, all air shall be expelled from the pipe. In pipe sizes 6-inch and larger, hydrants can be used for venting if air valves have not been installed. All fire hydrant branch valves and all stub-out isolation valves shall be opened for the pressure test. During the test, the pressure in the main shall not vary by more than 5 psi from the specified test pressure for 2 hours plus any additional time required for the District to make examine all the pipe being tested and for Contractor to locate any defective joints and pipe materials. If the pressure should drop below the 5-psi allowance during the test, the main shall be pumped back up to the specified pressure and the test repeated.

4. Acceptance

Any cracked or defective pipe, fittings, valves or hydrants discovered as a result of the pressure test shall be removed and replaced with sound materials and the test shall be repeated until the results meet the Standard Details set forth herein.

The pipe installation will not be accepted if the leakage exceeds the amount as defined in the formula referenced in Chapter 4, Paragraph 4.03-M.2. If any test of pipe has a greater leakage as defined in the formula, the defective joints or pipes shall be located and repaired until the leakage test is acceptable. All visible leaks are to be repaired by the Contractor regardless of the amount of leakage.

O. Disinfection of Water Mains

1. General

Each section of new water supply line shall be disinfected with chlorine then flushed and pass bacteriological testing before acceptance for domestic service. Disinfection shall be in accordance with ANSI/AWWA C-651-14.

2. General Considerations for Acceptable Methods of Chlorination

a. General

Two methods of chlorination are explained in this section: tablet and continuous feed. DWSD strongly recommends the continuous feed as the preferred method. Both methods require an initial dosage range of free chlorine at 50-60 mg/l. Caution should be used with highly chlorinated water when conducting hydrostatic pressure testing and with high volume flushing water.

Individual sections of new water main that are chlorinated and tested for service shall not exceed 2,400 feet. This ensures better control of the disinfection process and more thorough results.

b. Flushing

Potable water shall be used for disinfection, hydrostatic pressure testing, and flushing. Drainage should take place away from the construction or work area. Adequate drainage must be provided during flushing.

c. Dechlorination

When dechlorination is required, it is recommended that any high velocity flushing be completed prior to disinfection. Dechlorination equipment may not be capable of handling high flows with high levels

of chlorine.

3. Tablet Method of Chlorination (not acceptable for lines connecting to DWSD Wholesale Water Facilities)

a. Tablet Method

The tablet method consists of placing calcium hypochlorite tablets in the water main during installation and then filling the main with potable water to create a chlorine solution. This method may be used only if the pipes and appurtenances are kept clean and dry during construction.

b. Placement of calcium hypochlorite tablets during construction.

Calcium hypochlorite tablets (5-grams) shall be placed in the upstream end of each section of pipe to be disinfected, including branch lines. Also at least one tablet shall be placed in each hydrant branch and in other appurtenances. The table below shows the number of tablets required for commonly used sizes of pipe. Tablets shall be attached by adhesive meeting requirements of NSF/ANSI 61. There shall be adhesive only on the broadside of the tablet attached to the surface of the pipe. Attach tablets inside and at the top of the main. If the tablets are attached before the pipe section is placed in the trench, their positions shall be marked on the pipe exterior to indicate that the pipe has been installed with the tablets at the top.

Number of 5-g Calcium Hypochlorite Tablets required for dose of 50 mg/L					
	Length of Pipe Section (ft)				
	13 or less	18	20	30	40
Pipe Diameter (in)	Number of 5-g Calcium Hypochlorite Tablets				
4	1	1	1	2	2
6	2	2	2	3	4
8	2	3	3	5	6
10	3	5	5	7	9
12	5	6	7	10	14
16	6	7	8	12	16

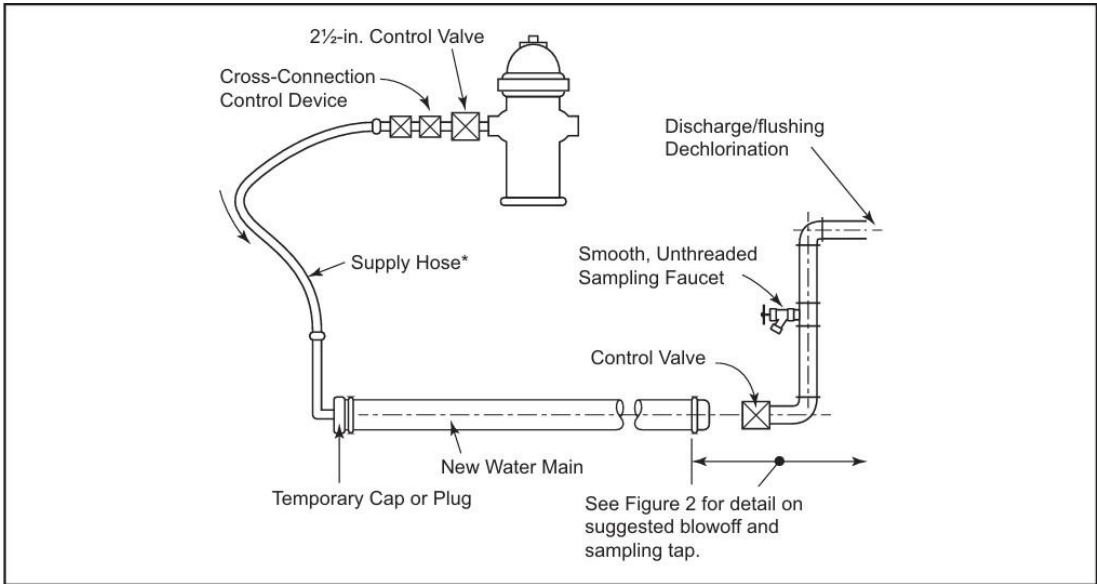
c. Filling and contact time.

When installation has been completed, the main shall be filled from a single location with water such that the full pipe velocity is no greater than 1 ft/sec (0.3 m/sec). Fill rate must be carefully controlled to ensure tablets do not come loose from pipe. Precautions shall be taken to ensure that air pockets are eliminated. The table below shows the flow rates required in various pipe diameters to achieve a 1 ft/sec filling rate.

Flow rates for filling various pipe diameters				
Pipe Diameter (in)	Radius (ft)	Area (sq. ft)	Flow Rate at 1 ft/sec (GPM)	Flow Rate at 3 ft/sec (GPM)

8	0.3333	0.3491	156	470
10	0.4167	0.5440	245	732
12	0.5000	0.7854	352	1057
14	0.5833	1.0690	480	1439
16	0.6667	1.3963	626	1880
20	0.8333	2.1817	832	2497
24	1.0000	3.1416	1047	3142

It is required by DWSD that water used to fill the new main(s) shall be supplied through a temporary connection that shall include an appropriate cross-connection control device, consistent with the degree of hazard, for backflow protection of the active distribution system, see figure below. The chlorinated water shall remain in the pipe for at least 24 hr. A free chlorine residual of no less than 10 mg/L shall be found at each sampling point after the 24-hr period.



Required temporary flushing/testing connection. This figure applies to pipes with diameters 4 in. through 12 in. Larger sizes must be handled on a case-by-case basis.³

Clean potable-water hoses only.

4. Continuous-Feed Method of Chlorination

a. Continuous-Feed Method

The continuous-feed method consists of completely filling the main with potable water, removing air pockets, then flushing the completed main to remove particulates, and refilling the main with potable water that has been chlorinated to 50-60 mg/L. After a 24-hr holding period in the main there shall be a free chlorine residual of not less than 10 mg/L.

b. Preliminary Flushing

Before the main is chlorinated, it shall be filled with potable water to eliminate air pockets and flushed to remove particulates. The flushing velocity in the main shall not be less than 3.0 ft/sec.

- c. Procedure for chlorinating the main.
 - i. Potable water may be supplied from a temporary backflow-protected connection to the existing distribution system or other supply source approved by the purchaser. The cross-connection control device shall be consistent with the degree of hazard for backflow protection of the active distribution system (see Figure 1). The flow shall be at a constant, measured rate into the newly installed water main. The main should undergo hydrostatic testing prior to disinfection.
 - ii. At a point not more than 10 ft (3 m) downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 50 mg/L free chlorine. To ensure that an appropriate concentration is achieved, the free chlorine concentration shall be measured at regular time intervals using an appropriate high chlorine test kit. The table below gives the amount of chlorine required for each 100 ft of pipe for various pipe diameters. Solutions with a minimum 1 percent chlorine concentration may be prepared with sodium hypochlorite or calcium hypochlorite. The latter solution requires 1 lb. (454 g) of calcium hypochlorite in 8 gallons of water.

Chlorine required to produce a 50 mg/L concentration in 100 ft of pipe by diameter		
Pipe Diameter (in)	100% Chlorine (lbs)	1% Chlorine Solution (gal)
4	0.026	0.32
6	0.060	0.72
8	0.108	1.28
10	0.170	2.04
12	0.240	2.88
16	0.434	5.20

- iii. Chlorine application shall not cease until the entire main is filled with chlorinated water. The chlorinated water shall be retained in the main for at least 24 hr, during which time valves and hydrants in the treated section shall be operated to ensure disinfection of the appurtenances. At the end of this 24-hr period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L of free chlorine.

5. Final Flushing for New Mains

- a. Clearing the main of heavily chlorinated water.

After the applicable retention period, heavily chlorinated water should not remain in prolonged contact with pipe. In order to prevent damage to the pipe

lining or to prevent corrosion damage to the pipe itself, the heavily chlorinated water shall be flushed from the main fittings, valves, and branches until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system or that is acceptable for domestic use.

b. Disposing of heavily chlorinated water.

The environment to which the chlorinated water is to be discharged shall be inspected. If there is any possibility that the chlorinated discharge will cause damage to the environment, a neutralizing chemical shall be applied to the water to be wasted to thoroughly neutralize the residual chlorine (see ANSI/AWWA C655 for neutralizing chemicals).

6. Final Connections to Existing Mains

Water mains and appurtenances must be completely installed, flushed, disinfected, and satisfactory bacteriological sample results received prior to permanent connections being made to the active distribution system. Sanitary construction practices must be followed during installation of the final connection so that there is no contamination of the new or existing water main with foreign material or groundwater.

a. Connections equal to or less than one pipe length

The new pipe, fittings, and valve(s) required for the connection may be spray disinfected or swabbed with a minimum 1% solution of chlorine just before being installed, if the total length of the connection from the end of a new main to the existing main is equal to or less than 20 ft.

b. Connections greater than one pipe length

The pipe required for the connection must be set up above ground, disinfected, and bacteriological samples taken if the total length of the connection from the end of a new main to the existing main is greater than 20 ft (6 m). After satisfactory bacteriological sample results have been received for the pre-disinfected pipe, the pipe can be used in connecting the new main to the active distribution system. Between the time that the satisfactory bacteriological sample results are received and the time that the connection piping is installed, the ends of the piping must be sealed with plastic wraps, watertight plugs, or caps.

7. Bacteriological Tests

a. Standard conditions for new mains.

It should be recognized that the primary means of ensuring the sanitary integrity

of a main are the sanitary handling of materials, the practices during construction, and continual inspection of work. After disinfection and final flushing such that typical system chlorine residuals are present, if the system operates with a residual, samples shall be collected and analyzed by DWSD staff as follows:

For new mains, take an initial set of samples once normal chlorine residuals are found in the main. A second set of samples are to be taken after a minimum of 16 hr. Both sets of samples must pass for the main to be approved for release.

- i. A “set of samples” includes one sample collected every 1,200 ft (370 m) of the new water main, one sample from the end of the line being disinfected and at least one sample from each branch greater than one pipe length.

b. Sample Results

Samples shall be tested for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater and shall show the absence of coliform bacteria. Upon receipt of the test results, Dominion Operations staff will promptly notify the owner and/or the contractor of the results.

c. Redisinfection

If the initial disinfection fails to produce satisfactory bacteriological results, or if other results indicate unacceptable water quality, the main may be re-flushed and shall be resampled. If check samples fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed method as described herein. If the following samples fail, the line shall be pigged and redisinfecting using the continuous feed method. If the following samples fail again, the line shall be ripped out and replaced.

P. Installation of Corrosion Protection for Pipelines

1. Cathodic Protection

The Contractor shall be responsible for all specified testing and the furnishing and proper installation of all materials and equipment as specified herein and as indicated on the drawings. The Contractor shall be responsible for maintaining a minimum separation between the water pipe and all other buried metals, including but not limited to, copper grounding systems and concrete reinforcing steel.

Splices in pipe, anode, or reference electrode lead wires will not be permitted.

The minimum burial depth of underground galvanic anodes shall be 18-inches below the pipe invert and the minimum horizontal distance from the pipe shall be 10 feet.

If solid bedrock or solid reinforced concrete is encountered at an anode location indicated on the drawings at a depth which will not permit installation of the anode vertically at the depth specified, an investigation of the immediate area shall be made to determine if the anode can be installed with the same orientation with respect to the pipe, and at the specified depth, at the location indicated on the drawings.

If the Contractor is unable to find a place in the immediate area of the specified anode location where the anode can be installed vertically to the anode depth indicated on the drawings, the anode shall be installed vertically closer to the surface so long as the earth cover over the top of the anode is at least 10 feet. If the depth of solid bedrock is such that a 10-foot earth cover cannot be maintained over a vertically installed anode, the Contractor shall advise the Engineer, who will direct the Contractor on how to proceed.

After burial of the packaged underground galvanic anode, but before backfilling the anode excavation, at least 5 gallons of water shall be poured over and around the anode package.

Packaged underground galvanic anodes shall be backfilled with clean earth, free from rocks and debris. Anodes shall not be backfilled with sand.

DIP shall be made electrically continuous by joint bonding where cable is bonded via the thermite process. The process for connecting cable to pipe shall be by exothermal welding. The completed connections and exposed metal surfaces shall be repair coated in the field by matching the existing coating and applying in two coats to obtain a 10-mil thickness. Surface shall be cleaned prior to field coating.

Joint bonding cable connections on either side of a joint shall be separated a minimum distance of 12 inches. Joint bonding cables shall be made with two #8 AWG cables. Joint bond cables shall contain at least 6 inches of slack wire to compensate for pipe movement and backfill settlement.

Lead wire and cable shall be installed at a minimum of 3 feet below grade. Where lead wire is connected to pipe or to field test stations, a minimum of 18 inches of slack shall be left in the lead wire to permit settling of the backfill without stressing the electrical connection.

All DIP shall be resistance tested during installation to ensure complete bonding of all pipe joints. Tests to verify acceptable individual joint bonding of pipe shall be made in accordance with the procedures listed below. The Contractor shall not permanently cover any joint bonded pipe with soil, concrete, or other backfill until the pipe continuity is tested. The pipe joint or joints shall be tested for continuity using the specified low-resistance dc ohm-meter as follows:

- a. Place one helical spring point test lead on each side of the pipe joint being tested. The test lead should be placed in contact with the pipe

adjacent to continuity bond wire exothermal weld on each pipe joint.

- b. Measure the electrical resistance across the mechanical joint under test directly using the low-resistance ohm-meter. The electrical resistance of the pipe joint must be less than 250 micro-ohms to be acceptable.
- c. Repair discontinuities as required. Repeat steps a and b above to verify all discontinuities are located and satisfactorily repaired.

Underground reference electrodes shall be installed in accordance with the following paragraph. After each underground reference electrode is installed, a minimum of 10 gallons of water shall be poured over and around the electrode package. After the surrounding soil and underground reference electrode package is thoroughly saturated with water, place a mild steel stake or rod in firm contact with the soil, several feet from the reference electrode package. Connect the negative test lead of the specified dc voltmeter to the reference electrode lead wire. Firmly connect the voltmeter positive test lead to the mild steel stake or rod. Measure and record the dc voltage on the voltmeter. For copper-copper sulfate type underground reference electrodes, a stable negative reading between -0.4 and -0.8 volts should be obtained with the lead wires connected as described above for the installation to be acceptable.

A NACE certified corrosion or cathodic protection specialist shall review installation procedures and supervise the testing.

2. Wax Tape

Ductile iron pipe, fittings, and appurtenances (including those installed as part of a PVC water main) shall be coated with wax tape in accordance with Chapter 4, Paragraph 4.02-Y.2. Additionally, wax tape shall be applied to all buried metallic hardware on pipe fittings, valves and restraints.

3. Polyethylene Wrapping

Shall be installed on all DIP pipe materials including, but not limited to, valves and fittings (including those installed as part of a PVC water main). Installation shall be in accordance with the Standard Details.

All ductile iron pipe, valves and fittings shall be wrapped with polyethylene wrapping, minimum 8 mil thickness in accordance with AWWA C-600.

A polyethylene tube which is approximately 2 feet longer than the pipe shall be slipped over the plain end and leaving it bunched up accordion style prior to the installation of the pipe in the trench.

After the pipe has been assembled in the trench, each joint shall be overlapped by pulling one bunched-up tube over the bell, folding it around the adjacent plain end, and securing it in place with three wraps of 2-inch wide, 10 mil thickness polyethylene adhesive tape, the polyethylene wrapping at the center of the pipe shall

be bunched- up and secured with three wraps of tape. Repeating the same procedure with the bunched-up tube on the adjacent pipe shall complete the overlap. Any rips, punctures or other damage to the polyethylene shall be repaired with tape or by cutting open a short length of tube, wrapping it around the pipe and securing with tape.

Tees, valves, crosses, taps, fire hydrants and other fittings shall be wrapped with a flat sheet obtained by splitting open a length of polyethylene tube. The sheet shall pass under the valve or fitting and be wrapped up around the body. The seams shall be secured firmly with polyethylene adhesive tape.

Polyethylene encasement tube shall conform to the following minimum size:

Nominal Pipe Diameter	Flat Tube Width
6-inch	20-inch
8-inch	24-inch
12-inch	30-inch

4. Final Cathodic Protection Tests

Tests to verify acceptable performance and final status of the cathodic underground electrical and mechanical connections to be made to the underground piping systems shall be complete before testing. It shall be the Contractor's responsibility to ensure that the underground piping is electrically isolated from above-ground piping installations during performance of the testing. The underground piping shall have been completely backfilled for at least one month before final testing is started, although prior tests may be made at the Contractor's option for his own information.

- e. Pipe Lead Wire Continuity Testing. Prior to performing anode current measurement tests or pipe potential tests, verify electrical continuity of pipe lead wires terminated in field test stations in accordance with Part A of this Section (above).
- f. The pipe lead wire continuity testing shall be made using the specified voltmeter and flexible test leads. If anode current measurements are required to help identify defective pipe lead wires, the specified low resistance ammeter may also be required. The measurements shall be made as follows:
- g. At the field test station, disconnect the applicable pipe lead wire or wires from any anodes or shunts. Then connect the specified voltmeter between the two pipe lead wires, and measure and record the potential obtained.
- h. If no potential exists between the pipe lead wires, use the specified ohmmeter to measure the resistance between the two pipe lead wires. This resistance reading should be a relative reading to nullify the resistance of the meter lead wires or the lead wire resistance should be subtracted from the reading to get the resistance of only

the pipe lead wires. The resistance reading must be stable and less than 0.1 ohm for both pipe lead wires to be considered satisfactory.

- i. If a potential exists, if the reading is unstable, or if there is a high resistance between the pipe lead wires, one or both of the pipe lead wires may be damaged. To determine if either of the pipe lead wires is satisfactorily connected to the pipe, perform the following tests:
- j. Determine if the anode(s) terminated in the test station are satisfactory by performing the anode open circuit potential testing specified in the article titled Anode Open Circuit Potential Testing.
- k. If the anode(s) terminated in the test station are satisfactory, measure the current which flows from a pipe lead wire to an anode. Record the current measurement. Repeat the above procedure, this time using the spare pipe lead wire.
- l. Pipe lead wires in which there is no current flow or minimal current flow are discontinuous with the pipe. Pipe lead wires which are discontinuous with the pipe shall be repaired or appropriately marked in the test station as determined by the Construction Manager.
- m. Restore the pipe lead wires to their original positions on the test station terminal board.
- n. Pipe Connected Anode Current Measurements. After the piping to be protected and the galvanic anodes have been backfilled with all anodes connected to the piping for a minimum of 30 days, and any connecting above-grade piping has been verified to be effectively isolated, the current from each galvanic anode terminated in a test station shall be measured as follows:
 1. At each field test station with connected anodes, place the specified dc voltmeter with millivolt scale across the shunt associated with each anode and measure the voltage drop. Record the voltage and the resistance values. Calculate the currents by Ohm's Law. Record the current measurement for each anode.
 1. For test stations not furnished with shunts, set the specified multimeter to the dc milliamperes (mA/A) scale. Connect the positive terminal (mA μ A) multimeter test lead wire to the Pipe Lead Wire 1 lug in the test station terminal block. Connect the negative terminal (COM) multimeter test lead wire to the anode lead wire lug in the test station terminal block. Observe and record dc milliamperes and polarity (should be positive) displayed by the multimeter.
- o.

- p. Pipe System Potential Measurements. After satisfactory current measurements have been obtained for all test station connected anodes on an isolated piping system, and with any connecting above-grade piping still effectively isolated, pipe potentials shall be measured.

The pipe potential measurements shall be made using the voltmeter, the flexible test leads, and the reference electrode specified in the article titled Test Equipment. The measurements shall be made as follows:

At each field test station, connect the negative terminal of the voltmeter to the reference electrode and connect the positive terminal of the voltmeter directly to a pipe lead wire.

Place the reference electrode in moist soil, free of vegetation, on the surface directly over the pipe. Record the measurement and the location where the reference electrode was placed. The polarity of the measurement should be negative if the meter is connected as indicated.

At locations where underground reference electrodes are installed, the measurements shall be made as follows.

Connect the negative terminal of the voltmeter to the underground reference electrode lead wire and connect the positive terminal of the voltmeter directly to a pipe lead wire.

Record the potential measurement. The polarity of the measurement should be negative if the meter is connected as indicated.

Within 15 calendar days after completion of the Final Cathodic Protection Tests, a complete report of the test results shall be submitted to DWSD.

4.04 WATER SERVICE LINE DESIGN

A. Flow Design Criteria

Design flows shall be based on an analysis by the Customer's P.E. Flows shall be established in accordance with the recommendations set forth in the American Water Works Association's Manual M22, "Sizing Water Service Lines and Meters".

The Customer's P.E. shall specify water conservation devices and fixtures for all facilities in accordance with the Rules and Regulations of the District.

B. Hydraulic Design

Water service lines shall be designed to deliver the maximum flow at an acceptable pressure within the building. Hydraulic losses shall be calculated for: the friction head within the pipe; losses due to valves and other appurtenances; elevation head loss and any other parameters deemed significant by the Customer's P.E.

C. Sizing

A water service line and meter shall be equal in size. Exceptions may be granted if a letter requesting a variance is sent to the District Engineer prior to the approval of the drawings.

1. In the event that a water service stub was previously installed to the property line that is larger than is needed by the customer, a reducer shall be installed and the remainder of the service line shall be the same size as the meter.
2. Service lines that are intended to be used for two or more separate meter installations may be larger than the individual meters that the line is serving. This combined service arrangement is acceptable in the following applications: independent domestic and irrigation meters, commercial buildings with multiple meters and townhomes/condominiums with multiple meters.
3. Water service lines which exceed 100 feet in length may be increased by one pipe diameter larger than the water meter.
4. The Customer's P.E. shall submit a detailed analysis of demands and the hydraulic calculations to support the sizing of the meters and/or service lines.
5. The minimum service line size shall be 3/4-inch.

D. Location and Alignment

Each single family residential detached and attached dwelling unit shall have a separate water service line and meter. Townhomes, condominiums and apartments which are designed to utilize common plumbing within the structure may have a single service line. Special applications such as those described in Chapter 4, Paragraph 4.07-B may also have common service line.

Service lines shall follow a straight horizontal alignment between the outlet of the building plumbing and the tap on the distribution main. The service line shall follow an alignment perpendicular to the main, with the exception of cul-de-sacs. At the end of cul-de-sacs, the distribution main shall not be more than 50 feet from the front property line of any lot.

Water service lines shall be located as shown in the Standard Details. Service lines may not cross private property unless placed in an easement dedicated to the property owner being served by the service line.

It shall be the responsibility of the Customer to stake the location of the service line to ensure that the service line is correctly located on the property.

All water service lines shall have a shutoff valve which can be accessed and operated from the outside of the building. Typically, this valve is considered to be a curb stop valve, wet tap valve or shutoff valve in a meter pit. Valves shall be the same size as the service line.

In the event that a fire sprinkler line is to be extended into a building, the water service line may only be tapped off the fire line with the approval the District Engineer and the Fire Marshall. Fire service lines that supply sprinklers shall be sized by the appropriate fire department and the persons responsible for the structure it protects. The determination of adequate sizing for both lines shall be the responsibility of the Customer's Professional Engineer. The water service line shall have a shutoff valve independent of the fire sprinkler line (reference Standard Details).

On commercial and multi-family projects the fire sprinkler line and water services shall be designed so that there is a minimum of a 5.0-foot horizontal separation between the lines at the point they enter the structure, measured center to center of pipe.

E. Depth

All water service lines shall be designed so that a minimum of 5 feet of cover exists over the top of pipe after final grade has been established. This minimum shall apply from the distribution main, through the foundation and to a point where the pipe is located in a heated or insulated space.

F. Service Taps

All service taps larger than 2 inches shall be made using tee fittings. All other service taps shall be made by direct tapping or with tapping saddles. If DIP is intended to be direct tapped for 3/4-inch service, the pipe class shall be increased to Special Thickness Class 52 to ensure three thread engagements for the tap. If the service line is larger than 3/4-inch, refer to AWWA C151 Table A.1 to determine necessary pipe thickness for three thread engagement. PVC pipe shall be direct tapped only for C900 pipe in pressure classes greater than 150 for taps 1 inch and smaller. Taps from 1 to 2 inches in size on PVC pipe shall be made with tapping saddles. Taps on PVC pipe 4-inch and smaller and 16-inch and larger shall be made with tapping saddles. C900 pipe shall not be direct tapped. All services for C900 pipe shall be tapping saddles.

Typically, water distribution mains 12-inch diameter and smaller are tapped for water service lines. In the event that a water transmission main 16-inch in diameter or larger must be tapped, the minimum size tap shall be 4-inch, unless otherwise approved by the District. Such a connection shall be made by use of a wet tap saddle in accordance with Chapter 4, Paragraph 4.03-H. In order to reduce the service line to the appropriate size, a blind flange shall be installed on the tapping valve which has been drilled and tapped to the service line size.

All service line wet taps shall be made under pressure. Minimum pressure shall be 30 psi; maximum pressure shall be operating pressure. Corporation taps shall be made in the upper half of the main at an angle of not more than 60° or less than 30° to the centerline of the pipe. Taps shall be made on the same side of the main as the water meter and shall have a "goose-neck" to provide a smooth curve into the trench. Service taps shall have a minimum separation of 18 inches, be staggered, and shall be no closer than 24 inches to a coupling or bell.

G. Materials

All materials for water service lines shall be in accordance with Chapter 4, Paragraph 4.05-A, 4.05-B and 4.05-C.

H. Valves

Valves to be used on water service lines shall comply with Chapter 4, Paragraph 4.05-F, 4.05-G, and 4.06-F.

I. Pressure Reducing Valves (PRV)

All water service lines shall have a pressure reducing valve installed between the distribution main and the meter. The PRV shall be located such that the Customer may have access for maintenance. Residential PRV's shall be adjusted by the Customer for a static pressure of 65 psi-70 psi and a residual pressure of 60 psi - 65 psi on new installations only. Commercial and irrigation PRV's may be adjusted by District personnel for pressures up to 90 psi, at the request of the Customer. Only District personnel may adjust PRV's. A PRV is not required when pressures are under 65 psi.

4.05 WATER SERVICE MATERIALS

A. "K" Copper Pipe

All water service lines 3/4-inch through 2-inch in diameter shall conform to Denver Water's Complete Engineering Standards.

B. Ductile Iron Pipe

Water service lines larger than 2-inch in diameter may be constructed of ductile iron pipe in compliance with Chapter 4, Paragraph 4.02-A. Only DIP shall be installed in meter vaults and backflow prevention vaults on lines larger than 2 inches.

C. Polyvinyl Chloride Pipe - PVC

Water service lines larger than 2-inch in diameter may be constructed of polyvinyl chloride pipe in compliance with Chapter 4, Paragraph 4.02-B. PVC pipe shall not be installed in meter vaults or backflow prevention vaults.

D. Bedding Material

Pipe bedding for all types of water service lines shall comply with Chapter 4, Paragraph 4.02-M.

E. Water Service Fittings

1. Pipe fittings for DIP and PVC service lines shall be cast-iron, mechanical joint in compliance with Chapter 4, Paragraph 4.02-E.
2. Pipe fittings for "K" copper service lines shall be all brass construction in accordance with AWWA C-800. Fittings used inside a building may be of the sweat copper type. See Chapter 4, Paragraph 4.06-D.

F. Valves

1. Valves on DIP and PVC service lines shall be gate valves in compliance with Chapter 4, Paragraph 4.02-E and 4.02-G. Valves in meter vaults or backflow prevention vaults shall have cast iron hand wheels, supplied by the valve manufacturer, which have an arrow on the wheel indicating the direction to open the valve. All gate valves shall open by turning the nut or wheel clockwise.
2. Valves on "K" copper service lines shall be of the following types, depending on which is specified on the construction drawings. The Customer may not deviate from the type specified on the construction drawings.

- a. Curb stop (ball valve grip joint compression connection)

Curb stops/ball valves shall conform to Denver Water's Complete Engineering Standards.

- b. Ball and Gate Valve with Drain

Gate valves shall be constructed of water works brass (85-5-5-5) with drain shall conform to Denver Water's Complete Engineering Standards.

- c. Valves that are 1-1/2-inch or larger shall have a 2-inch square operating nut. In the case of service, irrigation, or blowoff assembly valves, a brass cotter key fastener shall secure a 2-inch brass nut.

G. Corporation Stops

Corporation stops shall conform to Denver Water's Complete Engineering Standards.

H. Tapping Saddles

1. Ductile Iron Pipe

Water service tapping saddles for service lines shall conform to Denver Water's Complete Engineering Standards.

2. Polyvinyl Chloride Pipe

Water service tapping saddles for PVC pipe for service lines 2-inch diameter and smaller shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions.

Water service tapping saddles for service lines 3-inch diameter and larger shall conform to Chapter 4, Paragraph 4.02-I.

I. Copper Setters

Copper setters shall conform to Denver Water's Complete Engineering Standards.

J. Curb Boxes

Curb boxes shall conform to Denver Water's Complete Engineering Standards.

K. Bell Restraints

1. Ductile Iron Pipe Restraint

Restrain devices for bell and spigot joints of ductile iron pipe shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions.

Restrain devices shall carry water working pressure rating of 350 psi for sizes 4-inch - 6-inch, 250 psi for 8-inch and 200 psi for 10-inch - 12-inch.

2. Ductile Iron Pipe Restraint - Wedge Action Devices

Restraint devices for bell and spigot joints of ductile iron pipe shall conform to Denver Water's Complete Engineering Standards with the following additional requirements or exceptions.

Restraint devices shall carry water working pressure rating of 350 psi for 4-inch - 12-inch sizes and all components must be supplied as a recognized restraint harness assembly by the manufacturer.

4.06 WATER SERVICE INSTALLATION

A. Excavation

Excavation for water service lines shall be in accordance with Chapter 4, Paragraph 4.03-A, with the exception that a minimum clearance of 6 inches between the sides of the pipe to the trench wall is not required for "K" copper service lines.

B. Pipe Foundation and Bedding

1. DIP and PVC Service Lines

Pipe foundation and bedding for DIP and PVC service lines shall be in accordance with Chapter 4, Paragraph 4.03-B.

2. "K" Copper Service Lines

Pipe foundation and bedding for "K" copper service lines shall consist of placing squeegee bedding to a depth of at least 3 inches below and 3 inches around the copper service line for a minimum thickness of 6-3/4 inches of bedding material.

C. Trench Backfilling and Compaction

Trench backfilling and compaction of water service lines shall be in conformance with Chapter 4, Paragraph 4.03-C.

D. Installation of Water Service Lines

1. DIP and PVC Service Lines

Installation of DIP and PVC service lines shall be in accordance with Chapter 4, Paragraph 4.03-D.

2. "K" Copper Service Lines

The location of the service line shall be staked by the Owner to ensure that the service is correctly located on the respective property.

Copper service lines shall be installed in a straight horizontal alignment from the main to the curb stop valve. No fittings shall be allowed between the main and the curb stop valve. Water services shall be radial to the center line (or center point in cul-de-sacs) from the main to the back of sidewalk.

In the event that the distance between the curb stop and house exceeds 100 feet, a brass fitting in accordance with Chapter 4, Paragraph 4.05-E.2 shall be required.

E. Installation of Polyethylene Wrapping

Polyethylene wrapping shall be installed on all DIP water service lines and cast iron fittings in accordance with Chapter 4, Paragraph 4.03-P.3.

F. Installation of Valves and Valve Boxes

1. DIP and PVC Service Lines

Valves and valve boxes installed on DIP and PVC service lines shall be cast iron gate valves installed in accordance with Chapter 4, Paragraph 4.03-F. Valves shall be installed on all service lines at the property line except wet taps that have an isolation valve at the tapping saddle.

2. "K" Copper Service Lines

Valves installed on copper service lines shall be brass curb stop valves in accordance with Chapter 4, Paragraph 4.05-F. The size of the curb stop valve shall be the same size as the service line. Location of the curb stop valve shall be noted on the construction drawings. All curb stop valves shall be placed on a 9-inch diameter (or square), 2-inch thick concrete pad upon which the base of the curb stop service box shall rest. Under no circumstances shall the service box rest on the curb stop valve or service line.

G. Installation of Fittings

1. DIP and PVC Service Lines

Pipe fittings for DIP and PVC service lines shall be installed in accordance with Chapter 4, Paragraph 4.02-D.

2. "K" Copper Service Lines

All underground pipe fittings for "K" copper service lines shall be all brass construction with grip joint compression end connections.

No fittings shall be permitted between the main and curb stop valve.

Pipe fittings that are located inside a building or inside of a meter vault for line 2-inch and larger may have sweat copper or compression connections. Solder used in sweat copper connections shall not contain more than 0.2 percent lead (or less if required per federal regulations).

Solder used in pipe and pipe fittings shall not contain more than 8.0 percent lead (or less if required per federal regulations).

H. Installation of Ball and Gate Valves with Drains

Gate valves with drains shall be installed in accordance with the Standard Details. Ball and Gate valves of this type shall conform to Chapter 4, Paragraph 4.05-F.2. B.

I. Installation of Service Taps

All service lines shall be connected to the main by the use of a double strap bronze saddle for DIP water mains and single strap bronze saddles for PVC water mains or by a machine tap into the main. Fittings shall be installed in accordance with Chapter 4, Paragraph 4.04-F. Machine taps shall be made by directly threading a corporation stop into the main or in combination with a service tapping saddle. Table 4-6 outlines the type of connection required for given service line and main line sizes.

Corporation stops and tapping saddles shall conform to Chapter 4, Paragraph 4.05-G and 4.05-H. The District Engineer shall approve the tapping machine and shall be limited to the uses recommended by the manufacturer. Teflon tape, or equal, shall be used on all corporation stops.

Drill bits and shell cutters for PVC C900 Class 150 and Class 200 pipe shall have multiple cutting teeth or double fluted design. Anderson combination, cutter and tap or the Mueller tap and shank #581502-3/4-inch, 581503-1-inch with power seal double fluted bit #M9075-T 3/4-inch, M9100-T1-inch with washer or an approved equal shall be used. Single tooth cutters and twist drills are prohibited for PVC pipe.

No taps shall be permitted on a water main until the line has passed a pressure test and clear water test.

All service line taps shall be made under pressure. Minimum pressure shall be 30-psi; maximum pressure shall be operating pressure. Taps shall be made in the upper half of the main at an angle of not more than 60° or less than 30° to the centerline of the pipe. Tap shall be made on the same side of the main as the water meter and shall have a "goose-neck" to provide a smooth curve into the trench.

Service taps shall have a minimum separation of 18 inches, be staggered, and shall be no closer than 24 inches to a coupling or bell. Taps that are placed less than 24 inches from other taps, valves, fittings, bell of a pipe, or end of a pipe require the entire pipe be removed and replaced. After the tap has been completed, any damaged wrap and bedding shall be repaired or replaced by the Customer in such a manner as to protect both the service and the main. Upon completion of all service taps, a visual inspection shall be

made by the Utility Inspector to check for leakage. If any leakage exists and it cannot be corrected by tightening the corporation stop, a repair saddle may be used upon approval by the Utility Inspector. If any evidence exists of damage to the water main, then the defective segment shall be removed and replaced.

J. Abandonment of Water Service Lines

When a service line is abandoned, the service shall be excavated at the point of connection to the water main. The corporation cock shall be shut off and the remainder of the service shall be removed. A tapped flare nut (C.O. 133) with 3/4-inch brass pipe plug shall be placed on the end of the corporation to ensure that the corporation cock does not allow water to leak past the seat. All taps 1-1/2-inch and larger shall be removed and replaced by a solid sleeve with meg-a-lug restraints. DWSD shall be given no less than 48 hours prior notice for work planned to abandon a service line.

4.07 CROSS CONNECTION CONTROL CRITERIA

A. General

Dominion is responsible for protecting its public water system from contamination due to backflow occurrences through any water service connections (e.g., cross-connections) in accordance with CDPHE Regulation 11. Cross-connections of any type that permit a backflow of water into the District's potable water system, are strictly prohibited.

Dominion requires the assistance and the cooperation of the customer to ensure this responsibility is met. Dominion may request access to a property or facility to conduct an on-site cross-connection control audit. Failure to comply with installation and annual testing requirements may result in suspension of service.

An approved Backflow Prevention Facility assembly shall be manufactured in accordance with AWWA C510 and C511 and meet USC FCCCHR specifications. Components in contact with potable water shall be certified to comply with NSF/ANSI 61 and NSF/ANSI 372.

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It is the responsibility of the customer at all premises where backflow prevention devices are installed to have certified inspections and operational tests made at least once per year.

These standards incorporate herein by reference the Cross Connection Control Manual Of the Colorado Department of Public Health and Environment and the Colorado Primary Drinking Water Regulations Of the Colorado Department of Public Health and Environment, including all amendments made now or hereafter. Whenever there is a conflict between this standard and the Colorado Cross Connection Control Manual, the most stringent standard will apply.

B. Types of Cross-Connection Control Devices

The design, installation and maintenances of all cross-connection control devices shall be the sole responsibility of the Customer. The following standards shall apply to cross-connection control devices:

1. Air Gap (AG)

An air gap is the unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying water to a tank, plumbing fixture, or other device and the flood level rim of said vessel. The air gap shall be at least double the diameter of the supply pipe, measured vertically above the top of the rim of the vessel, and in no case less than 2 inches. When an air gap is used at the service connection, to prevent the contamination or pollution of the public potable water system, an emergency bypass is installed around the air-gap system and an approved reduced pressure principle assembly shall be installed in the bypass system. All air gaps shall be permanently constructed with rigid piping. Flexible hose or tubing shall not be acceptable for an air gap.

2. Double Check Valve Assembly (DCVA)

Double check valve assemblies shall consist of an assembly of two independently operating check valves with tightly closing shut-off valves on each side of the check valves, plus properly located test cocks for the testing of each check valve. The entire assembly shall meet the design and performance specifications and approval of a recognized and approved testing agency for backflow prevention devices. These devices shall be readily accessible for in-line maintenance and testing.

Double check valve assemblies shall be placed in a location that is protected from freezing.

3. Pressure Vacuum Breaker with Internal Check Valve (PVB)

Pressure vacuum breaker assemblies shall consist of at least one check valve, vacuum relief, inlet and discharge shutoff and properly installed test cocks. The pressure vacuum breaker shall have a vacuum relief valve which is internally loaded, normally by means of a spring. Pressure vacuum breakers shall not be installed more than 5 feet above the ground. Adequate room shall be made available for maintenance and testing.

4. Atmospheric Vacuum Breaker (AVB)

An atmospheric vacuum breaker is a device that allows air to enter the water line when the line pressure is reduced to a gauge pressure of zero or below.

The atmospheric vacuum breaker is designed to prevent back-siphonage only. It is not effective against backflow due to back pressure and shall not be installed where it will be under continuous operating pressure for more than 12 hours in any 24-hour period. Poppets of all atmospheric vacuum breakers shall be precision fitted to insure positive closure. Atmospheric breakers shall not be installed more than 5 feet above the ground.

5. Reduced Pressure Principle Device (RPPD)

A reduced pressure principle device is an assembly of two independently operating approved check valves with automatically operating differential relief valves between the two check valves, tightly closing shut-off valves on either side of the check valves, plus properly located test cocks for the testing of the check and relief valves. The entire assembly shall meet the design and performance specifications and approval of a recognized and approved testing agency for backflow prevention assemblies. The device shall operate to maintain the pressure in the zone between the two check valves at a level less than the pressure on the public water supply side of the device. In case of leakage of either of the check valves the differential relief valve shall operate to maintain the reduced pressure in the zone between the check valves by discharging to the atmosphere. When the inlet pressure is two pounds per square inch or less, the relief valve shall open to the atmosphere. These devices must be readily accessible for in-line maintenance and testing and must be installed in a location where no part of the device will be submerged. Under no circumstances shall a RPPD device be placed underground in a pit.

The device shall not be installed where the pressure can be maintained above the device's rated capacity. When the RPPD is located within a structure, it is recommended that a drain pipe be provided under the relief valve port of the device. An approved air gap between the port and the drain is required. All manufacturers' recommendations for the device shall be followed.

6. Hose Bibs

Hose bibs shall be directional with built in backflow preventer. Hose bibs will also have a drain down feature built into the unit.

C. Application of Devices

The type and complexity of the cross connection control device shall be determined by the Customer's Professional Engineer in accordance with the Colorado Department of Health Cross Connection Control Manual. All applications shall be submitted to the

District Engineer for review and approval. The determination of the type of device required shall be based on the degree of hazard caused to the public from contamination.

All devices shall be installed in a horizontal position with no electrical devices, lights, wiring, heaters, etc. within 30 inches of meter or backflow preventer.

The applications listed below may be used as a guideline but are not to be construed as the sole determining factor in selecting a device:

1. Residential irrigation systems (3/4-inch to 1-inch) shall have: a single pressure vacuum breaker prior to all valves within a system (including solenoid valves; or an atmospheric vacuum breaker with a single check valve downstream (or after) every valve, including solenoid valves and gate valves for each zone.
2. Commercial irrigation systems shall have an approved reduced pressure principle device. The backflow preventer shall be located a minimum of 5 feet or a maximum of 8 feet from the edge of the meter pit.
3. Fire protection sprinklers for buildings shall have an approved reduced pressure principle device.
4. Stock tanks require a reduced pressure principle device or an air gap.
5. Structures larger than 40 feet in height measured from the water main to the highest fixture within the structure shall have a Reduced Pressure Principle Device.
6. Sewage treatment plants shall have a reduced pressure principle device.
7. Lift stations and recreational vehicle sewage dumps shall have a reduced pressure principle device.
8. All commercial and industrial buildings require a reduced pressure principal device (containment backflow). The type and location of the device shall be shown on the construction drawings.

D. Water Conservation Devices

All devices shall conform to Appendix B of the Metro Water Conservation, Inc. guidelines for water conservation devices. It shall be the responsibility of the Customer to insure that the correct water conservation devices are utilized.

The following water conservation devices shall be required.

1. Toilets shall not use more than 1.6 gallons per flush.

2. Urinals shall not use more than 1.0 gallon per flush.
3. Kitchen and lavatory faucets shall have aerators, laminar flow devices, or other fixtures that restrict flow to a maximum of 3 gallons per minute. No inline flow control washers, orifices or other such fittings are permitted.
4. Shower heads shall be constructed so as to limit flow to a maximum of 3 gallons per minute. No inline flow controls, washers, orifices or other such fittings are permitted.
5. All parks, median strips, landscaped public areas and landscaping surrounding condominiums, townhomes, apartments, commercial establishments, developed open space areas and industrial parks shall utilize an automatic irrigation system operated by electric time control stations.

TABLE 4-1		
DOMESTIC DEMANDS – UNIT FLOW FACTORS		
Type of Use	Unit Flow (Average Daily Flow)	Peaking Factor (Maximum Day vs. Average Day)
Residential: Single Family	425 gpd/DU	2.5
Residential: Multi-Family	2,000 gpd/DU	2.0
Commercial	2,500 gpad	1.38
Industrial	2,500 gpad	1.38
Schools		
w/cafeteria & gym	25 gpsd	1.38
w/o cafeteria & gym	15gpsd	1.38
Hospitals	250 gpbd	1.38

Any use not addressed above shall conform to the fixture unit count table of the current edition of the AWWA M-22.

Definitions:	Single-Family	Any attached residential home
	Multi-Family	Any attached residential home
	DU	Dwelling Unit
	gpd	Gallons per day
	gpad	Gallons per acre day
	gpsd	Gallons per student per day
	gpbd	Gallons per bed per day

TABLE 4-2		
FIRE FLOW REQUIREMENTS		
Type of Use	Needed Fire Flow	Number of Hydrants Totaling N.F.F.
Single Family Detached/Attached	2500 gpm for 2 hours	2
Multi-Family	2500 gpm for 2 hours	2
Commercial (sprinklers required)	3500 gpm for 3 hours	3
Schools (sprinklers required)	4000 gpm for 3-4	3
Industrial (sprinklers required)	4000 gpm for 3-4	3

NOTE: The above criteria are guidelines; the Customer shall be responsible for determining the needed fire flow for each building based on the most recent version of the Insurance Services Office or International Fire Code. If the calculated fire flow is less than that shown on the table, a variance must be submitted for approval.

TABLE 4-3		
MAXIMUM PERMISSIBLE DEFLECTION IN LAYING PUSH-ON JOINT PIPE DUCTILE IRON PIPE		
Size of Pipe	Approximately Radius of Curve Produced by Succession of Joints	
4-inch – 12-inch	18 Foot Sticks	20 Foot Sticks
	258 feet	287 feet

NOTE: In no case shall the deflection exceed the manufacturers recommended maximums. Calculations are based on 4 degrees of deflection in the bell of the pipe.

TABLE 4-4		
MAXIMUM PERMISSIBLE DEFLECTION IN LAYING PUSH-ON JOINT PIPE – HIGH DEFLECTION JOINTS POLYVINYL CHLORIDE PIPE		
Size of Pipe	Approximately Radius of Curve Produced by Succession of Joints	
4-inch – 12-inch	18 Foot Sticks	20 Foot Sticks
	258 feet	287 feet

NOTE: In no case shall the deflection exceed the manufacturers recommended maximums. Calculations are based on 4 degrees of deflection in the bell of the pipe.

TABLE 4-5	
MAXIMUM PERMISSIBLE DEFLECTION IN LAYING PUSH-ON JOINT PIPE – INTEGRAL BELL POLYVINYL CHLORIDE PIPE	
Size of Pipe	Approximately Radius of Curve Produced by Succession of Joints – 20 Foot Sticks
4-inch – 12-inch	1433 feet

NOTE: In no case shall the deflection exceed the manufacturers recommended maximums. Calculations are based on 0.8 degrees' deflection in the bell of the pipe.

TABLE 4-6								
TAPPING REQUIREMENTS FOR SERVICE CONNECTIONS								
Size of Pipe	Ductile Iron Tap Size				Polyvinyl Chloride Tap Size			
	¾-	1-inch	1 ½-	2-	¾-	1-inch	1 ½-	2-inch
4-inch	S	S	NO	NO	S	S	NO	NO
6-inch	D	D	D	NO	D	D	D	NO
8-inch	D	D	D	D	D	D	D	D
10-inch	D	D	D	D	D	D	D	D
12-inch	D	D	D	D	D	D	D	D
16-inch	WT	WT	WT	WT	WT	WT	WT	WT
18-inch	WT	WT	WT	WT	WT	WT	WT	WT

- Definitions:
- S: Tapping saddle required. All saddles shall have the AWWA taper on its threads.
 - D: Direct tapping is allowed. Three thread engagement is required. Saddle taps may be used as an alternate.
 - NO: No tap permitted with or without a saddle, a tee connection may be permitted if specifically authorized by the District.
 - WT: Wet tap required. Wet tap shall be full circle fabricated steel saddle with stainless steel bolts. Minimum size available for wet taps 4-inch diameter.

CHAPTER 5

SANITARY SEWER COLLECTION SYSTEM STANDARDS

TABLE OF CONTENTS

	PAGE
5.01 SANITARY SEWER MAIN DESIGN CRITERIA	
A. Design Flow Criteria.....	1
B. Hydraulic Design	2
C. Location and Alignment	3
D. Depth.....	5
E. Manholes	6
F. Underdrain Systems.....	7
G. Sewer Main Cleanouts.....	8
H. Special Applications	8
I. Limits of Accuracy	9
5.02 SANITARY SEWER MAIN MATERIALS	
A. Polyvinyl Chloride Pipe – SDR 35 & 26.....	10
B. Polyvinyl Chloride Pipe – C900	10
C. PVC Fittings.....	10
D. Precast Concrete Vaults and Manholes	11
E. Pipe Encasement.....	11
F. Concrete	11
G. Concrete Reinforcement	11
H. Manhole Rings and Covers.....	11
I. Bedding Material	11
J. Nonshrink Grout	11
K. Flexible Plastic Joint Sealing Compound.....	11
L. Resilient Manhole to Pipe Connectors	11
M. Coal Tar Epoxy Dampproofing	12
N. Corrosion Resistant Epoxy Lining.....	12
O. Groundwater Barriers	12
P. Tracer Wire.....	12
Q. Marking Tape	12

CHAPTER 5

SANITARY SEWER COLLECTION SYSTEM STANDARDS

TABLE OF CONTENTS

	PAGE	
5.03	SANITARY SEWER MAIN INSTALLATION	
	A. Excavation.....	13
	B. Pipe Foundations and Bedding.....	13
	C. Trench Backfilling and Compaction.....	14
	D. Installation of Sanitary Sewer Main	14
	E. Installation of Tracer Wire.....	15
	F. Installation of Marking Tape.....	15
	G. Installation of Manholes.....	15
	H. Alignment and Deflection Testing	17
	I. Leakage Testing.....	18
5.04	SANITARY SEWER SERVICE DESIGN CRITERIA	
	A. Flow Design Criteria.....	21
	B. Hydraulic Design	21
	C. Location and Alignment	21
	D. Depth.....	22
	E. Manholes.....	22
	F. Materials.....	23
	G. Underdrain Systems	23
	H. Sewer Service Cleanouts	23
	I. Sand/Oil and Grease Interceptors	23
	J. Lift Stations.....	24
5.05	SANITARY SEWER SERVICE MATERIALS	
	A. PVC Pipe	32
	B. Bedding Material	32
	C. Sanitary Sewer Service Fittings.....	32
	D. Tapping Saddles.....	32
	E. Precast Concrete Sand/Oil and Grease Interceptors.....	32
	F. Manhole Rings and Covers.....	32
	G. Pipe Adapters/Couplings	32
	H. Lamphole/Cleanout Ring and Cover	33

CHAPTER 5

SANITARY SEWER COLLECTION SYSTEM STANDARDS

TABLE OF CONTENTS

	PAGE
5.06 SANITARY SEWER SERVICE INSTALLATION	
A. Excavation.....	34
B. Pipe Foundation and Bedding.....	34
C. Trench Backfilling and Compaction.....	34
D. Installation of Sanitary Sewer Service Lines	34
E. Installation of Service Line Taps	34
F. Installation of Sand/Oil and Crease Interceptors.....	35

CHAPTER 5

SANITARY SEWER COLLECTION SYSTEM STANDARDS

5.01 SANITARY SEWER MAIN DESIGN CRITERIA

A. Design Flow Criteria

Sanitary sewer mains designed to transport domestic sewage shall comply with the criteria in these Standards. Since virtually all of DWSD's collection system will be built subsequent to 2016, infiltration and inflow (I/I) can be held to low levels if designers and contractors strictly adhere to the Standards, which prohibit the connection of any storm water or ground water source to the sanitary sewer system. This includes roof, foundation, area, yard, and storm water drains, as well as sump or dewatering pumps. This prohibition applies to completed facilities as well as those under construction. The design flow parameters listed below shall be considered the minimum criteria and, at the discretion of the DWSD Engineer, higher unit flow factors may be required for specific facilities.

Average design sewage flows shall be based on the buildout projection of dwelling units (DUs), 3.0 occupants per dwelling unit, and 50 gallons per capita per day (gpcd), plus non-residential sewage flows expected at buildout in the tributary area served by the sewer(s) in question. Average non-residential sewage flow allowances shall be approved by the DWSD in advance of designing sewers and lift stations. Design peak sewage flows (q_p) shall be estimated as follows and shall be utilized to size new collection system mains and lift stations:

- Residential q_p = Number of DUs x (3.0 people per DU) x (50 gpcd) x (3.0 peaking factor) x (1.1 I/I allowance)
- Non-Residential q_p = Average Non-Residential Sewage Flow x (3.0 peaking factor) x (1.1 I/I allowance)

Where: q_p = Design peak sewage flow in gallons per day (gpd) at the maximum allowable d/D ratios listed below; d = maximum allowable depth of flow in the sewer at the calculated design peak sewage flow (q_p); D = the full internal diameter of the pipe in question; I/I = infiltration/inflow allowance.

- The slope of each sewer shall be set such that a self-cleansing flow velocity of 2.0 feet per second is attained when peak flows reach the design peak sewage flow (q_p) at the design depth, d.
- The design d/D ratios shall be 0.5 for 8 and 10-inch internal pipe diameter sewers; 0.67

for 12, 15, and 18-inch internal pipe diameter sewers; and 0.75 for internal pipe diameter sewers larger than 18-inches.

- The minimum internal diameter for sewer mains shall be eight inches. Four and six-inch internal diameter pipes may only be used for building service lines that feed into the main.

B. Hydraulic Design

The peak flow velocity within the pipe at the maximum allowable design d/D ratios shall not be less than 2 feet per second (fps) nor more than 10 fps based on Manning's formula (see below). Where sufficient grade is available, the designer is encouraged to provide a minimum peak flow design velocity of 3 fps (at the maximum allowable design d/D ratio) to encourage self-cleansing of solids that settle when flows are less than those used for design. Designers shall assume n is variable within a circular pipe when computing the velocity and discharge ratios that correspond to the design d/D ratios listed above.

Manning's Formula:

$$V=1.49(R^{.667} \times S^{-.5})/n$$

Where: V = mean velocity

R = hydraulic radius

S = slope of energy grade line

n = Manning's full pipe flow roughness coefficient

($n = 0.011$ for polyvinyl chloride (PVC) or other forms of plastic pipe)

DWSD's sewer sizing procedure shall be used for each portion of a sanitary sewer main. The minimum slopes listed in Table 5-1 are for reference only and will provide a full-pipe flow velocity of 2.0 fps when Manning's n is 0.013, which will be required when non-plastic piping materials are used, or if DWSD directs that an n factor of 0.013 be used by the designer. The principal driver in the hydraulic design procedure is to provide a minimum peak flow velocity of 2.0 fps when the liquid level in the sewer is at the design d/D ratios listed. This necessarily requires that the full-pipe flow velocity be slightly higher than 2.0 fps, and this shall be taken into account by the designer.

For lift stations, consideration shall be given to phasing of pump capacity and/or installing more pumps to provide low end flexibility to reduce (1) peak flow surges into DWSD's Water Reclamation Facility (WRF) and (2) energy usage at the lift stations. While meeting Colorado Department of Public Health and Environment (CDPHE) site application and design criteria is a requirement of DWSD, it is not enough that the lift station design provide the minimum number of pumps needed to meet high-end pumping requirements as per CDPHE.

The impact of each lift station on such factors as energy usage; ease of operation and maintenance; worker and public safety; odor and noise generation potential; annual costs;

and WRF performance must also be considered prior to DWSD design approval and construction of the pump station and force main. To what extent these factors are taken into account by DWSD and the designer will vary on a case-by-case basis. An initial scoping meeting with DWSD is required to minimize the potential for the designer having to revise the Approved Documents at a later stage in their project.

The following slopes are generally permissible for sewer mains:

Table 5-1		
ALLOWABLE SLOPES		
Nominal Size of Sewer (Inches)	Minimum Slope (Per 100 Feet)	Maximum Slope (Per 100 Feet)
8	0.40	15
10	0.28	12
12	0.22	11
15	0.15	8.5
18	0.12	6.5
21	0.10	5
24	0.08	4.5
27	0.067	3.5
30	0.058	3.2

Sanitary sewer main sizing shall be determined by the minimum line size on the lowest portion of the system. Line sizing may only be decreased going uphill. An upsize main may not be used to accommodate a flat slope unless all the main line downstream is of equal size or larger.

C. Location and Alignment

1. Streets

Sanitary sewer mains shall be located at the centerline of the street or 6 feet from flowline. Manholes shall be 6 feet from flowline. If not located in the centerline, the sanitary sewer main in streets running north and south shall be on the west side of the street, and in streets running east and west, on the south side of the street. In curved roadways, the sanitary sewer main shall not zig-zag and its location shall be approved by DWSD. On the inside of curves, pipes may be aligned tangent to the street flowline.

2. Easements

Sanitary sewer mains shall be located within dedicated streets. When such an alignment is not feasible, sanitary sewer mains may be located within a

dedicated easement of a minimum width of 15 feet as required in Chapter 2, Paragraph 2.05. In some instances, additional width may be required in accordance with Chapter 2, Paragraph 2.05 of these Standards. The maximum change in direction of a sanitary sewer main through a manhole located within an easement is 45 degrees. Curvilinear sanitary sewer mains are not permitted within easements. The sanitary sewer main shall be placed along the centerline of the easement with a minimum depth of cover of 6 feet. Neither manholes nor jogs in sanitary sewer mains are permitted in easements in the back of a lot.

Manholes shall be placed at each end of the easement at a location that permits access by large, tandem wheel maintenance vehicles. Manholes may be located in dedicated open space or common areas, provided that access is available, but not between residential lots.

Grading within an easement is permissible; however, the side slope may not exceed a 6:1. The grade along the length of the easement may not exceed 5% unless otherwise approved by DWSD.

3. Dedicated Open Space and Drainageways

When a sanitary sewer main is located in dedicated open space, the main shall run straight from manhole to manhole. When a sanitary sewer main crosses an existing or future drainageway, the main shall cross perpendicular to the drainageway or as close to perpendicular as feasible. If the slope of the drainageway downstream from the crossing exceeds a grade of 0.5 percent within 200 feet of the crossing, a cutoff wall located 10 feet to 15 feet downstream from the crossing shall be required. The cutoff wall shall continue to a minimum depth of 2 feet below the sanitary sewer main. A minimum 6-foot-wide footing is required at the bottom of the cut off wall. The water line shall be concrete encased as required in the Standard Details for the width of the drainageway plus 5 feet on each side

4. Alignment with Other Utilities

Alignment with other utilities shall follow requirements outlined in Chapter 4, Paragraph 4.01-C.3.

5. Curvilinear Sewer Mains

Curvilinear alignments for sanitary sewer mains will only be considered by special variance submitted to DWSD for approval where the design using only straight pipe must be shown to be highly impractical. If approved, the curvilinear alignment will be permitted only in accordance with the criteria

outlined in Tables 4-3, 4-4 and 4-5. Curves shall be designed using standard length pipe (13, 18 or 20 feet). The field cutting of pipe to achieve a smaller radius shall not be permitted. Curvilinear alignments shall follow the same location criteria set forth in Chapter 4, Paragraph 4.01-C.1.

Sanitary sewer mains shall follow horizontally straight alignments between manholes whenever possible. If such an alignment results in a substantial increase in the number of manholes, curvilinear sewers may be permitted. Curvilinear sewers shall parallel the street centerline from manhole to manhole.

The curvature of the sanitary sewer main shall be achieved by a uniform deflection of the pipe joints. Deflecting of the pipe barrels is not permitted. Curvilinear sewers may either be a continuous curve from manhole to manhole or a single transition from tangent to curve or curve to tangent. Complex curves or segmented tangent to curve to tangent alignments are not permitted.

Curvilinear Pipes will be only allowed for 12-inch pipe and smaller. Deflection design and layout shall follow pipe manufacturer standards for pipe specified. Deflections shall be at joints only and may require the use of a high deflection coupling when manufacturer's recommended deflection will be exceeded. If high deflection couplings are utilized, they shall be submitted for review and approval. High deflection couplings shall only be used if they are compatible with the pipe materials. Otherwise, manholes shall be used to create deflection points for sanitary sewer mains. For both types of installation (deflection of standard joints and the use of high deflection couplings) the designed deflection shall be no greater than 80% of the manufacturer's allowable deflection (i.e. 4 degrees where 5 degrees is allowed by manufacturer). It is common for standard joints to allow up to 1 degree of deflection and high deflection couplings to allow up to 5 degrees of deflection. Refer to the minimum allowable design curves in Chapter 4 for PVC water mains. Joints within a single radius shall be either standard or high deflection couplings, they shall not be mixed.

Plan drawings shall include a labeled radius of curvature for locations requiring a curve in the alignment.

D. Depth

Sanitary sewer mains shall have a minimum of 5 feet of cover over the top of pipe after final grade has been established.

Sanitary sewer mains shall be bedded with pipe bedding in accordance with Chapter 4, Paragraph 4.02-M. Sanitary sewer mains with a depth of cover less than 20 feet shall require the use of SDR 35 PVC pipe. Sanitary sewer mains with a depth of cover in excess of 20 feet shall require the use of SDR 26, PVC pipe.

E. Manholes

1. Spacing

Manholes shall be installed at the end of each line, at all changes in grade, size, or alignment, and at all junctions or intersections of sewer mains. Manholes shall be installed at distances not greater than 400 feet for 8-inch through 15-inch sewers, 500 feet for 18-inch through 30-inch sewers assuming straight horizontal alignments. Distances up to 600 feet may be approved in locations with larger sewers if DWSD feels that it can adequately maintain the sewers. Curvilinear sewers shall have manholes at distances not greater than 300 feet.

2. Type and Sizing

Manholes shall be constructed of a poured in place or precast concrete base, precast concrete barrel sections and an eccentric cone section.

The inside dimension of the manhole shall not be less than 48 inches for sewer mains 8-inch to 12-inch in diameter and 60 inches for sewer mains 15-inch to 24-inch in diameter. Manholes which have a 48 inch inside diameter shall have a 24-inch diameter ring and cover. Manholes which have a 60 inch inside diameter shall have a 30-inch ring and cover.

3. Hydraulic Design

Manholes shall have a minimum drop across the manhole of 0.1 feet along the flow channel where the sewer continues straight through. Manholes shall have a minimum drop across the manhole of 0.2 feet along the flow channel where the sewer changes direction and at junctions. Manholes shall have a maximum drop of 0.5 feet. At manholes where there is a change in pipe diameter, the crown elevation of the pipes shall match.

Head losses through manholes shall not exceed a 0.10-foot loss for a straight run or intersection greater than 90 degrees to the outlet line; and a 0.20-foot loss for 90 degrees intersections to the outlet main.

4. Drop Manholes

Drop manholes shall be a standard manhole with an internal drop system

installed inside. The interior of the manhole shall be completely lined with a corrosion resistant epoxy as specified in Chapter 5, Paragraph 5.02-N.

For drops less than 5 feet but greater than 1 foot, a RELINER Inside Drop Bowl or equal shall be used. For drops greater than 5 feet, an IPEX Vortex Flow drop shall be used. Components shall be corrosion resistant plastic, fiberglass or stainless steel.

5. Waste Metering Manholes

A waste metering manhole may be required by DWSD. Waste metering manholes shall be constructed in accordance with Chapter 5, Paragraph 5.04-E and the Standard Details.

6. Sampling Manhole

Sampling manholes shall be installed in sewer service lines to non- domestic users as deemed necessary by DWSD. The manholes will be located in the collection line after all process wastewater discharges from the building have been combined and prior to combining with domestic wastewater from this site, other dischargers or the public main. These manholes shall be required on warehouse type facilities and in spec buildings where a designated tenant may not have been defined at the time of construction. Maintenance of the manhole shall be the responsibility of the Customer. Sampling manholes shall be constructed in accordance with the Standard Details.

7. Service Connections to Manholes

Residential sewer service lines shall not be connected directly to a manhole. The end of a sewer main shall always be a cleanout manhole. Services shall be connected downstream of the manhole.

8. Grade Adjustments

Manholes shall be constructed to permit grade adjustments by use of precast concrete adjusting rings not to exceed a total height of 8 inches. In dedicated open space or landscape areas, manhole rims shall be set 4 inches above grade to prevent infiltration from surface runoff. A concrete collar shall be placed around the ring and cover in landscaped tracts and dedicated open space areas as shown in the Standard Details.

F. Underdrain Systems

Underdrains, roof drains and other surface water collection systems shall not discharge into the sanitary sewer system.

Underdrains shall not be considered part of the sanitary sewer system and are not required by, nor are they the responsibility of DWSD.

If an underdrain is designed as part of the Customer's requirements and is located in the same trench as the sanitary sewer, the type, capacity, and sizing shall be submitted to DWSD for approval. Additionally, a detailed drawing of any underdrain cross-section shall be included on the sanitary sewer plans.

An underdrain system shall be designed and constructed as a groundwater conveying system independent of the sanitary sewer line foundation and bedding material. No allowance shall be taken for the porosity of the sewer main bedding material in calculating the underdrain capacity. Along the trench where the underdrain system and the sewer foundation bedding meet, filter fabric shall be installed around all sides of the underdrain bedding in order to prevent the migration of the foundation material into the underdrain trench. Underdrains shall be bedding with Graded Gravel Fill material as specified in Chapter 4.

Underdrain systems shall have adequate daylight points to permit the groundwater to drain freely from the system. When a daylight line leaves the underdrain trench a groundwater barrier shall be constructed immediately downstream, in the underdrain trench. A groundwater barrier shall follow the requirements of Chapter 5, Paragraph 5.02-O.

When passing around or below manholes, underdrain systems shall be constructed of a solid wall pipe to prevent water from accumulating around the manhole. Under no circumstances shall a sump condition exist below the manhole base. Ground water barriers shall be required upstream of the manhole as specified in Chapter 5, Paragraph 5.02-O and shall break both the sanitary sewer and underdrain bedding.

Clean outs shall in no case be installed inside of a sanitary sewer manhole but are allowed to be installed on the outside of a manhole. Unless agreed by DWSD, clean outs shall not be the responsibility of DWSD to maintain and shall be constructed in accordance with the Standard Details.

G. Sewer Main Cleanouts

The use of sewer main cleanouts shall not be permitted. The manhole of a dead-end sewer shall be a cleanout manhole as shown in the Standard Details.

H. Special Applications

Special applications or designs of sanitary sewer systems, such as lift stations, siphons, elevated pipelines, etc. are generally not permitted. Any situations which dictate the need for such an application shall be presented as a variance prior to design and permitting.

I. Limits of Accuracy (Allowable Error)

Limits of accuracy shall refer to the horizontal and vertical deviation from the Approved Documents permissible during the laying of sewer mains. The allowable error shall be a maximum of plus or minus 0.02 feet for lines designed at 1% or less in a vertical direction. Lines designed at greater than 1% shall be a maximum of plus or minus 0.1 feet in a vertical direction. Vertical deviation limits shall apply to the entire Project, not each reach. No bellies or low points in the sewer will be allowed as a way to adjust slope to get within allowable deviation limits. In a horizontal direction the allowable error shall be a maximum of 0.3 feet. Any line that does not meet the criteria shall be removed and reinstalled. On curvilinear mains, the maximum horizontal deviation shall not exceed plus or minus 0.3 feet.

5.02 SANITARY SEWER MAIN MATERIALS

Pipe materials used in the construction of the sanitary sewer system shall conform to the requirements specified herein. Other material proposed as an equal must be approved by DWSD in writing prior to construction. Materials furnished shall be new and undamaged. Everything necessary to complete installations in accordance with these Standards shall be furnished and installed whether shown on Approved Documents or not. Installations shall be completed as fully operable.

A. Polyvinyl Chloride (PVC) Pipe - SDR 35 & 26

PVC pipe 4-inch to 24-inch in diameter furnished under this standard shall be manufactured in accordance with ASTM D 3034 and ASTM D 1784.

PVC plastic shall have a minimum cell classification of 12354 in accordance with ASTM D 1784.

Joints shall be made using a bell and spigot joint with integral bell push-on type elastomeric gaskets in accordance with ASTM D 3212.

Pipe furnished shall have a DR ratio of 35 or 26. SDR 35 shall be used in applications with less than 15 feet of cover. Applications where the pipeline is 15-20 feet deep, SDR 26 shall be used.

B. PVC Pipe - C900

Polyvinyl chloride pipe furnished under this Standard shall be manufactured in accordance with AWWA C900.

Joints shall use a standard elastomeric joint.

Pipe furnished under this Standard shall be Pressure Class 150 minimum.

C900 PVC pipe may be used where indicated for horizontal separation or bury depth deeper than 20 feet variances.

C. PVC Fittings

PVC fittings shall only be permitted for service connections such as tees and wyes. PVC fittings shall be manufactured in strict accordance with ASTM D 1784, ASTM D 3034, ASTM F 477 and ASTM F 679. Joint type shall be identical to that of the pipe. Solvent weld fittings are allowed only for sand and grease interceptors.

D. Precast Concrete Vaults and Manholes

See Chapter 4, Paragraph 4.02-N.

E. Pipe Encasement

See Chapter 4, Paragraph 4.02-S.

F. Concrete

See Chapter 4, Paragraph 4.02-O.

G. Concrete Reinforcement

See Chapter 4, Paragraph 4.02-P.

H. Manhole Rings and Covers

See Chapter 4, Paragraph 4.02-Q

I. Bedding Material

Bedding for sewer mains constructed of PVC shall be CDOT Gradation No. 7, in accordance with ASTM C 33. Bedding shall be placed in layers not more than 6-inches deep and shall be compacted around the pipe as specified.

J. Nonshrink Grout

Grout shall be non-shrink consisting of Portland cement, sand and admixtures required to meet the site conditions. Nonshrink grout shall be precision cementitious grout with demonstrated non-shrinking properties; L&M Crystex, BASF Masterflow 713 Plus or Masterflow 928, Sika SikaGrout 328, Hilti CB-G PG Precision Grout, or Five Star Products Five Star Grout.

K. Flexible Plastic Joint Sealing Compound

See Chapter 4, Paragraph 4.02-R.

L. Resilient Manhole to Pipe Connectors

Pipe shall be connected to manholes with A-Lok Premium manhole pipe seal. Connector shall be cast into the manhole during fabrication. Straps shall be stainless steel.

M. Coal-Tar Epoxy Dampproofing

See Chapter 4, Paragraph 4.02-U.

N. Corrosion Resistant Epoxy Lining

Corrosion resistant epoxy shall be installed on the interior of each drop manhole, cleanout manhole, waste metering manholes and all manholes within a minimum distance of 1000' downstream of a force main discharge point from a lift station or as shown on the Approved Documents. The coating may be applied at the precast factory or in the field. If the product is installed at the factory, a can of touch up material shall be supplied and the joints "striped" with two coats of the material following installation of the manhole. Any visible pinholes or damage shall be repaired. The manufacturer's installation specifications shall be followed. Additional epoxy coating may be required at the request of DWSD Engineer due to special circumstances as determined by DWSD.

Product shall be a 100% solids epoxy, spray or trowel applied product with documented chemical resistant to hydrogen sulfide and other common wastewater corrosive chemicals. Product shall be Environmental Coatings Sewer Shield, SpectraShield, Tnemec Perma-Shield 436, or Warren Environmental S-301.

O. Groundwater Barriers

See Chapter 4, Paragraph 4.02-T

P. Tracer Wire

See Chapter 4, Paragraph 4.02-W.

Q. Marking Tape

See Chapter 4, Paragraph 4.02-X.

5.03 SANITARY SEWER MAIN INSTALLATION

A. Excavation

1. Limit of Excavation

See Chapter 4, Paragraph 4.03-A.1

2. Trench Width

See Chapter 4, Paragraph 4.03-A.2.

3. Tunneling and Boring

See Chapter 4, Paragraph 4.03-A.3.

4. Trench Support

See Chapter 4, Paragraph 4.03-A.4.

5. Grading and Stockpiling

See Chapter 4, Paragraph 4.03-A.5.

6. Dewatering

See Chapter 4, Paragraph 4.03-A.6.

7. Blasting

See Chapter 4, Paragraph 4.03-A.7.

B. Pipe Foundations and Bedding

1. Pipe Foundation

See Chapter 4, Paragraph 4.03-B.1.

2. Pipe Bedding

See Chapter 4, Paragraph 4.03-B.2.

C. Trench Backfilling and Compaction - See Chapter 4, Paragraph 4.03-C.

1. Procedure within the Pipe Zone - See Chapter 4, Paragraph 4.03-C.1.
2. Compaction above the Pipe Zone- See Chapter 4, Paragraph 4.03-C.2.
3. Compaction Tests See Chapter 4 - Paragraph 4.03-C.3.
4. Final Clean-up See Chapter 4 - Paragraph 4.03-C.4.

D. Installation of Sanitary Sewer Main

1. General

Pipe shall be laid without break and upgrade from structure to structure, with the bell ends of pipe upgrade. Pipe shall be laid to the line and grade given so as to form a close concentric joint with the adjoining pipe and prevent sudden offsets of the flow line. Deflections of pipe joints shall be within no more than 80 percent of the pipe manufacturer's deflection tolerances for curvilinear sewers. The pipe and appurtenances shall be survey staked as required by DWSD and the interior of the sewer pipe shall be cleaned of dirt and superfluous materials as the work progresses.

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. This provision shall apply during work breaks, including the noon hour, as well as overnight. Under no circumstances shall sewers be used as drains for removing water which has accumulated into the construction trenches. At the beginning of a construction project, a watertight plug shall be installed in the connection manhole, or first manhole upstream, in order to prevent any inflow into the existing sewer system. This plug shall be removed by the Customer only in the presence of DWSD. Related costs shall be borne by the Customer.

Sewer mains shall have a minimum of 5 feet of cover from finished grade. Pipe and fittings shall be carefully examined for cracks and other defects before installation. Lumps, blisters and excessive coating shall be removed from the bell or coupling and spigot ends of each pipe. Defective pipe or fittings shall be set aside for inspection by DWSD who may require repairs or reject the pipe.

Polyvinyl chloride pipe shall be installed in accordance with ASTM D 2321, Uni-Bell Standard UNI-PUB-06, the manufacturer's recommendation and these standards. Pipe and fittings shall be carefully lowered into the trench in such a manner as to prevent damage to the materials. Under no circumstances

shall sewer main materials be dropped or dumped into the trench. PVC pipe stored outside and exposed to sunlight for more than 30 days shall be covered with an opaque material. Clear plastic sheets shall not be used to cover pipe. Both ends of the pipe shall be clear to allow for air circulation under the covering.

Immediately before joining two lengths of sanitary sewer pipe, the inside of the bell or coupling, the outside of the spigot and the gasket shall be thoroughly cleaned to remove foreign material. Lubrication of the joint and rubber gasket shall be done in accordance with the pipe manufacturer's recommendations.

Care shall be taken that only the correct gasket, compatible with the annular groove of the bell, is used. Insertion of the gasket in the annular groove of the bell or coupling shall be in accordance with the manufacturer's recommendations. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint. The spigot and bell or coupling shall be aligned and pushed until the reference line on the spigot is flush with the end of the bell or coupling. Pushing shall be done in a smooth, steady motion.

E. Installation of Tracer Wire

See Chapter 4, Paragraph 4.03-E. The tracer wire shall be brought to grade at intervals not to exceed 500 feet. Test stations shall be located at the nearest manhole to the 500-foot interval but shall not exceed 500 feet.

F. Installation of Marking Tape

See Chapter 4, Paragraph 4.02-X.

G. Installation of Manholes

1. Excavation and Backfill

See Chapter 4, Paragraph 4.03-A and 4.02-M.

2. Manhole Base

The manhole base shall be set over a 6-inch base of (minimum) Granular Fill, as specified in Chapter 4, and shall be either poured in place concrete or an approved precast manhole base. The manhole stubs and sewer main shall be set with water stop gasket before the concrete is placed and shall be rechecked for alignment and grade before the concrete has set. The various sized inlets and outlets to the manhole shall be located as shown in the

Standard Details. The base shall be extended 8 inches below the bottom of the lowest pipe. Invert elevations of connecting sewers may vary depending upon sizes. The crown elevation of all pipes shall be the same as the crown elevation of the largest pipe.

Transitions shall be smooth (free of edges and burrs) and of the proper radius to give an uninterrupted transition of flow. The concrete shall be Class A concrete with 3/4-inch maximum size aggregate and shall have a slump not greater than 2 inches. The concrete base shall be shaped with a wood float and shall receive a hard steel trowel finish before the concrete sets. In the event additional mortar is required after initial set has taken place, the surface to receive the mortar shall be primed with a concrete bonding agent, in order to secure as chip-proof a result as possible. No mortar lifts less than 2 inches in thickness shall be permitted. The base shall set a minimum of 24 hours before the manhole construction is continued.

The accumulation of water on the surface of the concrete due to water gain, segregation, or other causes during placement and compacting shall be prevented as much as possible by adjustments in the mixture. Provisions shall be made for the removal of such accumulated water so that under no circumstances will new concrete be placed in such accumulations.

When concrete is placed, the temperature of the concrete mix shall not be lower than 50°F nor higher than 80°F. Concrete shall not be placed on a substrate which is frozen or has standing water. If freezing temperatures are expected during the cure time, the concrete shall be kept at a temperature no less than 50°F for 5 days. Heaters and blankets may be necessary.

When concrete is deposited against ground or aggregate, it shall be covered with 8 mil polyethylene sheeting to prevent the ground from drawing water from the concrete.

The upstream side of each manhole shall have a groundwater barrier installed in order to break continuity of the embedment material. Material shall meet ASTM D 2487 soil clarification GC, SC, CL, or ML-CL and shall be compacted to 95 percent of maximum density as determined by ASTM D 698. Barrier shall be 3 feet wide and extend the entire width of the trench and effectively break the bedding material.

3. Precast Manhole Sections

Each manhole section shall be placed in accordance with the manufacturer's recommendations in a perfectly plumb position. Each joint between the manhole sections shall have a layer of flexible plastic joint sealing compound

on both the tongue and groove part of the joint. The eccentric cone shall be located over the downstream side of the manhole centered over the pipe. Exterior dampproofing and interior corrosion resistant epoxy lining, as required herein, shall be placed in accordance with these Standards for sanitary sewer manholes.

4. Manhole Frames and Covers

Manhole frames and covers shall be set to the proper elevations and shall match final grades. Manhole frames shall be set 1/4 inch below flush with the final grade of the asphalt or concrete roadway and shall be securely attached to the manhole shaft unit with a grout bed and fillet. After the frames are securely set, the frames and covers shall be cleaned and scraped to ensure a satisfactory fit. In the event the manholes are placed in open space areas the ring and cover shall be placed a minimum of 4 inches above final grade in an 18-inch wide collar of reinforced concrete the depth of the ring and cover, or 12 inches minimum.

5. Watertightness of Manholes

Manholes and appurtenances shall be watertight and free from infiltration. The DWSD Engineer shall determine the adequacy of manholes and appurtenances as to watertightness.

6. Connection to Existing Manholes

Connections to existing manholes wherein stubs have not been provided shall be made by core drilling through the base or as approved by DWSD. Connection shall be as shown on the Standard Details.

7. Installation of Grout

Grout shall be applied in accordance with the manufacturer's recommendations. Grout shall have a troweled finish and shall be protected from a rapid loss of moisture with a covering of wet rags or polyethylene sheets. The temperature of the grout and the surfaces receiving the grout shall be maintained between 65°F and 85°F until after setting.

H. Alignment and Deflection Testing

After the sewer main and appurtenances have been installed and have passed the compaction test, the line shall be inspected for alignment and deflection.

Prior to any testing of the sewer mains, the lines shall be thoroughly flushed and balled to remove debris and dirt. The lowest manhole (or manholes) within the Project shall be

plugged with an approved water tight plug (Pollard or approved equal) on the downstream outlet of the manhole. Water, silt and debris shall be removed from this manhole and disposed of properly. The plug shall be installed once the base for the lowest manhole has been constructed and shall not be removed at any time without the consent of DWSD.

Sewer mains shall be mandrel tested and TV Inspected 14 days after installation of the reach has been completed.

1. Mandrel Testing

The Customer shall supply necessary equipment and personnel to perform the testing. Testing consists of pulling an approved calibrated mandrel equal to 95 percent of the inside diameter, through the pipe from manhole to manhole. If excessive deflection does not allow the mandrel to pass through the line, the defective section shall be removed and replaced.

2. TV Inspection

The Customer shall provide the TV equipment and give 24-hour notice prior to such inspection. DWSD shall receive a copy of the video following completion of the inspection. The Customer shall correct any defective portions. Costs for the TV inspection and any repairs shall be borne by the Customer.

- I. Leakage Testing

Once the pipe has passed the alignment and deflection tests, the pipe shall be tested for leakage and infiltration. Materials and associated costs for such tests shall be at the Customer's expense.

1. Exfiltration Test

The water exfiltration test may be conducted if groundwater was not encountered during installation and the invert of the lower manhole is not greater than 25 feet below the invert of the upper manhole. Such testing shall be conducted by plugging the inlet of the lower manhole and the inlet(s) of the upper manhole with an approved water tight plug. The segment shall then be filled with water to a point 2 feet above the crown of the open sewer in the upper manhole. The segment shall remain filled for at least two hours. The leakage shall not exceed 100 gallons per inch of nominal diameter per mile of pipe.

The length of service connection shall not be used in computing the length of sewer main being tested.

If the leakage is greater than allowed, further inspection shall be conducted by a TV inspection. The defective area shall be repaired, and the process shall be repeated until the test section meets the allowable limits. Costs for the testing and repair shall be borne by the Customer.

2. Low Pressure Air Test

Low pressure air testing may be used in lieu of exfiltration testing for 24-inch diameter and smaller pipe. Air testing shall not be used for manholes, or for pipe larger than 24 inches in diameter.

Low pressure air testing shall comply with ASTM F1417 for PVC, and composite pipe. The schedule of testing shall be submitted to DWSD prior to starting the tests.

The time elapsed for a one psi drop in air pressure shall be not less than, nor shall the air loss exceed, the limits set forth in the governing standard.

If the length of sewer to be tested is fully or partially submerged in groundwater, the test pressure shall be increased if necessary, to overcome the actual static pressure exerted by the groundwater. If a test pressure greater than 8 psi results, air testing shall not be used, and exfiltration testing will be required.

Leaks shall be located by testing short sections of pipe. Leaks shall be repaired, and the reach of sewer retested.

If the leakage is greater than allowed, further inspection shall be conducted by a TV inspection. The defective area shall be repaired, and the process shall be repeated until the test section meets the allowable limits. Costs for the testing and repair shall be borne by the Customer.

3. Infiltration and Inflow Test

If groundwater is present, the end of the sewer at the upper manhole shall be plugged with an approved watertight plug and the section shall be tested for infiltration. The infiltration shall not exceed 100 gallons per inch of nominal diameter per mile of pipe. The length of house laterals entering that section are not to be used in computing the length of sewer main being tested.

The amount of infiltration shall be measured through the use of a pipe weir, flume or other approved apparatus in the presence of the DWSD Engineer.

If the leakage is greater than allowed, further inspection shall be conducted by a TV inspection. The defective area shall be repaired, and the process

shall be repeated until the test section meets the allowable limits. Costs for the testing and repair shall be borne by the Customer.

4. Vacuum Test of Manholes

Manholes shall be tested before the ring and cover and concrete adjustment collars have been installed. Pipes entering the manhole shall be plugged and braced and a vacuum of 10 inches of mercury shall be drawn. The vacuum pump shall be turned off and the time monitored as the vacuum drops one inch. The vacuum must not drop more than one inch in 60 seconds for a 4-foot diameter manhole, or one inch in 75 seconds for a 5-foot diameter manhole.

For manholes that fail the vacuum test, defects shall be repaired, and the tests repeated. Repair and repeat testing shall be continued until the testing requirements have been met. Costs for the testing and repair shall be borne by the Customer.

5.04 SANITARY SEWER SERVICE DESIGN CRITERIA

A. Flow Design Criteria

Flow design criteria for residential and non-residential sanitary sewer service lines shall be based on the estimated flow determined by the Customer's architect or mechanical engineer and shall comply with the most current UPC.

B. Hydraulic Design

Service lines shall be designed to carry the peak discharge and transport suspended materials from the building sewer to the collection main. Service lines shall be laid to a constant grade between the collection main and the outlet of the building sewer. In situations where the collection main is deeper than 20 feet, the service line may be laid at a constant slope to a point where an angle fitting is installed to make a relatively steep (45 degrees) connection to the collection main.

Although the hydraulic characteristics of each sanitary sewer service line shall be calculated by the Customer's P.E., the following slopes are generally permissible for service lines:

Diameter	Minimum Slope (Foot/Foot)	Minimum Fall (Inch/Foot)
4-inch	0.0208	1/4
6-inch	0.0104	1/8

The minimum diameter for a sanitary sewer service line shall be 4-inch.

C. Location and Alignment

Each single family residential detached or attached dwelling unit shall have a separate sanitary sewer service line and tap. Townhomes, condominiums and apartments that are designed to utilize common plumbing within the structure may have a service line that serves more than one dwelling unit.

Service lines shall follow a straight horizontal alignment between the outlet of the building sewer and the connection to the collection main. In the event that a horizontal deflection is necessary, a cleanout will be required in accordance with the Standard Details.

Sanitary sewer service lines shall be located as shown in the Standard Details.

In the event that two service lines are located at the same station on the main line, the service wye for the lot on the long side of the street shall be placed a minimum of 2 feet

downstream of the adjacent service wye. When the service lines are the same length the service wye for the service lines on the east or north side of the street shall be placed a minimum of 2 feet downstream of the adjacent service. The service line shall extend from the main to the lot in a manner that is parallel with the lot line or perpendicular with the main. Services in cul-de-sacs shall be radial to the center of the lot provided that the angle of connectors does not exceed 90 degrees. When the service to a lot is at the end of the sanitary sewer main, the manhole shall be located at the center of the lot and the service shall connect to the main 5 feet down from the manhole and shall enter the lot as shown on the Standard Details.

It is the responsibility of the Customer to stake the location of the service to ensure that it is correctly located.

A service that is connected to a sanitary sewer main that runs between two lots in a dedicated easement shall be placed 15 feet from the rear property line. If the adjacent service connects to the same main, it shall be 20 feet from the rear property line.

Service taps may be made to 18-inch and smaller pipes, using a wye for the connections. Saddle tap with wye fitting would be acceptable if needed after installation of main is completed. The wye connection or wye tapping saddle shall be rotated upward as shown on the Standard Details with no exceptions.

D. Depth

Sanitary sewer service lines shall be designed so that a minimum of 5 feet of cover exists over the top of pipe after final grade has been established. Sanitary sewer services with a depth of cover less than 20 feet shall require the use of SDR 35 PVC pipe. Sanitary sewer services with a depth of cover in excess of 20 feet shall require the use of SDR 26, PVC pipe.

Sanitary sewer service stubs shall be no deeper than 15 feet at the end of the stub, 10 feet into the lot.

Sanitary sewer service lines shall be bedded with pipe bedding in accordance with Chapter 5, Paragraph 5.02-I.

E. Manholes

Manholes for sanitary sewer service lines 8-inch diameter and larger shall comply with Chapter 5, Paragraph 5.01-E of these Standards. Manholes for sanitary sewer service lines shall be required for the purposes of monitoring or sampling in accordance with Appendix E, Chapter 5.

F. Materials

Materials for sanitary sewer service lines shall be in accordance with Chapter 5, Paragraph 5.02 and 5.05.

G. Underdrain Systems

Underdrain systems shall not be connected to the sanitary sewer system.

H. Sewer Service Cleanouts

Cleanouts shall be installed on sewer sanitary service lines within three feet of the exit point of the service line from the structure, every 100 feet thereafter, and at all points of horizontal deflection. Cleanouts shall be spaced a maximum of 100 feet apart. The cleanout diameter shall match the nominal diameter of the service line and shall be constructed in accordance with the Standard Details. Cleanouts shall be located so that surface water does not accumulate. When cleanouts are located in existing or future landscape areas, the cleanout cover shall be 4 inches to 6 inches above finished grade. See Chapter 5, Paragraph 5.01-E.8.

I. Sand/Oil and Grease Interceptors

South Platte Renew is the publicly owned treatment works that receives DWSD wastewater. DWSD performs plan reviews for sand/oil and grease interceptors in compliance with SPR standards but may defer to SPR for additional review prior to construction under their pretreatment program. See Chapter 6 of the DWSD Rules and Regulations and Appendix E for more information.

Restaurants, cafeterias and other food preparation facilities shall have a grease interceptor installed on the sanitary sewer service line. Restaurants, cafeterias or other food preparation facilities shall have a grease interceptor installed on the sanitary sewer service line. The sizing of the grease interceptor shall be determined by the Customer's P.E. The grease interceptor shall be owned and maintained by the Customer. Bypasses of process grease waste around grease interceptors will not be permitted.

Services which discharge any quantities of sand, oil or other inert debris into the sanitary sewer system shall have a sand/oil interceptor installed. Examples of such services include, but are not limited to: automobile service stations, mechanical repair shops, car washes, garden nurseries, warehouses and garages with floor drains. The sizing of the sand/oil interceptor shall be determined by the Customer's P.E. The sand/oil interceptor shall be owned and maintained by the Customer. Bypasses of process wastewater around sand/oil interceptors will not be permitted.

Although a facility may not have been originally constructed with a sand/oil or grease

interceptor, DWSD or South Platte Renew may require that one be installed in the event of a change in the type of use of the facility. Costs shall be borne by the Customer.

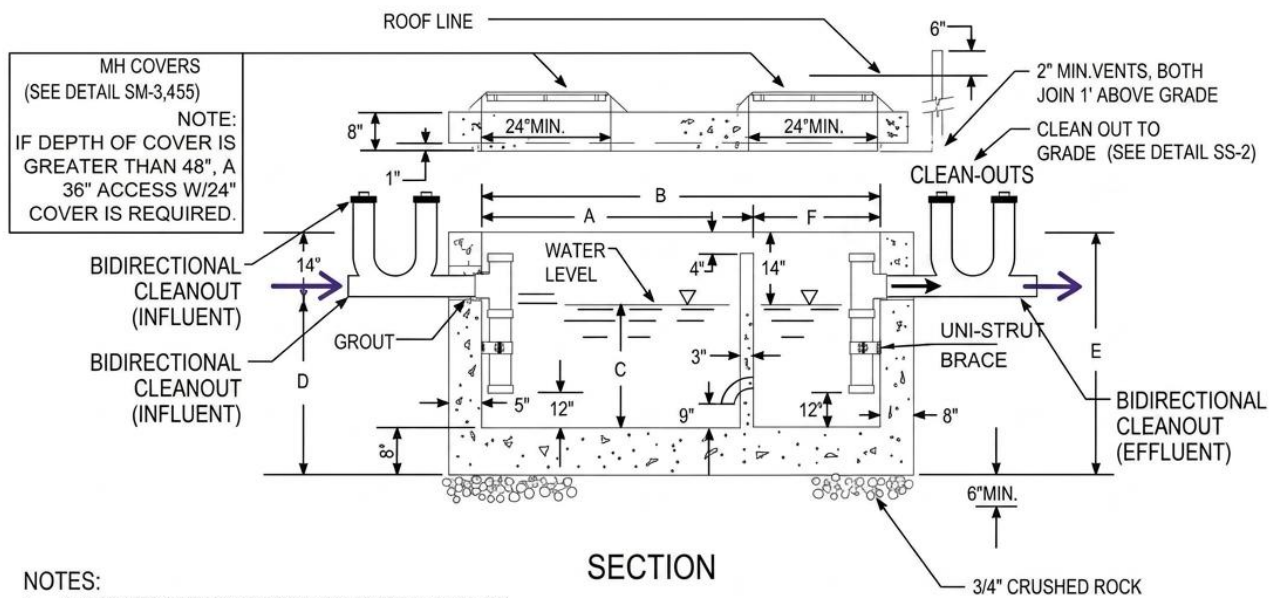
1. General Specifications and Sizing for Gravity Grease Interceptors (GGIs):
Pre-cast Concrete GGIs: Pre-cast GGIs shall conform to the size, shape, form, and details shown on Diagram 1. Concrete for pre-cast units shall be defined in the following specifications:
2. All units shall be adequate to withstand AASHTO H-20 (44.30% impact, soil weight = 130 pcf, equivalent fluid pressure = 55 pcf) loading and shall be designed in accordance with ACI 301 and ASTM C-858.
3. All structures not specified in the standard detail shall be submitted to DWSD for approval as a shop drawing at least three (3) weeks prior to installation.
4. A flexible plastic joint sealing compound shall be used for any tongue and groove joints to provide a watertight joint. The performing flexible plastic joint sealing compound shall meet Federal Specifications SS-S-210 and AASHTO M198 75 1, Type B.
5. The sealing compound shall show no visible deterioration when immersed separately in a solution of acid, alkali, and saturated hydrogen sulfide for a period of 30 days.
6. All piping within these GGIs shall be solvent weld PVC — SCH 40 DWV.
7. Vertical influent and effluent piping shall be secured to the GGI walls with non-corroding support brackets.
8. GGIs installed in a parking lot or a roadway shall have manhole rings and covers raised to grade by using pre-cast concrete riser rings that are a minimum of 6" wide.
9. Manhole Rings and Covers: Manhole rings and covers shall be cast iron in accordance with ASTM A-48, Class 35 B. Twenty-four (24) inch diameter assemblies shall be Neenah- 1706, or approved equal, style with a combined weight of not less than 400 pounds (approx. distribution: Frame 235 lbs., Lid 165lbs.) Covers shall be checkered with letters designating "sewer". All bearing surfaces shall be machined. Manhole lids shall be manufactured with a 1" wide elongated oval lifting hole. Manhole lids with more than one lifting hole shall not be accepted. Rim elevation shall be 2" to 4" above grade in open space and shall be 0" to 1/2" below grade of any finished surface.

10. Concrete: Class A concrete shall be used for all pre-cast concrete GGIs. The concrete shall have a minimum 28-day compressive strength of 4,000 psi for pre-cast structures. Class B concrete shall be used for all thrust blocks, protective pads, and encasements. Class B concrete shall have a minimum 28-day compressive strength of 2000 psi.
11. The sizing of the GGI shall be determined using the tables below (2009 UPC)

Drainage Fixture Units (DFUs)				
Fixture Type	Drain Size	DFUs	Quantity	TOTAL
Floor Drain	2.0-3.0"	2.0		
Floor Sink	2.0"	4.0		
	3.0"	6.0		
	4.0"	8.0		
Mop Sink	2.0-3.0"	3.0		
Hand/Bar Sink	1.5-2.0"	2.0		
Additional Fixture(s) (direct connection)	1.5"	3.0		
	2.0"	4.0		
	3.0"	6.0		
	4.0"	8.0		
TOTAL DFUs				

Gravity Grease Interceptor (GGI) Sizing	
Total DFU's	GGI Volume (gallons)
2-21	750
22-35	1000
36-90	1250
91-172	1500
173-216	2000
217-307	2500
308-342	3000
343-428	4000
429-576	5000
577-720	7500
721-2112	10000
2113-2640	15000

Core and Shell GGI Sizing	
GCI Inlet Pipe Size (inches)	Interceptor Size (gallons)
2	750
3	1000
4	2000
5	4000
6	7500



NOTES:

1. SECONDARY COMPARTMENT HAS VOLUME EQUAL TO 1/3 OF TOTAL CAPACITY.
2. ALL PIPE AND FITTINGS SHALL BE SOLVENT WELDED SCHEDULE 40 P.V.C. MIN. 3" DIA. WITHIN TRAP.
3. WALLS AND BOTTOM REINFORCED THROUGHOUT WITH 2x16 6/10 REMESH.
4. COVERS TO BE REINFORCED LONGITUDINALLY WITH NO. 6 REBAR ON 8" CENTERS, NO. 4 REBAR ON 8" CENTERS WIDTHWISE, AND NO. 8 REBAR DIAGONALLY AROUND ACCESS HOLES.
5. CLEAN OUT SHALL BE PVC SCREW PLUG.
6. VENT PIPE MAY BE CAST IRON OR PVC SCHEDULE 40, TO A POINT 8" ABOVE ROOF LINE.
7. MANHOLE RING AND COVER SHALL BE 24" DENVER HEAVY, OR EQUAL. SEE 4.02-Q THESE SPECIFICATIONS (SEE SM-3,4&5)
8. CHECK WITH SUPPLIER FOR EXACT DIMENSIONS.
9. ALL BRACING SHALL BE CONSTRUCTED OF STAINLESS STEEL MATERIALS
10. NO BOLT DOWN COVERS ALLOWED WITHOUT PERMISSION FROM THE DISTRICT.
11. SEE SECTION 5.05-E.

WATER CAPACITY APPROX. GALLONS	DIMENSIONS					
	TWO COMPARTMENT TANK					
	INCHES					
	A	B	C	D	E	F
320	48	72	22	30	44	24
500	48	72	36	46	44	24
780	48	96	40	48	62	32
1060	72	102	34	42	58	34

Diagram Of An Approved Gravity Grease Interceptor (GGI)

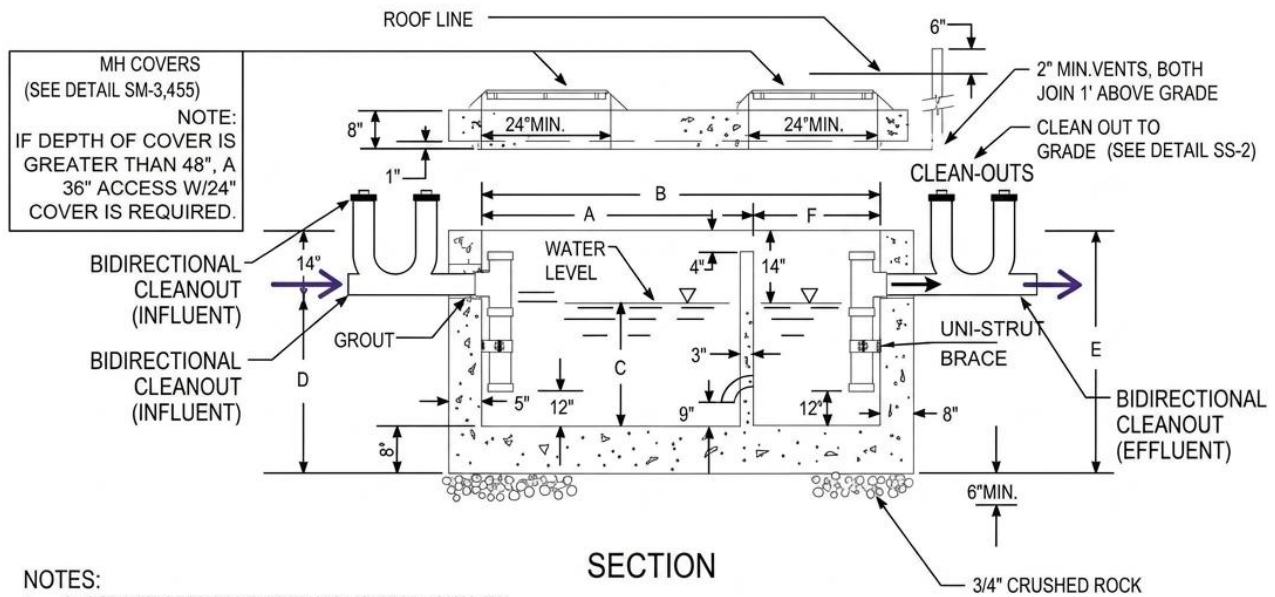
12. GGI Design Requirements

- a. Concrete lid and base of GGI shall be a minimum of 8" thick. Sidewalls shall be a minimum of 5" thick. Baffle wall shall be a minimum of 3" thick.
- b. Baffle wall shall extend a minimum of 10" above water level.
- c. PVC screw plug clean outs shall be taken to grade and protected by a cast iron lamp hole cover with a locking lid marked "sewer". Lamp hole covers shall be secured in a square concrete pad. The concrete pad shall extend 12" beyond the center of each cleanout and have a depth equal to the lamp hole cover. Concrete pad to be poured at time of final grade.
- d. Inlet invert shall be a minimum of 2" higher than outlet invert.
- e. Vent must be PVC, schedule 40, taken to 6" above roof line or grade depending on location.
- f. GGI shall be bedded in a minimum of 6" of 3/4" crushed rock.
- g. Solids/Grease capacity rated for large compartment only. Secondary compartment has volume equal to 1/3 of total capacity.
- h. No bolt down covers allowed without permission from DWSD.
- i. Within trap, all pipe and fittings shall be solvent welded schedule 40 PVC min. 3" diameters.
- j. Grey water use only; black water shall be carried by separate sewer.
- k. Recommendation for clean out(s) on outlet.

13. General Specifications and Sizing for Petroleum, Oil, Grease and Sand (POGS) Separators

- a. Petroleum, Oil, Grease and Sand (POGS) separators shall be required for all POGS facilities. Sizing and installation shall follow applicable building codes and as shown below. Those POGS separators not able to achieve compliance with DWSD's

Rules and Regulations shall be subject to modification and/or replacement.



NOTES:

1. SECONDARY COMPARTMENT HAS VOLUME EQUAL TO 1/3 OF TOTAL CAPACITY.
2. ALL PIPE AND FITTINGS SHALL BE SOLVENT WELDED SCHEDULE 40 P.V.C. MIN. 3" DIA. WITHIN TRAP.
3. WALLS AND BOTTOM REINFORCED THROUGHOUT WITH 2x16 6/10 REMESH.
4. COVERS TO BE REINFORCED LONGITUDINALLY WITH NO. 6 REBAR ON 8" CENTERS, NO. 4 REBAR ON 8" CENTERS WIDTHWISE, AND NO. 8 REBAR DIAGONALLY AROUND ACCESS HOLES.
5. CLEAN OUT SHALL BE PVC SCREW PLUG.
6. VENT PIPE MAY BE CAST IRON OR PVC SCHEDULE 40, TO A POINT 8" ABOVE ROOF LINE.
7. MANHOLE RING AND COVER SHALL BE 24" DENVER HEAVY, OR EQUAL. SEE 4.02-Q THESE SPECIFICATIONS (SEE SM-3,4&5)
8. CHECK WITH SUPPLIER FOR EXACT DIMENSIONS.
9. ALL BRACING SHALL BE CONSTRUCTED OF STAINLESS STEEL MATERIALS
10. NO BOLT DOWN COVERS ALLOWED WITHOUT PERMISSION FROM THE DISTRICT.
11. SEE SECTION 5.05-E.

WATER CAPACITY APPROX. GALLONS	DIMENSIONS					
	TWO COMPARTMENT TANK					
	INCHES					
	A	B	C	D	E	F
320	48	72	22	30	44	24
500	48	72	36	46	44	24
780	48	96	40	48	62	32
1060	72	102	34	42	58	34

Diagram Of An Approved POGS Separator

14. POGS Separator Design Requirement

- a. Concrete lid and base of POGS separator shall be a minimum of 8" thick. Sidewalls shall be a minimum of 5" thick. Baffle wall shall be a minimum of 3" thick.
- b. Baffle wall shall extend a minimum of 10" above water level.
- c. PVC screw plug clean outs shall be taken to grade and protected by a cast iron lamp hole cover with a locking lid

marked "sewer". Lamp hole covers shall be secured in a square concrete pad. The concrete pad shall extend 12" beyond the center of each cleanout and have a depth equal to the lamp hole cover. Concrete pad to be poured at time of final grade.

- d. Inlet invert shall be a minimum of 2" higher than outlet invert.
- e. Vent must be PVC, schedule 40, taken to 6" above roof line or grade depending on location.
- f. POGS separator shall be bedded in a minimum of 6" of 3/4" crushed rock.
- g. Solids/oil capacity rated for large compartment only. Secondary compartment has volume equal to 1/3 of total capacity.
- h. No bolt down covers allowed without permission from DWSD.
- i. Within trap, all pipe and fittings shall be solvent welded schedule 40 PVC min. 3" diameters;
- j. Grey water use only; black water shall be carried by separate sewer; and
- k. Recommendation for cleanout(s) on outlet.

Drainage Fixture Units (DFUs)				
Fixture Type	Drain Size	DFUs	Quantity	TOTAL
Floor Drain	2.0-3.0"	2.0		
Floor Sink	2.0"	4.0		
	3.0"	6.0		
	4.0"	8.0		
Mop Sink	2.0-3.0"	3.0		
Hand/Bar Sink	1.5-2.0"	2.0		
Additional Fixture(s) (direct connection)	1.5"	3.0		
	2.0"	4.0		
	3.0"	6.0		
	4.0"	8.0		
TOTAL DFUs				

Sand/Oil Interceptor Sizing	
Total DFU's	Interceptor Volume (gallons)
2-21	750
22-35	1000
36-90	1250
91-172	1500
173-216	2000
217-307	2500
308-342	3000
343-428	4000
429-576	5000
577-720	7500
721-2112	10000
2113-2640	15000

Core and Shell POGs Separator Sizing	
GCI Inlet Pipe Size (inches)	Interceptor Size (gallons)
2	750
3	1000
4	2000
5	4000
6	7500

J. Lift Stations

Lift stations will not be permitted to provide service to individual buildings. Lift stations may be used to serve multiple buildings or a small service area in the event that gravity service is not possible for that area but should not be considered until other options have been investigated. Lift stations shall not be used as an alternative to extending a gravity service line, which may be longer or deeper than normal.

Lift stations shall be designed by the Customer's P.E. and shall include a commutator or grinder for solids. The force main shall be sized for the maximum discharge flow and the pump.

A variance request must be applied for prior to the design and permitting of a Lift Station can begin. Lift station designs shall be submitted to the DWSD Engineer for approval. The use and design of the lift station shall also be approved by the Douglas County

Building Department and CDPHE.

Costs, maintenance and operation of the lift station, force main and gravity service line shall be detailed in the Inter Governmental Agreement between the Customer and DWSD.

5.05 SANITARY SEWER SERVICE MATERIALS

A. PVC Pipe

Sanitary sewer service lines may be constructed of polyvinyl chloride pipe in compliance with Chapter 5, Paragraph Sections 5.02-A, 5.02-B and 5.02-C.

B. Bedding Material

Pipe bedding for sanitary sewer service lines shall comply with Chapter 5, Paragraph 5.02-I.

C. Sanitary Sewer Service Fittings

Pipe fittings for PVC service lines shall be PVC, bell and spigot joint in compliance with Chapter 5, Paragraph 5.03-D. No solvent weld fittings may be used except for sand and grease interceptors.

D. Tapping Saddles

Sanitary sewer service tapping saddles shall be constructed of PVC manufactured in strict accordance with ASTM D 1784, ASTM D 3034, ASTM F 477 and ASTM F 679. Tapping saddles shall consist of a rubber gasket attached to the flange of the saddle which will seal against the outside wall of the main, a bell and spigot gasket in the bell of the service outlet and a minimum of two stainless steel straps which secures the saddle to the main line. Solvent welded saddles shall not be used.

E. Precast Concrete Sand/Oil and Grease Interceptors

Precast concrete sand/oil and grease interceptors shall be constructed in the same manner as Precast Concrete Vaults, see Chapter 4, Paragraph 4.2-N and the Standard Details. Piping within these interceptors shall be solvent weld PVC. Interceptors installed in a parking lot or a roadway shall be raised to grade by using precast concrete riser rings that are a minimum of 6 inches wide in accordance with the Standard Details.

F. Manhole Rings and Covers

Manhole rings and covers for sand/oil and grease interceptors shall comply with Chapter 4, Paragraph 4.02-Q.

G. Pipe Adaptors/Couplings

Pipe adaptors, couplings or bushings shall be used to connect pipes of different materials or dimensions. Adaptors, couplings and bushing shall provide a secure, leak

proof joint that shall meet or exceed the leak testing requirements of the pipe.

Adaptors, couplings and bushings shall be secured to the pipe by means of a mechanical connection such as stainless-steel clamps or a positive bell and spigot gasketed joint. The nominal diameter of the adaptor, coupling, or bushing shall match the nominal diameter of the pipes being connected. Field modifications of these items shall not be permitted. Couplings shall be Fernco – Strong Back Couplings or an approved equal. Concrete collars with "diapers" shall not be permitted.

H. Lamphole/Cleanout Ring and Cover

Lamphole/cleanout rings and covers shall be cast iron, heavy duty with an ability to withstand traffic loading. Lamphole covers shall be a Tyler series 6855 slip type section with locking lid or an approved equal in accordance with the Standard Details.

5.06 SANITARY SEWER SERVICE INSTALLATION

A. Excavation

Excavation for sanitary sewer service lines shall be in accordance with Chapter 4, Paragraph 4.03-A.

In the event that a joint trench is specified for both a sewer and water service line, the subgrade bench for the water service line shall have a minimum width of 12 inches. This bench shall be excavated from undisturbed soil at an elevation no less than 18 inches above the top of the sanitary sewer service.

B. Pipe Foundation and Bedding

Pipe foundation and bedding for service lines shall be in accordance with Chapter 4, Paragraphs 4.03-B and 5.02-I.

C. Trench Backfilling and Compaction

Trench backfilling and compaction of sewer service lines shall be in conformance with Chapter 4, Paragraph 4.03-C.

D. Installation of Sanitary Sewer Service Lines

Installation of service lines shall be in accordance with Chapter 5, Paragraph 5.03-D.

Sewer services shall be connected to the main by means of a wye fitting or tapping saddle entering the main at an angle of 45 degrees vertically above the spring line of the main. Service lines shall be extended from the main using a combination of no more than three eighth bends (45 degrees) or sixteenth bends (22½ degrees). Service lines shall be plugged at the end of the line with a watertight plug manufactured for use with the service line material and shall not exceed a 15 feet depth at the plug.

End plugs must be able to withstand the internal pressure of leakage testing required by these Standards.

E. Installation of Service Line Taps

Service lines shall be connected to the main by means of either a PVC molded wye installed in conjunction with the main line or a PVC saddle in accordance with Chapter 5.05-D. Allowable combinations of service line connections are outlined in Table 5-3.

The sewer main shall be scored to the shape of the wye using a template approved by the saddle manufacturer. The hole shall be cut with a hole cutter or keyhole saw and cleanly machined by hand to remove all burrs, rough edges and debris. The exterior of the main

shall be wiped clean and prepared with an approved cleaning solvent prior to the installation of the saddle. The saddle shall be drawn tight by means of stainless steel straps.

Upon completion of the tap, the main, the tapping saddle and the service line shall be bedded and hand tamped prior to backfilling. Saddle taps may be tested for leakage in accordance with Chapter 5, Paragraph 5.03-I.

F. Installation of Sand/Oil and Grease Interceptors

When required, sand/oil and grease interceptors shall be installed in accordance with Chapter 5, Paragraph 5.05-E. Pipes and fittings installed as part of the interceptor shall be a minimum of Schedule 40 PVC solvent weld. Interceptors installed in a parking lot or a roadway shall be raised to grade by using precast concrete riser rings that are a minimum of 6 inches wide.

TABLE 5-2	
QUANTITIES OF WASTEWATER – UNIT FLOW	
Type of Use	Unit Flow (Average Daily Flow)
Residential: Single Family	150gpd/DU
Residential: Multi-Family	150gpd/DU
Commercial	1500 gpad
Industrial	3810 gpad
Schools	
with cafeteria & gym	25 gpsd
without cafeteria & gym	15 gpsd
Hospitals	250 gpbd

Definitions: Single Family: Any detached residential home
Multi-Family: Any attached residential home
gpd: Gallons per day
gpac: Gallons per acre day (gross acres of entire lot)
gpsd: Gallons per student per day
gpbd: Gallons per bed per day
DU: Dwelling Unit

TABLE 5-3				
TAPPING REQUIREMENTS FOR SERVICE CONNECTIONS ON PVC SEWER MAIN				
Nominal Size of Sewer Main	Tap Size (inches)			
	4	6	8	10 & over
8-inch	S/F	S/F	M	N/A
10-inch	S/F	S/F	M	M
12-inch	S/F	S/F	M	M
15-inch	S/F	S/F	M	M
18-inch	S/F	S/F	M	M

S/F - Tapping Saddle (Wye) or Fitting (Wye)
M - Manhole Required
N/A - Not Applicable

CHAPTER 6

STANDARD DRAWING

DETAILS AND NOTES

TABLE OF CONTENTS

	PAGE
6.01 STANDARD DETAIL INDEX.....	1
6.02 STANDARD NOTES	3
6.03 STANDARD SIGNATURE BLOCKS.....	7

6.01 STANDARD DETAIL INDEX:

Use DWSD's Water System Details when available. In all other instances, reference Denver Water Capital Projects Construction Standards.

District Water Notes
District Sanitary Sewer Notes

Trench & Bedding Detail – Sewer	SM-1
Concrete Encasement Detail	SM-2
Manhole on Existing Sewer	SM-3
Manhole on New Sewer	SM-4
Internal Drop Manhole on Existing Sewer	SM-5
Internal Drop Manhole on New Sewer	SM-6
Standard Sewer Manhole	SM-7
Typical Base and Deflector Details	SM-8
Manhole Invert Tie-In Detail	SM-9
Square Manhole Base Re-bar Basket	SM-10
Circular Manhole Base Re-bar Basket	SM-11
Cleanout Manhole Detail	SM-12

Sewer Service Line Tapping Detail	SS-1
In-Line Sanitary Sewer Cleanout (4” and 6”)	SS-2
Typical Sanitary Sewer Service Location	SS-11

Underdrain Cleanout Detail 6”, or 8” Underdrain Cleanout Access	UD-1
Pipe Bedding Detail for Sewer with Underdrain	UD-2
Underdrain Details	UD-3
Underdrain Alignment at Manholes	UD-4

Carsonite Marker Post	WM-1
Valve Box Detail	WM-2
Restrained Joints at Vertical Bends	WM-4
Tie-Rod Retaining Clamp	WM-5
Standard for Temporary Blow-off Valve Installation	WM-7
Permanent Blowoff Installation	WM-8
Valve and Fire Hydrant Location Detail	WM-10
Typical Fire Hydrant and Assembly	WM-11
Air Vent Detail	WM-13
Pressure Reducing Vault (Detail 1 of 2)	WM-14

Pressure Reducing Vault (Detail 2 of 2)	WM-15
Wet Tap	WM-18
Water Quality Sampling Station	WM-25

Typical - Curb Stop for ¾" & 1" Water Service	WS-1
Residential – Typical Water Service Location	WS-2
Residential – Curb Stop Box Location	WS-3
Residential – Water Service Installation with Curb Stop Valve	WS-4
Commercial - Corporation Tap & Service Line Detail	WS-6
Backflow Assembly for 2½" and Larger Service – Vertical Setting	WS-18
Backflow Assembly for 2½" and Larger Service – Horizontal Setting	WS-19
Thrust Blocks for Service Taps	WS-20

Tracer Wire – Sample Water Plan Detail	TR-1
Tracer Wire – Sample Water Detail	TR-2
Tracer Wire – Hydrant Detail	TR-3
Tracer Wire – Sample Sewer Plan Detail	TR-4
Tracer Wire – Sewer Service Detail	TR-5
Tracer Wire – Sewer Manhole Detail	TR-6
Tracer Wire – Notes (1 of 5)	TR-7
Tracer Wire – Notes (2 of 5)	TR-8
Tracer Wire – Notes (3 of 5)	TR-9
Tracer Wire – Notes (4 of 5)	TR-10
Tracer Wire – Notes (5 of 5)	TR-11

6.02 STANDARD NOTES:

DISTRICT WATER NOTES: THESE NOTES SHALL BE ADDED TO THE GENERAL NOTES SHEET OF ALL CONSTRUCTION DOCUMENTS.

1. THE INSTALLATION OF ALL WATER MAINS AND APPURTENANCES SHALL COMPLY WITH THE DOMINION WATER & SANITATION DISTRICT STANDARDS (DWSDS), LATEST VERSION.
2. EXISTING UTILITIES AND STRUCTURES (UNDERGROUND, SURFACE, AND OVERHEAD) ARE INDICATED ONLY TO THE EXTENT THAT SUCH INFORMATION WAS MADE AVAILABLE TO THE SURVEYOR, UTILITY LOCATOR, OR ENGINEER, FOR CONTRACT DOCUMENT PREPARATION. NOT ALL LOCATIONS, CONFIGURATIONS, AND ELEVATIONS OF EXISTING UNDERGROUND POWER, TELEPHONE, FIBER OPTIC CABLE, DUCT WAYS, SPRINKLER SYSTEMS, SEPTIC SYSTEMS, WATER, GAS, SEWER AND SERVICE LINES ARE INDICATED. OTHER UTILITIES AND STRUCTURES NOT DISCOVERED MAY BE PRESENT. UNDERGROUND LOCATIONS AND ELEVATIONS OF EXISTING UTILITIES AND STRUCTURES AS FURNISHED BY THE OWNER OF EACH UTILITY OR STRUCTURE, ARE APPROXIMATE AND ARE NOT TO BE CONSTRUED AS AN ACCURATE LOCATION OF THEIR UTILITY. THE ENGINEERING INVESTIGATIONS, LOCATIONS, AND DESIGNATIONS OF SUBSURFACE UTILITIES INDICATED IN THESE CONTRACT DOCUMENTS HAS BEEN PERFORMED TO QUALITY LEVEL 'C' IN ACCORDANCE WITH GENERALLY ACCEPTED ENGINEERING PRINCIPLES AND PRACTICES AS OUTLINED IN ASCE STANDARD AND GUIDELINE BULLETIN CI/ASCE 38-02, UNLESS OTHERWISE DESIGNATED. WHERE SUCH ACTIVITIES HAVE BEEN TO A HIGHER LEVEL OF QUALITY, THE HIGHER QUALITY LEVEL FOR THE AFFECTED AREAS ARE INDICATED IN THE CONTRACT DOCUMENTS.
3. WATER MAINS SHALL BE AWWA C900 PRESSURE CLASS 150 MINIMUM, PVC UNLESS OTHERWISE NOTED. DIP WATER LINES SHALL BE AWWA C151 PRESSURE CLASS 250 UNLESS OTHERWISE NOTED.
4. FIRE HYDRANT LEADS AND FIRE SERVICE LINES SHALL BE PRESSURE CLASS 250 DIP.
5. WATER MAIN DEPRESSIONS FOR PVC WATER LINES SHALL BE A MINIMUM OF AWWA C900 CLASS 200 PVC.
6. NO VERTICAL AND/OR HORIZONTAL BENDS ARE ALLOWED IN FIRE HYDRANT LEADS AND FIRE LINES WITHOUT APPROVAL OF DWSO.
7. NO FITTINGS ARE ALLOWED ON DOMESTIC SERVICE LINES BETWEEN THE MAIN AND THE CURB STOP.

8. COVER OVER WATER MAINS SHALL BE A MINIMUM OF 5 FEET UNDER PAVEMENT AND 6 FEET IN OPEN SPACE. MAXIMUM ALLOWABLE COVER IS 10 FEET, UNLESS OTHERWISE APPROVED BY DWSD.
9. WATER MAIN CROSSINGS SHALL COMPLY WITH CHAPTER 4, PARAGRAPH 4.01-C.3 OF THE DWSDS.
10. WATER MAINS SHALL BE MECHANICALLY RESTRAINED AND BEDDED IN ACCORDANCE WITH CHAPTER 4 OF THE DWSDS.
11. WATER MAINS SHALL BE AS-BUILT IN ACCORDANCE WITH CHAPTER 3, SECTION 3.12.B. OF THE DWSDS.

DISTRICT SANITARY SEWER NOTES: THESE NOTES SHALL BE ADDED TO THE GENERAL NOTES SHEET OF ALL CONSTRUCTION DOCUMENTS.

1. THE INSTALLATION OF ALL SEWER MAINS AND APPURTENANCES SHALL COMPLY WITH THE DOMINION WATER AND SANITATION DISTRICT STANDARDS (DWSDS) LATEST VERSION.
2. EXISTING UTILITIES AND STRUCTURES (UNDERGROUND, SURFACE, AND OVERHEAD) ARE INDICATED ONLY TO THE EXTENT THAT SUCH INFORMATION WAS MADE AVAILABLE TO THE SURVEYOR, UTILITY LOCATOR, OR ENGINEER, FOR CONTRACT DOCUMENT PREPARATION. NOT ALL LOCATIONS, CONFIGURATIONS, AND ELEVATIONS OF EXISTING UNDERGROUND POWER, TELEPHONE, FIBER OPTIC CABLE, DUCT WAYS, SPRINKLER SYSTEMS, SEPTIC SYSTEMS, WATER, GAS, SEWER AND SERVICE LINES ARE INDICATED. OTHER UTILITIES AND STRUCTURES NOT DISCOVERED MAY BE PRESENT. UNDERGROUND LOCATIONS AND ELEVATIONS OF EXISTING UTILITIES AND STRUCTURES AS FURNISHED BY THE OWNER OF EACH UTILITY OR STRUCTURE, ARE APPROXIMATE AND ARE NOT TO BE CONSTRUED AS AN ACCURATE LOCATION OF THEIR UTILITY. THE ENGINEERING INVESTIGATIONS, LOCATIONS, AND DESIGNATIONS OF SUBSURFACE UTILITIES INDICATED IN THESE CONTRACT DOCUMENTS HAS BEEN PERFORMED TO QUALITY LEVEL 'C' IN ACCORDANCE WITH GENERALLY ACCEPTED ENGINEERING PRINCIPLES AND PRACTICES AS OUTLINED IN ASCE STANDARD AND GUILDLINE BULLETIN CI/ASCE 38-02, UNLESS OTHERWISE DESIGNATED. WHERE SUCH ACTIVITES HAVE BEEN TO A HIGHER LEVEL OF QUALITY, THE HIGHER QUALITY LEVEL FOR THE AFFECTED AREAS ARE INDICATED IN THE CONTRACT DOCUMENTS.
3. SEWER MAINS SHALL BE SDR-35 PVC FOR DEPTHS LESS THAN OR EQUAL TO 20 FEET; AND SDR 26 FOR DEPTHS GREATER THAN 20 FEET, UNLESS OTHERWISE NOTED.
4. MATCH PIPE CROWNS AT MANHOLES WHERE THERE IS A CHANGE IN PIPE DIAMETER.
5. COVER OVER SEWER MAINS SHALL BE A MINIMUM OF 5 FEET UNDER PAVEMENT AND 6 FEET IN OPEN SPACE.
6. IN NON-PAVED AREAS MANHOLE RIMS SHALL BE SET 4 INCHES ABOVE FINISHED GRADE WITH A 6-INCH WIDE 12-INCH DEEP MINIMUM CONCRETE COLLAR AROUND THE RING AND COVER.
7. SEWER MAIN CROSSINGS SHALL COMPLY WITH CHAPTER 5, PARAGRAPH 5.01-C.4 OF THE DWSDS.

8. SEWER MAINS SHALL BE BEDDED IN ACCORDANCE WITH CHAPTER 5 OF THE DWSDS AND NOTE 3 ABOVE.

6.03 STANDARD SIGNATURE BLOCKS:

CIVIL ENGINEER'S STATEMENT

I, _____, BEING A REGISTERED PROFESSIONAL ENGINEER IN THE STATE OF COLORADO, HEREBY ATTEST THAT ALL GRADING, UTILITY AND DRAINAGE IMPROVEMENTS IDENTIFIED ON THIS (name of document) HAVE BEEN DESIGNATED AND ENGINEERED IN CONFORMANCE WITH THE DOMINION WATER & SANITATION DISTRICT STANDARDS, OR DIFFERENCES AND VARIANCES THAT HAVE BEEN APPROVED IN WRITING DURING THE PLAN REVIEW PROCESS.

REGISTERED PROFESSIONAL ENGINEER

DATE

DOMINION WATER & SANITATION DISTRICT ACCEPTANCE

THESE PLANS HAVE BEEN REVIEWED BY A REPRESENTATIVE OF DOMINION WATER AND SANITATION DISTRICT IN ORDER TO CONFIRM ALL REQUIREMENTS OF THE ADOPTED DESIGN AND CONSTRUCTION STANDARDS HAVE BEEN MET AND THAT THESE PLANS MAY BE USED FOR BIDDING AND CONSTRUCTION. THIS REVIEW INCLUDED ONLY THE WATER AND WASTEWATER UTILITIES AND DOES NOT COVER ANY OTHER UTILITIES OR FEATURES OR COORDINATION REQUIRED THEREWITH. NO DETAILED DESIGN CALCULATIONS OR METHODOLOGIES WERE REVIEWED. IT IS THE RESPONSIBILITY OF THE ENGINEER OF RECORD TO ENSURE COMPLIANCE WITH ALL FEDERAL, STATE, AND LOCAL JURISDICTIONS.

GENERAL MANAGER

RECORD DRAWINGS

DOMINION WATER & SANITATION DISTRICT PERMIT NO. _____

BASED UPON REVIEW AND RELIANCE ON THE FIELD SURVEY DATA AND OTHER PERTENENT DATA PROVIDED BY: _____

I HEREBY STATE THAT TO THE BEST OF MYKNOWLEDGE, FACILITIES SHOWN ON THSE DRAWINGS WERE CONSTRUCTED IN SUBSTANTIAL CONFORMANCE WITH THE APPROVED CONSTRUCTION DRAWINSG. THIS STATEMENT IS BASED ONLY ON REVIEW OF FIELD SURVEY DATA AND A FINAL SITE INVESTIGATION. I ALSO UNDERSTAND THAT DOMINION WATER & SANITATION DISTRICT HAS NOT VERIFIED THE ACCURACY OF THIS INFORMATION AND SHALL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH MAY BE INCORPORATED INTO THESE RECORD DRAWINGS.

REGISTERED PROFESSIONAL ENGINEER

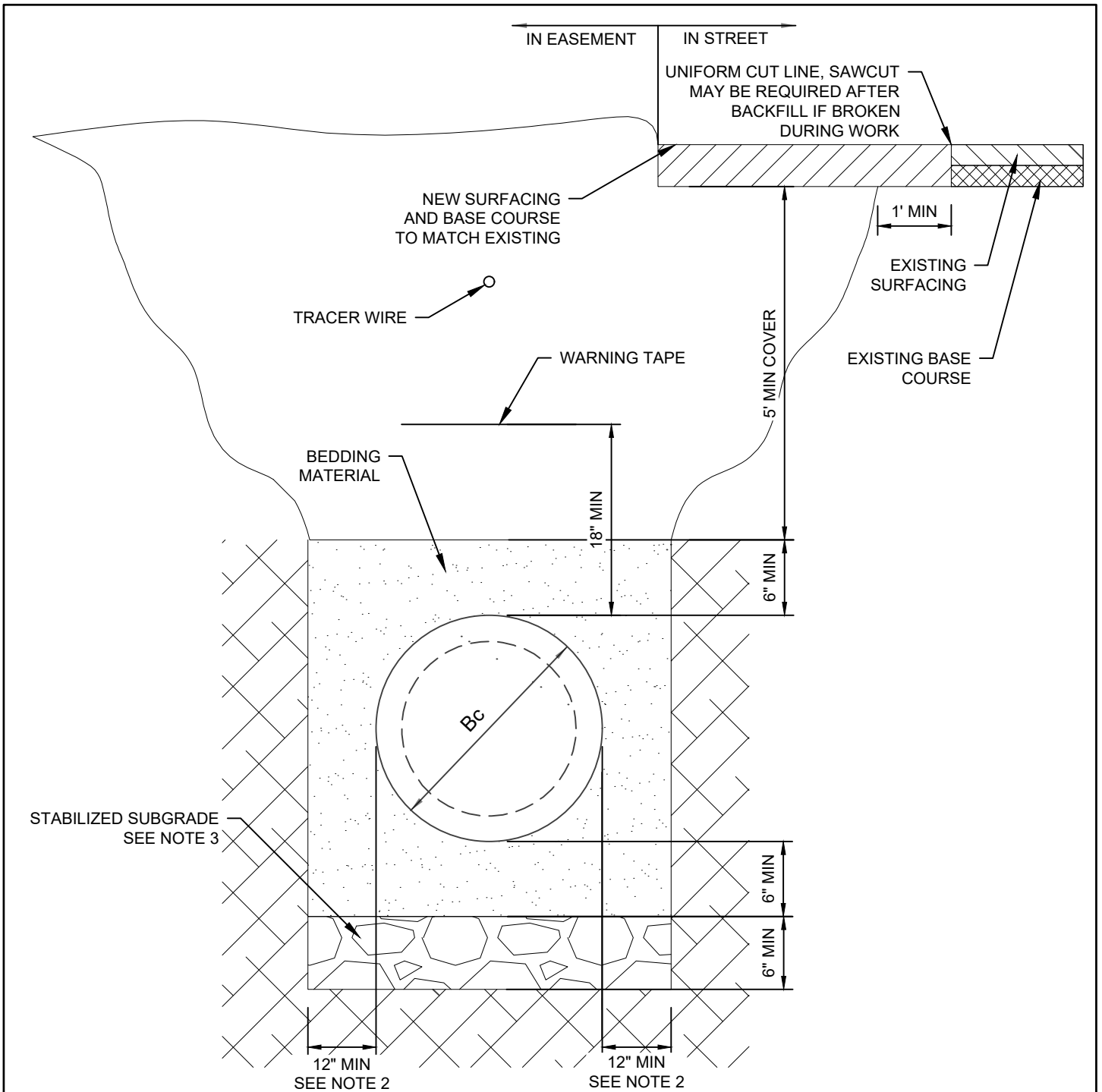
DATE

SOUTH METRO FIRE RESCUE AUTHORITY APPROVALS

FIRE HYDRANTS SHALL BE INSTALLED ACCORDING TO DOMINION WATER & SANITATION DISTRICT STANDARDS. THE NUMBER AND LOCATION OF THE FIRE HYDRANTS AS SHOWN ON THE OVERALL UTILITY PLAN ARE CORRECT AS SPECIFIED BY THE SOUTH METRO FIRE RESCUE AUTHORITY.

FIRE CHIEF OR DESIGNATED REPRESENTATIVE

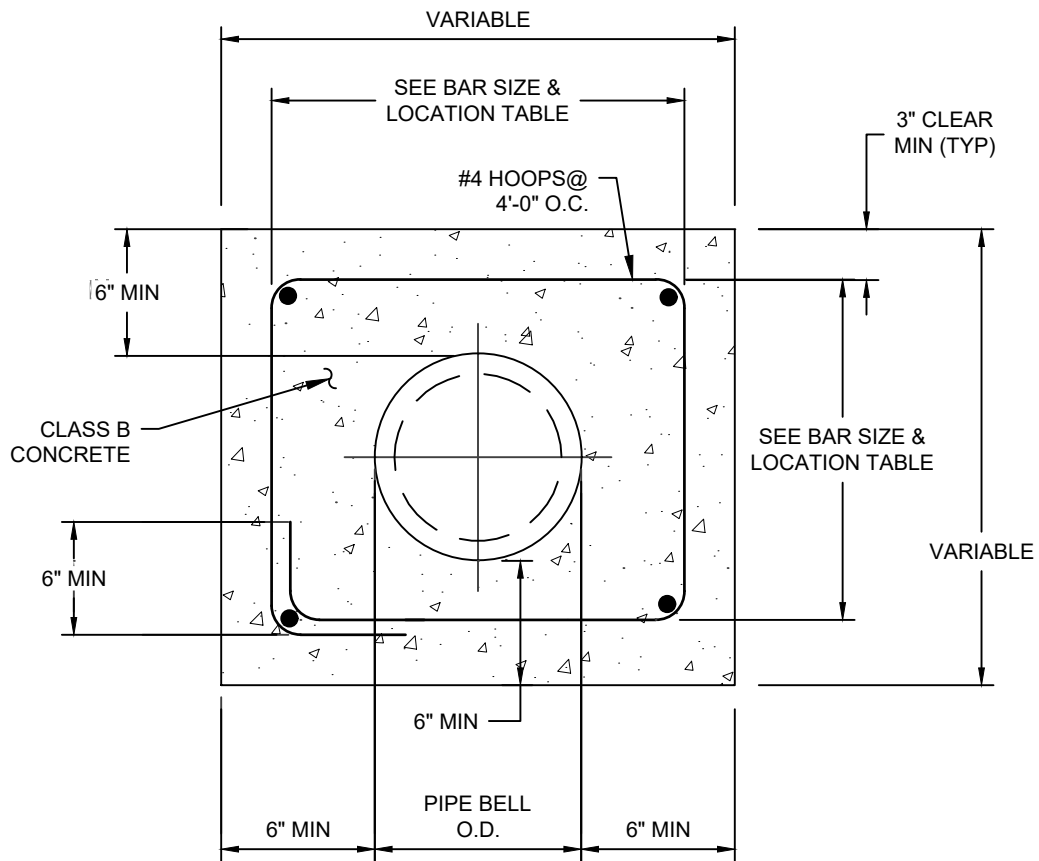
DATE



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. CLEARANCE IS FROM PIPE OUTER WALL TO INNER FACE OF TRENCH SHORING, SHEETING, OR TRENCH BOX.
3. IN LOCATIONS WHERE UNSTABLE SUBGRADES ARE ENCOUNTERED OR DEWATERING IS REQUIRED, OVER EXCAVATE AND PLACE GRANULAR FILL OR PUSH GRANULAR FILL INTO SUBGRADE TO STABILIZE. DEPTH SHALL BE 6" MINIMUM, MATERIAL SHALL BE AS SPECIFIED IN THE TRENCHING AND BACKFILLING, CHAPTER 4, PARAGRAPH 4.03-C.
4. SEE CHAPTER 4, PARAGRAPH 4.02-M FOR BEDDING MATERIAL.
5. TRACER WIRE SHALL NOT BE PLACED DEEPER THAN 15 FEET FROM GRADE

NOVEMBER 2025	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	
TRENCH & BEDDING DETAIL - SEWER		SM-1



PIPE I.D.	NO. OF LONGITUDINAL BARS & LOCATION
6"	4 - NO. 4 BARS 1 EACH CORNER
8"	8 - NO. 4 BARS 3 EACH SIDE
10"	8 - NO. 4 BARS 3 EACH SIDE
12"	8 - NO. 4 BARS 3 EACH SIDE
15"	8 - NO. 4 BARS 3 EACH SIDE
18"	8 - NO. 4 BARS 3 EACH SIDE
21"	12 - NO. 4 BARS 4 EACH SIDE
24"	12 - NO. 4 BARS 4 EACH SIDE
27"	12 - NO. 4 BARS 4 EACH SIDE
30"	12 - NO. 4 BARS 4 EACH SIDE
33"	12 - NO. 4 BARS 4 EACH SIDE
36"	12 - NO. 4 BARS 4 EACH SIDE

NOTES:

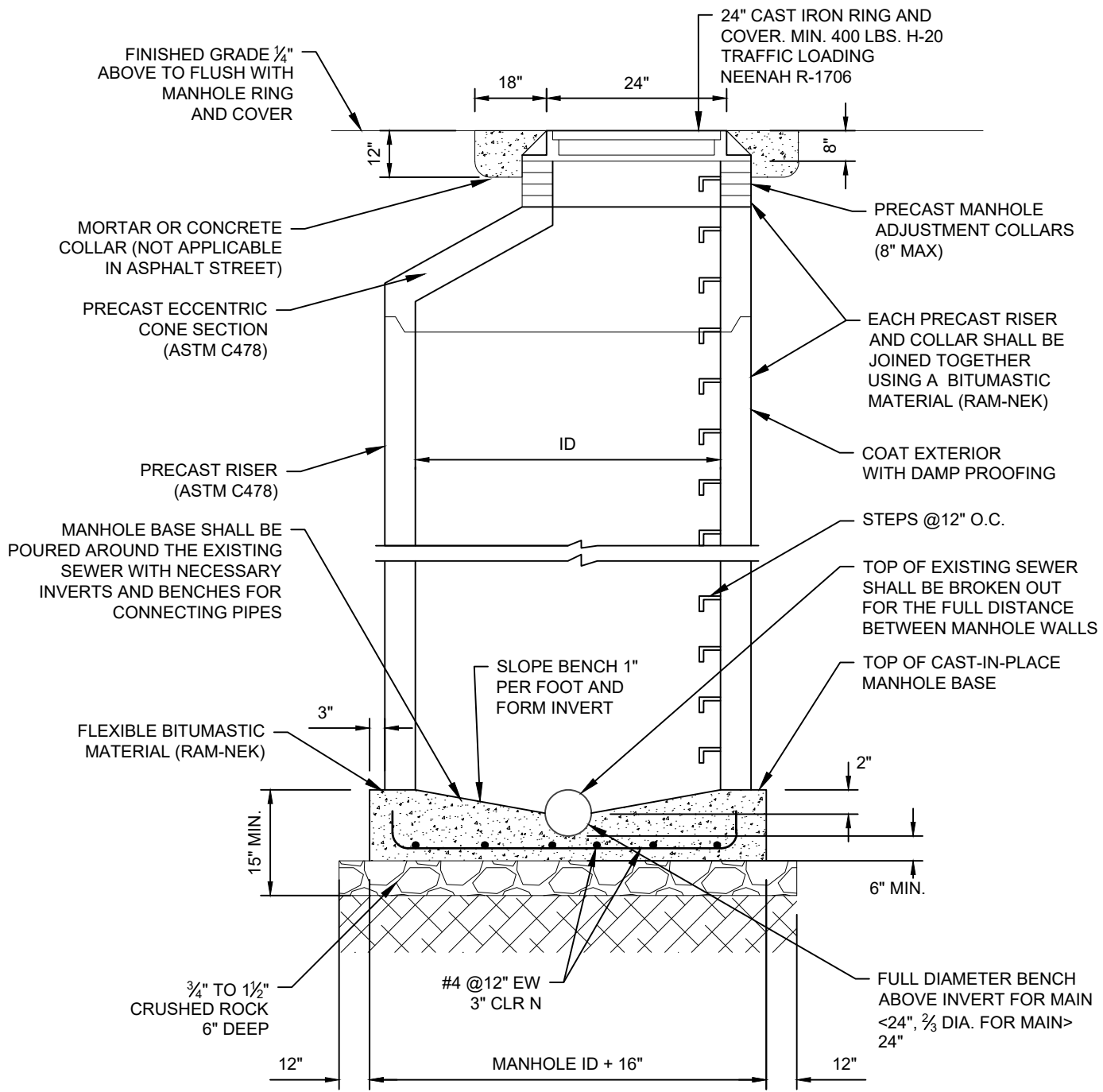
1. THE DISTRICT SHALL REVIEW THIS DETAIL FOR USE ON A CASE BY CASE BASIS. SPECIAL ENCASEMENTS MAY BE REQUIRED AT DRAINAGE WAY OR CREEK CROSSINGS AND CONDUIT CROSSINGS

NOVEMBER 2025

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

CONCRETE ENCASEMENT DETAIL

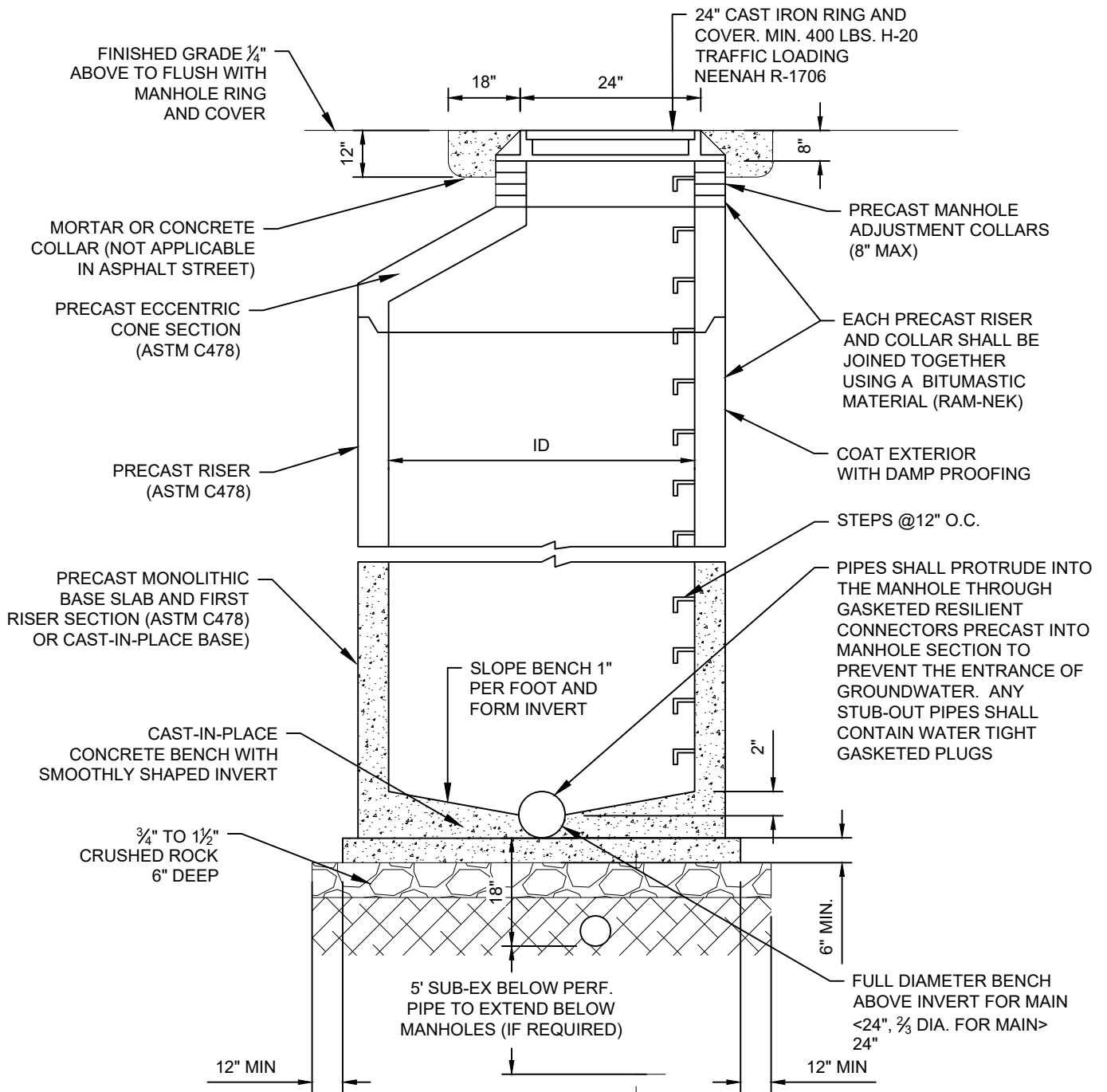
SM-2



MANHOLE:
 ID = 4' FOR SEWER WITH MAIN DIAMETER < 15"
 ID = 5' FOR SEWER WITH MAIN DIAMETER 15" < Ø < 24"
 ID = 6' FOR SEWER > 24"

- NOTE:
1. INSTALL A GROUND WATER BARRIER AROUND EACH PIPE IN THE PIPELINE TRENCH, ENTERING OR EXITING A MANHOLE.
 2. WHEN LOCATED IN CONCRETE, MANHOLE SHALL BE INSTALLED IN A DIAMOND-SHAPED CUTOUT WITH EXPANSION JOINT MATERIAL.

NOVEMBER 2025	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	SM-3
MANHOLE ON EXISTING SEWER		



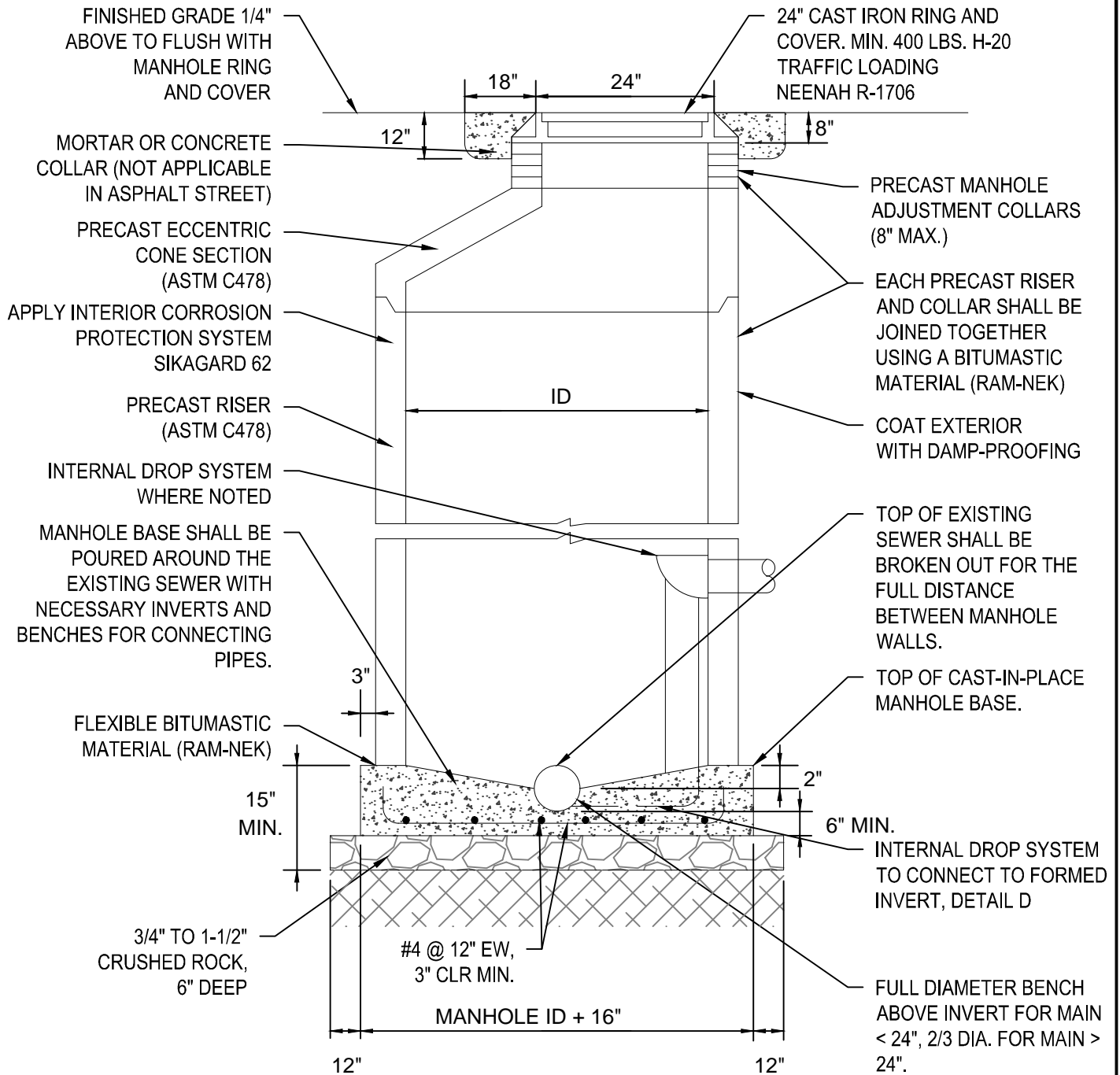
MANHOLE:

- ID = 4' FOR SEWER WITH MAIN DIAMETER < 15"
- ID = 5' FOR SEWER WITH MAIN DIAMETER 15" < Ø < 24"
- ID = 6' FOR SEWER > 24"

NOTE:

1. INSTALL A GROUND WATER BARRIER AROUND EACH PIPE IN THE PIPELINE TRENCH, ENTERING OR EXITING A MANHOLE.
2. WHEN LOCATED IN CONCRETE, MANHOLE SHALL BE INSTALLED IN A DIAMOND-SHAPED CUTOUT WITH EXPANSION JOINT MATERIAL.

NOVEMBER 2025	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	SM-4
MANHOLE ON NEW SEWER		



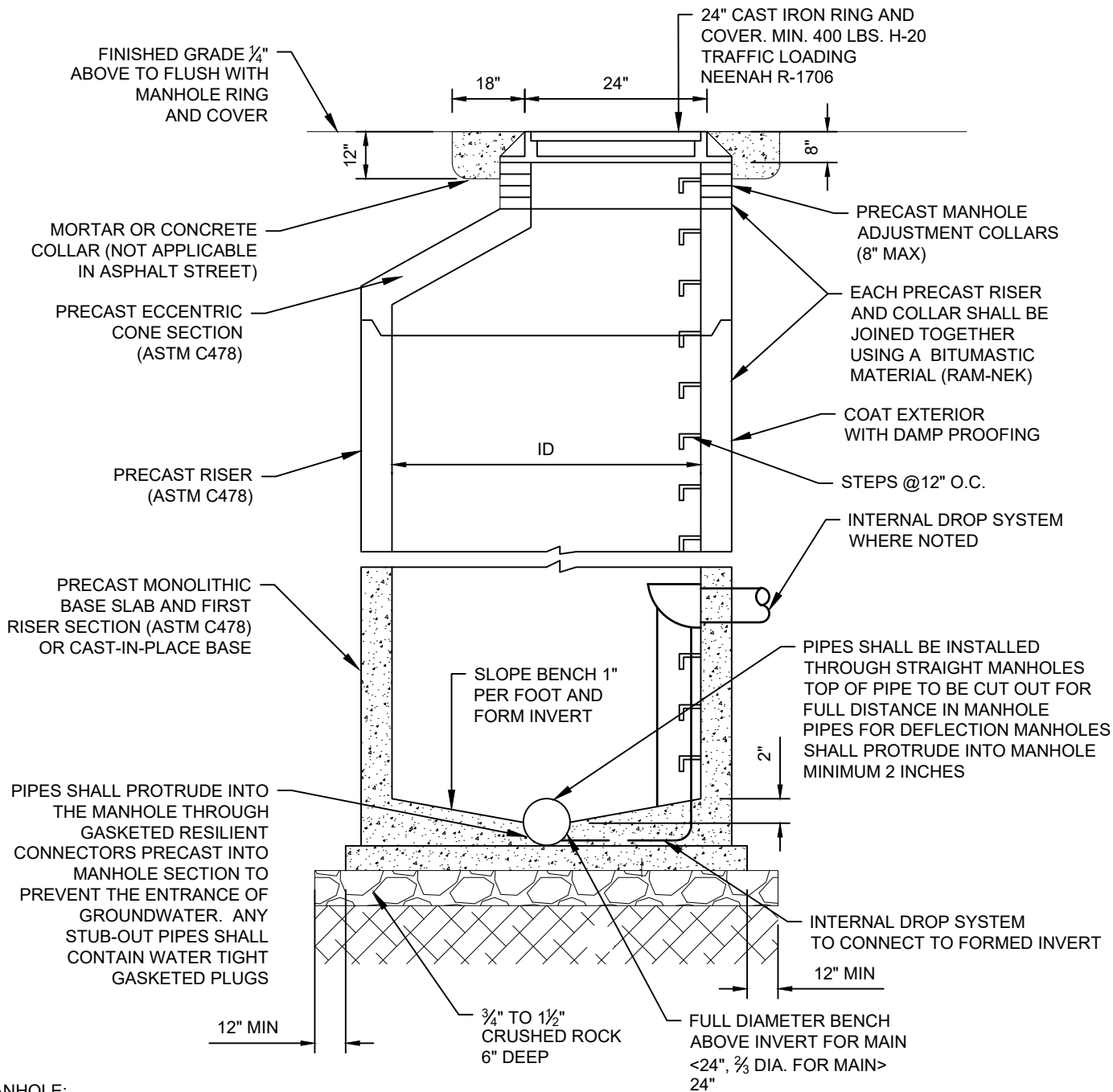
MANHOLE:

- ID = 4' FOR SEWER WITH MAIN DIAMETER $\leq 15"$
- ID = 5' FOR SEWER WITH MAIN DIAMETER $15" < \text{Ø} \leq 24"$
- ID = 6' FOR SEWER $> 24"$

NOTE:

1. INSTALL A GROUND WATER BARRIER AROUND EACH PIPE IN THE PIPELINE TRENCH, ENTERING OR EXITING A MANHOLE.
2. WHEN LOCATED IN CONCRETE, MANHOLE SHALL BE INSTALLED IN A DIAMOND-SHAPED CUTOUT WITH EXPANSION JOINT MATERIAL.

FEBRUARY 2020	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	SM-5
	INTERNAL DROP MANHOLE ON EXISTING SEWER	



MANHOLE:

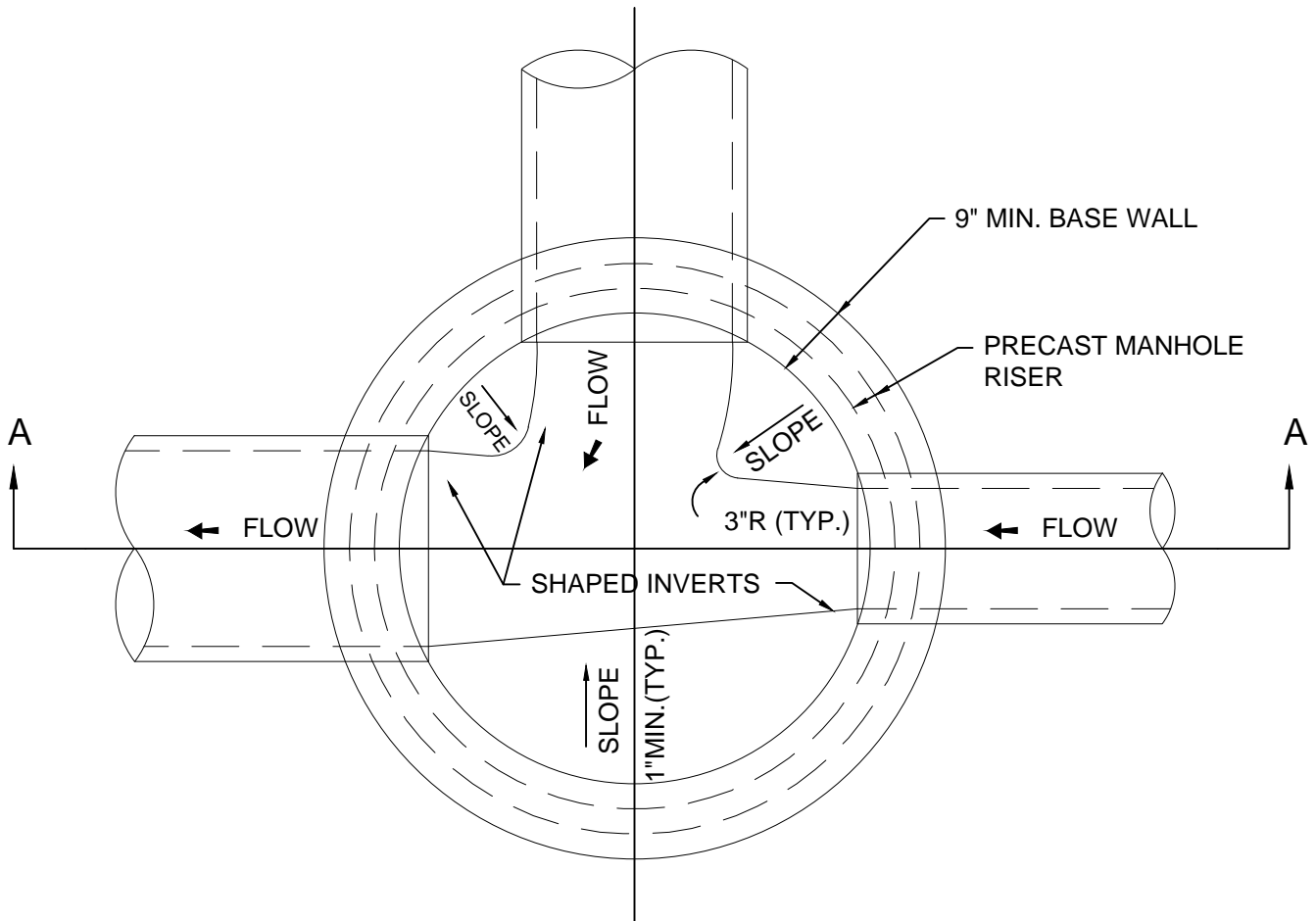
ID = 4' FOR SEWER WITH MAIN DIAMETER < 15"
 ID = 5' FOR SEWER WITH MAIN DIAMETER 15" < Ø < 24"
 ID = 6' FOR SEWER > 24"

NOTE:

1. ALL INSIDE DROP CONNECTIONS SHALL USE THE RELINER-DURAN INSIDE DROP BOWL SYSTEM OR APPROVED EQUAL.
2. INSTALL A GROUND WATER BARRIER AROUND EACH PIPE IN THE PIPELINE TRENCH, ENTERING OR EXITING A MANHOLE.
3. WHEN LOCATED IN CONCRETE, MANHOLE SHALL BE INSTALLED IN A DIAMOND-SHAPED CUTOUT WITH EXPANSION JOINT MATERIAL.

NOVEMBER 2025	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	
	INTERNAL DROP MANHOLE ON NEW SEWER	SM-6

PLAN MONOLITHIC BASE



NOTES:

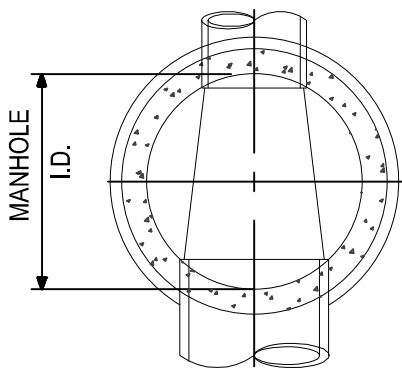
1. MANHOLES SHALL HAVE REINFORCED CONCRETE BASES PER DETAIL SM-10 AND SM-11.
2. SQUARE BASES ARE ALLOWED PER DETAIL SM-10 AND SM-11.
3. SEE DETAILS SM-10 AND SM-11 FOR SECTIONS A-A AND PLAN VIEW.

FEBRUARY 2020

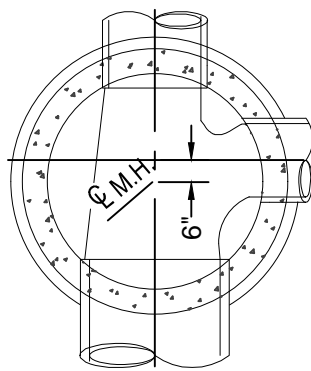
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

STANDARD SEWER MANHOLE

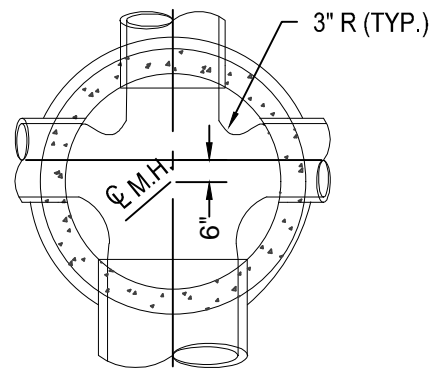
SM-7



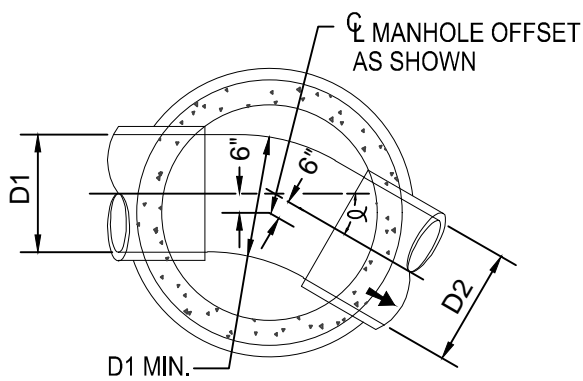
THROUGH PIPE



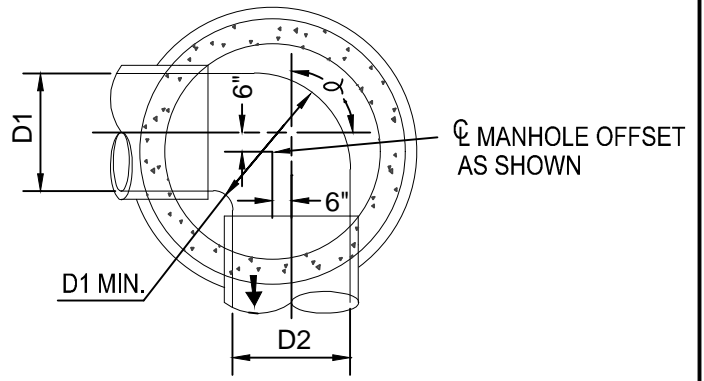
THROUGH PIPE
ONE COLLECTION LINE



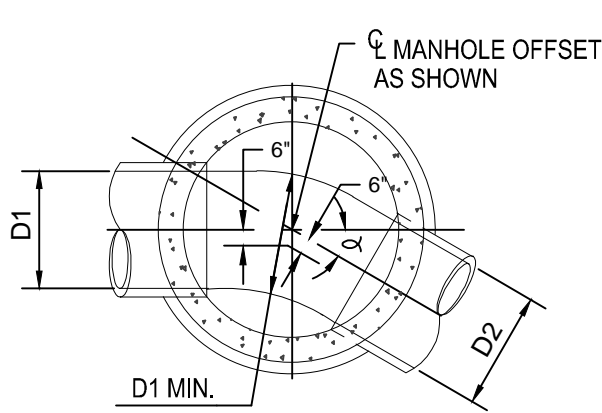
THROUGH PIPE
TWO COLLECTION LINES



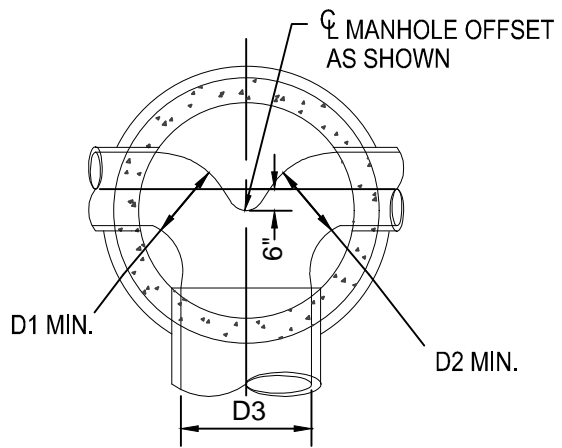
INTERMEDIATE ANGLE
 $\alpha = 30^\circ$



SHARP ANGLE
 $\alpha = 90^\circ$



INTERMEDIATE ANGLE
 $\alpha = 45^\circ$



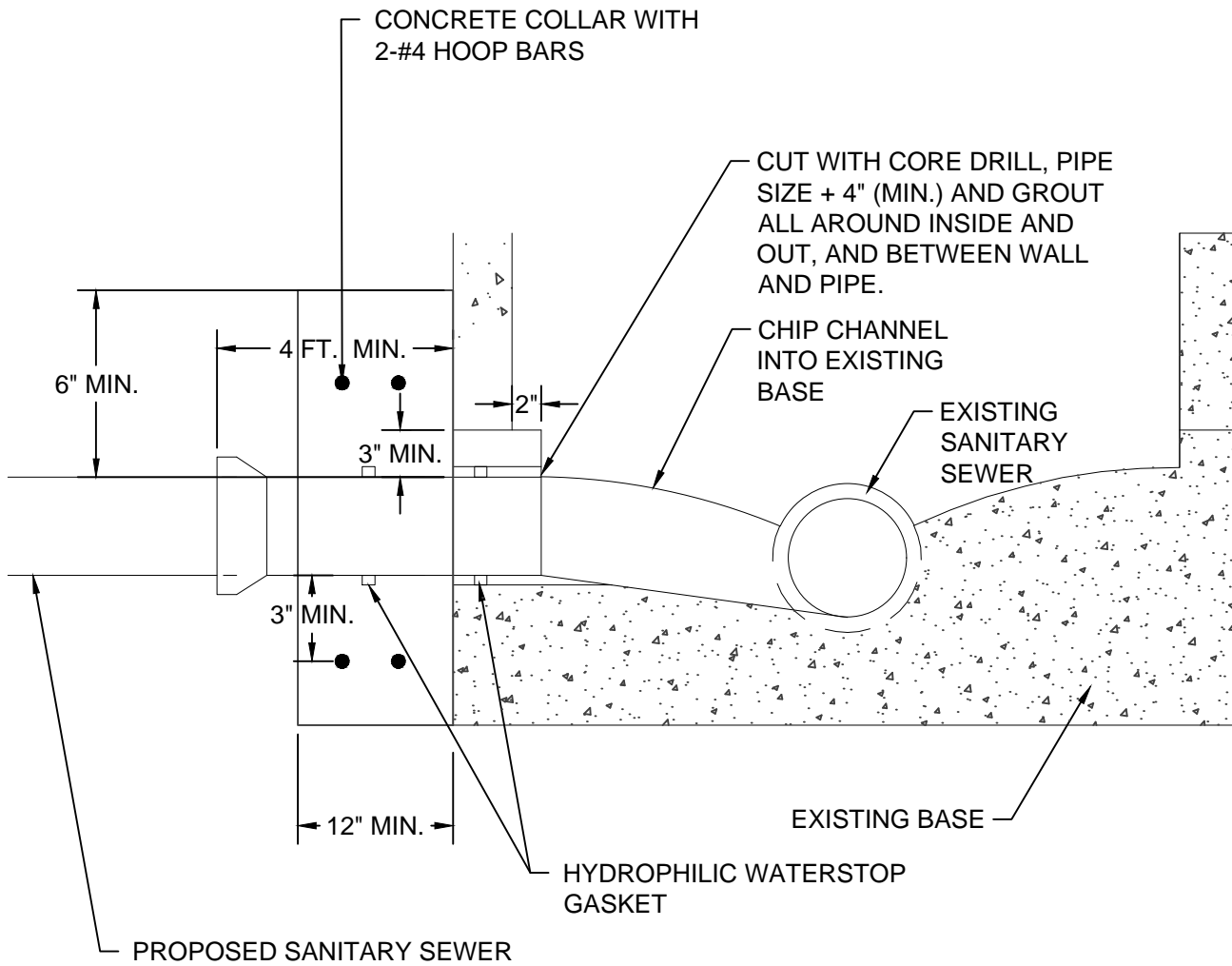
OPPOSED LATERALS

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

TYPICAL BASE AND DEFLECTOR DETAILS

SM-8



NOTES:

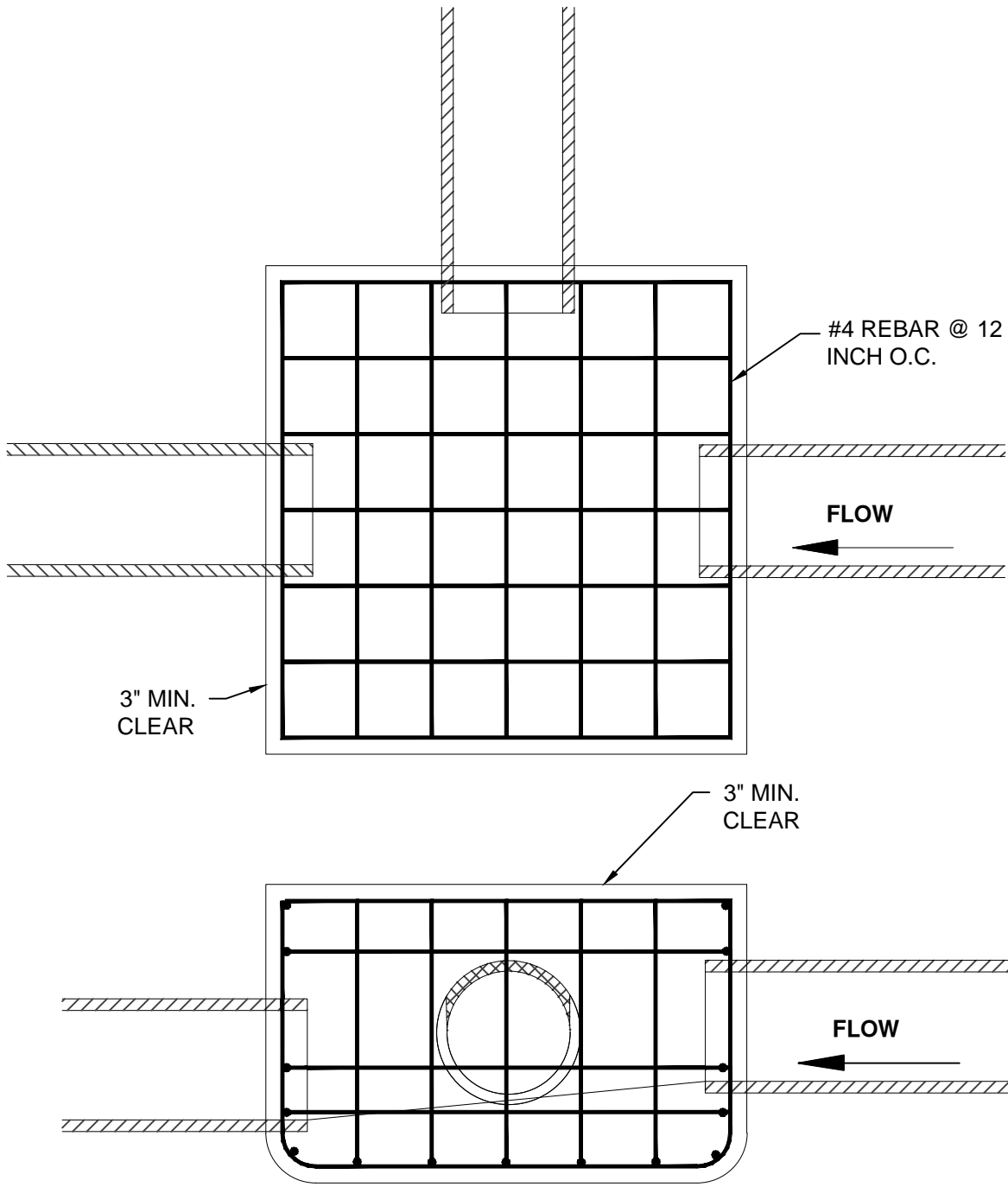
1. TIE-INS SHALL ONLY BE PERMITTED THROUGH BASE WALL.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

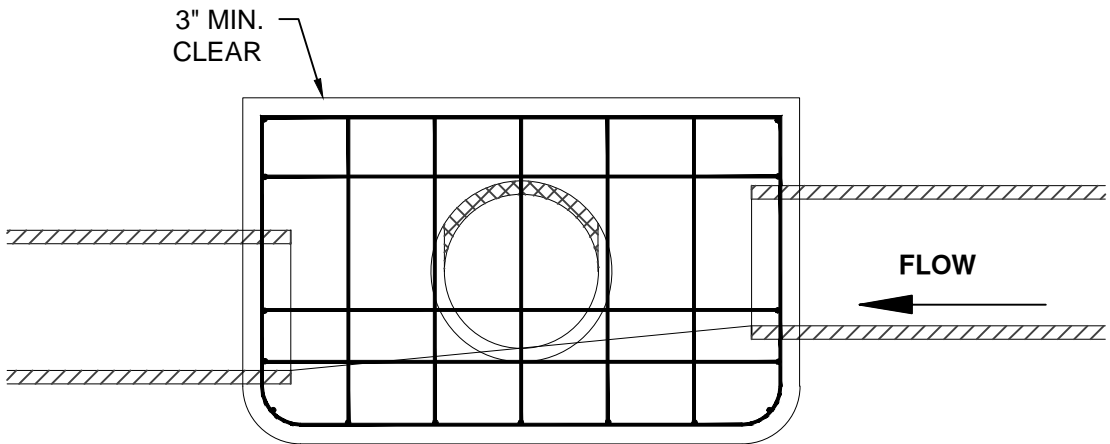
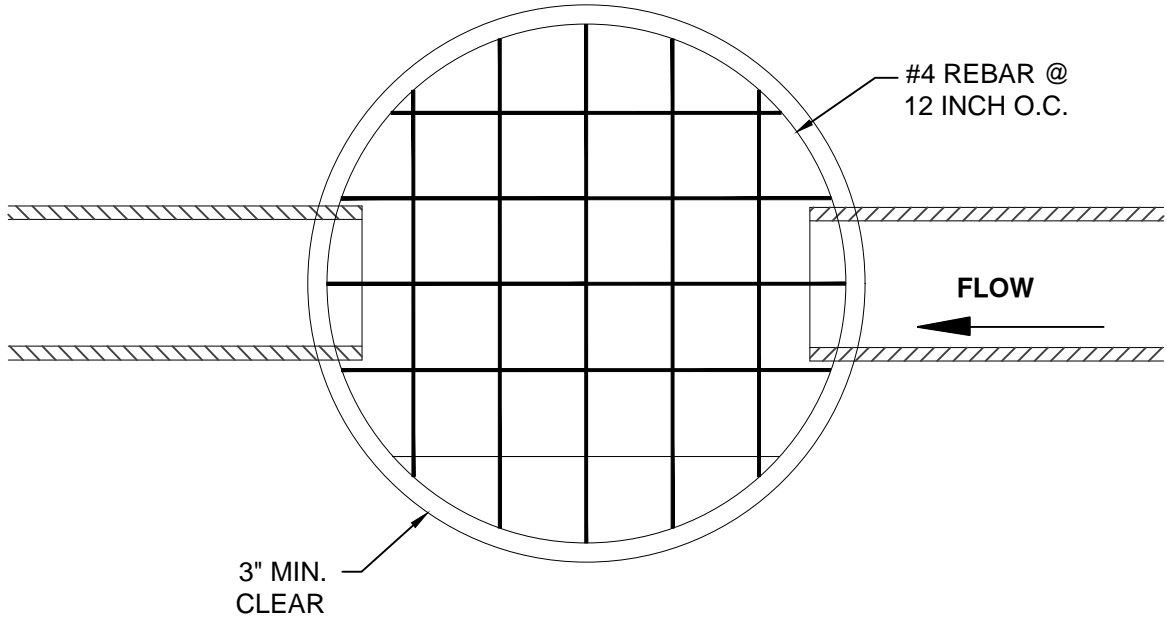
MANHOLE INVERT TIE-IN DETAIL

SM-9



1. THE REBAR BASKET MAY BE EITHER CIRCULAR (SEE SM-11) OR SQUARE.

FEBRUARY 2020	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	SM-10
SQUARE MANHOLE BASE RE-BAR BASKET		



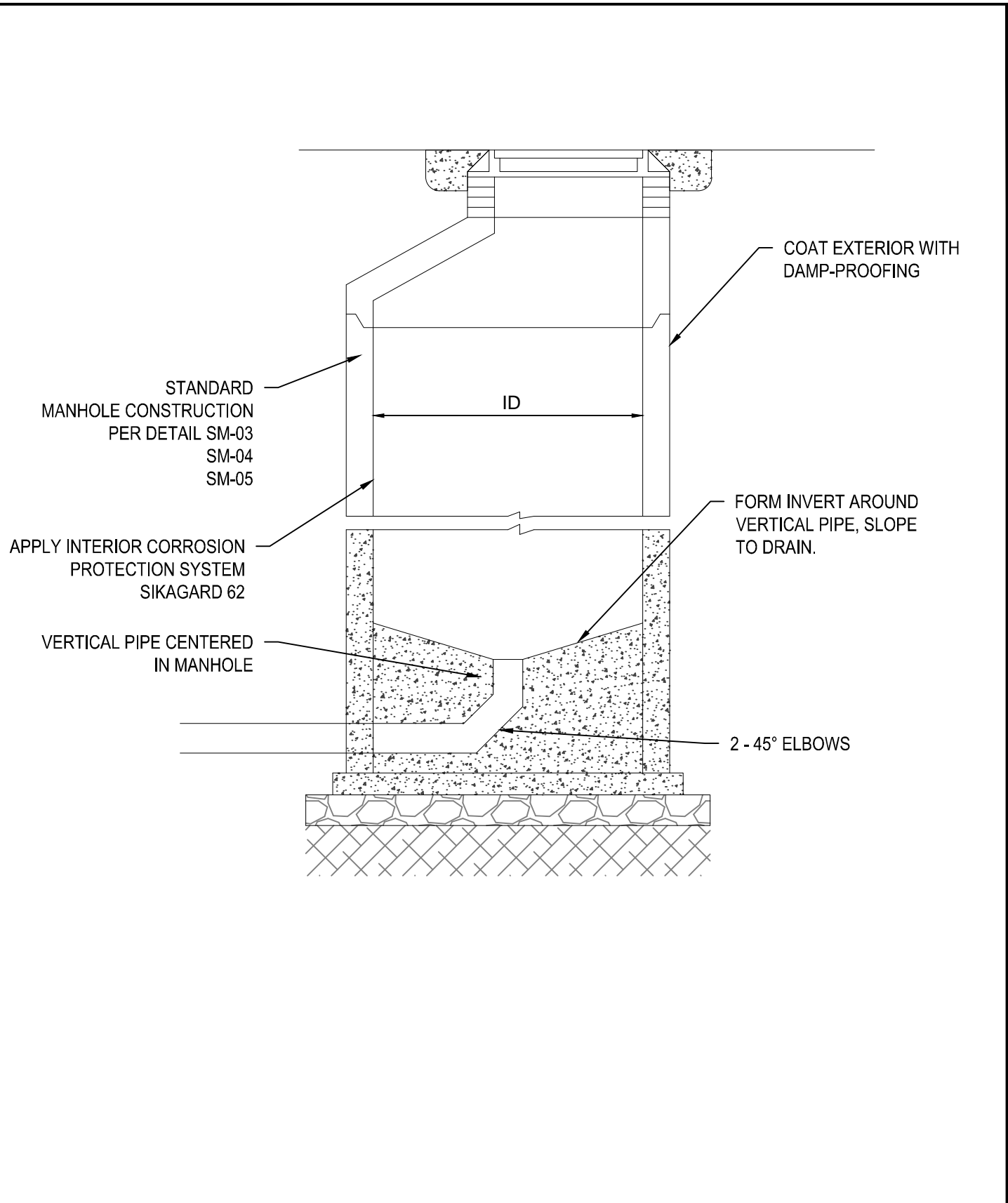
1. THE REBAR BASKET MAY BE EITHER CIRCULAR OR SQUARE (SEE SM-10).

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

CIRCULAR MANHOLE BASE RE-BAR
BASKET

SM-11

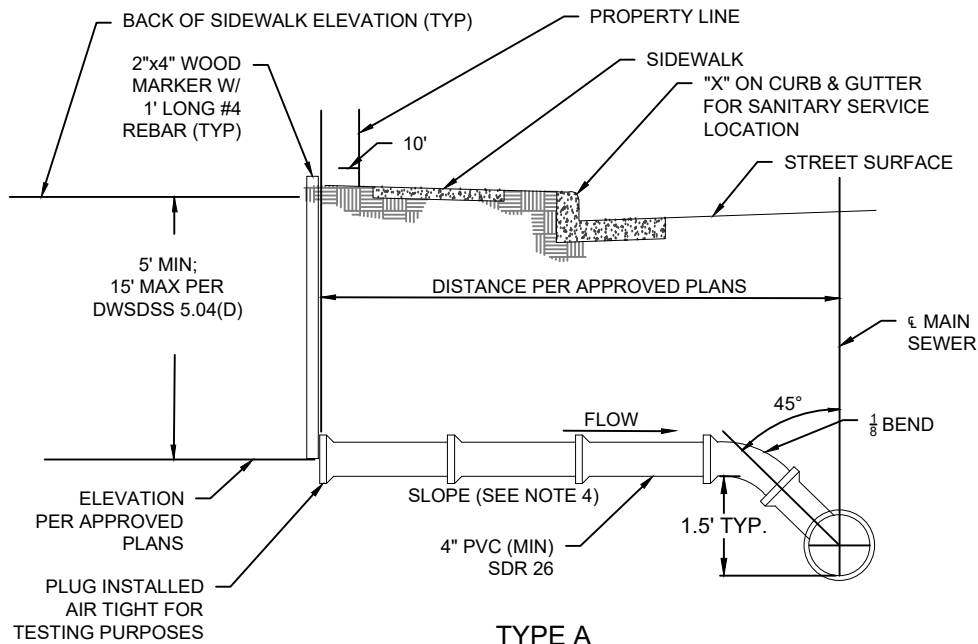


FEBRUARY 2020

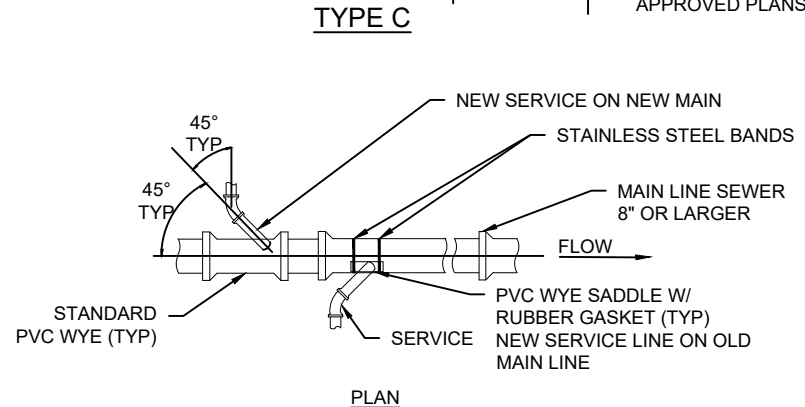
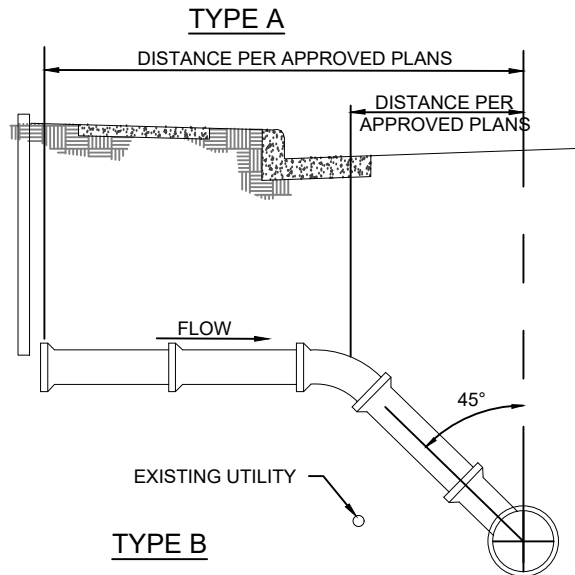
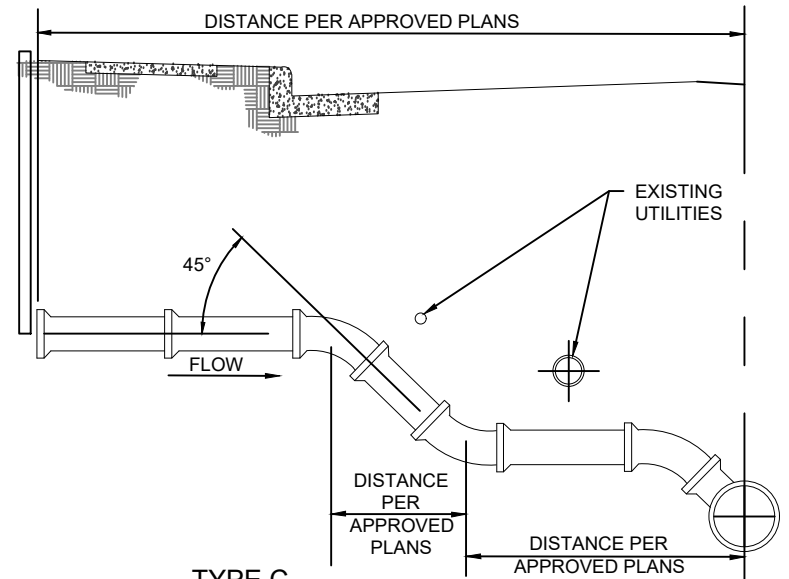
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

CLEANOUT MANHOLE DETAIL

SM-12



- NOTE:
1. TYPE "A" ELEMENTS ARE TYPICAL FOR ALL TYPES UNLESS SPECIFICALLY NOTED OTHERWISE.
 2. ALL LATERALS SHALL BE LOCATED PER DWSOSS DETAIL SS-11.
 3. ALL SEWER LATERAL CONNECTIONS SHALL BE TYPE "A" AND SHALL BE CONSTRUCTED ON A STRAIGHT LINE AND GRADE BETWEEN CONTROL POINTS EXCEPT AS OTHERWISE INDICATED ON THE APPROVED PROJECT PLANS.
 4. MIN SLOPE = 2.0% FOR 4", 1.0% FOR 6". MAX SLOPE = 8.0%
 5. INSTALL TRACER WIRE PER TR-4 AND TR-5.

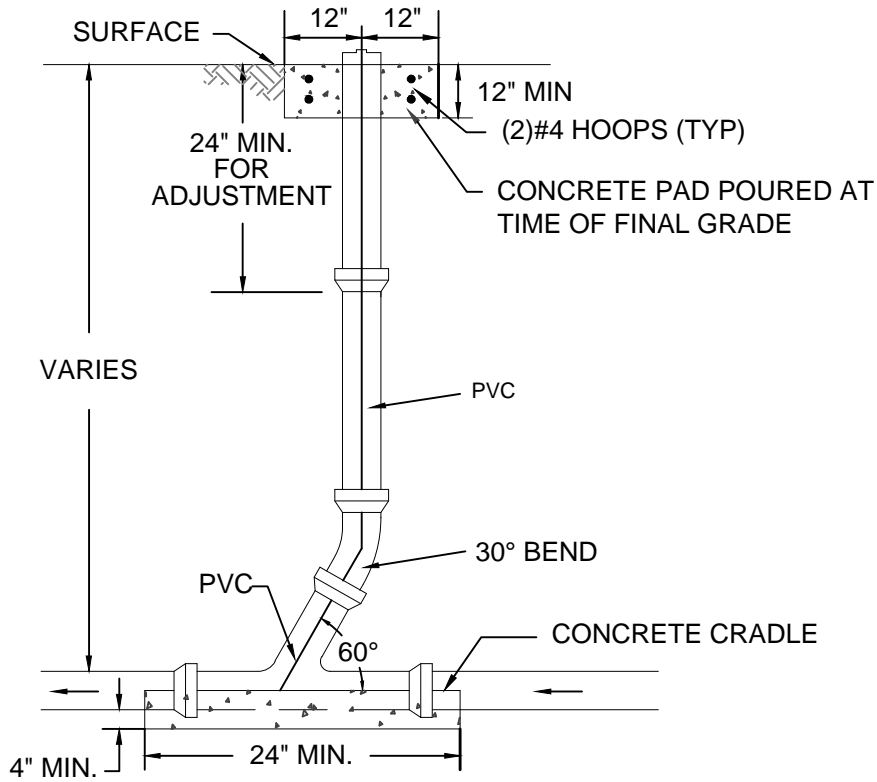


FEBRUARY 2020

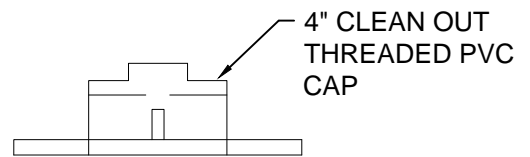
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

SEWER SERVICE LINE TAPPING DETAIL

SS-1



PLAN VIEW



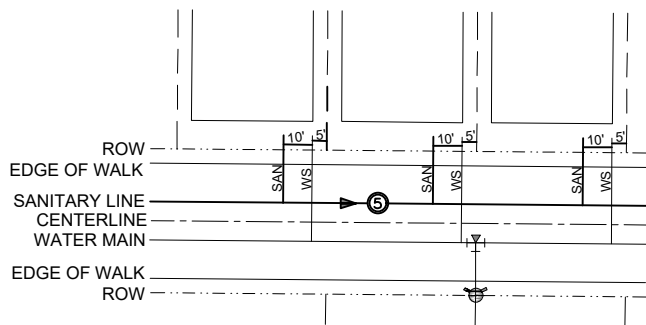
COVER DETAIL

FEBRUARY 2020

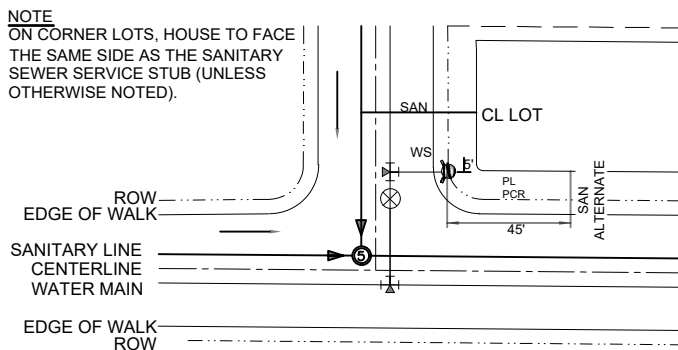
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

IN-LINE SANITARY SEWER CLEANOUT
(4-INCH AND 6-INCH)

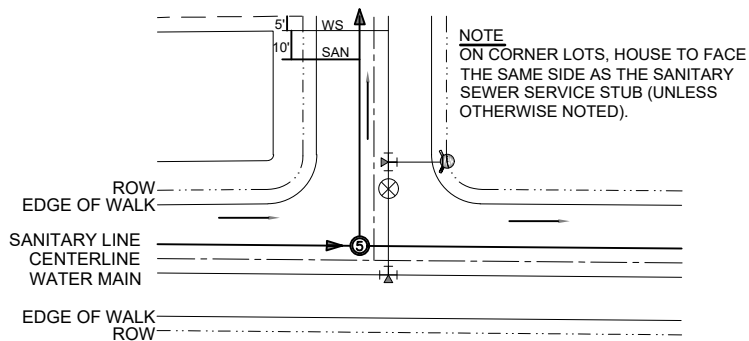
SS-2



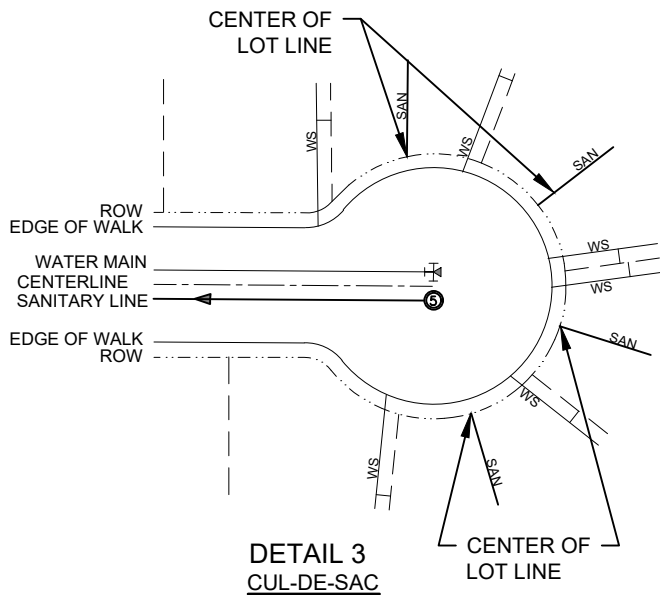
DETAIL 1
STRAIGHT LOT



DETAIL 2A
CORNER LOT
STREET GRADED TO INTERSECTION



DETAIL 2B
CORNER LOT
STREET GRADED AWAY INTERSECTION



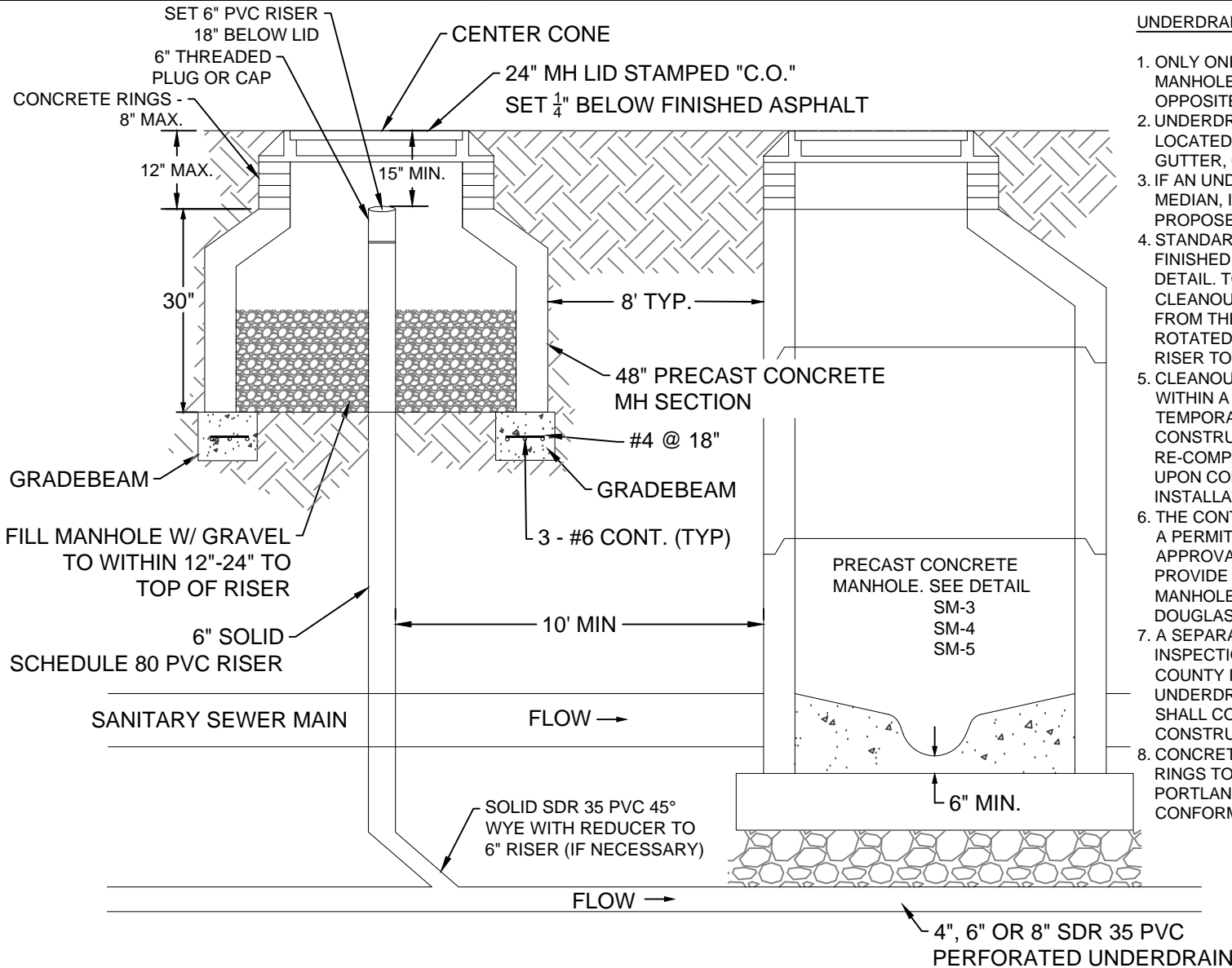
DETAIL 3
CUL-DE-SAC

NOVEMBER 2025

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

**TYPICAL SANITARY SEWER SERVICE
LOCATION**

SS-11



UNDERDRAIN NOTES:

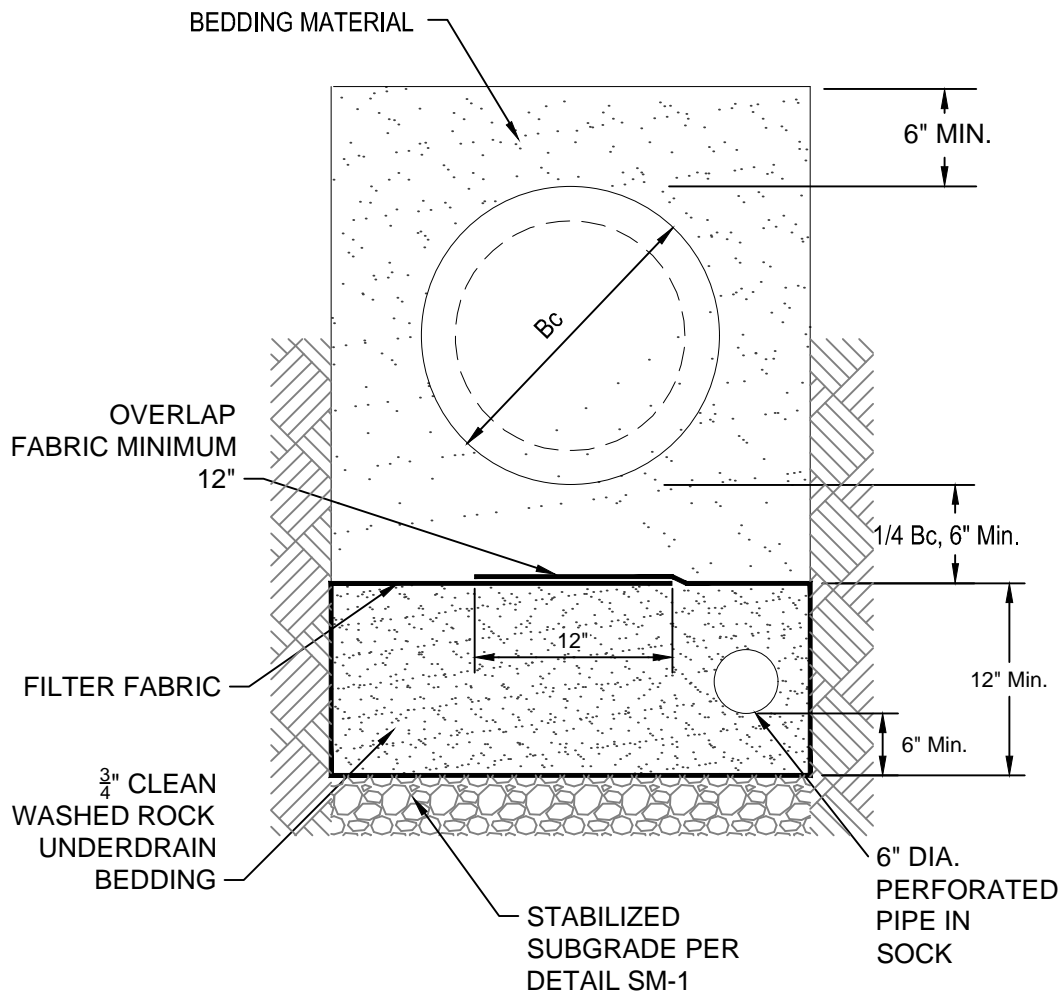
1. ONLY ONE CLEANOUT IS REQUIRED FOR EACH MANHOLE AND SHALL BE LOCATED ON THE OPPOSITE SIDE OF THE DOWNSTREAM INVERT.
2. UNDERDRAIN CLEANOUTS SHALL NOT BE LOCATED IN VEHICLE WHEEL PATHS, CURB AND GUTTER, CROSS-PANS OR SIDEWALKS.
3. IF AN UNDERDRAIN CLEANOUT FALLS WITHIN A MEDIAN, IT SHALL BE LOCATED BEHIND THE PROPOSED TRENCH DRAIN.
4. STANDARD CLEANOUTS SHALL BE RAISED TO FINISHED GRADE VERTICALLY AS SHOWN ON THIS DETAIL. TO AVOID OBSTRUCTIONS, THE CLEANOUT CAN BE LOCATED FURTHER UPSTREAM FROM THE MANHOLE OR THE 45° WYE CAN BE ROTATED AND A 45° BEND USED TO BRING THE RISER TO GRADE VERTICALLY.
5. CLEANOUT RISERS SHALL BE INSTALLED TO WITHIN A MINIMUM OF 18" BELOW SUBGRADE AND TEMPORARILY CAPPED DURING ROADWAY CONSTRUCTION INCLUDING SCARIFYING, RE-COMPACTING AND ROAD BASE INSTALLATION. UPON COMPLETION, THE CLEANOUT RISER INSTALLATION MAY BE COMPLETED.
6. THE CONTRACTOR WILL BE REQUIRED TO SUBMIT A PERMIT APPLICATION FOR REVIEW AND APPROVAL BY DOUGLAS COUNTY AND MUST PROVIDE A PRODUCT SUBMITTAL FOR THE MANHOLE SECTIONS AND LIDS SEPARATELY TO DOUGLAS COUNTY FOR APPROVAL.
7. A SEPARATE INSPECTION AND ASSOCIATED INSPECTION FEE MAY BE REQUIRED BY DOUGLAS COUNTY FOR THE 8 MIL POLY OF FILTER FABRIC UNDERDRAIN CONNECTIONS. THE CONTRACTOR SHALL CONTACT DOUGLAS COUNTY PRIOR TO CONSTRUCTION.
8. CONCRETE EXTENSION COLLARS AND MANHOLE RINGS TO BE FIELD MORTARED. MORTAR-1 PART PORTLAND CEMENT TO 3 PARTS SAND CONFORMING TO ASTM C 35.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

UNDERDRAIN CLEANOUT DETAIL
6", OR 8" UNDERDRAIN CLEANOUT ACCESS

UD-1



NOTES:

1. SEE CHAPTER 4, PARAGRAPH 4.02-M FOR BEDDING MATERIAL.
2. SEE CHAPTER 4, PARAGRAPH 4.03-B FOR BEDDING REQUIREMENTS.
3. SEE CHAPTER 5, PARAGRAPH 5.06-B FOR MATERIAL VARIANCE.
4. CDOT CLASS 1 WHEN IN BEDROCK.
5. NO UNDERDRAIN CLEANOUTS TO BE PROVIDED.
6. GEOTECH ENGINEER TO REVIEW BEDDING AND FABRIC SUBMITTALS
7. CUTOFF WALL AND 6" SOLID PIPE UNDERDRAIN OUTFALL TO BE PROVIDED AT DOWNSTREAM END OF SEWER RUN INTO A SWALE, NOT A CLOSED CONDUIT STORM SEWER SYSTEM.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

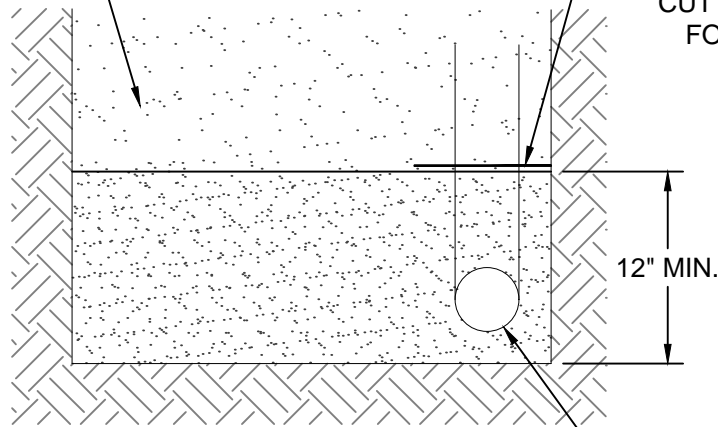
PIPE BEDDING DETAIL FOR
SEWER WITH UNDERDRAIN

UD-2

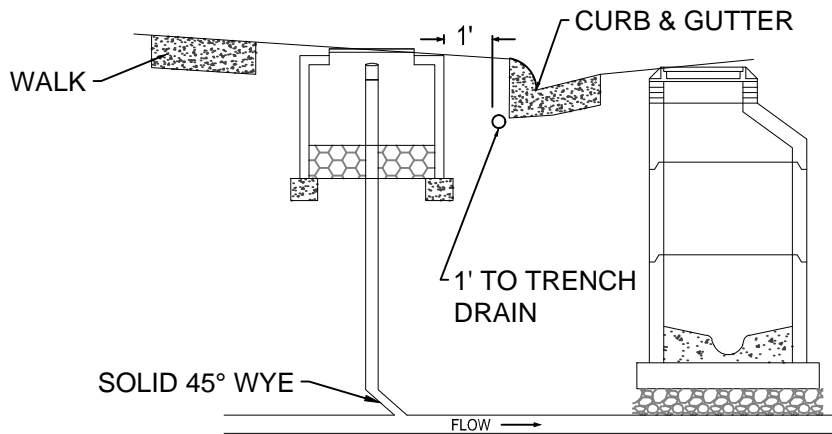
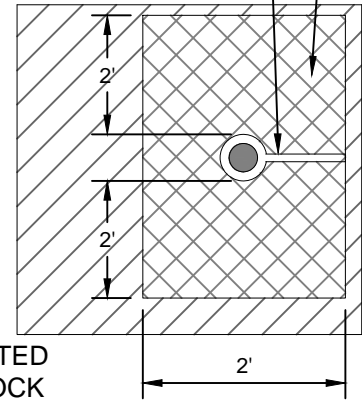
BEDDING MATERIAL

PENETRATION FOR UNDERDRAIN RISER. OVERLAP ADDITIONAL FILTER FABRIC 2-FT ON EACH SIDE OF PENETRATION

CUT 8 MIL FILTER FABRIC FOR CLEAN OUT RISER

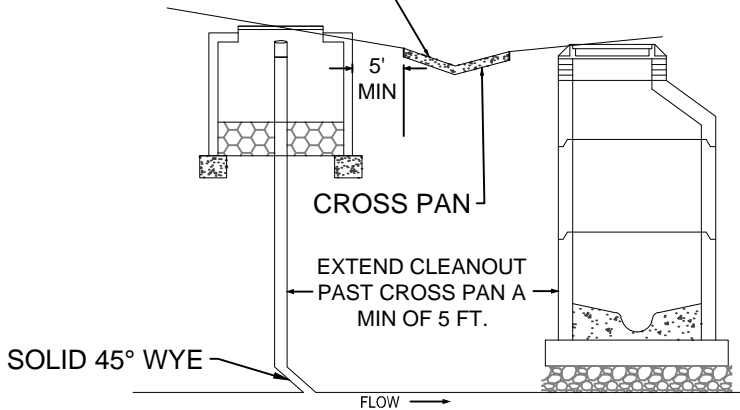


PERFORATED PIPE IN SOCK



FOR INSTANCES WHERE THERE IS A CONFLICT WITH CURB AND GUTTER OR A CROSS PAN, LOCATE RISER AND CLEANOUT AS SHOWN. RISERS SHALL BE LOCATED A MINIMUM OF 5-FT FROM THE EDGE OF GUTTER OR CROSS PAN.

EXTEND CLEANOUT PAST CROSS PAN A MIN. OF 5'

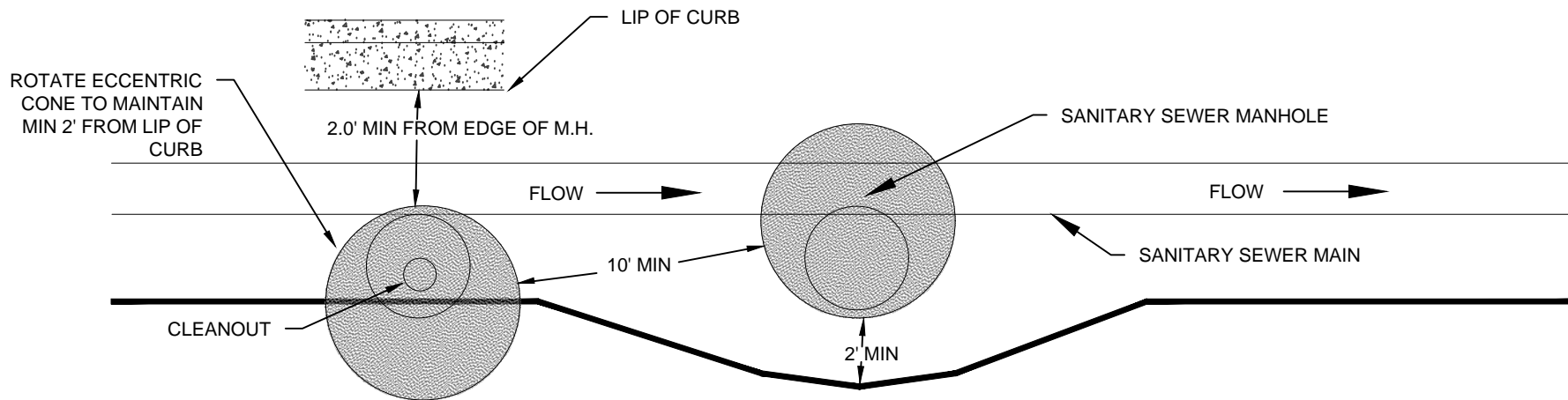


FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

UNDERDRAIN DETAILS

UD-3



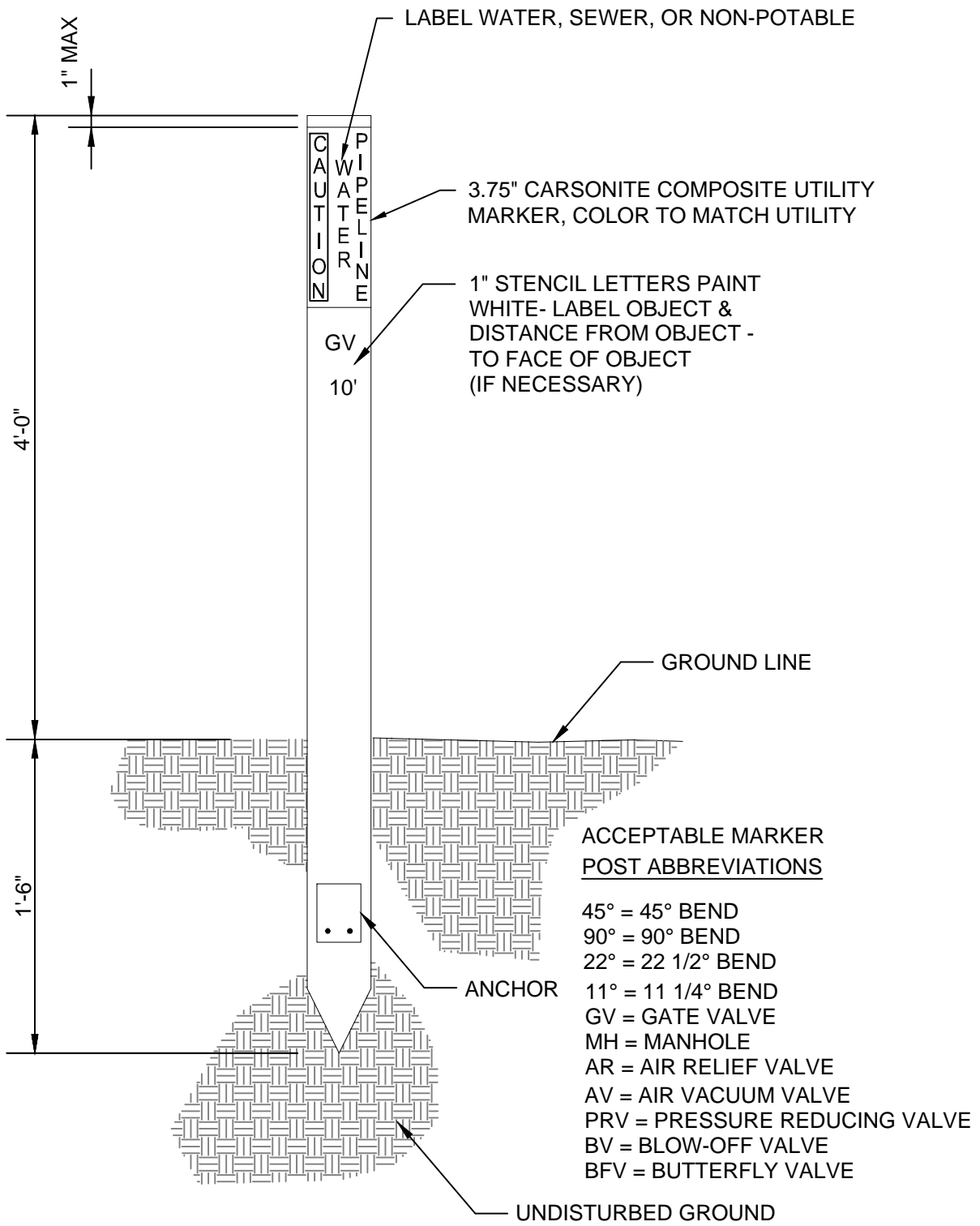
NOTE:
 PROVIDE EITHER $11\frac{1}{4}$ DEGREE
 OR $22\frac{1}{2}$ DEGREE BENDS WHEN DEFLECTIONS WILL
 EXCEED 1 DEGREE PER JOINT

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
 DOUGLAS COUNTY, COLORADO

UNDERDRAIN ALIGNMENT AT MANHOLES

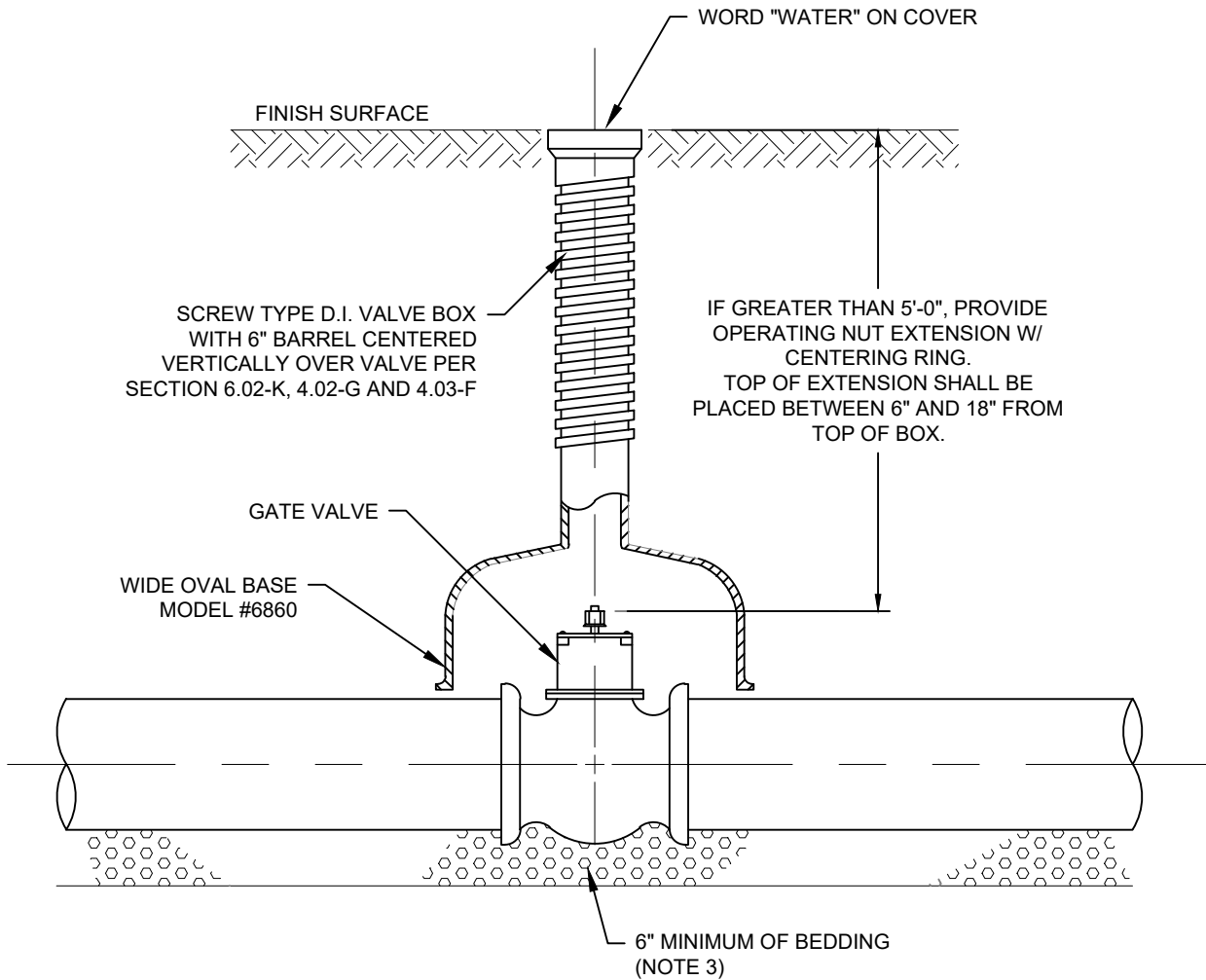
UD-4



NOTE:

1. USE MARKER POST IN AREAS WHERE UTILITY CANNOT BE LOCATED FROM OTHER IMPROVEMENTS, AND IN EASEMENTS AND OPEN SPACE.

FEBRUARY 2020	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	
	CARSONITE MARKER POST	WM-1



NOTES:

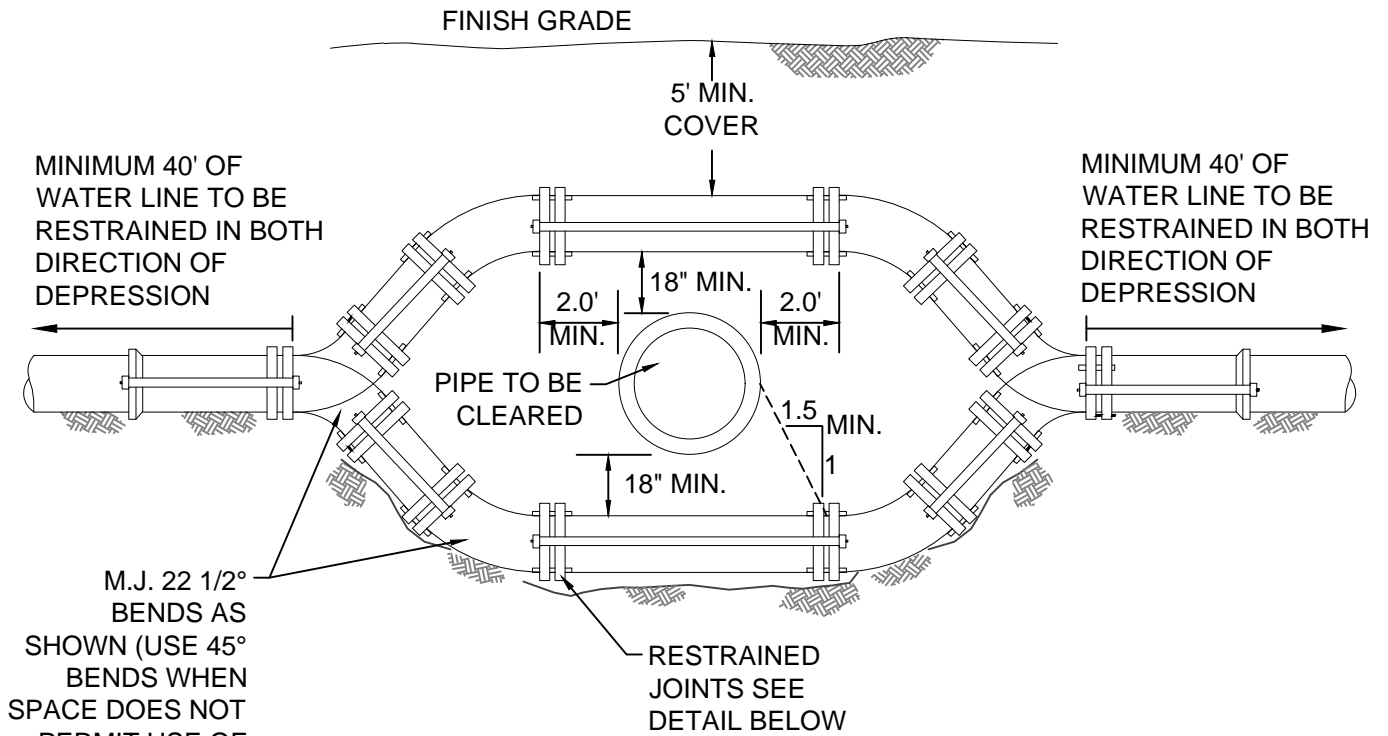
1. FITTINGS SHALL BE WRAPPED WITH 8 MIL MINIMUM THICKNESS POLYETHYLENE.
2. WHEN VALVES ARE TO BE INSTALLED WITHIN CONCRETE PAVEMENT, A 12" DIAMOND CUTOUT AND EXPANSION JOINT MATERIAL SHALL BE INSTALLED.
3. VALVE BOX SHALL SIT ON COMPACTABLE FILL DIRT/BASE MIX.

NOVEMBER 2025

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

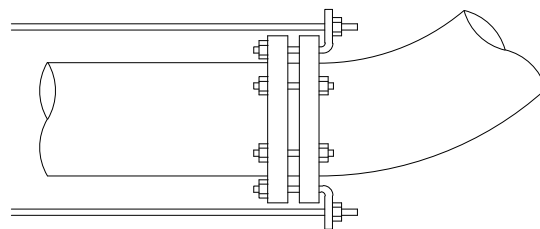
VALVE BOX DETAIL

WM-2



TYPICAL DETAIL FOR WATER LINE DEPRESSION

4", 6", 8", 10" & 12" DIAMETERS



TYPICAL RESTRAINED JOINTS

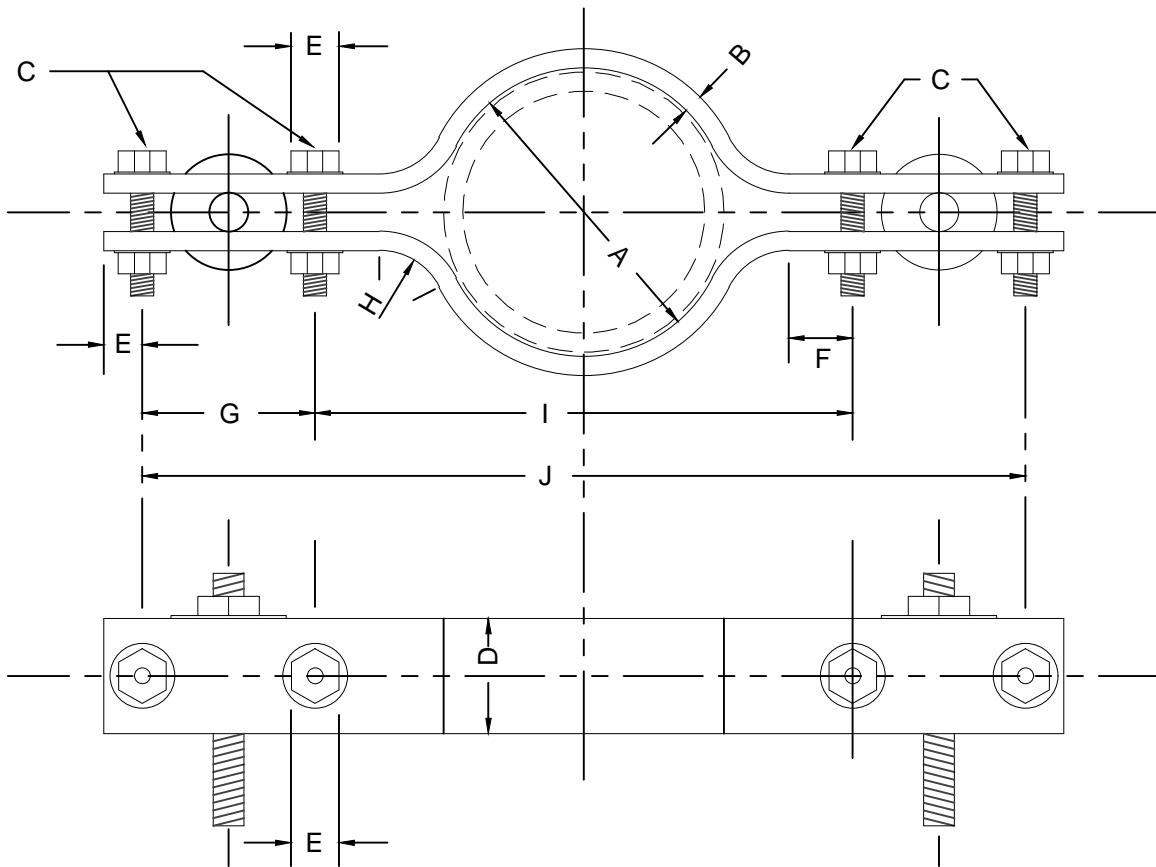
MEG-A-LUGS TYPE RESTRAINT OR APPROVED EQUAL

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

RESTRAINED JOINTS AT VERTICAL BENDS

WM-4



DIMENSIONS - INCHES

PIPE SIZE	ROD DIA.	A	B	C	D	E	F	G	H	I	J
4	$\frac{3}{4}$	5	$\frac{1}{2} \times 3 \frac{1}{2}$	$\frac{1}{2}$	2	$\frac{3}{4}$	0.660	3.10	1.13	8.58	16.28
6	$\frac{3}{4}$	$7 \frac{1}{16}$	$\frac{1}{2} \times 3 \frac{1}{2}$	$\frac{1}{2}$	2	$\frac{3}{4}$	0.660	3.10	1.13	10.64	18.34
8	$\frac{3}{4}$	$9 \frac{3}{16}$	$\frac{1}{2} \times 3 \frac{1}{2}$	$\frac{1}{2}$	2	$\frac{3}{4}$	0.660	3.10	1.13	12.78	20.48
10	$\frac{3}{4}$	$11 \frac{3}{8}$	$\frac{1}{2} \times 3 \frac{1}{2}$	$\frac{1}{2}$	2	$\frac{3}{4}$	0.660	3.10	1.13	14.96	22.66
12	$\frac{3}{4}$	$13 \frac{1}{2}$	$\frac{1}{2} \times 3 \frac{1}{2}$	$\frac{1}{2}$	2	$\frac{3}{4}$	0.660	3.10	1.13	17.08	24.78
14	1	$15 \frac{3}{4}$	$\frac{5}{8} \times 4 \frac{1}{2}$	$\frac{3}{4}$	3	$1 \frac{5}{16}$	0.780	4.14	1.69	20.70	30.86
16	1	$17 \frac{7}{8}$	$\frac{5}{8} \times 4 \frac{1}{2}$	$\frac{3}{4}$	4	$1 \frac{5}{16}$	0.780	4.14	1.69	22.80	32.96
18	1	20	$\frac{3}{4} \times 5$	$\frac{3}{4}$	4	$1 \frac{1}{8}$	0.950	4.14	1.69	25.28	35.81
20	1	$22 \frac{1}{8}$	$\frac{3}{4} \times 5$	$\frac{3}{4}$	4	$1 \frac{1}{8}$	0.950	4.14	1.69	27.40	37.93
24	$1 \frac{1}{4}$	$26 \frac{3}{8}$	$\frac{3}{4} \times 5 \frac{1}{2}$	$\frac{3}{4}$	5	$1 \frac{1}{8}$	0.950	5.18	1.69	31.66	42.19

NOTES:

1. DIMENSIONS ARE BASED ON BOX END WRENCH CLEARANCES. 2. DIMENSION "G" HAS BEEN SIZED TO ACCOMMODATE TWO (2) RODS, IF NEEDED.
3. STEEL PLATE OR WASHERS ARE TO BE USED TO SECURE TIE ROD.
4. CLAMPS SHALL BE EPOXY COATED.

FEBRUARY 2020

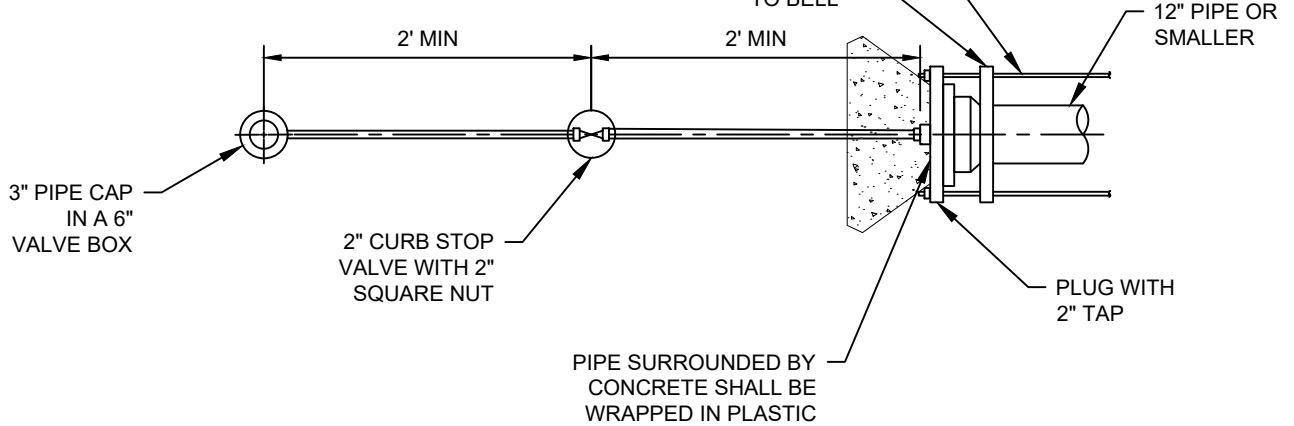
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

TIE-ROD RETAINING CLAMP

WM-5

NOTE:

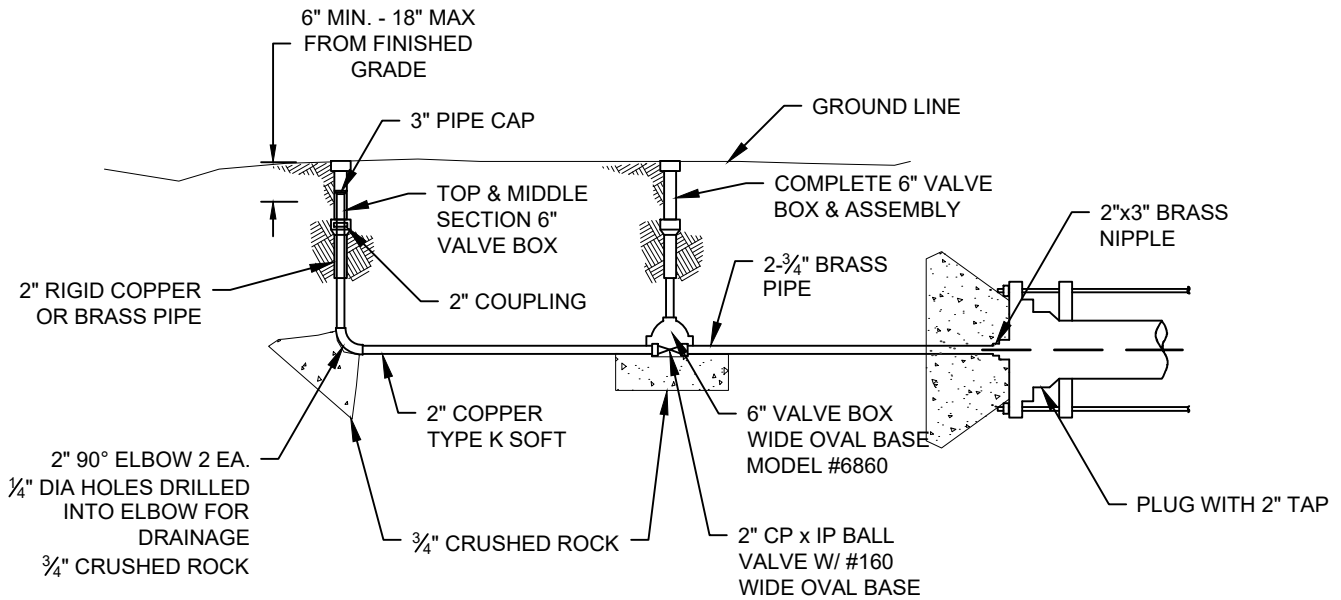
1. PLUG SHALL BE MECHANICALLY RESTRAINED. A. FOR SLEEVE TYPE MACHINED COUPLING. PIPE TIE BACK TO NEXT COUPLING.
- B. FOR BELL AND SPIGOT PIPE TIE TO BELL



NOTE:

2. CONTRACTOR TO ORIENT THE 2" BLOW OFF LINE AND ASSOCIATED VALVE BOXES WITH DOMINION ONSITE APPROVAL.

PLAN



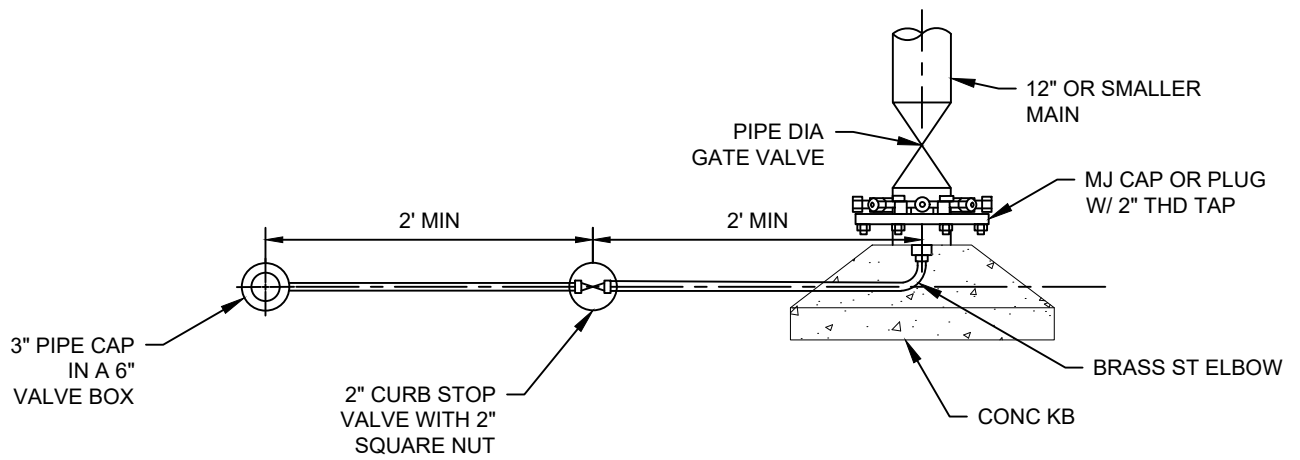
ELEVATION

NOVEMBER 2025

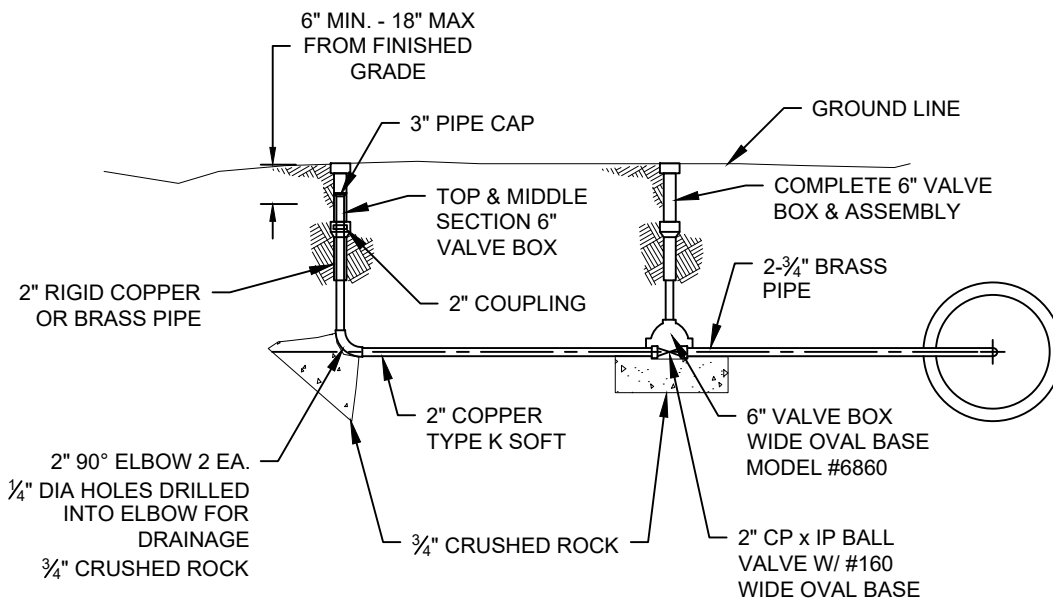
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

**STANDARD FOR TEMPORARY
BLOW-OFF VALVE INSTALLATION**

WM-7



PLAN



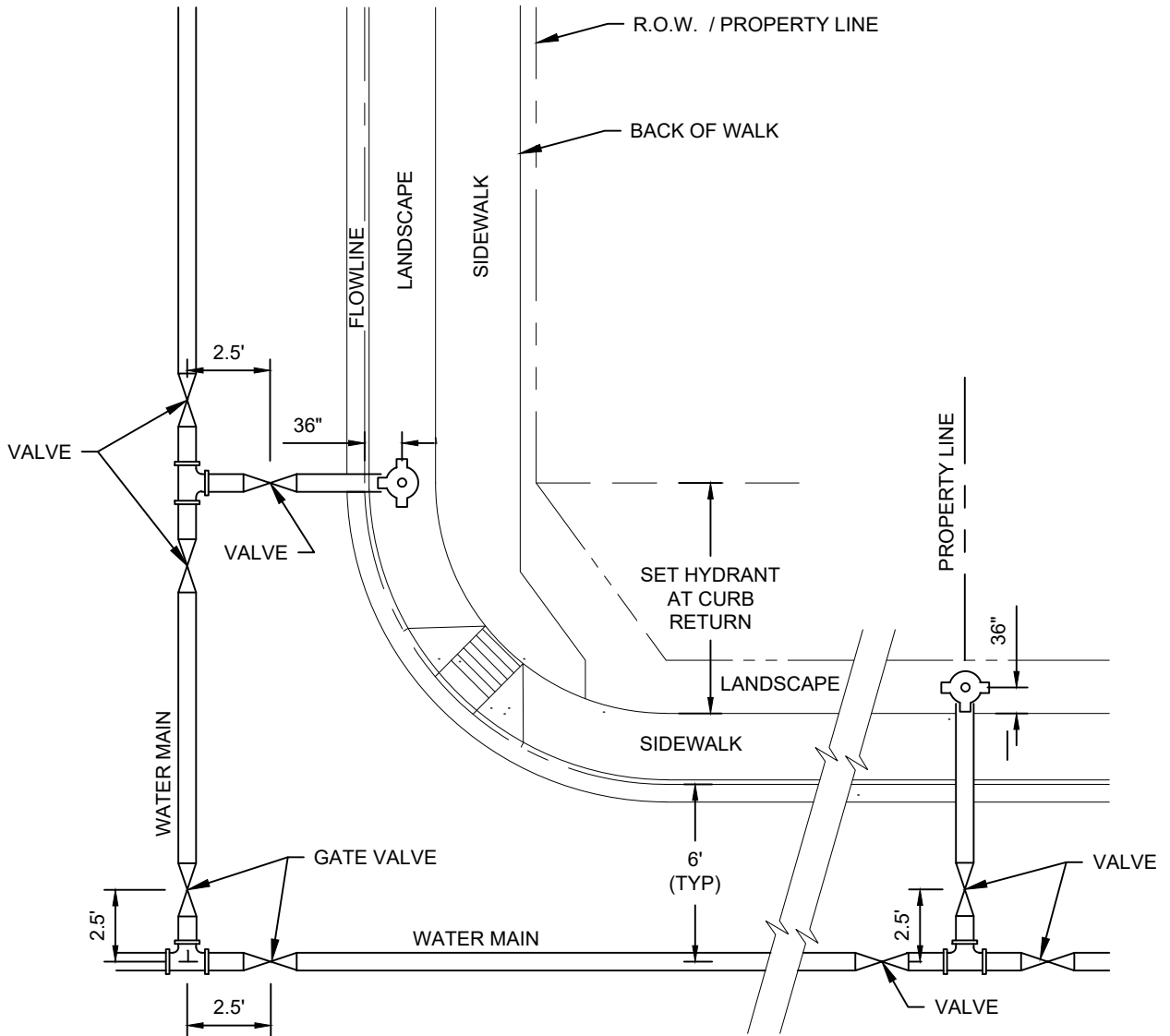
ELEVATION

NOVEMBER 2025

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

PERMANENT BLOW-OFF INSTALLATION

WM-8



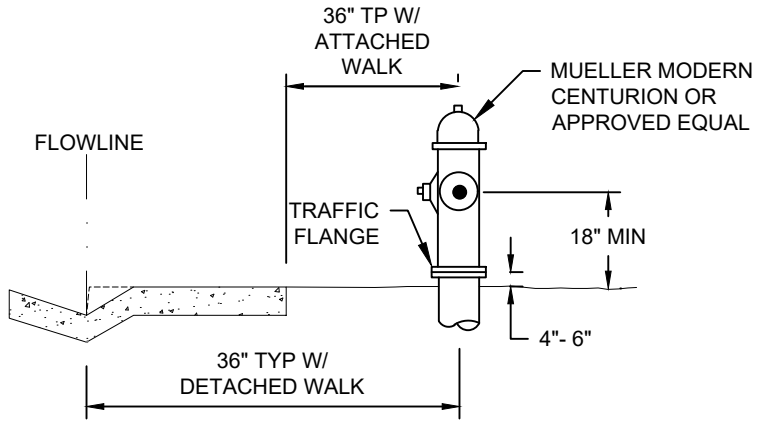
NOTE:
 FIRE HYDRANTS SHALL BE PLACED 36" FROM THE CENTER OF THE HYDRANT TO THE FLOWLINE FOR DETACHED WALKS, OR 36" FROM THE CENTER OF THE HYDRANT TO THE BACK OF WALK FOR ATTACHED WALKS

NOVEMBER 2025

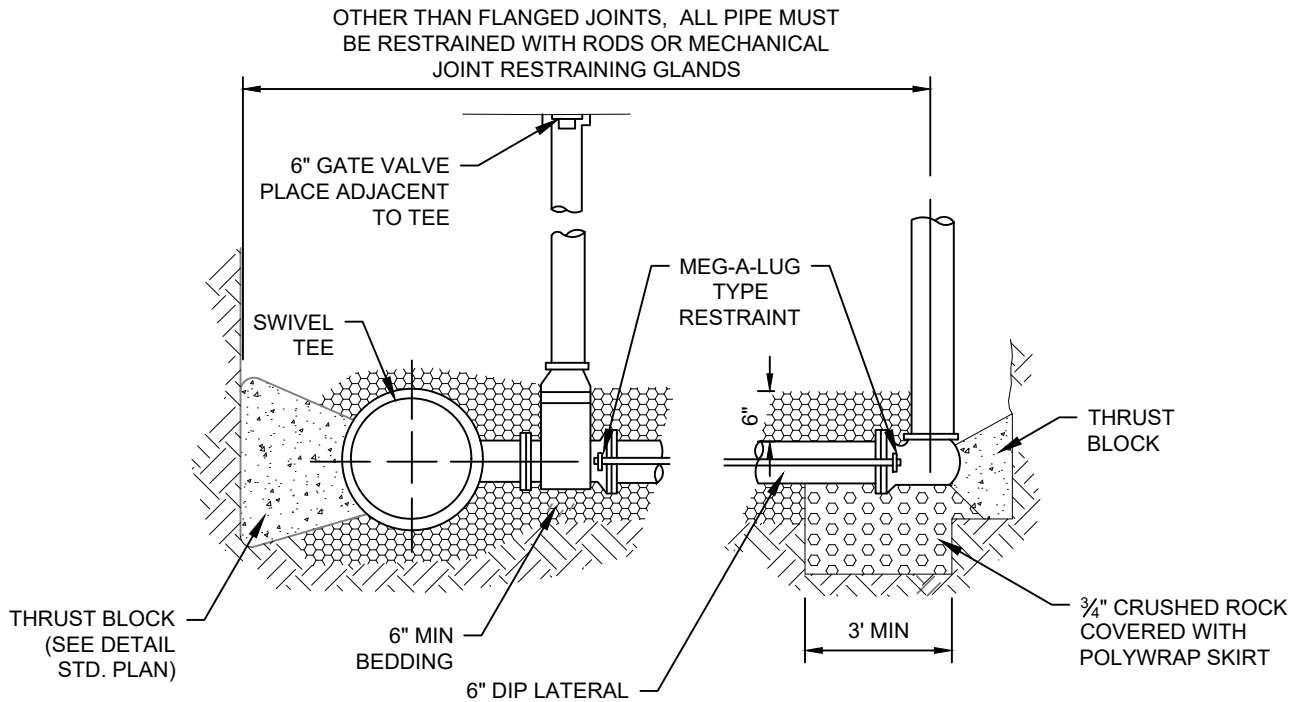
DOMINION WATER AND SANITATION DISTRICT
 DOUGLAS COUNTY, COLORADO

VALVE AND FIRE HYDRANT LOCATION
 DETAIL

WM-10



HYDRANT & LATERAL RESTRAINED & WRAPPED



NOTES:

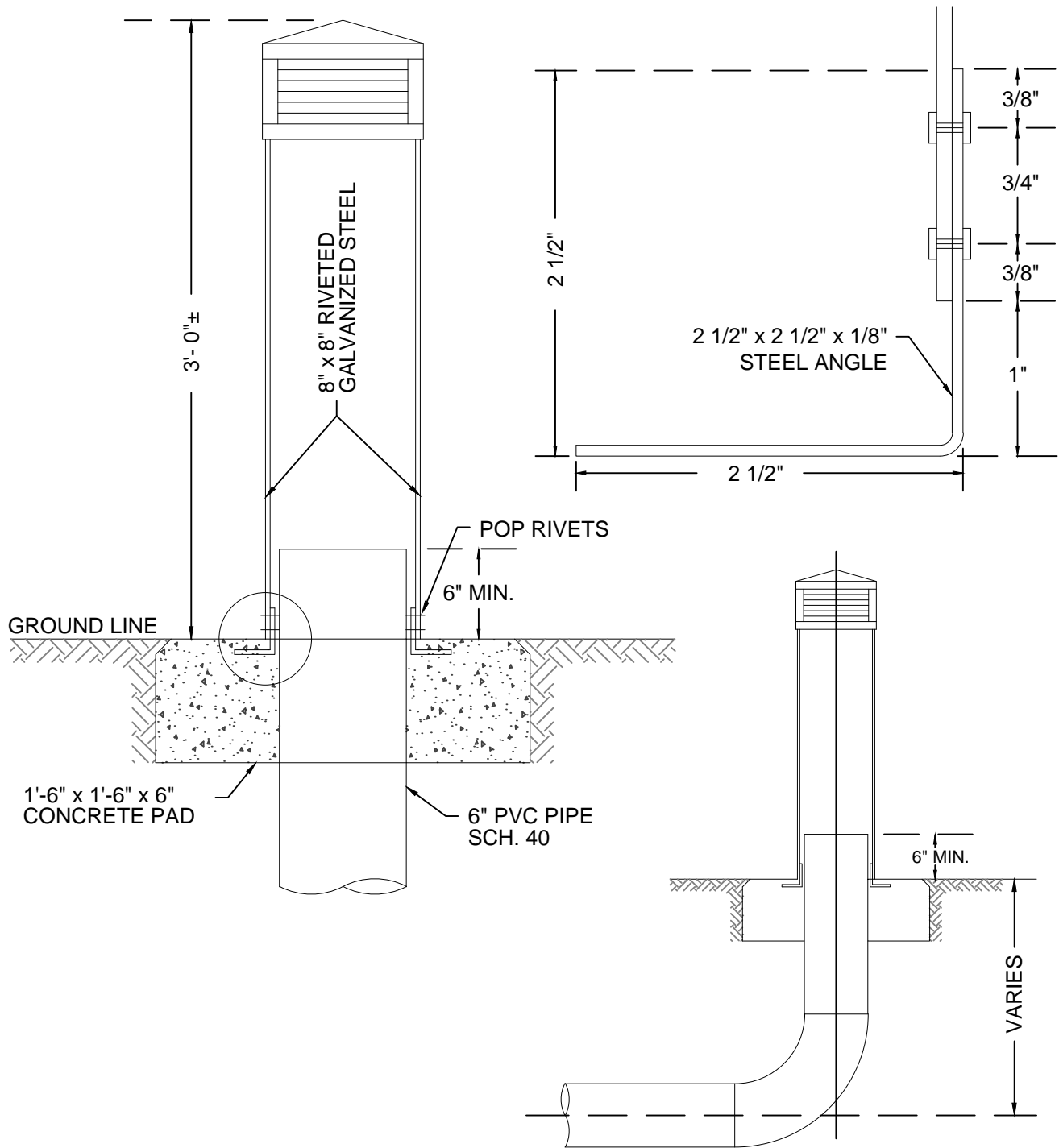
1. HYDRANT PIT SHALL CONTAIN A MINIMUM OF 1 C.Y. OF 3/4" CRUSHED ROCK.
2. REFERENCE SECTION 4.03-I FOR DISTANCE FROM BACK OF WALK.

NOVEMBER 2025

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

TYPICAL FIRE HYDRANT AND ASSEMBLY

WM-11

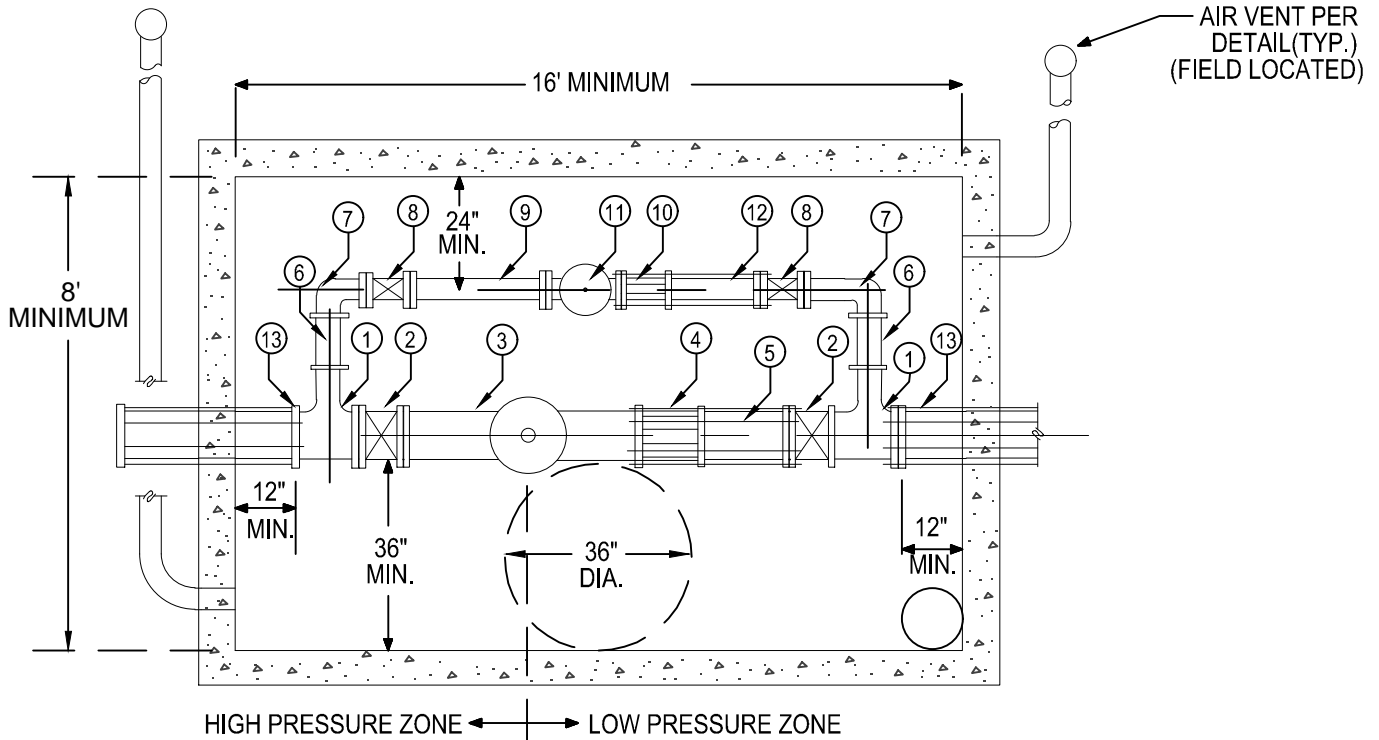


FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

AIR VENT DETAIL

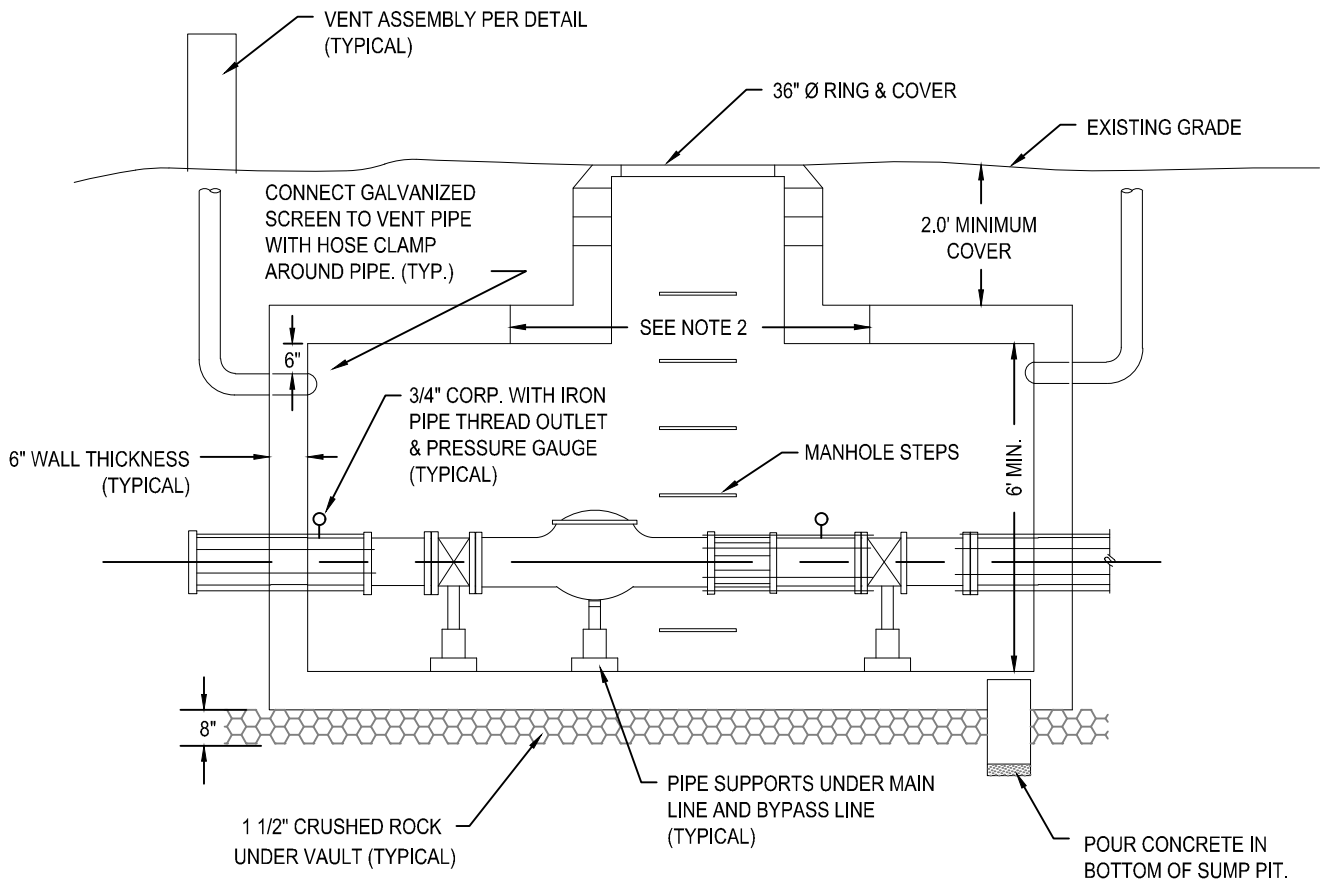
WM-13



HIGH PRESSURE ZONE ← | → LOW PRESSURE ZONE
 FOR SCHEDULE OF PIPING SEE DETAIL WM-12c.

- 1. ** x 8" Tee (FL x FL x FL)
 - 2. ** Gate Valve (FL x FL)
 - 3. ** Pressure Reducing / Sustaining Valve CLA -VAL Series 92G-01
 - 4. ** Dresser Coupling
 - 5. ** Spool (FL x PE)
 - 6. 8" x 4" Reducer (FL x FL)
 - 7. 4" 90° Bend (FL x FL)
 - 8. 4" Gate Valve (FL x FL)
 - 9. 4" Spool (FL x FL)
 - 10. 4" Dresser Coupling
 - 11. 4" Pressure Reducing / Sustaining Valve CLA-VAL Series 92G-01
 - 12. 4" Spool (FL x PE)
 - 13. Adaptor (FL x MJ) W/ Insulating Flange
 - 14. All fittings and piping will be painted "Precaution Blue" Enamel
- ** = Size to be determined by main pipeline

FEBRUARY 2020	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	WM-14
	PRESSURE REDUCING VAULT (DETAIL 1 OF 2)	



NOTES

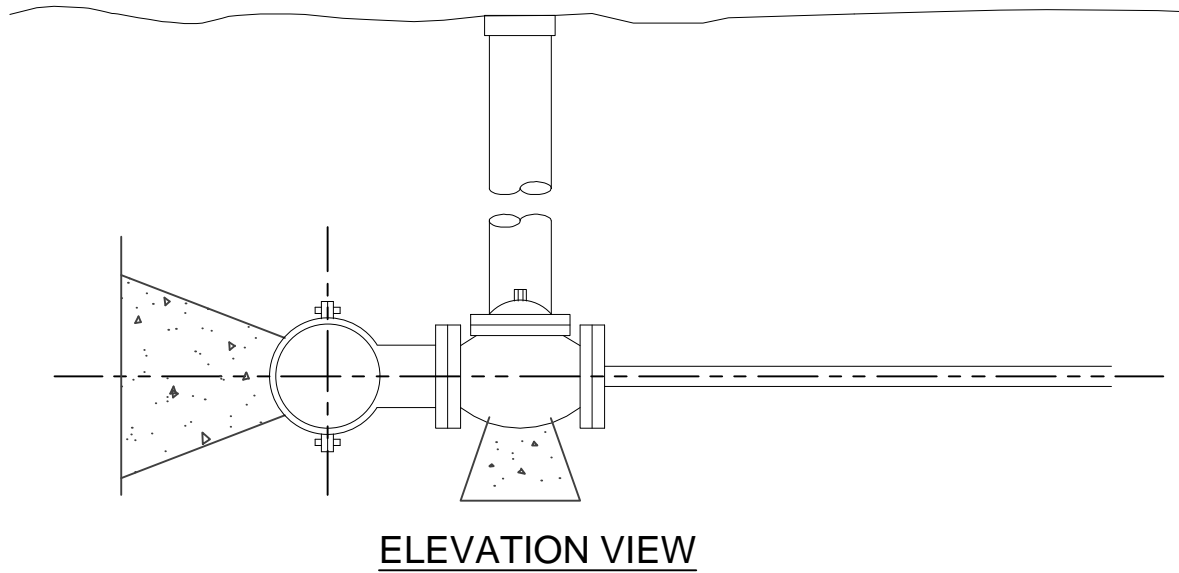
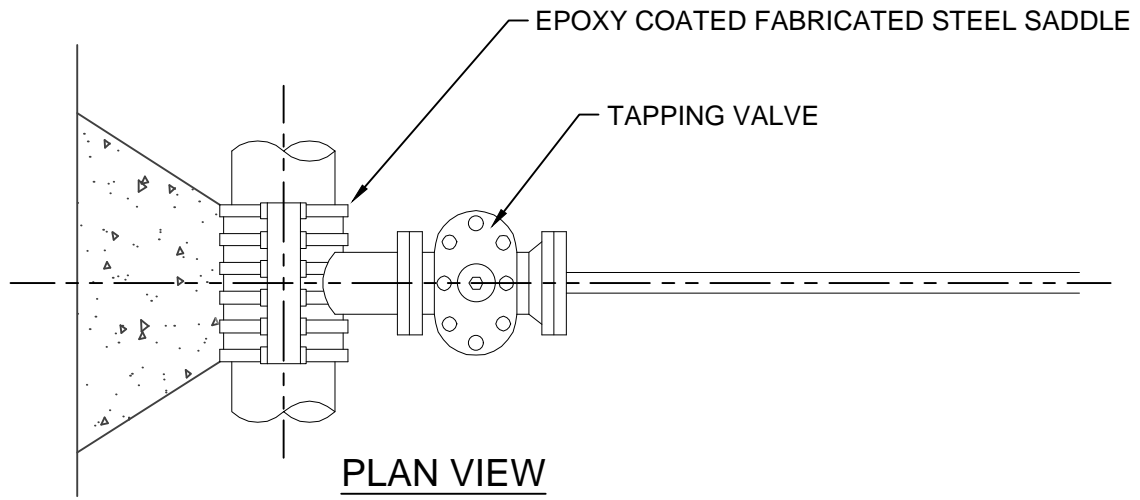
1. EXTERIOR CONCRETE SURFACES SHALL BE DAMP-PROOFED IN ACCORDANCE WITH THE SPECIFICATIONS.
2. VAULT LID SHALL HAVE A REMOVABLE SECTION (MINIMUM 6' WIDE) WITH LIFTING RING.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

PRESSURE REDUCING VAULT
(DETAIL 2 OF 2)

WM-15



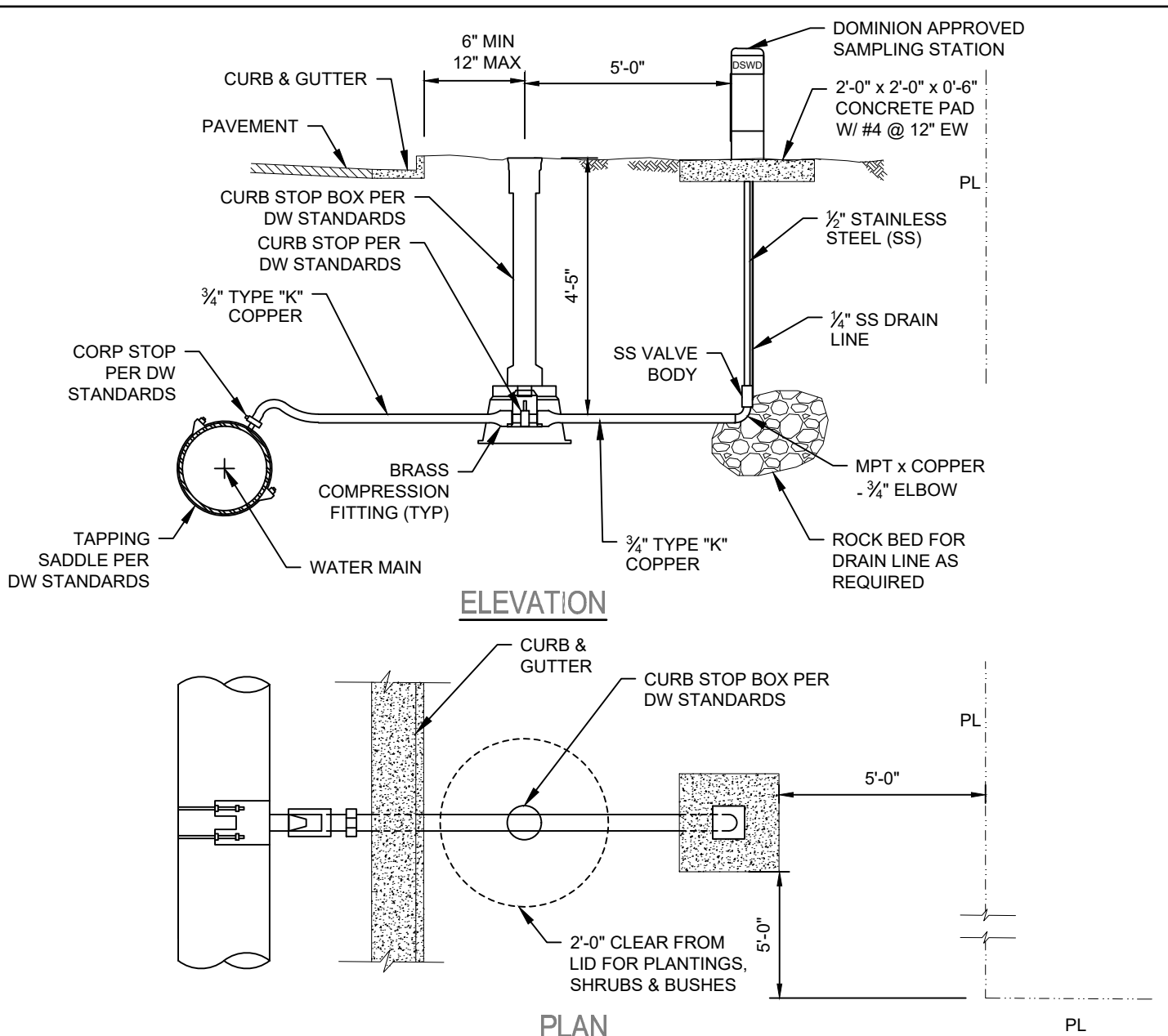
NOTE: WET TAP ON 16" OR LARGER MAINS SHALL BE A MINIMUM OF 4" DIAMETER.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

WET TAP

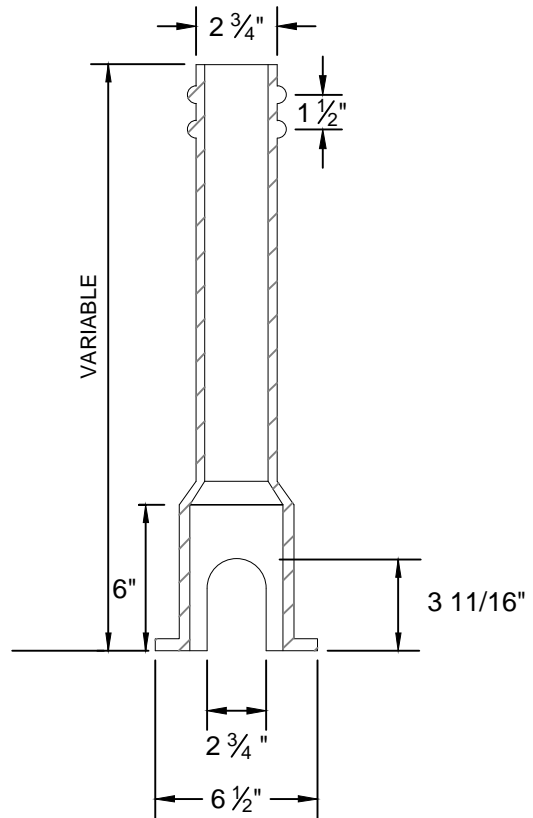
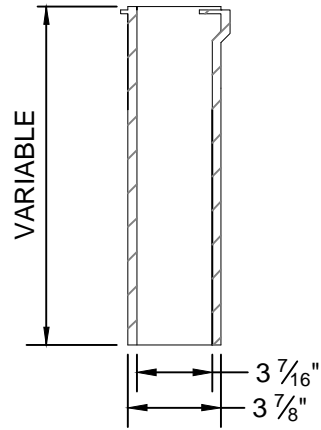
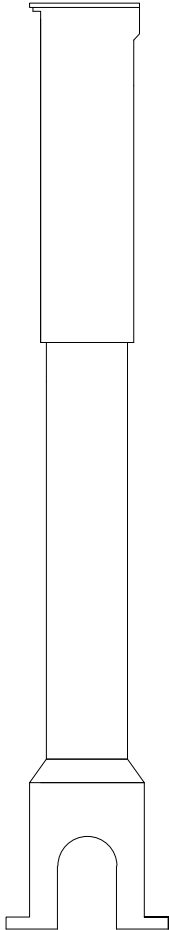
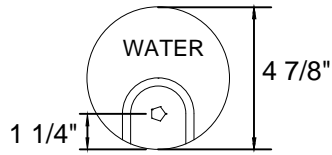
WM-18



NOTES:

1. PROVIDE KEPFERLE ECLIPS #88-SS WITH THE FOLLOWING OPTIONS:
 - A. 3/4" FIP INLET
 - B. 3/4" NON-THREADED NOZZLE
 - C. DWSO LOGO ON HOUSING
 - D. 1/4" PETCOCK ASSEMBLY ON DRAIN LINE
2. IF THERE IS A TREE LAWN BETWEEN THE CURB AND SIDEWALK, INSTALL THE STOP BOX AN THE REMOTE SAMPLING STATION IN THE TREE LAWN. IF NO TREE LAWN EXISTS, AND THE SIDEWALK IS ADJACENT TO THE BACK OF THE CURB, THE CURB BOX SHALL BE 6 INCHES (6") TO TWELVE INCHES (12") FROM THE BACK OF THE SIDEWALK.
3. LOCATE THE STOP BOX IN A PUBLIC RIGHT-OF-WAY, SIX INCHES (6") TO TWELVE INCHES (12") FROM THE BACKSIDE OF THE CURB OR SIDEWALK, IN A LANDSCAPED AREA, TWENTY-FOUR INCHES (24") FROM THE INLET SIDE OF THE REMOTE SAMPLING STATION. FOR A CURB STOP LOCATED BENEATH PAVEMENT, USE A ROADWAY BOX OVER A STANDARD STOP BOX WITH A BOND BREAKER. THE CURB STOP SHALL NOT BE LOCATED BENEATH PARKING AREAS.

NOVEMBER 2025	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	
WATER QUALITY SAMPLING STATION DETAIL		WM-25



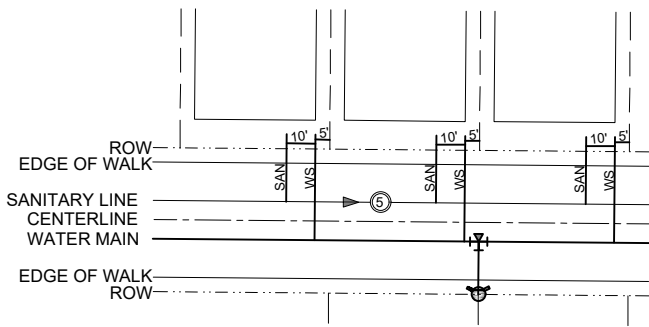
1. CURB STOP BOX SHALL BE TYLER MODEL 6500 SERIES, SIZE 95E OR APPROVED EQUAL.
2. A 2" X 9" CONCRETE PAD SHALL BE PLACED UNDER THE CURB STOP VALVE AND BOX.

FEBRUARY 2020

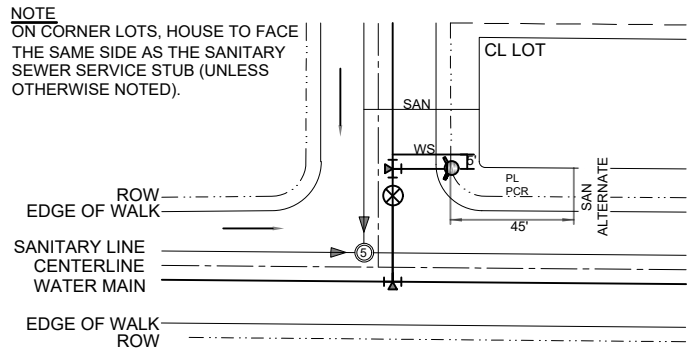
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

TYPICAL - CURB STOP FOR
3/4" & 1" WATER SERVICE

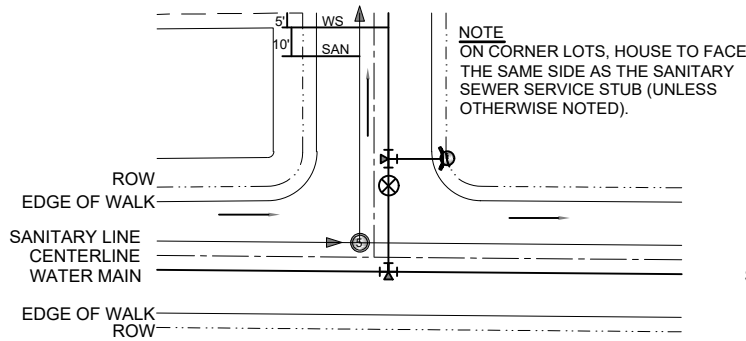
WS-1



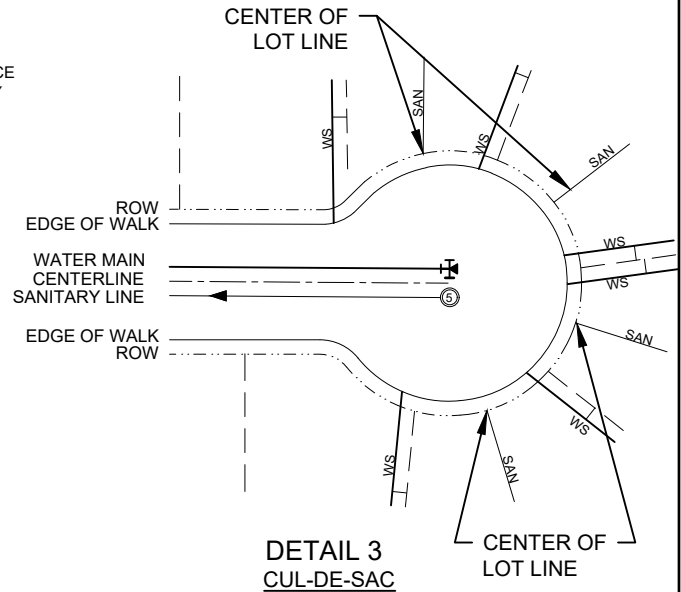
DETAIL 1
STRAIGHT LOT



DETAIL 2A
CORNER LOT
STREET GRADED TO INTERSECTION



DETAIL 2B
CORNER LOT
STREET GRADED AWAY INTERSECTION



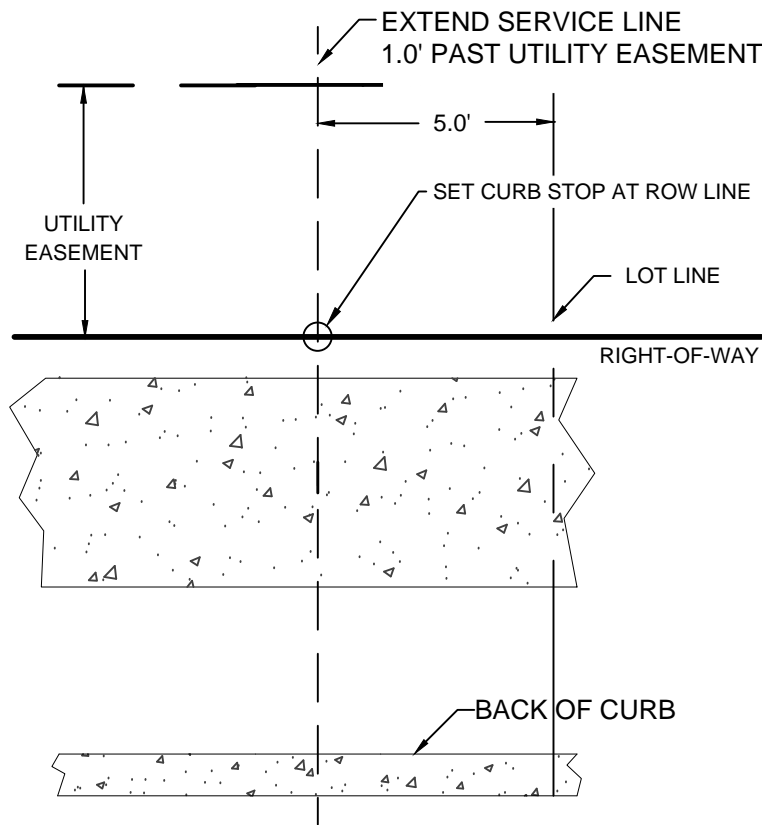
DETAIL 3
CUL-DE-SAC

NOVEMBER 2025

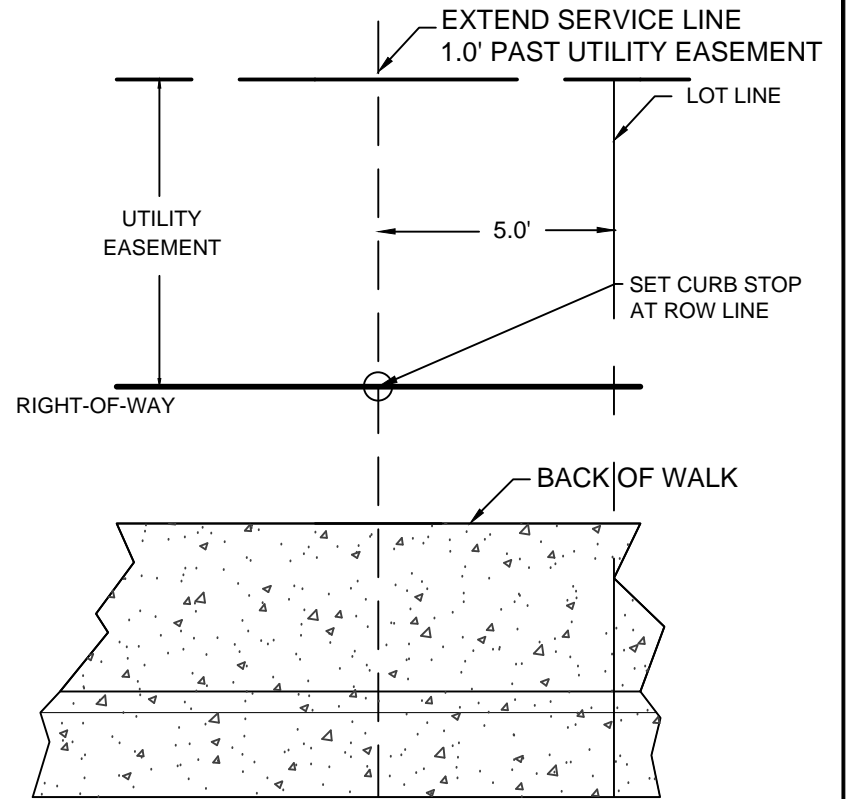
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

**RESIDENTIAL - TYPICAL WATER SERVICE
LOCATION**

WS-2



DETACHED SIDEWALK



ATTACHED SIDEWALK

NOTES:

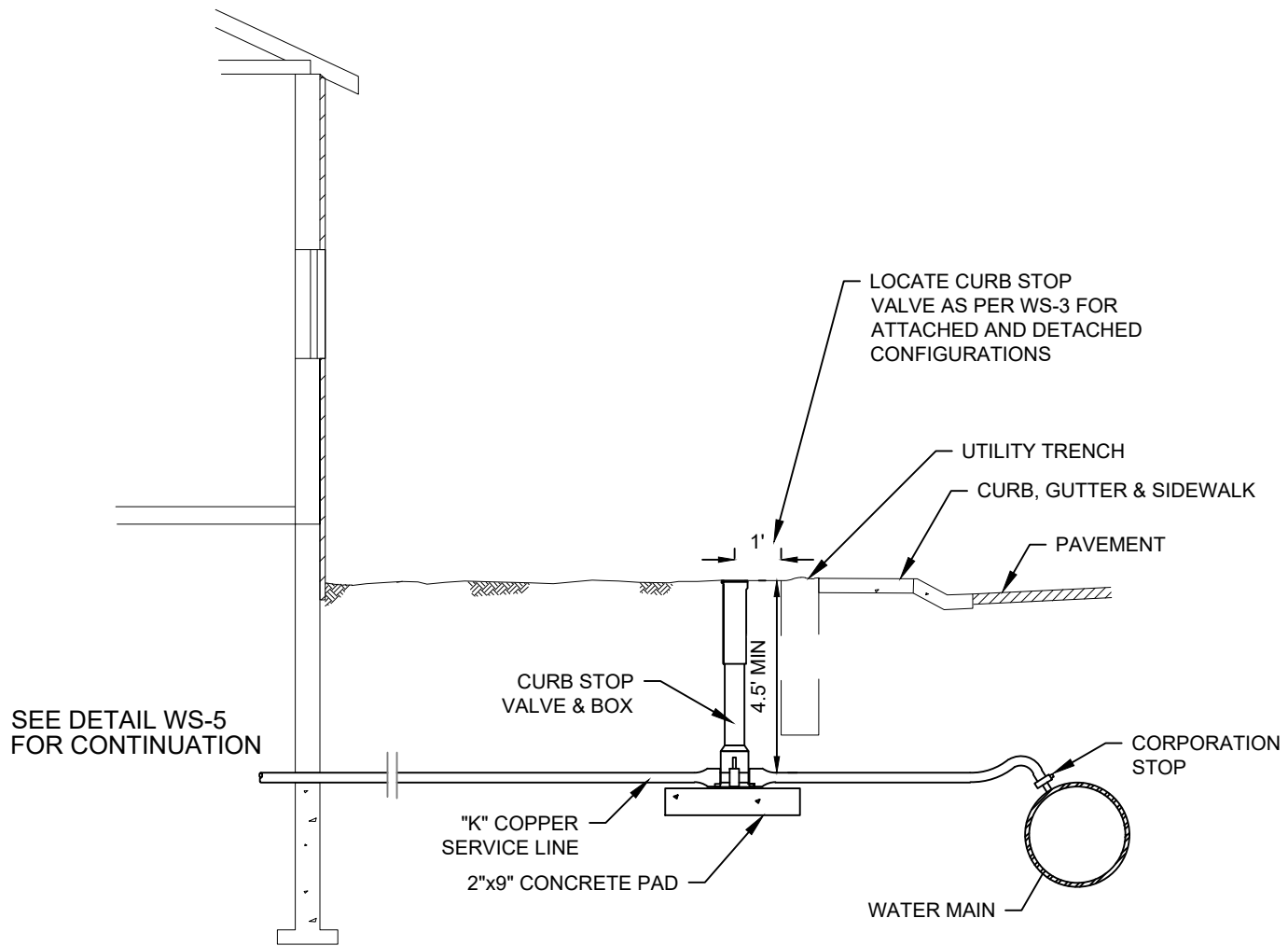
1. A "V" SHALL BE CUT IN THE FACE OF THE CURB AND GUTTER BY THE BUILDER TO PERMANENTLY MARK THE LOCATION OF THE CURB STOP BOX. THE "V" SHALL BE A MINIMUM OF 3" IN HEIGHT AND 1/8" IN DEPTH.
2. ALL WATER SERVICE LINES SHALL BE PLACED AS SHOWN ON WS-2

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

RESIDENTIAL - CURB STOP BOX LOCATION

WS-3

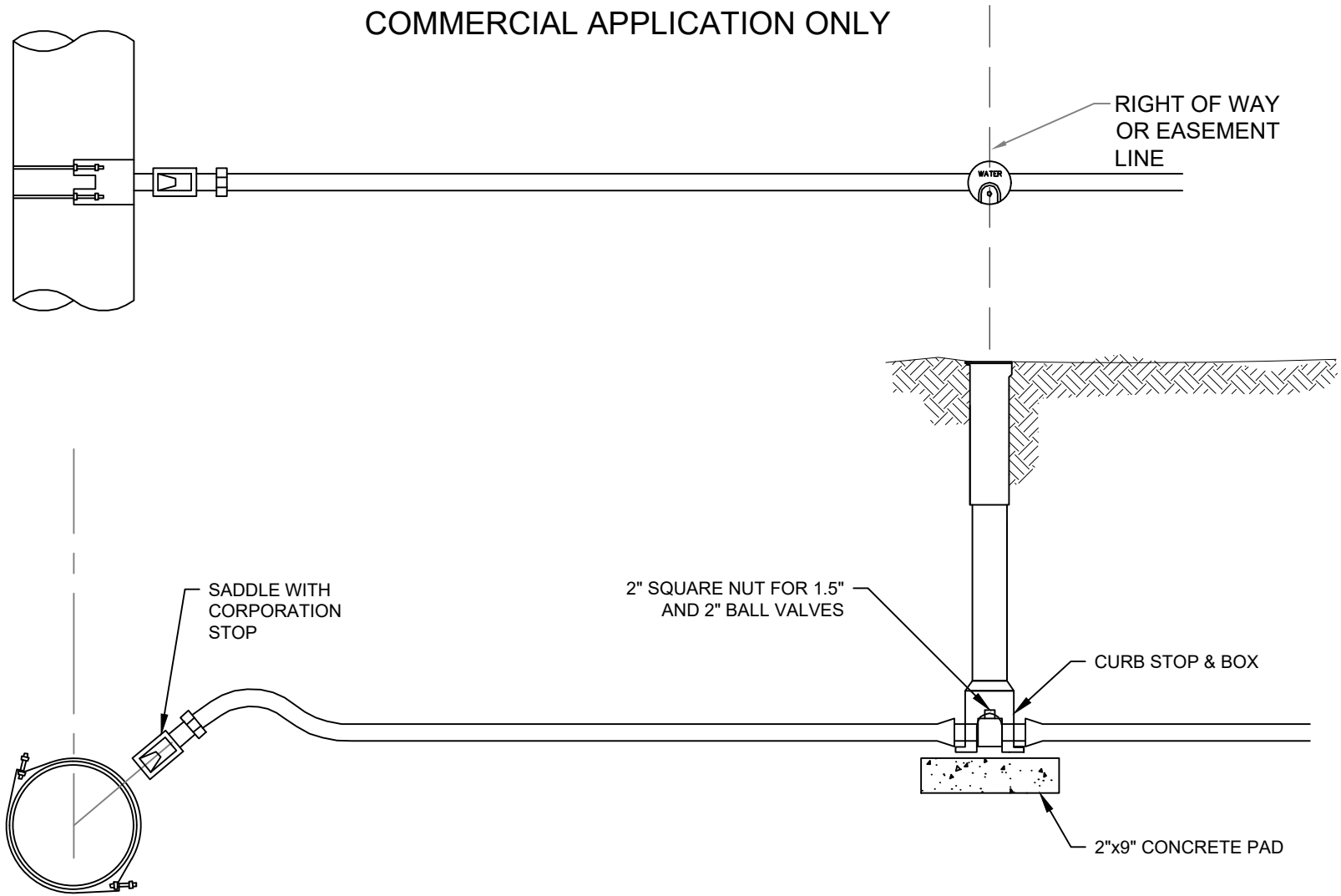


NOTES:

1. A "V" SHALL BE CUT IN THE FACE OF THE CURB AND GUTTER BY THE BUILDER TO PERMANENTLY MARK THE LOCATION OF THE CURB STOP BOX.
2. ALL WATER SERVICE LINES SHALL BE PLACED AS SHOWN ON WS-2.
3. THE HOMEOWNER IS RESPONSIBLE FOR THE MAINTENANCE OF THE WATER SERVICE LATERAL FROM THE METER ASSEMBLY INSIDE THE STRUCTURE TO THE CURB STOP, AND THE CAB IS RESPONSIBLE FOR THE WATER SERVICE FROM THE CURB STOP TO THE MAIN.
4. THE HOMEOWNER IS RESPONSIBLE FOR THE SEWER SERVICE LATERAL IN IT'S ENTIRETY (IN-HOME PLUMBING TO THE MAIN).
5. ALL TAPS MADE OF DUCTILE IRON SHALL HAVE AN INSULATOR.

NOVEMBER 2025	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	WS-4
RESIDENTIAL - WATER SERVICE INSTALLATION WITH CURB STOP VALVE		

COMMERCIAL APPLICATION ONLY



NOTES:

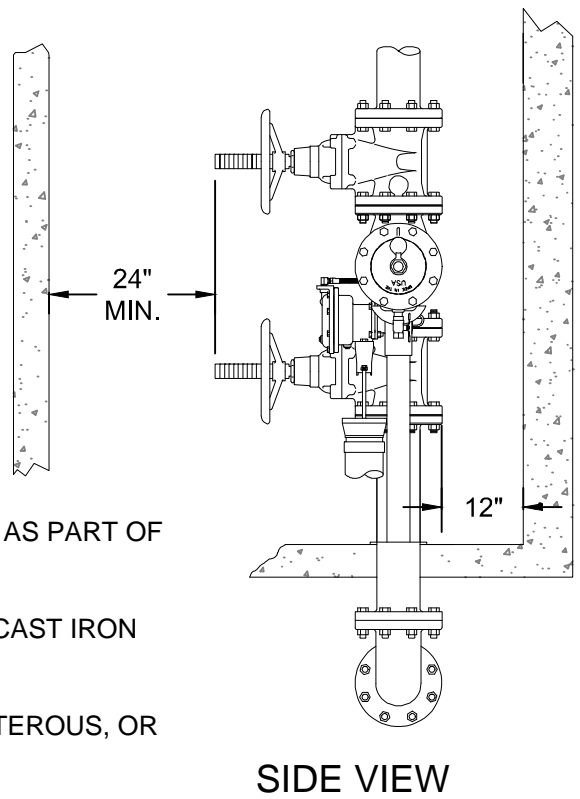
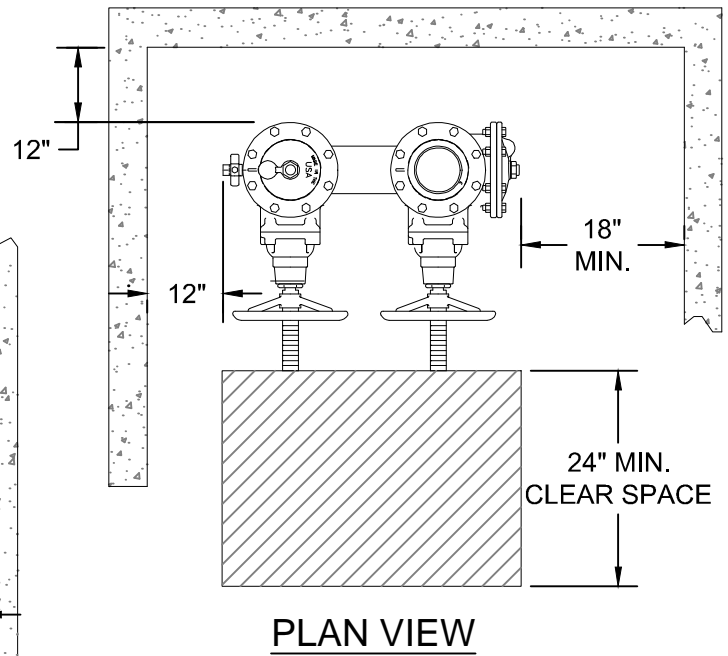
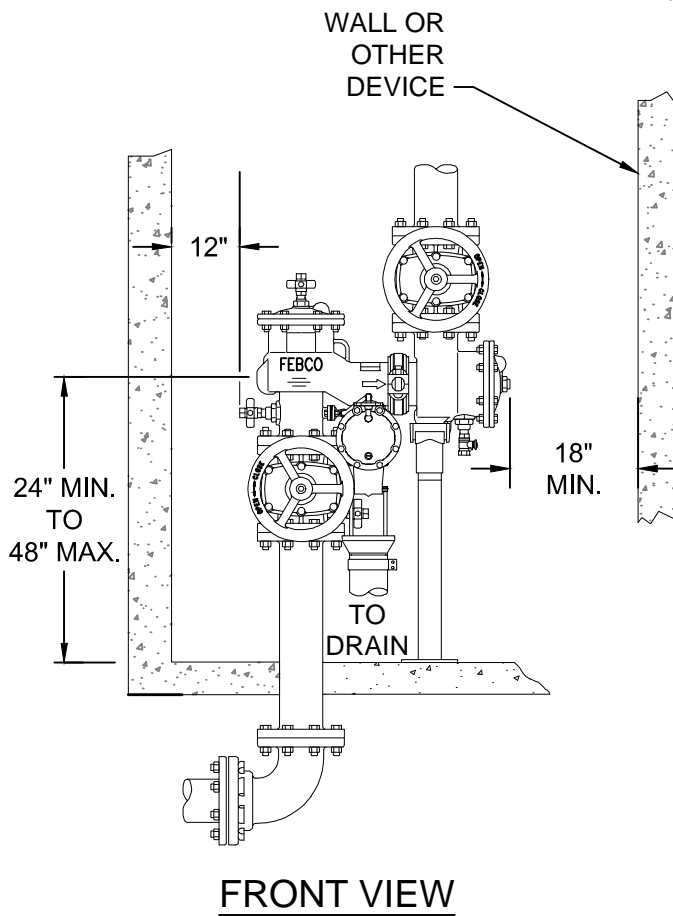
- 1. SADDLE AND SERVICE SHALL BE WRAPPED WITH POLYWRAP AND TAPE CLOSED FOR A LENGTH OF 3 FEET PAST TAP LOCATION.
- 2. ALL TAPS MADE OF DUCTILE IRON SHALL HAVE AN INSULATOR.

NOVEMBER 2025

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

COMMERCIAL - CORPORATION TAP & SERVICE LINE
DETAIL

WS-6



NOTES:

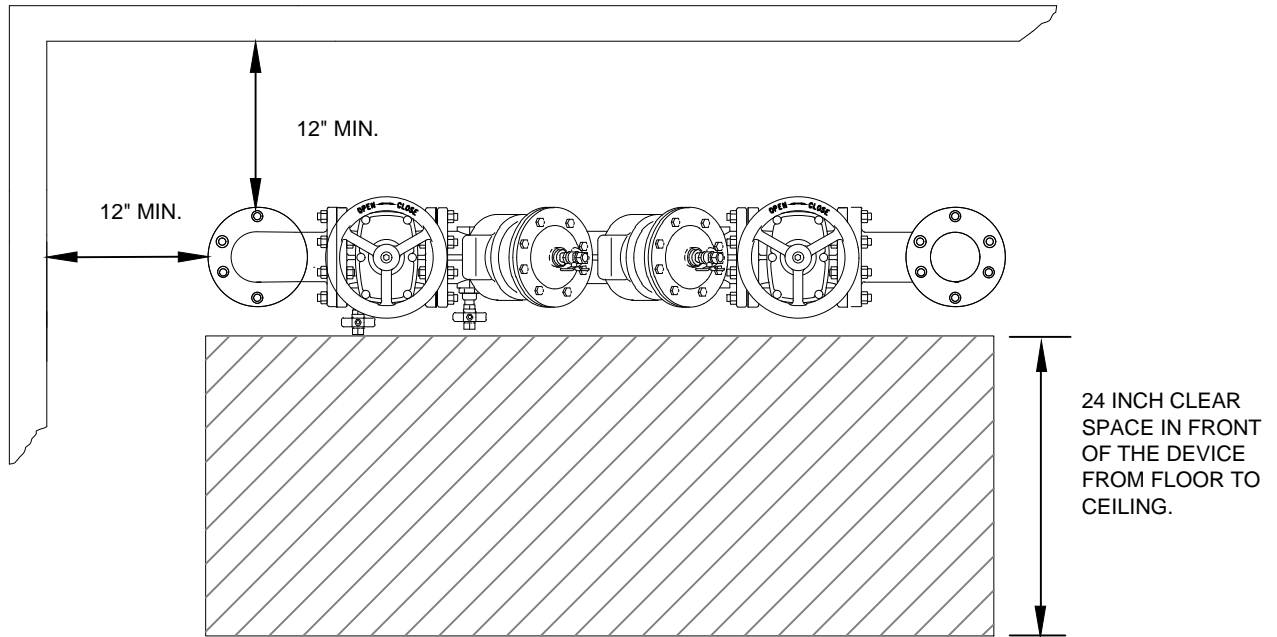
1. NO GALVANIZED PIPES OR FITTINGS ARE ALLOWED AS PART OF THE ASSEMBLY.
2. ALL VALVES SHALL BE RESILIENT EPOXY COATED, CAST IRON BODY, WITH A NON-RISING STEM.
3. GATE VALVES SHALL BE MUELLER, CLOW, AFC, WATEROUS, OR US PIPE METRO SEAL.

FEBRUARY 2020

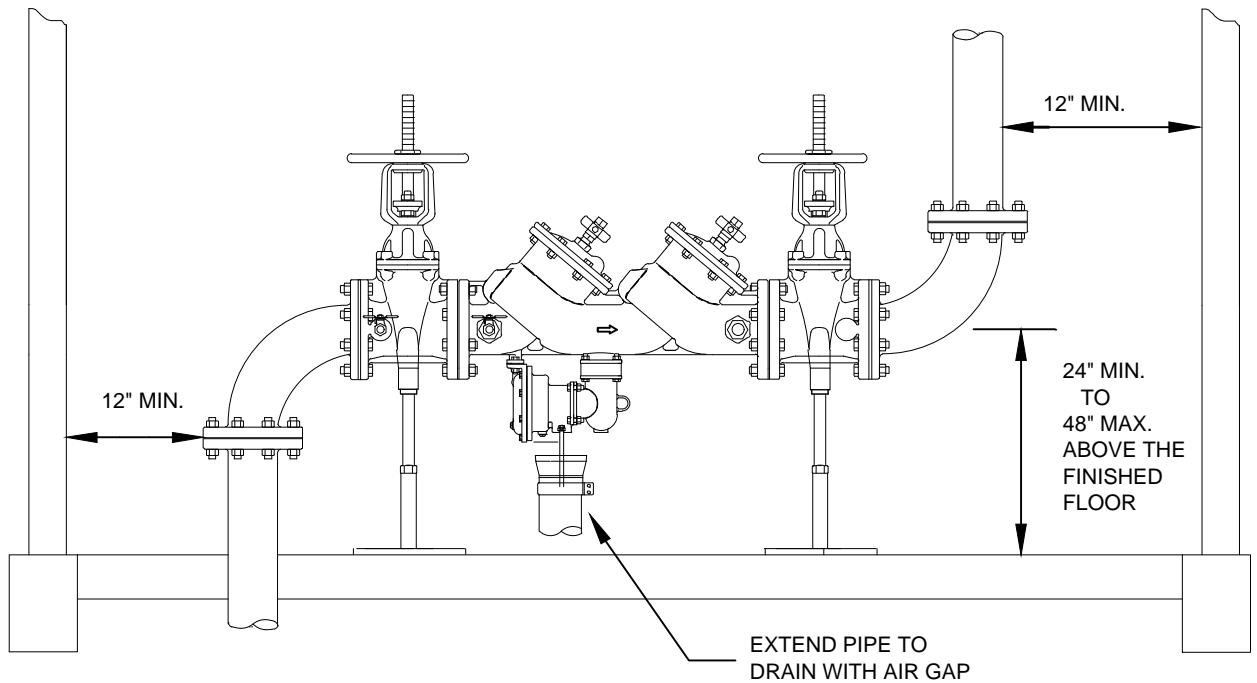
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

**BACKFLOW ASSEMBLY FOR 2 1/2" AND
LARGER SERVICE - VERTICAL SETTING**

WS-18



PLAN VIEW



ELEVATION VIEW

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

BACKFLOW ASSEMBLY FOR 2 1/2" AND
LARGER SERVICE - HORIZONTAL SETTING

WS-19

**WATER MAIN & TAP SIZE COMBINATIONS WHICH REQUIRE A
CONCRETE KICKBLOCK BEHIND THE MAIN AT THE TAPPING
SLEEVE, SADDLE, OR TEE.**

MAIN SIZE (IN)

	4	6	8	10	12	14	16	18	20	24
TAP SIZE (IN)	4	6	8	10	12	14	16	18	20	24
4	X	X	X	X	X	X				
6		X	X	X	X	X	X	X		
8			X	X	X	X	X	X	X	X
10				X	X	X	X	X	X	X
12					X	X	X	X	X	X
14						X	X	X	X	X
16							X	X	X	X

KICKBLOCK REQUIREMENTS FOR WATER MAIN & TAP SIZE COMBINATIONS OTHER THAN
THOSE SHOWN WILL REQUIRE SPECIAL DESIGN APPROVAL BY DISTRICT.

NOTE:
SEE STANDARD DETAIL WM-3 FOR THRUST BLOCK SIZING REQUIREMENTS

LEGEND:



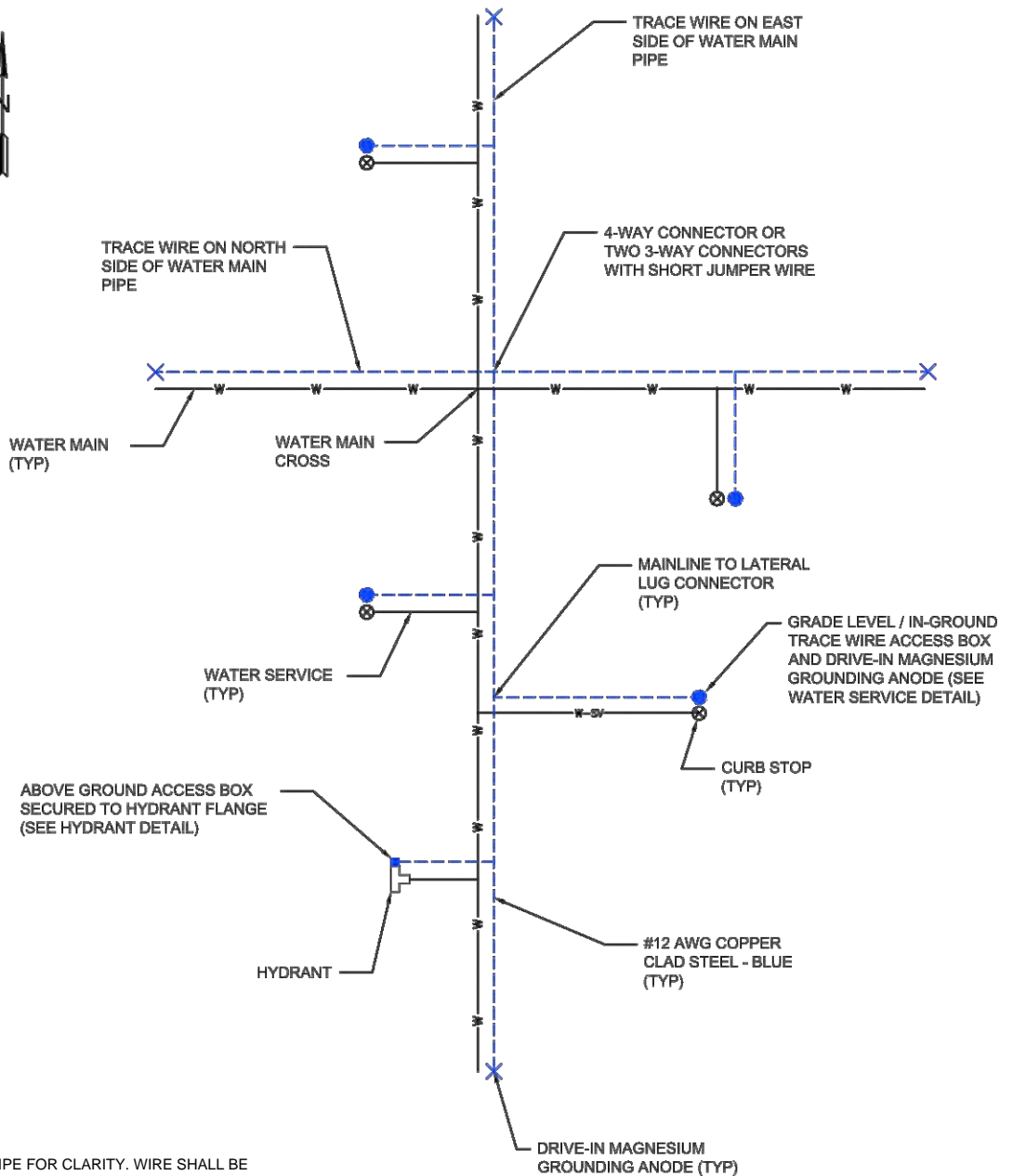
INDICATES CONCRETE KICKBLOCK IS REQUIRED.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

THRUST BLOCKS FOR SERVICE TAPS

WS-20



NOTES:

1. WIRE SHOWN AWAY FROM PIPE FOR CLARITY. WIRE SHALL BE INSTALLED ON THE TOP SIDE OF THE PIPE. THE WIRE SHALL BE FASTENED TO THE PIPE WITH TAPE OR PLASTIC TIES AT 5' INTERVALS
2. ALL TRACER WIRE TERMINATION POINTS SHALL BE PLACED IN AN ACCESS BOX AT A MINIMUM OF 2' INSIDE THE LOT.
3. FOR LONG RUNS, IN EXCESS OF 500 LINEAR FEET WITHOUT SERVICE LATERALS OR HYDRANTS, TRACER WIRE ACCESS MUST BE PROVIDED UTILIZING AN APPROVED GRADE LEVEL/IN-GROUND TRACE WIRE ACCESS BOX, LOCATED AT THE EDGE OF THE ROAD R.O.W., AND OUT OF THE ROADWAY. THE GRADE/LEVEL IN-GROUND TRACER WIRE ACCESS BOX SHALL BE DELINEATED USING A MINIMUM 48" POLYETHYLENE MARKER POST, COLOR CODED PER APWA STANDARD FOR THE SPECIFIC UTILITY BEING MARKED. IF MARKERS INSTALLED WITHIN THE R.O.W. IMPACT A TRAFFIC CONTROL ITEM, THEY WILL BE RELOCATED, WITH THE RESPONSIBILITY OF SUCH FALLING ON DOMINION WATER & SAN. DISTRICT

TRACE WIRE PLAN (WATER)

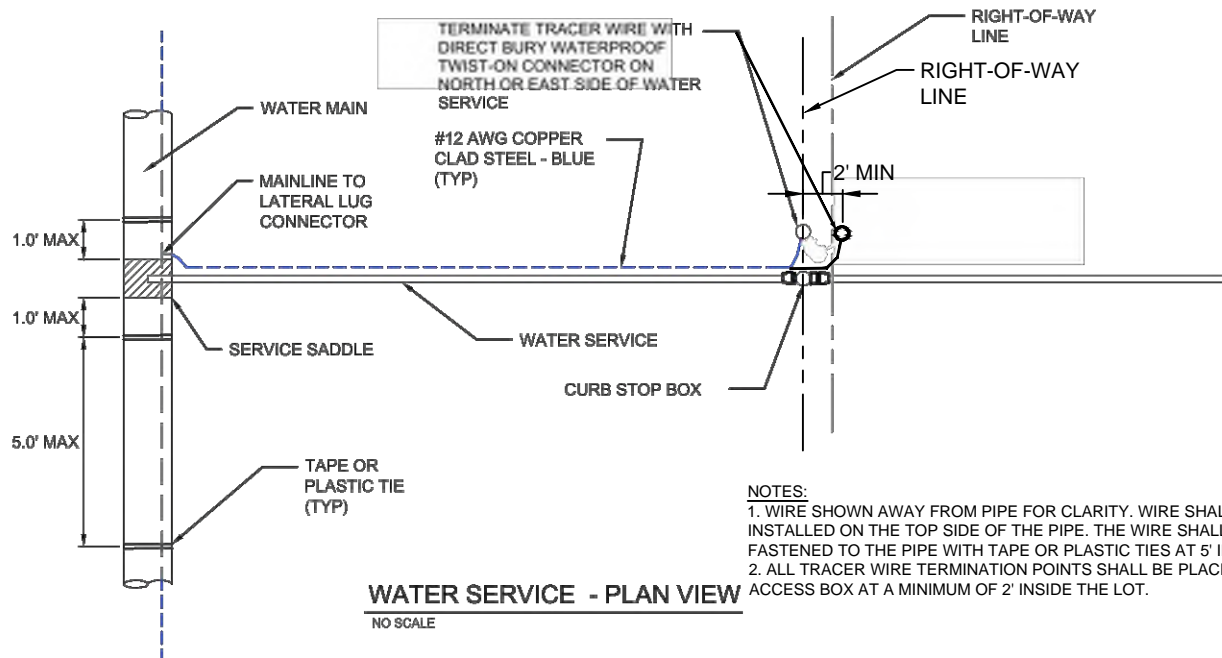
NO SCALE

FEBRUARY 2020

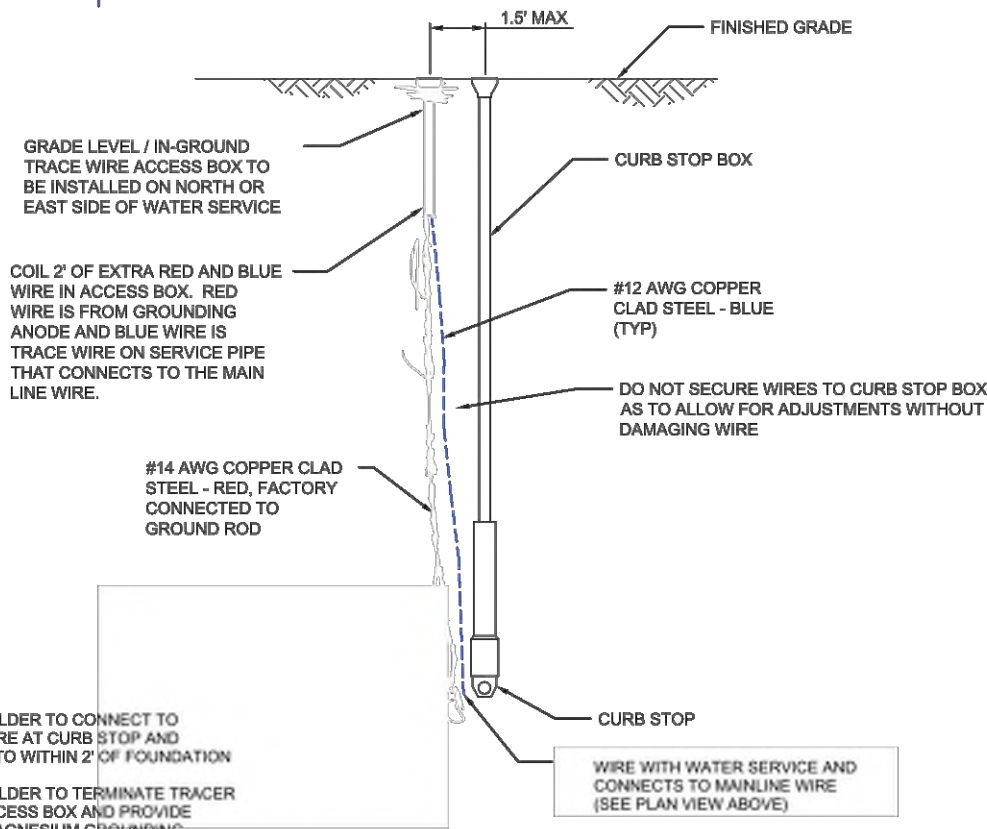
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

**TRACER WIRE
SAMPLE WATER PLAN DETAIL**

TR-1



NOTES:
 1. WIRE SHOWN AWAY FROM PIPE FOR CLARITY. WIRE SHALL BE INSTALLED ON THE TOP SIDE OF THE PIPE. THE WIRE SHALL BE FASTENED TO THE PIPE WITH TAPE OR PLASTIC TIES AT 5' INTERVALS
 2. ALL TRACER WIRE TERMINATION POINTS SHALL BE PLACED IN AN ACCESS BOX AT A MINIMUM OF 2' INSIDE THE LOT.



NOTES:

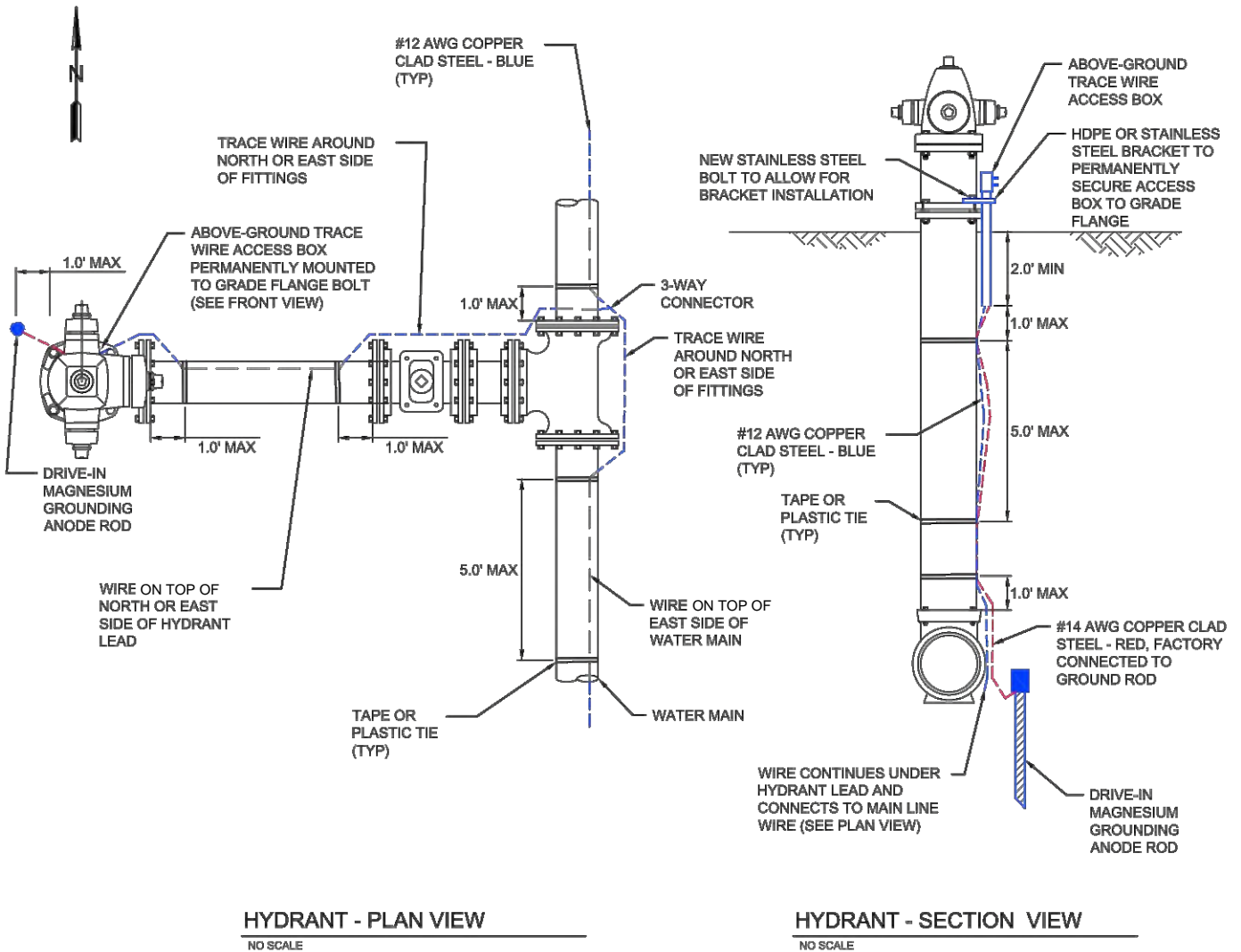
1. HOMEBUILDER TO CONNECT TO TRACER WIRE AT CURB STOP AND CONTINUE TO WITHIN 2' OF FOUNDATION
2. HOMEBUILDER TO TERMINATE TRACER WIRE IN ACCESS BOX AND PROVIDE DRIVE-IN MAGNESIUM GROUNDING ANODE ROD.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

**TRACER WIRE
SAMPLE WATER DETAIL**

TR-2



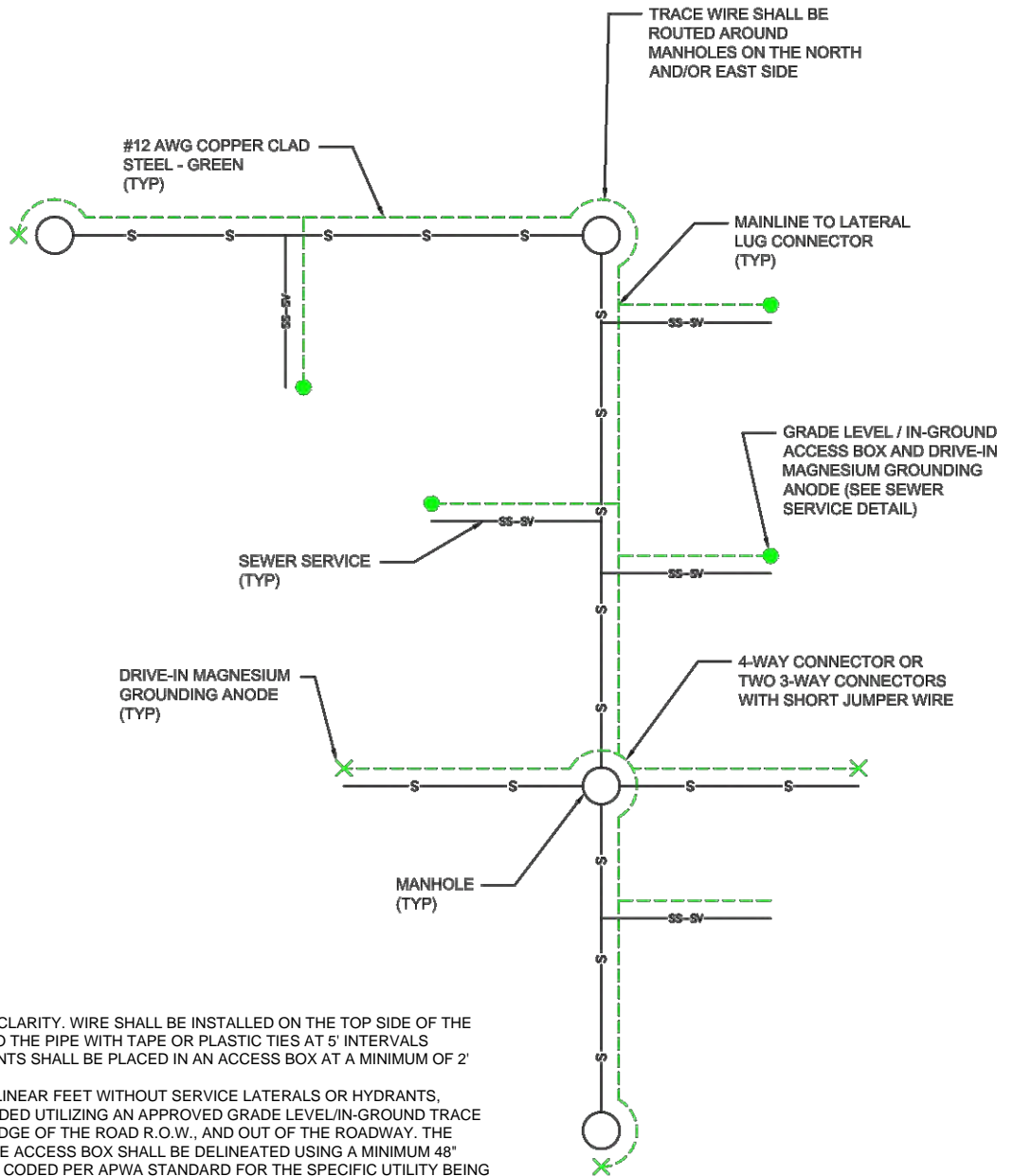
NOTES:
1. ALL TRACER WIRE TERMINATION POINTS SHALL BE PLACED IN AN ACCESS BOX AT A MINIMUM OF 2' INSIDE THE LOT.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

TRACER WIRE
HYDRANT DETAIL

TR-3



NOTES:

1. WIRE SHOWN AWAY FROM PIPE FOR CLARITY. WIRE SHALL BE INSTALLED ON THE TOP SIDE OF THE PIPE. THE WIRE SHALL BE FASTENED TO THE PIPE WITH TAPE OR PLASTIC TIES AT 5' INTERVALS
2. ALL TRACER WIRE TERMINATION POINTS SHALL BE PLACED IN AN ACCESS BOX AT A MINIMUM OF 2' INSIDE THE LOT.
3. FOR LONG RUNS, IN EXCESS OF 500 LINEAR FEET WITHOUT SERVICE LATERALS OR HYDRANTS, TRACER WIRE ACCESS MUST BE PROVIDED UTILIZING AN APPROVED GRADE LEVEL/IN-GROUND TRACE WIRE ACCESS BOX, LOCATED AT THE EDGE OF THE ROAD R.O.W., AND OUT OF THE ROADWAY. THE GRADE/LEVEL IN-GROUND TRACER WIRE ACCESS BOX SHALL BE DELINEATED USING A MINIMUM 48" POLYETHYLENE MARKER POST, COLOR CODED PER APWA STANDARD FOR THE SPECIFIC UTILITY BEING MARKED. IF MARKERS INSTALLED WITHIN THE R.O.W. IMPACT A TRAFFIC CONTROL ITEM, THEY WILL BE RELOCATED, WITH THE RESPONSIBILITY OF SUCH FALLING ON DOMINION WATER & SAN. DISTRICT

TRACE WIRE PLAN (SEWER)

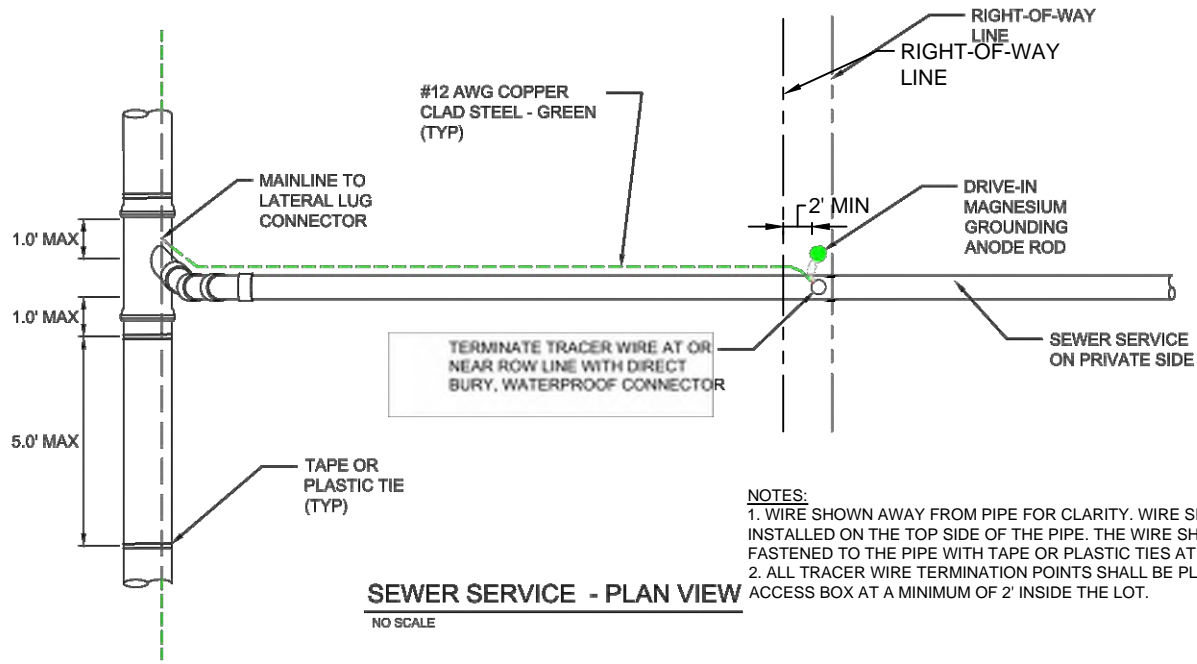
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FEBRUARY 2020

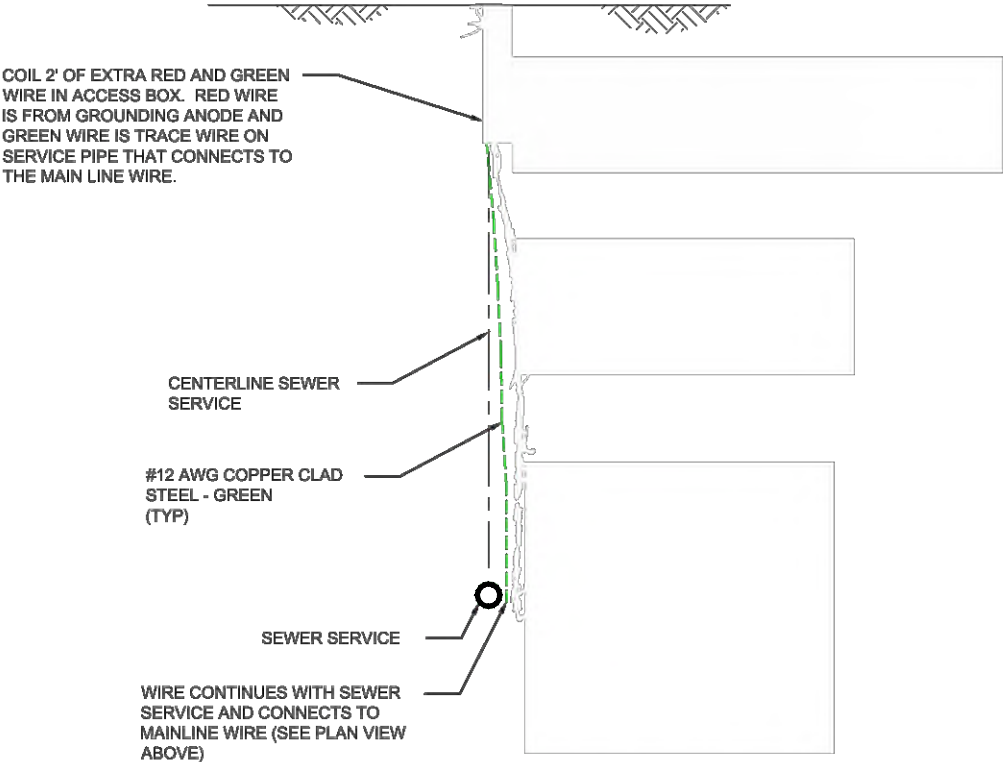
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

TRACER WIRE
SAMPLE SEWER PLAN DETAIL

TR-4



- NOTES:**
1. WIRE SHOWN AWAY FROM PIPE FOR CLARITY. WIRE SHALL BE INSTALLED ON THE TOP SIDE OF THE PIPE. THE WIRE SHALL BE FASTENED TO THE PIPE WITH TAPE OR PLASTIC TIES AT 5' INTERVALS
 2. ALL TRACER WIRE TERMINATION POINTS SHALL BE PLACED IN AN ACCESS BOX AT A MINIMUM OF 2' INSIDE THE LOT.

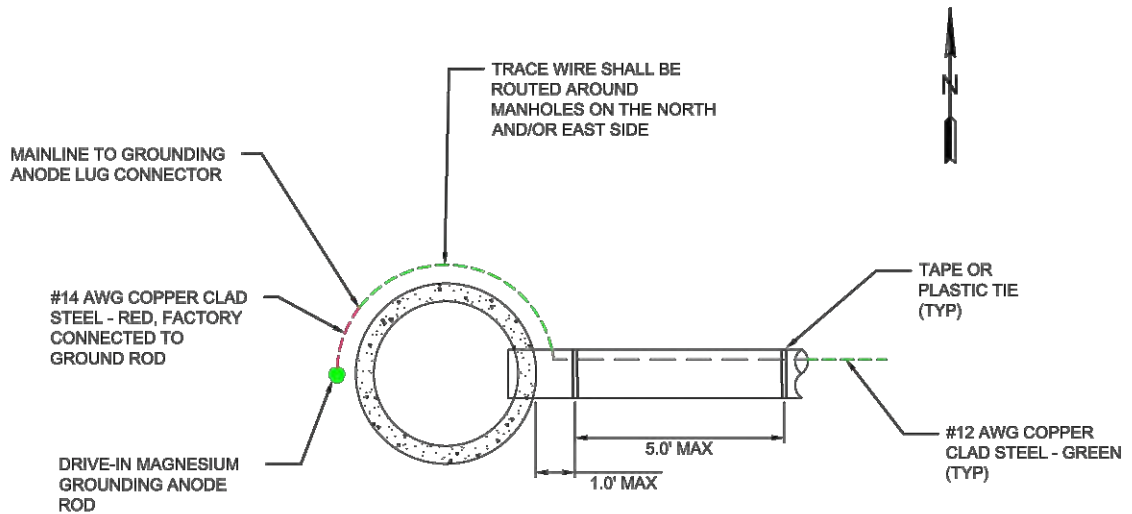


FEBRUARY 2020

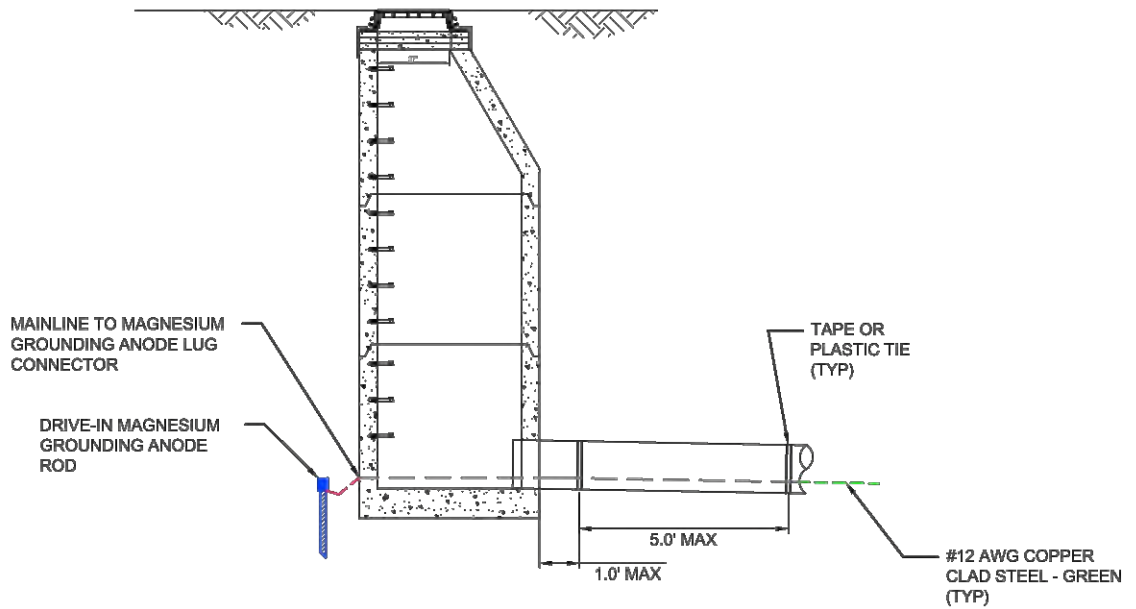
DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

**TRACER WIRE
SEWER SERVICE DETAIL**

TR-5



SEWER MANHOLE - PLAN VIEW
NO SCALE



SEWER MANHOLE - SECTION VIEW
NO SCALE

NOTES:
1. ALL TRACER WIRE TERMINATION POINTS SHALL BE PLACED IN AN ACCESS BOX AT A MINIMUM OF 2' INSIDE THE LOT.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

TRACER WIRE
SEWER MANHOLE DETAIL

TR-6

Sanitary/Private Storm/Water Utility – Tracer Wire Specification

Materials

General

All tracer wire and tracer wire products shall be domestically manufactured in the U.S.A.

All tracer wire shall have HDPE insulation intended for direct bury, color coated per APWA standard for the specific utility being marked.

Tracer wire

- **Open Trench** – Tracer wire shall be #12 AWG Copper Clad Steel, High Strength with minimum 450 lb. break load, with minimum 30 mil HDPE insulation thickness.
- **Directional Drilling/Boring** – Tracer wire shall be #12 AWG Copper Clad Steel, Extra High Strength with minimum 1,150 lb. break load, with minimum 30 mil HDPE insulation thickness.
- **Tracer wire – Pipe Bursting/Slip Lining** – Tracer wire shall be 7 x7 Stranded Copper Clad Steel, Extreme Strength with 4,700 lb. break load, with minimum 50 ml HDPE insulation thickness.

Connectors

- All mainline tracer wires must be interconnected in intersections, at mainline tees and mainline crosses. At tees, the three wires shall be joined using a single 3-way lockable connector. At Crosses, the four wires shall be joined using a 4-way connector. Use of two 3-way connectors with a short jumper wire between them is an acceptable alternative.
- **Direct bury wire connectors** – shall include 3-way lockable connectors and mainline to lateral lug connectors specifically manufactured for use in underground tracer wire installation. Connectors shall be dielectric silicon filled to seal out moisture and corrosion and shall be installed in a manner so as to prevent any uninsulated wire exposure.
- Non locking friction fit, twist on or taped connectors are prohibited.

Termination/Access

- All tracer wire termination points must utilize an approved tracer wire access box (above ground access box or grade level/in-ground access box as applicable), specifically manufactured for this purpose.
- All grade level/in-ground access boxes shall be appropriately identified with "sewer" or "water" cast into the cap and be color coded.
- A minimum of 2 ft. of excess/slack wire is required in all tracer wire access boxes after meeting final elevation.
- All tracer wire access boxes must include a manually interruptible conductive/connective link between the terminal(s) for the tracer wire connection and the terminal for the grounding anode wire connection.
- Ground anode wire shall be connected to the identified (or bottom) terminal on all access boxes.

FEBRUARY 2020	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	
	TRACER WIRE NOTES (1 OF 5)	TR-7

Sanitary/Private Storm/Water Utility – Tracer Wire Specification

- **Service Laterals on public property** – Tracer wire must terminate at an approved in-ground tracer wire direct bury connector, located at the edge of the right-of-way, and out of the roadway.
- **Service Laterals on private property** – Tracer wire must terminate at an approved above-ground tracer wire access box, affixed to the building exterior directly above where the utility enters the building, at an elevation not greater than 5 vertical feet above finished grade, or terminate at an approved grade level/in-ground tracer wire access box, located within 2 linear feet of the building being served by the utility.
- **Hydrants** – Tracer wire must terminate at an approved above-ground tracer wire access box, properly affixed to the hydrant grade flange. (affixing with tape or plastic ties shall not be acceptable)
- **Long-runs, excess of 500 linear feet without service laterals or hydrants** – Tracer wire access must be provided utilizing an approved grade level/in-ground tracer wire access box, located at the edge of the road right-of-way, and out of the roadway. The grade level/in-ground tracer wire access box shall be delineated using a minimum 48" polyethylene marker post, color coded per APWA standard for the specific utility being marked.

Grounding

- Tracer wire must be properly grounded at all dead ends/stubs
- Grounding of tracer wire shall be achieved by use of a drive-in magnesium anode rod with a minimum of 20ft of #12 red HDPE insulated copper clad steel wire connected to anode (minimum 1.5 lb.) specifically manufactured for this purpose, and buried at the same elevation as the utility.
- When grounding the tracer wire in areas where the tracer wire is continuous and neither the mainline tracer wire or the grounding anode wire will be terminated at/above grade, install grounding anode directly beneath and in-line with the tracer wire. Do not coil excess wire from grounding anode. In this installation method, the grounding anode wire shall be trimmed to an appropriate length before connecting to tracer wire with a mainline to lateral lug connector.
- Where the anode wire will be connected to a tracer wire access box, a minimum of 2 ft. of excess/slack wire is required after meeting final elevation.

Installation

General

- Tracer wire installation shall be performed in such a manner that allows proper access for connection of line tracing equipment, proper locating of wire without loss or deterioration of low frequency (512Hz) signal for distances in excess of 1,000 linear feet, and without distortion of signal caused by multiple wires being installed in close proximity to one another.
- Tracer wire systems must be installed as a single continuous wire, except where using approved connectors. No looping or coiling of wire is allowed.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

TRACER WIRE
NOTES (2 OF 5)

TR-8

Sanitary/Private Storm/Water Utility – Tracer Wire Specification

- Any damage occurring during installation of the tracer wire must be immediately repaired by removing the damaged wire, and installing a new section of wire with approved connectors. Taping and/or spray coating shall not be allowed.
- Tracer wire shall be installed at the bottom half of the pipe and secured (taped/tied) at 5' intervals.
- Tracer wire must be properly grounded as specified.
- Tracer wire on all service laterals/stubs must terminate at an approved tracer wire direct bury waterproof connector located directly above the utility, at the edge of the road right-of-way, but out of the roadway. (See Tracer wire Termination/Access)
- At all mainline dead-ends, tracer wire shall go to ground using an approved connection to a drive-in magnesium grounding anode rod, buried at the same depth as the tracer wire. (See Grounding)
- Mainline trace wire shall not be connected to existing conductive pipes. Treat as a mainline dead-end, ground using an approved waterproof connection to a grounding anode buried at the same depth as the tracer wire.
- All service lateral tracer wires shall be a single wire, connected to the mainline tracer wire using a mainline to lateral lug connector, installed without cutting/splicing the mainline trace wire.
- In occurrences where an existing tracer wire is encountered on an existing utility that is being extended or tied into, the new tracer wire and existing tracer wire shall be connected using approved splice connectors, and shall be properly grounded at the splice location as specified.

Sanitary Sewer System

- A mainline tracer wire must be installed, with all service lateral tracer wires properly connected to the mainline tracer wire, to ensure full tracing/locating capabilities from a single connection point.
- Lay mainline tracer wire continuously, by-passing around the outside of manholes/structures on the North or East side.
- Tracer wire on all sanitary service lateral must terminate at an approved tracer wire access box color coded green and located directly above the service lateral at the edge of road right of way.

Water System

- A mainline tracer wire must be installed, with all service lateral tracer wires properly connected to the mainline tracer wire, to ensure full tracing/locating capabilities from a single connection point.
- Lay mainline tracer wire continuously, by-passing around the outside of valves and fittings on the North or East side.
- Tracer wire on all water service laterals must terminate at an approved tracer wire access box color coded blue and located directly above the service lateral at the edge of road right of way.
- Above-ground tracer wire access boxes will be installed on all fire hydrants.
- All conductive and non-conductive service lines shall include tracer wire.

FEBRUARY 2020

DOMINION WATER AND SANITATION DISTRICT
DOUGLAS COUNTY, COLORADO

TRACER WIRE
NOTES (3 OF 5)

TR-9

Sanitary/Private Storm/Water Utility – Tracer Wire Specification

Storm Sewer System

- If the storm sewer system includes service laterals for connection of private drains and tile lines, it shall be specified the same as a sanitary sewer application.
- Lay mainline tracer wire continuously, by-passing around the outside of manholes/structure on the North or East side

Prohibited Products and Methods

The following products and methods shall not be allowed or acceptable

- Uninsulated tracer wire
- Tracer wire insulations other than HDPE
- Tracer wires not domestically manufactured
- Non locking, friction fit, twist on or taped connectors
- Brass or copper ground rods
- Wire connections utilizing taping or spray-on waterproofing
- Looped wire or continuous wire installations, that has multiple wires laid side-by-side or in close proximity to one another
- Tracer wire wrapped around the corresponding utility
- Brass fittings with tracer wire connection lugs
- Connecting tracer wire to existing conductive utilities

Testing

All new tracer wire installations shall be located using typical low frequency (512Hz) line tracing equipment, witnessed by the contractor, engineer and facility owner as applicable, prior to acceptance of ownership.

This verification shall be performed upon completion of rough grading and again prior to final acceptance of the project.

Continuity testing in lieu of actual line tracing shall not be accepted.

FEBRUARY 2020	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	
	TRACER WIRE NOTES (4 OF 5)	TR-10

Sanitary/Private Storm/Water Utility – Tracer Wire Specification

Products

The following products have been deemed acceptable and appropriate. These products are a guide only to help you choose the correct applications for your tracer wire project.

- **Copper clad Steel (CCS) tracer wire**
 - Open Trench – Copperhead #12 High Strength part # 1230* - HS**
 - Directional Drilling/Boring – Copperhead Extra High Strength part #1245*-EHS**
 - Pipe Bursting/Slip Lining – Copperhead SoloShot Extreme Strength 7 x 7 Stranded part # PBX-50*-**
 - * Denotes color: B=Blue, G=Green, P=Purple
 - ** Denotes spool size. 500' 1000' 2500'
- **Connectors**
 - Copperhead 3-way locking connector part # LSC1230*
 - DryConn 3- way Direct Bury Lug: Copperhead Part # 3WB-01
- **Termination/Access**
 - Non-Roadway access boxes applications: Tracer wire access boxes Grade level Copperhead adjustable lite duty Part # LD14*TP or Direct Bury Waterproof Connector
 - Concrete / Driveway access box applications: Tracer wire access boxes Grade level Copperhead Part # CD14*TP 14"
 - Fire hydrant tracer wire access box applications: Above ground two terminal Cobra Test Station, denoting "F" includes hydrant mounting flange. Copperhead part # T2*-FLPKG-5/8 to fit hydrants with 5/8" bolts and T2*-FLPKG-3/4 to fit hydrants with 3/4" bolts.
- **Grounding**
 - Drive in Magnesium Anode: Copperhead Part # ANO-12 (1.5 lb)

Manufacture product options:

The information provided by Copperhead Industries gives you product options to help you choose the correct wire – termination/access points – connectors and grounding products. Other manufactures provide these products; this information is only a guide.

FEBRUARY 2020	DOMINION WATER AND SANITATION DISTRICT DOUGLAS COUNTY, COLORADO	
	TRACER WIRE NOTES (5 OF 5)	TR-11